AN INVENTORY OF GEOGRAPHIC RESEARCH OF THE HUMID TROPIC ENVIRONMENT

VOLUME II

COMPENDIUM AND APPENDICES

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PREFACE

Contract DA 49-092-ARO-33 was awarded to the Science Services division of Texas Instruments Incorporated on 6 February 1964. The award was based on evaluation of a proposal submitted by Texas Instruments in response to RFP No. ARO-RFQ-4 issued by the Army Research Office on 1 October 1963. The basic objectives of the program include collection and evaluation of a bibliography, identification of authorities and depositories, an inventory of maps and aerial photographs, an assessment of the state of knowledge, and the identification of research gaps and remedial recommendations to fill identified gaps in knowledge of the humid tropic environment.

The contract provided for a multidisciplinary effort extending over a 35-month period. Approximately 130 man-months of effort were involved in fulfilling the objectives of the study. Administrative and managerial functions were performed by Harvey Vogel, with technical responsibility for the program assigned to Harvey Vogel and Jack R. Van Lopik. The program was conducted on a task-force basis, and various individuals were assigned responsibility for specific areas. The volume and chapter headings of the program's reports provide a convenient outline for indicating contributions of Texas Instruments program personnel.

Volume I — KWIC INDEX — HUMID TROPIC ENVIRONMENTAL LITERATURE	H. Vogel D.J. Selis B.A. Tessler*
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Chapter I — Introduction	F. Betz H. Vogel
Chapter II — Physical Features	F. Betz
Chapter III — Plant and Animal Life	H. Vogel M.R. Wilson J.E. Estes
Chapter IV — Weather and Climate	H. Vogel M.R. Wilson J.E. Estes

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Chapter V — Coastal Zones	F. Betz
Chapter VI — Regional Studies	H. Vogel M. R. Wilson
Appendix A — Directory of Authorities	H. Vogel
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Appendix C — Index of Maps and Aerial Photographs	H. Vogel D. J. Selis S. A. Terry

Consulting services and manuscript review were provided to the program by the following scientists. Their affiliations and areas of specialization and program review tasks are indicated.

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C. F. Bennett Jr.	University of California, Los Angeles	Animal Life, Physical Features, Weather and Climate, Regional Studies, Central America
R. N. Colwell	University of California	Plant Life, Maps and Aerial Photographs
P. Dansereau	New York Botanical Garden	Plant Life
R. W. Fairbridge	Columbia University	Physical Features, Coastal Zones
B. J. Garnier	McGill University	Physical Features, Weather and Climate, Regional Studies, Africa
P. Gourou	Université de Bruxelles	Physical Features, Coastal Zones, Regional Studies, South Asia

B. Maguire	New York Botanical Garden	Plant Life
P. W. Richards	University of North Wales	Plant Life
R. W. Richardson	San Diego State College,	Regional Studies, Latin America
R. J. Russell	Louisiana State University	Coastal Zones
J. T. Stark	Jackson, Tennessee	Physical Features
H. O'R. Sternberg	University of California	Physical Features, Regional Studies, Latin America
J. Thorp	Richmond, Indiana	Physical Features
J. D. Weaver	University of Puerto Rico, Mayaguez	Physical Features

Technical editing of this report was performed by M.R. Wilson, and B. Littlejohn. Various technical drafting tasks were performed by D.A. Rutledge, N.A. Douglas and D.L. Ramsey.

The study was conducted under the cognizance of the Army Research Office, Arlington, Virginia, and the Army Natick Laboratories, Natick, Massachusetts. G.N. Parmenter (ARO), L. Alpert (ARO) and I.V. Bennett (Natick) periodically reviewed program progress and provided technical direction. W.M. Dallas (TI), R. Fink (ARO) and E.J. Corbett (Natick) were contract officers for the program.

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CHAPTER I

INTRODUCTION

A. DEFINITION OF PROJECT

1. Scope

The Army Research Office defines this project as an inventory of geographic research and evaluation of the state of knowledge of the humid-tropical environment.

2. Purpose

The project has two indicated purposes: (1) to provide the information needed for planning and management of future research programs and other efforts that are designed to improve United States Army capabilities in humid-tropical environments, and (2) to direct the attention of organizations performing or supporting research and individual scientists to the significant research problems and opportunities in the humid tropics.

3. Aims

The specific aims of the project are to provide (a) a comprehensive overview of the published literature on the environment of the humid tropics; (2) listings of the major individual authorities on humid-tropical problems, principal depositories of environmental information on the humid tropics and all institutions primarily engaged in research on the humid tropical environment; (3) identification of current environmental research activities concerning the humid tropics; (4) critical evaluation of the state of knowledge of different elements of the humid tropics; (5) identification of the significant gaps in knowledge; (6) identification of the major barriers to the advancement of knowledge; and (7) identification of the recommendations to promote the advancement of knowledge of the humid-tropical environment.

4. Product

The investigations to accomplish the aims of the project have resulted in five products presented in two volumes.

Volume 1 is the KWIC Index of Humid Tropic Environmental Literature. This volume contains a bibliography of 14,515 document. Approximately 10 percent of the titles are accompanied by abstracts. The indices list 58,830 keywords and 9170 authors.

Volume 2 contains the discussion of current research activities concerned with the natural environment of the humid tropics and the gaps in information on different topics, the evaluation of the state of knowledge and the recommendations for its further improvement. This volume also contains three appendices. The first lists and locates 1117

major authorities on the various elements of humid-tropical environments. The second lists and locates 333 depositories of materials dealing with the humid tropics. They include libraries, herbaria, zoological collections, and research institutes. The third is an inventory of the coverage and sources of aerial photographs and maps (topographic and planimetric, geologic, soils and land capability, vegetation, land use, ecology and forest inventory) of the humid tropics.

B. DEFINITION OF RESEARCH

In this Inventory, research stands for both basic and applied research. The National Science Foundation [1] defines basic research as "the search for and understanding of the laws of nature without regard to the ultimate applications of the results" and applied research as research "with practical objectives in mind."

P. Auger[2], in his recent survey of the main current trends in scientific research for UNESCO, observes that "At the present time, this classification into two categories has become somewhat inadequate and it may be useful to distinguish two intermediate dividing lines between pure science and pure technique, the first separating fundamental research into free research and oriented research and the second, separating applied research from development work."

"Free fundamental research or pure research," Auger notes, "is generally the work of an individual, or, at all events, there is one person who plays the leading part in the progress of the experiments, in the theoretical planning, in the determination of operations and standards." A century ago, the individual "pure" scientist was responsible for all aspects of scientific investigation. Progressively, the responsibility for systematic accumulation of data has shifted from the individual scientist to the oriented or applied research organization. The "free fundamental" researcher is concerned more today with specialized studies of the interrelationships of phenomena and conditions.

Following Auger, the present Inventory can be said to cover primarily "oriented fundamental research," which includes the systematic surveys of environmental features performed by scientific and technical agencies, and "applied research," which represents investigations channeled to defined objectives, such as the study of soil trafficability to determine the suitability of areas for vehicular movement.

C. DEFINITION OF HUMID TROPICS

For the purposes of this project, the Army Research Office specified that the boundaries of the humid tropics essentially would be those drawn by A.S. Küchler on his map prepared for UNESCO in 1959 and

published in the Geographical Review.[3] Küchler based his delimitation of the humid tropics "on the relative absence of paucity of xeromorphic features of the vegetation." However, he noted that "Xeromorphy increases gradually as the climate becomes more arid, and it is therefore not possible to draw a precise line of demarcation between what is humid and what is not humid." At the same time, B.J. Garnier delimited the humid tropics on the basis of climatic criteria for the Commission on the Humid Tropics of the International Geographical Union. F.R. Fosberg, chairman of the Advisory Committee on the UNESCO Humid Tropics Research Program, observed that "As will readily be seen by examination of the (two) maps, the basic patterns of the boundaries are different, even though, in general, the humid tropical areas are the same."

In the course of the program, various modifications of Küchler's definition of the humid tropics were made with the consent of the Army Research Office (see Figure 1 and Political Subdivision Key).

In South America, very small areas of Argentina that fall within Küchler's limits of the humid tropics were eliminated. A major change was the omission of the Ethiopian upland, which is a non-contiguous part of the humid tropics in Africa as defined by Küchler. It may be noted that this area is not considered a part of the humid tropics by Garnier. Since only small areas of Mali, Upper Volta, Somalia, Southwest Africa, and Bechuanaland are included in Küchler's delimitation, they were all excluded from consideration in this project.

Finally, the map by Küchler does not take into account the Pacific Islands northeast of Palau. From this region, the Army Research Office chose to include only the Hawaiian Islands in the areal scope of the project.

D. PRESENT INTEREST IN THE HUMID TROPICS

Long a region of colonies of European nations, the humid tropics have been in the process of acquiring political independence for more than a century. With the recent creation of numerous autonomous countries in Africa, Southern Asia and Oceania, the process has virtually reached its completion.

As a group the humid-tropical countries, both new and old, belong among the developing nations of the world. In the past, their natural and human resources have been neglected or used without regard to the stability and growth needed by independent countries.

The urgency of the demands from the humid-tropical countries for assistance has enlisted vast support from intergovernmental, governmental, and private organizations throughout the world. So far, the support has served mainly to indicate the obstacles that must be overcome before the development of these countries can proceed.

POLITICAL SUBDIVISION KEY

TO FIGURE 1, THE HUMID TROPICS

1 Barbados
2 Bolivia
3 Brazil
4 British Guiana
5 British Honduras
6 Colombia
7 Costa Rica
8 Cuba
9 Dominica Island
10 Dominican Republic
11 Ecuador
12 El Salvador
13 French Guiana
14 Guadeloupe Island
15 Guatemala
16 Haiti
17 Honduras
18 Jamaica
19 Margarita Island (Venezuela)
20 Martinique
21 Mexico
22 Nicaragua
23 Panama
24 Paraguay
25 Peru
26 Puerto Rico
27 St. Lucia Island
28 St. Vincent Island
29 Surinam
30 Trinidad and Tobago
31 Venezuela
32 West Indies

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33 Angola
35 Burundi
36 Cabinda (Angola)
37 Cameroon
38 Central African Republic
39 Chad
40 Comores Islands
41 Congo, French
42 Congo, Belgian
43 Dahomey
44 Fernando Pōo
45 Gabon.
46 Gambia
47 Ghana
48 Guinea
49 Ivory Coast
50 Kenya
51 Liberia
52 Madagascar
54 Mozambique
55 Nigeria
56 Northern Rhodesia
57 Nyasaland
58 Portuguese Guinea
59 Rio Muni
60 Rwanda
61 Senegal
62 Sierra Leone
63 (Southern) Rhodesia
65 Sudan (Anglo-Egyptian)
66 Tanganyika
67 Togo
68 Uganda
70 Zanzibar and Pemba Islands

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71 Andaman Islands
72 Burma
73 Cambodia
74 Ceylon
75 China (Communist)
76 China (Nationalist)
77 India
78 Laos
79 Malaysia
80 Nicobar Islands
81 Pakistan (East)
82 Thailand
83 Vietnam (North)
84 Vietnam (South)

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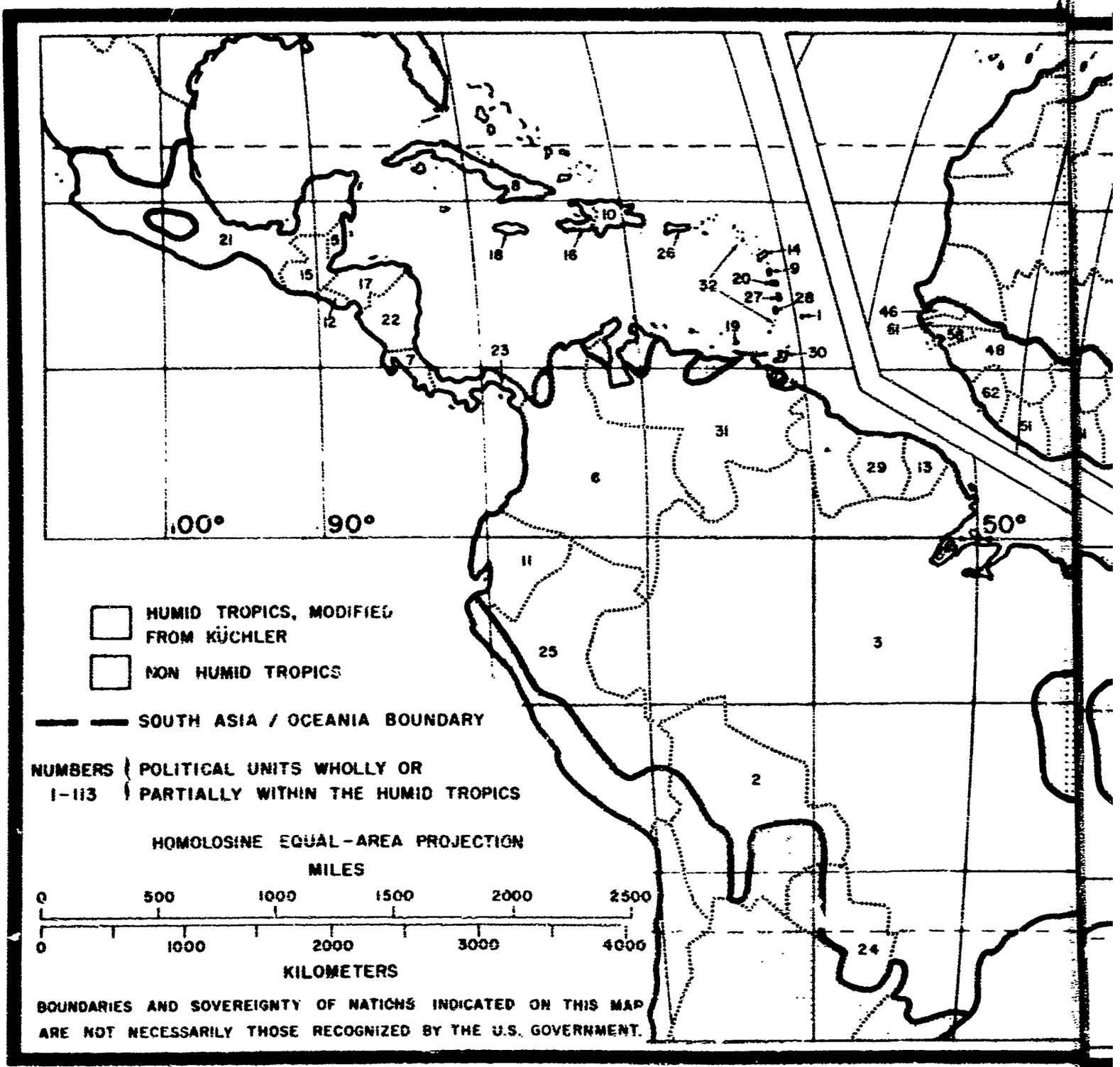
85 Australia
86 Borneo
87 Brunei
88 Fiji Islands
89 Indonesia
90 New Caledonia
91 New Guinea
92 New Hebrides
93 North Borneo
94 Palau Islands
95 Papua
96 Philippines
97 Ryukyu Islands
98 Sarawak
99 Solomon Islands
100 Timor
113 Hawaii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HUMID TROPICS, MODIFIED FROM KÜCHLER
NON HUMID TROPICS
SOUTH ASIA / OCEANIA BOUNDARY
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KILOMETERS
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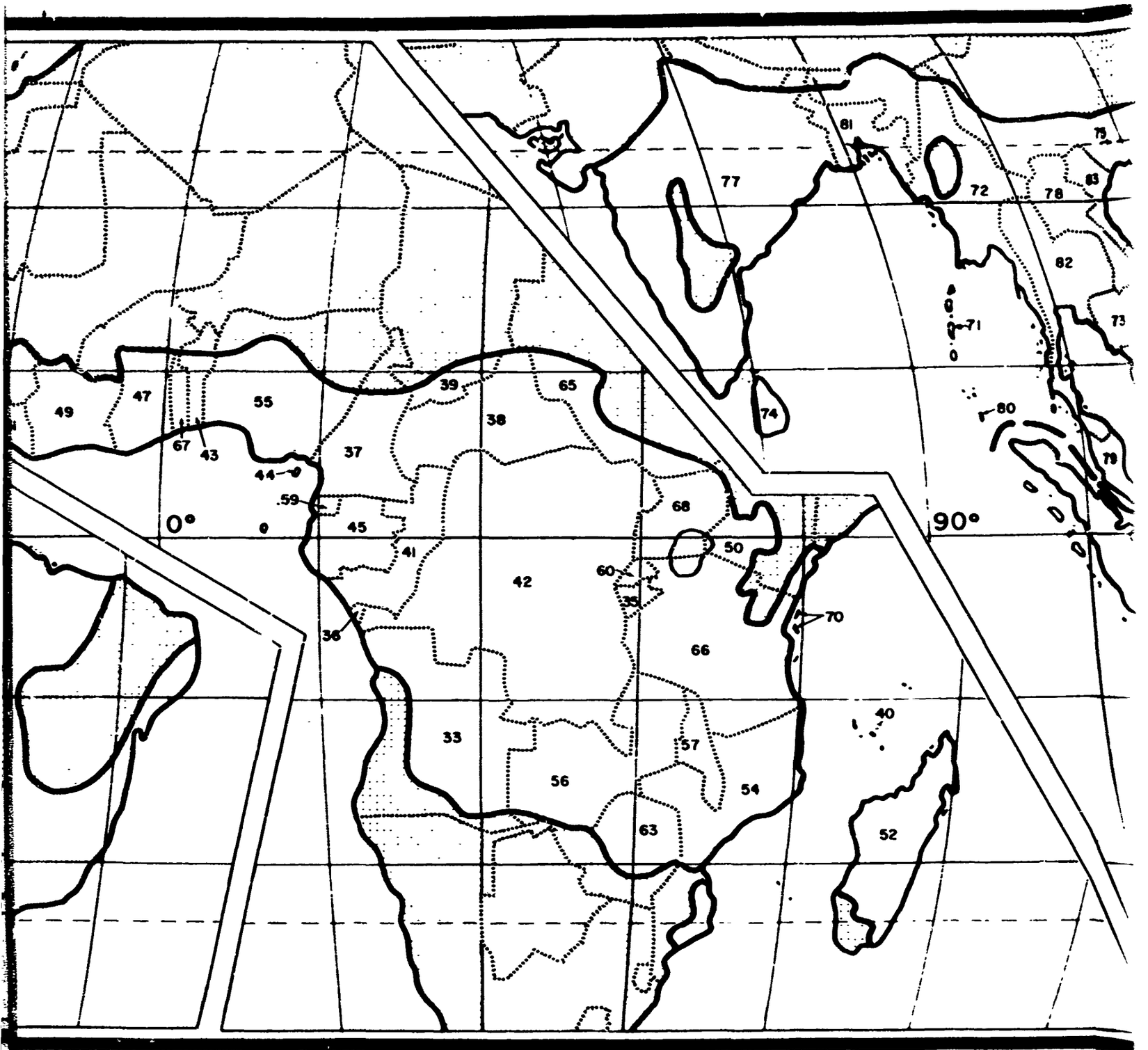
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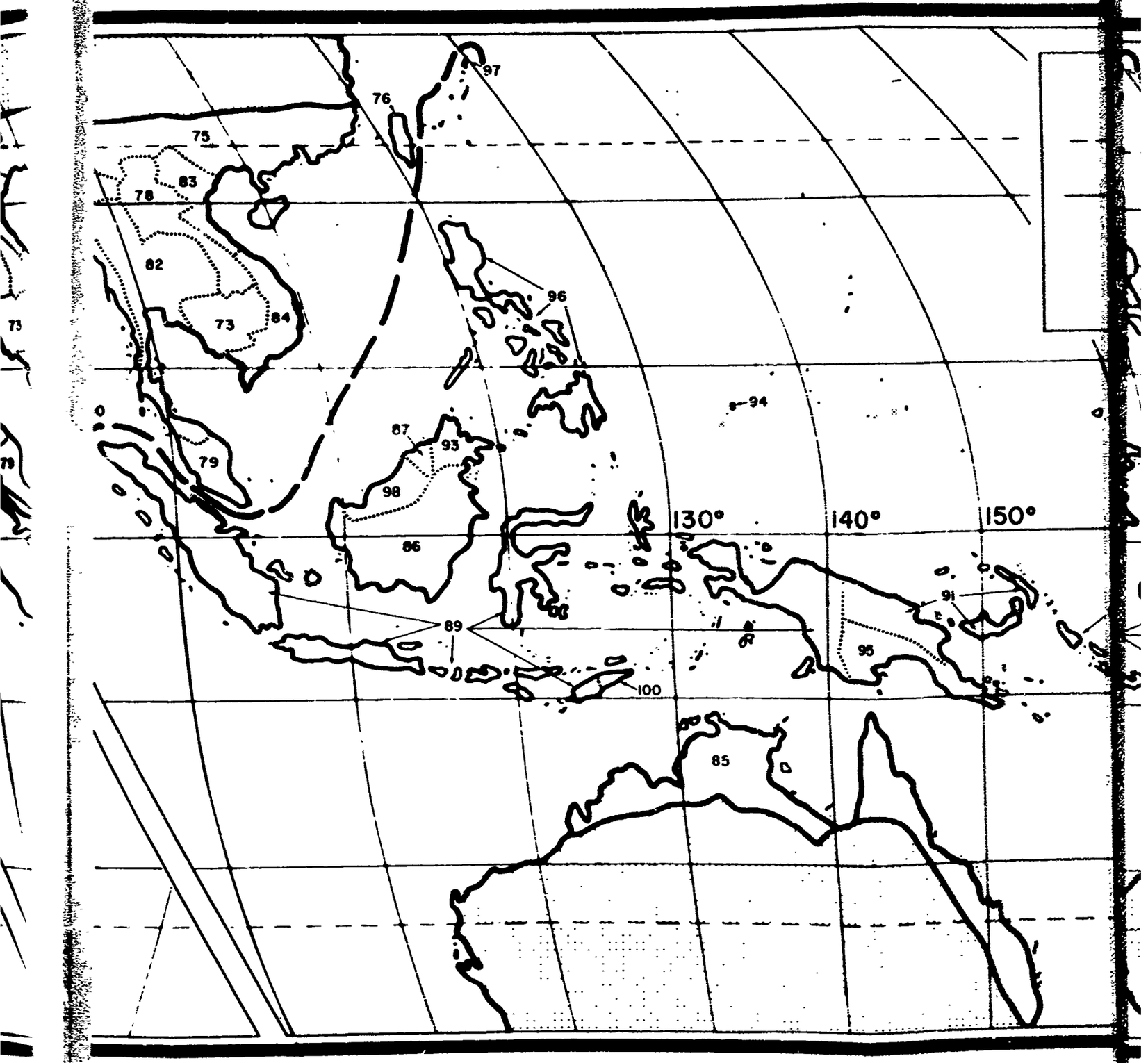

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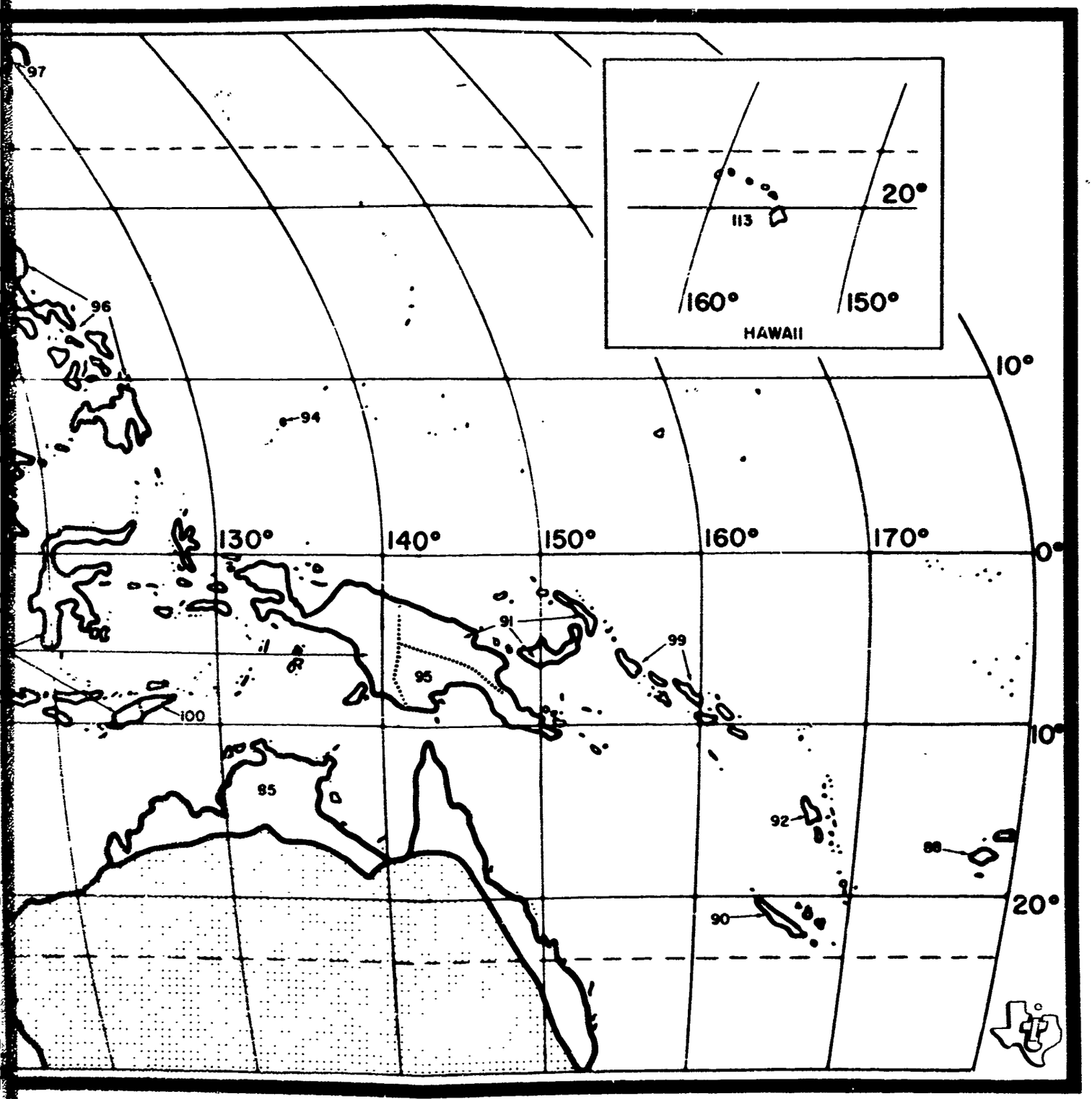

Figure 1. The Humid Tropics

The assessment of the present state of knowledge is one of the first problems to be faced. The present project deals with this problem in respect to the natural features, which include the basic physical resources of the humid tropics. After examining various features separately, it was observed that the state of knowledge is much the same for each type of feature and all parts of the humid tropics. The common needs were found to be: more detailed information of the natural features; more well-trained scientists and technologists in the humid tropics to work there regularly on both research and development problems; more centers for storage and rapid retrieval of basic and interpretive data. The common prerequisites for meeting these needs are financial resources, time, and uninterrupted activity.

The humid tropics also have been the scene of most military events, whether resulting from intergovernmental disputes or internal national unrest since World War II. In these actions, unorthodox concepts and procedures of warfare have been employed more extensively than in the major wars of the past. The departures from usual practice of military art appear to have been feasible largely because of characteristics of the humid-tropical environments. It is apparent that a thorough knowledge of these environments is a prerequisite to developing the capabilities of military forces to operate in the humid tropics.

Much of the basic information on natural features of the humid tropics needed for military purposes is the same as that required to initiate economic development. Military establishments can make use, therefore, of the results of current research activity for non-military purposes, and can share an interest in the determination of gaps in knowledge and ways of closing them. It is to be assumed that their own contributions to increasing knowledge of the humid tropics will become useful for a wide variety of purposes.

E. CURRENT RESEARCH AND DEVELOPMENT ACTIVITIES

In records of current research and development programs in the humid tropics, the financial and technical support of the United Nations and its executing organizations is most conspicuous. Specifically, the United Nations Special Fund, the Economic Commission for Asia and the Far East, the Food and Agricultural Organization, and the World Meteorological Organization are major contributors of assistance.

Fundamental research is sponsored and coordinated by UNESCO. Its Humid Tropics Research Program has been in operation since 1956; regrettably, because of a lack of funds, the future of this program is in doubt. The International Hydrologic Decade, in which humid-tropical countries will participate, is coordinated by UNESCO.

Research and development are further promoted by intergovernmental bodies such as the Commission for Technical Cooperation South of the Sahara and the Inter-American Committee for Agricultural Development.

A third category of supporting organizations is the foreign governmental agency, which provides technical assistance. Representative are the U.S. Geological Survey, the Office de la récherche scientifique et technique outre-mer in France and the Road Research Laboratory of the British Department of Scientific and Industrial Research.

Despite the importance of international and foreign aid to scientific and technical research and development in the humid tropics, national agencies should not be overlooked as supporters and participants. Geologic, mining, soil, agricultural, land-use, forestry, meteorologic, and hydrologic services function in most humid-tropical countries. The established need for outside help and training programs indicates the limited capabilities of these services generally, but some of them can show accomplishments that compare favorably with those of similar services anywhere.

Finally, the role of military organizations in sponsoring or conducting research and development programs in the humid tropics is well documented. Among the organizations prominently identified with investigations of humid-tropical environments are the Advanced Research Projects Agency, the U.S. Army Research Office, the U.S. Army Engineer Waterways Experiment Station, the U.S. Army Natick Laboratories, the Office of Naval Research, and the U.S. Air Force Office of Aerospace Research. Although not included by definition in the areal scope of the present inventory, special mention should be made of the major program of mapping, description, and analysis of the geology, soils, vegetation, and hydrology of western Pacific islands, which was conducted by the Military Geology Branch of the U.S. Geological Survey for the Office of the Chief of Engineers during more than a decade after World War II. It should be noted that the American military organizations support investigations by both American and foreign scientists and engineers.

F. SCOPE OF THE INVENTORY

For the purposes of the inventory, the Army Research Office designated five topics, which form the subjects of the chapters that follow this Introduction. The topics are PHYSICAL FEATURES; PLANT AND ANIMAL LIFE; WEATHER AND CLIMATE; COASTAL ZONES; and TROPICAL REGIONS.

It is apparent that the topics are broad in scope, and that two kinds of topics are involved. The first three topics deal with features and conditions throughout the humid tropics; the last two are concerned with regions within the humid tropics, which are characterized by all types of conditions

in the preceding group. Further, COASTAL ZONES is merely one of the TROPICAL REGIONS, which deserves special attention because of its military and civilian importance. Clean-cut division of the subject matter of natural environment into mutually exclusive topics is, of course, virtually impossible because of the intimate interrelationships of the environmental factors.

In each chapter, the elements of each topic and the factors composing each element, which are considered in this Inventory as initially directed by the Army Research Office and later the Army Natick Laboratories, are enumerated.

In keeping with the purposes of the project the primary emphasis in selecting information and evaluating the state of knowledge has been placed on the military aspects of the humid-tropical environments. Relatively less emphasis is placed on the factors that are important for the economic, political, and social development of the humid-tropical countries. Accordingly, the examination of the different topics in this inventory does not deal with the full range of investigations conducted by the various sciences—especially geology, geomorphology, soil science, botany, hydrology, and climatology—and technologies in the humid tropics.

Information selection and evaluation during this program did not extend to classified materials.

G. CHAPTER REFERENCES

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2. Auger, P., 1961, Current trends in scientific research: UNESCO, New York and United Nations, Paris, 245 p.
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CHAPTER II
PHYSICAL FEATURES*

A. INTRODUCTION

1. Topical Elements and Factors

Physical features in this Inventory comprise the following elements:

- Surface Configuration: relief, landforms
- Surface Materials: rock, soil
- Drainage Features: lakes, streams, canals, ditches, paddies, bodies of standing water
- Groundwater: aquifers, springs, artesian wells, other wells

The factors composing each element, which are considered relevant to the purposes of the Inventory, are

- Surface Configuration

  (1) Measurements: relief (micro, macro), slope, elevations, roughness
  (2) Characteristics of landforms: types, patterns, profiles, dimensions, origin and permanence
  (3) Applications: engineering use, cross-country movement

- Surface Materials

  (1) Measurements: distribution, thickness, volume
  (2) Characteristics: grain size, density, permeability, stability, moisture content, organic content
  (3) Suitability for engineering use: wearing course, base course, subgrade, foundation, construction material

*Dr. Hilgard O'R. Sternberg (University of California), Prof. Benjamin J. Garnier (McGill University), Dr. Pierre Gourou (University of Brussels), Dr. John Stark (Jackson, Tennessee), Dr. James Thorp (Richmond, Indiana), Dr. Rhodes W. Fairbridge (Columbia University), Dr. Charles F. Bennett Jr. (University of California, Los Angeles), and Dr. John D. Weaver (University of Puerto Rico), acting as consultants to Texas Instruments Incorporated for this program, have critically reviewed this chapter in its draft stages.

- Drainage Features

  (1) Measurements: width, depth, volume, velocity
  (2) Physical characteristics: banks, bottom conditions, channel form, tides, periodic variations
  (3) Quality of water: turbidity, salinity, bacterial pollution, organic and chemical content, odor, temperature, potability
  (4) Regulation and control: levees, dams, flooding
  (5) Effects: obstacles to cross-country movement, crossings

- Groundwater

  (1) Measurements: volume, depth, yield, hydrostatic pressure, permeability, drawdown rate
  (2) Physical characteristics: source, position of water table, periodic variations
  (3) Quality of water: see (3) above

2. Limitations on Scope of Coverage and Treatment

The topical elements are in the fields of interest of several sciences. Surface configuration falls mainly in the provinces of geomorphology and geology; surface materials come within the purview of soil science and geology; and drainage features and groundwater are topics of hydrology and geology. The practical uses of these elements are the concern of the engineering field.

Specialists in these scientific and technical fields will recognize that (1) the Inventory is limited mainly to those evidences of knowledge developed by the different fields that are more or less directly related to the elements and factors enumerated here, and (2) other topics investigated in the humid tropics by these researchers in these fields are disregarded purposely or only considered incidentally.

The specifications for the Inventory necessitated some arbitrary decisions with respect to classification of information and organization of the discussion of its significance. For example, the material on surface configuration and surface materials contained in Chapter V (Coastal Zones) should be regarded as an integral part of this chapter. In the humid tropics, vegetation is the primary indicator of soil and subsoil. Because soil and vegetation investigations are often linked, additional information on soil studies will be found in Chapter III (Plant and Animal Life). More information on hydrologic investigation conducted in conjunction with meteorologic research can be found in Chapter IV (Weather and Climate).

3. Present Interest in Physical Features of the Humid Tropics

The influence of physical features on warfare has been recognized throughout history in all regions. Most military actions during the past decade have occurred in the humid tropics. Reference is made to events in Cuba, the Dominican Republic, the former Belgian Congo, Vietnam, and New Guinea. They alone suffice to motivate interest in the influence of Physical Features on the conduct of military operations in the humid tropics. The fact that these areas display a variety of natural conditions should serve as a reminder that similarity of climatic conditions, which is the chief basis for defining the low-altitude humid tropics, does not exclude the possibility of heterogeneity in the terrain assemblages.

The recent events in the humid tropics call attention to the paucity of detailed information on the physical features of almost all parts of the humid tropics in the open literature and other generally accessible sources. They also show the great importance of terrain information in combatting guerrilla tactics.

The humid tropics contain a large proportion of the newly independent countries, all of them greatly concerned with attaining economic and social stability. Most of the countries in the humid tropics have few sources of revenue in developed industries. They are interested, therefore, in systematic geologic, soils, and hydrologic surveys designed to disclose hitherto unknown resources, to promote the efficient exploitation of these resources, and to generally improve human activity and welfare in the humid tropics.

The importance of paying prompt attention to the practical study of physical features is suggested by E. B. Worthington[1] in the following statement made in 1958: "Water is scanty in at least three-quarters of Africa south of the Sahara and it would be no exaggeration to say that in more than half the region is the principal factor limiting all forms of human endeavor."

However, P. Gourou* questions the accuracy of this statement insofar as it applies to humid-tropical Africa and reaches a different conclusion. Gourou considers the supply to be adequate but points out that

*Personal Communication, February 2, 1966.

native Africans have neither conserved surface water nor sought groundwater. Water shortages are, accordingly, largely due to human fault. By contrast, Gourou notes, Indians have long known how to manage their water resources and accommodate the needs of a vastly greater population. In Africa, therefore, Gourou concludes, the primary need is the development of capability in Africans to st dy the physical features of their continent and make use of the knowledge.

4. Historical Notes on Development of Knowledge and Concepts

a. Rocks

The rock materials of the earth have been the principal object of investigation by geologists for more than 150 years. Systematic description, classification and mapping of these materials represent major functions of governmental geological surveys. Such agencies have functioned for about a century in various European countries and the United States. Elsewhere, as in the humid tropics, there are surveys in most countries, most of which have come into existence in the present century. Exceptions are the surveys of India and the East Indies (now Indonesia), which are more than 100 years old. A significant part of the total research in the field of geology has always been contributed by geologists in universities and research institutes. Their work is now usually concerned more with the origin of geologic features, dating of materials and chronology of events, and development of classification systems than with systematic mapping. Nevertheless, much of their research produces byproduct information on the distribution and properties of the rock materials.

Until World War I, practical applications of geologic knowledge, except in connection with mining, had been neglected. In that war the work of British and German military geologists on engineering problems of military mining, construction of trenches, drainage, and procurement of emergency water supplies was an important demonstration of the usefulness of geology. Without the benefit of previous experience, these geologists were obliged to improvise the criteria for applying geologic data to military problems. The success of military geology during the war led directly to creation of a field of engineering geology for civilian purposes after the war. The latter field has had a continuing responsibility for planned accumulation of knowledge on the physical behavior of rock materials.

During World War II, military geology went on to become the focal point of interdisciplinary study by geologists, soil scientists, botanists, and hydrologists of environment in its relationship to military operational problems. In the humid tropics, American and Australian groups made terrain investigations of the southwestern Pacific islands. A large number of reports on geologic, geomorphic, and hydrologic conditions in Southeastern

Asia were prepared for military use by the Strategic Branch of the Geological Survey of India. A military geologic service functioned in the Netherlands East Indies in the war period. In 1947, the Indonesian Topographical Service formed a Geographical Institute to prepare military geographic and geologic reports.

b. Soils

The pedologic concept of soils originated with V. V. Dokuchaiev and his associates in Russia during the 1870's. Although it became known outside of Russia in the next decades, the science of pedology was not firmly established throughout the world until the late 1920's.

The diversity of soil categories that emerged through application of the pedologic concept created a difficult problem of classification, which has not been finally solved. Thus, the Soil Survey of the U. S. Department of Agriculture[2] issued seven "approximations" (revisions) of its classification system between 1951 and 1960.

Pedology serves mainly the purposes of agriculture and land use. From an engineering standpoint, a concept of soil that emphasizes physical characteristics is more relevant than the pedologic concept. An engineering classification system constructed by A. Casagrande in the 1930's has been developed further by the U.S. Army Corps of Engineers and U.S. Bureau of Reclamation as the Unified Soil Classification System.[3]

Besides being concerned with construction problems, military engineers have also had to deal with problems of vehicle mobility in different types of terrain. A large amount of laboratory and field research on soil trafficability has been performed or supported by military engineering agencies. The U.S. Army Engineer Waterways Experiment Station has not only conducted extensive programs in the United States but also, in the humid tropics, has programs in Puerto Rico, Panama and Thailand.

The great majority of systematic soil surveys are motivated by governmental interest in improving the agricultural economy of a country and determining the land capability. Since World War II, many humid-tropical countries have received financial and technical support from intergovernmental and world organizations to conduct surveys. The history of investigation of soils in this region predates this period of more organized effort. Before World War I, work had been done in Asia, Africa and South America, mainly by geologists and petrologists. By 1938, a bibliography of more than 800 titles on soils of Central Africa alone, especially of the Belgian Congo, could be published. In a recent study of worldwide tropical soils for engineering purposes, T. Liang[4] examined more than 1200 titles, which apparently represented only a sample of the existing literature.

Among the soil scientists who have contributed notably to the knowledge of soils of large areas are C. F. Marbut (Africa, South America), G. Aubert and J. D'Hoore (Africa), E. C. J. Mohr (East Indies, Equatorial Regions), R. L. Pendleton and F. J. Moorman (Southeastern Asia), H. H. Bennett (Middle America), M. G. Cline (Hawaii), and P. Vageler and D. L. Bramao (South America).

c. Landforms

Scientific interest in landforms and their development has been shared by geologists and geographers. A relationship between rock characteristics and surface configuration was recognized or sensed by the early geologists in the latter part of the 18th century. James Hutton in his "Theory of the Earth" (1785) discussed the denudation of the land surface by the very slow, continued action of different subaerial processes. In 1834, Karl von Hoff published a long record of the changes of surface configuration recorded in historical time and discussed their causes. His more famous contemporary, Charles Lyell, advanced the principle of uniformity to establish a basis for interpreting the origin of geologic features. This principle has often been regarded as a natural law but today is treated commonly as a methodological precept.

Creation of a science of geomorphology in the late 19th century is attributed to W. M. Davis, who conceived of cycles of erosion to explain the progressive development of different landscapes. The Davisian concept dominated geomorphologic thinking for about half a century but has long been challenged by various other concepts which seek to deal more acceptably with the peculiarities of landscapes in different environments. Among these concepts, climatic geomorphology has gained widespread consideration, although it, too, is challenged, especially by some geologists.

Specifically in the humid tropics, much of the geomorphic research has been concentrated on coastal features, as in Oceania and the Caribbean Islands (see Chapter V for a discussion). In 1958, F. Dixey concluded the work conducted over 20 years of arranging the countless landforms of Central and Southern Africa (mostly in the humid tropics) in a relatively simple system of denudational cycles. In 1962, L. C. King, known for studies in Africa and Eastern Brazil, completed a monograph on worldwide morphology with particular attention to Africa.

An historical note on geomorphology would not be complete in the present context without brief mention of the long-time interest of armies in the influence of landforms on military operations. In the early 19th century, J. S. von Grouner, a German geologist and soldier, studied the Alps for the purpose of defining and interpreting the geologic influences on

the conduct of war in a mountainous region. His posthumously published work (1826) was the first publication in the field of military geology. Another landmark in the historical record was the activity of the noted geomorphologist D. W. Johnson as an adviser on terrain problems to the Allied Headquarters in World War I. Johnson's work laid the foundation for modern terrain evaluation. Today, the interest is directed mainly to other regions and environments, such as the humid tropics and arid zones.

Quantification of geomorphic data has made noticeable progress since World War II. This development has been stimulated especially by the demands of armies for more precise information on surface geometry (relief, roughness, slope). Quantitative data are being used to characterize landforms and determine terrain analogs.

d. Hydrologic Features

The modern science of hydrology came into existence in the 17th century, when measurements were made to show that the water in streams and springs was derived from precipitation on the land. The concept of the hydrologic cycle is said to have been correctly understood by ancient civilizations.

Hydrology has been largely developed by other sciences. Thus, the first measurements were made by physicists; the development of the principles of hydraulics was the work of mathematicians; the behavior of subsurface water was studied by geologists. From a scientific heritage, hydrology has turned in modern times almost entirely to a concern with engineering applications, as in water-supply systems, stream regulation and irrigation systems. The Ad Hoc Panel on Hydrology of the (U.S.) Federal Council of Science and Technology[5] has commented that "the bulk of hydrologic research is sufficient to produce only the empirical results needed to solve a particular hydrologic problem."

R. G. Kazmann in 1965 summarized the state of hydrology as follows: "Hydrologists have not evolved a clear-cut science of hydrology, nor have they come to any consensus on how to evaluate water-development projects from the standpoint of hydrology. Moreoever, no procedure has been proposed for the evaluation, even systematic analysis, of the side effects of hydrologic projects." Hydrologic investigation of the humid tropics shares the general difficulty in which hydrology finds itself.

5. Sources of Information*

New literature on physical features of the humid tropics is listed in various worldwide and regional indices. Some of the more important and readily available guides in this group are enumerated and discussed briefly in Table 1.

*Further discussion of this topic is presented in Chapter V, Section A. 5.

Table 1

BIBLIOGRAPHIES AND ABSTRACTS OF PHYSICAL FEATURES INCLUDING COVERAGE OF HUMID-TROPICAL LITERATURE

GEOLOGY (and generally with Hydrology)

Bibliography of Geology Exclusive of North America
Published by Geological Society of America since 1933 in annual volumes, which appear irregularly. Brief annotations in English.

Bibliography of North American Geology
Published by U.S. Geological Survey since 1896. Annual volumes appear irregularly; also issued in 10-year cumulations.

Abstracts of North American Geology
Published by U.S. Geological Survey, monthly from January 1966. Informative abstracts in English.

Geoscience Abstracts
Published by American Geological Institute, monthly since 1959. Informative abstracts in English.

Bulletin Signaletique: Section 11 - Sciences de la terre, II.
Published monthly by the Centre de documentation of the Centre national de la recherche scientifique in Paris. Brief annotations in French.

Zentralblatt für Geologie und Paläontologie
Published by E. Schweizerbart in Stuttgart, Germany, since 1830. Appears in two parts: I. General, applied, and regional geology; II. Historical geology and paleontology, in 6-7 issues per year. Informative abstracts in German. Known formerly as Neues Jahrbuch, Referate.

Referativnyi Zhurnal: Geologiya
Published monthly by All-Union Institute of Scientific and Technical Information (VINITI) in Moscow. Brief abstracts in Russian.

GEOMORPHOLOGY AND GEOGRAPHY

Geographical Abstracts, A: Geomorphology
Published by Department of Geography, London School of Economics, currently every other month. Informative abstracts in English. Known from 1960 to 1965 as Geomorphological Abstracts.

Table 1 (Contd.)

Current Geographical Publications
Published 10 times a year by American Geographical Society. Titles only, classified geographically and by subject.

New Geographical Literature and Maps
Published by Royal Geographical Society twice a year. Titles only.

Acta Geographica, Supplement Bibliographique
Published 5-6 times annually by Société de Géographie in Paris. Informative abstracts in French.

Bibliographie Géographique Internationale
Prepared by International Geographical Union with UNESCO support, published by Centre national de la recherche scientifique. Brief annotations in French.

Petermanns Geographische Mitteilungen
Periodical published by Justus Perthes Verlag and successors in Gotha, Germany, since 1855. Includes extensive listings of titles and contents of journals; also full abstracts of many titles in German.

Westermanns Geographische Bibliographie
Published since 1954 by G. Westermann Verlag in Braunschweig, Germany. Titles only.

Referativnyi Zhurnal: Geografiya
Published monthly by All-Union Institute of Scientific and Technical Information (VINITI) in Moscow. Brief abstracts in Russian.

SOIL SCIENCE

Bibliography of Soil Science, Fertilizers and General Agronomy
Prepared by Commonwealth Bureau of Soils, Rothamsted Experimental Station, Harpenden, England, since 1931. Issued every 3 yrs.

Soils and Fertilizers
Prepared by same organization as above, since 1938. Issued 6 times a year.

Special continuing bibliographies of humid-tropical physical features are not known to exist. Among occasional bibliographies of recent date, which deal with a broad range of literature on the humid tropics, are (1) the annotated bibliography prepared by T. L. Hills and published by the Commission on the Humid Tropics of the International Geographical Union in 1960 and (2) the bibliography and KWIC Index published in 1965 as Volume I of the present Inventory.

Extensive listings of titles, both old and new, are contained in publications dealing with parts of the humid tropics. For example, the reviews of natural resources of Africa published by UNESCO in 1963 include long lists of titles on geology, geomorphology, soils, and hydrology. The geologic bibliography has already been expanded in published supplements. These reviews, as well as the review prepared by Worthington[1] in 1958, serve to provide a record of awareness of recent research. In general, however, there is no systematic reporting of current research activity.

B. SURVEY OF CURRENT RESEARCH ACTIVITY

1. General Comments

Complete, meaningful identification of current research on topics or geographic areas is a difficult, unsolved problem of the emerging science of scientific information. Even in the United States, with well-developed scientific communication networks, the problem of establishing continuing current awareness of research activities and trends within the country itself has not been conquered, despite direct efforts by the Government to bring it under control. Comparable resources for collecting current-awareness data, in the form of clearinghouses and information centers, do not exist in the countries of the humid tropics. Therefore, research projects generated within these countries tend to become known only after the publication of results. Projects conducted or supported by foreign or international organizations are not apt to be any better publicized while in progress. A noteworthy exception is provided by the U.S. Geological Survey, which has for several years published an annual summary of current investigations in the United States and foreign territories.[7] Most disappointing is the reporting of activities by the United Nations and its executing agencies because this group is the leading sponsor of investigations in the humid tropics. Information on projects, proceedings of sponsored conferences, and results of investigations are often long delayed in publication, or not published at all, and if published are frequently difficult to obtain because of small printings.

Relevant to these observations is the following statement by the UNESCO Advisory Committee for Humid Tropics Research, made in December 1963: "Considering that publications on scientific work on the

humid tropics, including reviews of research, have not received adequate publicity and considering that there is a need for the dissemination of information on such publications among scientific institutions in this area, the Committee recommends that UNESCO should prepare a full list of all publications resulting in any way from the UNESCO Humid Tropics programme and that this list, with full bibliographic details and information about where these publications are available, should be given the widest publicity among scientists and scientific institutions."[8]

2. World Organizations

The support of practical investigations in developing countries motivates the United Nations Special Fund. In the period from May 1959 to June 1964, it has contributed to 44 surveys of and 3 research projects on natural resources of humid-tropical countries. The main subjects and the distribution of effort by countries are summarized as follows:[9]

- Surveys

(1) Land use and water use

Latin America: Brazil, British Guiana, Ecuador, Haiti, Venezuela

Oceania: Indonesia, Philippines, Solomon Islands

Africa: Congo (Brazzaville), Ghana, Kenya, Nigeria, Tanzania, Togo, Uganda, Zambia

Asia: Burma, China, Malaysia, Pakistan

(2) Soil

Latin America: British Guiana, Colombia

Asia: Pakistan

(3) Mining

Latin America: Bolivia, Brazil, British Guiana, Colombia, Ecuador, Mexico, Nicaragua, Surinam

Africa: Ivory Coast, Kenya, Malagasy, Nigeria, Senegal, Tanzania, Togo, Uganda, Upper Volta

Oceania: Indonesia, Philippines, Solomon Islands

(4) Ground

Latin America: El Salvador, Jamaica

- Research Projects

(1) Mining

Latin America: Bolivia

(2) Groundwater

Asia: Thailand

In addition to sponsoring investigations, the UN Special Fund assists in the training of skilled manpower for development of resources. In the period from 1959 to 1964, training was supported in the following fields and countries:

- Mining

Africa: Congo (Leopoldville)

Asia: India

- Groundwater

Oceania: Philippines

The United Nations Water Resources Development Centre presents biennial reports to the UN Economic and Social Council in which current activities of UN organizations in the field of water resources are enumerated. For the years 1962 and 1963,[10] the latest for which a report has been published, 458 instances of technical and financial assistance are recorded. Many of them involve short-term assistance to humid-tropical countries. Although this type of assistance is apt to be concerned with specific problems, several major topics, which represent long-term problems, recur in the enumeration. They are: (1) general water-resources development, (2) integrated river-basin development, (3) hydro-power resources development, (4) water-supply problems (especially quality of water), (5) watershed management, irrigation and drainage, (6) hydrologic characteristics, and (7) desalination of sea and brackish waters.

The UN Economic Commission for Asia and the Far East (ECAFE) has been concerned since 1951 with problems of flood control, river basin development, and development of water resources. ECAFE has

initiated preparation of a compendium on international rivers in Southern Asia and the Far East for the purpose of identifying the possibilities of development. Much of the information can be compiled from existing sources, but some reconnaissance surveys and direct collection of data by the riparian countries will undoubtedly be necessary.

This organization has paid particular attention to development of the Mekong River basin. The UN Water Resources Development Centre terms the project "the most important multi-purpose undertaking on an international basis" in Asia. Besides the four riparian countries (Cambodia, Laos, Thailand, and the Republic of Vietnam), 20 other countries across the world, 12 UN agencies, 3 foundations, and private companies are cooperating in the program of investigations and studies. As of January 1963, more than $44,000,000 has been made available for use by the Mekong River Committee.[10]

In the area of soil investigations, the UN Food and Agriculture Organization (FAO) conducts and assists programs in many countries. The Inter-American Committee for Agricultural Development (CIDA) reports that both FAO and the U. S. Department of Agriculture "are interested in the preparation of a map of the great soil groups of Latin America. Soil scientists from most (Latin American) countries are taking great interest and collaborating in the project. A number of international meetings have been held in which the status of soil classification in the various countries was discussed." FAO sponsored the Conference on Soils and Fertilizers for the Latin American Region in 1960 and the 1st Soil Conservation Seminar for South and Central America in 1962. This organization has prepared a small-scale soil map of Ecuador, is carrying out a reconnaissance soil survey of the Llanos Orientales in Colombia, and cooperates actively with various government agencies of Brazil in soil studies. In Africa, FAO is preparing a general work on the ferrallitic and tropical black soils. A study of the major soils of Southeast Asia, dealing with morphology, chemistry, environmental conditions, occurrence, land use, and agricultural potential, was completed for FAO by R. Dudal and F. R. Moorman in 1962. Work on the soils of Thailand and the Republic of Vietnam has continued.

Since 1956 UNESCO has concerned itself with (1) coordination of research on scientific problems relating to the humid tropics and (2) international or regional measures to expand the research. An Advisory Committee for Humid Tropics Research has periodically examined proposals and selected problems that will receive the attention of the Humid Tropics Research Program. So far, the program has focused on soil, vegetation, and water, and their interrelationships. In October 1961, the Advisory Committee[11] re-evaluated the scope of the program and selected eight subjects as suitable for long-term action. Four of them fall within the scope of the present discussion of physical features. Three are more specific problems:

laterization; chemistry and biology of tropical soils; and delta areas. The fourth, the general problem of principles and methodology of integrated research in the humid tropics, involves careful consideration of the characteristics of geologic, geomorphic, soils, and hydrologic research.

Some progress has been reported on consideration of the first three problems:

(1) An extensive survey of research on laterites by R. Maignien[12] was completed in 1964. The problems of intercontinental correlation of lateritic soils have been under study by experts.

(2) In December 1962, within the framework of the program, a Seminar on Analysis of Soils of the Humid Tropics was held in Caracas, Venezuela, which considered such topics as salinity of soils, soil colloids, mechanism of soil genesis, soil classification, and organic matter in humid tropical soils.

(3) Delta areas, the Advisory Committee concluded in its October 1961 meeting, "are in many respects the most important regions of the humid tropics since they are those of greater human concentration. The scientific problems of the deltas result from their geographical, geological, hydrological, pedological,and biological characteristics and have to be studied through an integrated approach." In cooperation with ECAFE, UNESCO sponsored the Regional Symposium on Flood Control, Reclamation, Utilization and Development of Deltaic Areas,[13] which was held at Bangkok in July 1963. This meeting permitted an exchange of expert opinions on these areas of great importance in Southeast Asia and the phrasing of recommendations for research. For some of the areas, so-called geomorphologic maps have already been produced. In reality, they do little more than show the distribution of landform and/or soil types.

UNESCO has also participated in the furtherance of hydrologic investigations on a worldwide basis. Thus, in October 1962, it sponsored jointly with the International Association of Scientific Hydrology a Symposium on Continental Erosion held at Bari, Italy. Since 1962, UNESCO has coordinated the implementation of the International Hydrologic Decade. The numerous objectives, plans, and contemplated procedures of this major international program were elaborated by the Intergovernmental Meeting of Experts[14] held in Paris in April 1964. The program was scheduled to begin in 1965.

The 53 member countries of the International Hydrologic Decade include the following 21 in the humid tropics:

Latin America: Brazil, Cuba, Ecuador, Peru, Venezuela

Africa: Cameroon, Chad, Congo (Brazzaville), Dahomey, Gabon, Ghana, Ivory Coast, Malagasy, Nigeria, Togo, Uganda

Asia: India, Pakistan, Thailand

Oceania: Australia, Philippines

Furthermore, UNESCO has encouraged research on the East African Rift Zone on the recommendation of the Upper Mantle Committee of the International Union of Geodesy and Geophysics. A grant from UNESCO to the East African Committee on Cooperation in Geophysics made possible the preparation of an extensive report[15] on the state of knowledge of the geology and geophysics of the Rift Zone. The report was presented to a seminar, sponsored by UNESCO and the Upper Mantle Committee, of interested scientists who met at Nairobi in April 1965. From this meeting has come a detailed statement of plans for future research.

The Commission on the Humid Tropics (T. L. Hills, chairman) of the International Geographical Union was established in 1956. Its purposes are to "stimulate research in the geography of the humid tropics, and especially into the nature of the humid-tropical environment; to serve as a clearing-house of relevant information (publications, techniques, personnel and research agencies); and to cooperate closely with UNESCO during the Hydrologic Decade."[16] The program has been concerned with the definition and delimitation of the humid tropics, climatic factors, and ecological boundaries. The special problems of rocks, soils, water, and landforms appear to have had secondary importance so far but are certain to receive attention when the details of the humid-tropical environment are studied.

3. Regional Organizations

The Commission for Technical Cooperation in Africa South of the Sahara (CCTA), an organization of 22 African countries and Belgium, Portugal, and the United Kingdom, and its Scientific Council (CSA) act to further the application of science to solution of problems in Central and Southern Africa. The CCTA convenes conferences, recommends measures to be taken, and assists member countries in joint efforts to obtain assistance from international organizations. In the field of geology, CCTA functions through three Regional Geological Committees, composed of the heads of governmental geological surveys in the regions.

A further important effort by CCTA was the sponsorship of an Inter-African Conference on Hydrology[17] held at Nairobi in 1961. This meeting considered (1) the need for assessment of water resources prior to and during the development of countries, (2) the hydrology of the principal river basins, (3) the effects of land-use policies on water resources, and

(4) the cooperation between hydrology and other fields. A program of 65 technical papers on hydrometeorology, surface-water hydrology, catchment-area experiments, and groundwater hydrology showed special concern with investigative methods and analysis of data.

The Association of African Geological Surveys comprises governmental and mining-company geological surveys throughout Africa. Functioning as a commission of the International Geological Congress, it conducts important projects dealing with all of Africa, such as the compilation of a geological map (1:5,000,000), a structural map (1:10,000,000) and a stratigraphic lexicon, and the convening of symposia.

The Inter-American Committee for Agricultural Development (CIDA) (members are the Organization of American States, Inter-American Development Bank, UN Food and Agricultural Organization, UN Economic Commission for Latin America, and Inter-American Institute of Agricultural Sciences) has been conducting an Inventory of Information Basic to the Planning of Agricultural Development in Latin America. A regional report, most of the 19 country reports, and a bibliography of 5083 titles have been published.[18] A series of atlases containing indices to several types of the map coverage is being issued.[19]

The reports contain information on the progress of topographic mapping, geologic and geomorphic investigations, soil surveys, and hydrologic work, among other topics involved in the evaluation of the agricultural potential. They identify the national organizations in these countries that are responsible for the execution of surveys and the foreign and international agencies that provide technical and financial assistance. In virtually all of these countries, plans exist for the systematic mapping of the physical features and the evaluation of their influence on economic development. It is evident from an examination of these reports that the progress of the programs has been generally slow. Detailed information, which must be shown on maps of large to medium scales, is being amassed much more slowly than the reconnaissance data, which can be and has been presented for most countries in small-scale maps.

4. Foreign Organizations

Since the humid tropics have until recently been predominantly colonial territories of European countries, surveys of natural resources and other scientific investigations have been planned, directed, and staffed mainly by Europeans.

The activities were organized in various ways, ranging from central bodies with worldwide responsibility to local territorial agencies. In Africa especially, the number of European organizations involved in geologic, hydrologic, and soil work in recent decades is large.

The recent discussions by Worthington[1] and Dixey[20a] indicate that the current status of Belgian, British, and French organizations in the rapidly changing political environment of Africa is not readily determinable. It can be assumed that, in many countries, the organizations have been transferred to the control of new national governments, but it appears that some advisory or cooperating functions are still exercised by European central organizations. Thus, as late as 1963, despite independent surveys in the new countries, the majority of the former French colonies "entrust their geological work (mapping, geological syntheses, publication, hydro-geology, general prospection) to the Bureau de recherches geologiques et minières (BRGM)," [20a] a French organization. The British Overseas Geological Surveys, headquartered in London, perform geological work for the British colonies and, by arrangement, provide basic analytical services for geological surveys of former British territories.

Scientific aid to the developing countries has been rendered by various French organizations, notably the Office de la recherche scientifique et technique d'outre-mer (ORSTOM), which has provided the central direction for scientific research in the French territories since 1953. "Its function is to organize fundamental research, while leaving the investigation of immediate problems to the research organs of the specialist government services, and to create research centers in areas in which adequate provision has not previously existed." [20a] ORSTOM has conducted geologic, geophysical, pedologic, and hydrologic projects. The soil investigations are concerned mainly with classification and distribution of soils but also with the relation of soil types to vegetation, climate, and land use. The geological surveys have emphasized exploration for mineral deposits. Geophysical surveys in various regions have been directed toward aiding geologic and oceanographic studies.

The Road Research Laboratory of the British Department of Scientific and Industrial Research has conducted investigations of road and airfield construction problems, construction materials, and soil trafficability in British Honduras, Barbados, Jamaica, Leeward Islands, Windward Islands, British Guiana, former British colonies of Western and Eastern Africa, Malaya, Borneo, and Fiji since World War II. This organization has assisted local agencies in developing research programs and materials testing laboratories. It has conducted broad studies on the formation, classification, and characteristics of tropical soils and special studies on tropical black and red clays. Also regional surveys have been made of road-building materials, in which engineering geologic maps and morphologic maps with data on level of water table, steepness and distribution of slopes, drainage areas, and areas considered susceptible to erosion are included.

The U.S. Geological Survey has provided technical assistance in geology, hydrology, and related sciences to developing countries for more than 20 years under the auspices of the U.S. Agency for International Development (AID), formerly International Cooperation Administration;

other American agencies; and international organizations. The countries in the humid tropics that have benefitted from this assistance are:

Latin America: Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Panama, Peru

Africa: Congo, Dahomey, Ghana, Liberia, Nigeria, Sierra Leone

Asia: Ceylon, India, Pakistan

Oceania: Indonesia, Philippines, Republic of China, Thailand, Republic of Vietnam

The main objectives of the programs conducted by the U. S. Geological Survey have been: (1) appraisal of mineral and water resources and (2) training of earth scientists to staff national geological and hydrological services in the developing countries. The record of publications based on the programs attests to the wealth of scientific data they have yielded. The program is continuing.

5. Military Organizations

The Advanced Research Projects Agency (ARPA) of the U. S. Department of Defense sponsored a long-term research project "with the ultimate goal of providing the vehicle designer and ground mobility analyst with quantitative information concerning the effects of the various features of the physical environment on the movement of surface vehicles. '[21] The project, entitled Mobility Environment Research Study (MERS), dealt with the environmental factors of Thailand. Originally Laos, Vietnam, Cambodia, Malaya, and Burma were also to be included. The program was administered by the U. S. Army Engineer Waterways Experiment Station and conducted with the collaboration of several American technical governmental agencies. The program was concerned with delineating the problems to be investigated and surveying the published and unpublished sources of information. The scope of the mobility research went beyond the consideration of physical features as defined in the present report, but a major part of the project concerned problems of soil classification and quantitative measurement of the surface and hydrologic geometry. Research on these problems will have basic values, aside from the results applicable to military movement. It should be anticipated that the data will also be applicable to non-military uses of the terrain.

One of the research objectives of the United States Air Force is the study of environmental problems that can influence its technological capabilities.[22] Terrain analysis is recognized as an important segment of this area of research. The topics studies are "the crustal materials, surface

morphology, and dynamic processes of remote and little exploited areas of the earth." The investigations are conducted or sponsored by the Office of Aerospace Research and its subordinate units. For example, T. Liang[4] has initiated a program of research on tropical soils for the Air Force Cambridge Research Laboratories with a critical examination of their characteristics and classification.

C. MAJOR PROBLEMS FOR CONTINUED AND FUTURE INVESTIGATION

1. Geology

Dixey[20a] notes that at the end of World War I the geology of the British territories in Africa was "virtually unknown." The situation improved noticeably only after World War II when concerted efforts were made to strengthen geological surveys and accelerate mapping and mineral investigations. Dixey concludes "that there would clearly be unwarranted optimism in envisaging an early end to geological mapping and mineral exploration in the continent of Africa." While the conclusion is undoubtedly valid, note should be taken of progress in some areas. Gourou* points out that the geology of the former Belgian Congo is accurately mapped at the scale of 1:100,000 and of Madagascar at 1:200,000. In Asia, complete geologic map coverage of Vietnam is available at the scale of 1:500,000.

The Standing Committee on Geology and Geophysics of the Pacific Science Association[23] presented a series of reports to the 10th Pacific Science Congress in 1961 on the progress of investigations in the circum-Pacific region and adjoining areas of Southeastern Asia. In many of the countries, reconnaissance surveys have had to suffice as a background for planning mineral and petroleum exploration. However, as A. Alcaraz noted in the Philippines, rapid surveys by airborne geophysical methods have not provided the detail ultimately required. Further ground surveys will be necessary. In Indonesia, only 4.5 percent of area has been systematically mapped and large areas are unknown geologically, according to J. Katili. Of special importance in this tropical region is rock weathering, a subject that has not received adequate attention. S. Buravas points to the piecemeal development of mineral resources of Thailand and observes that, to realize the full potential of the country, basic geologic data must be collected regionally. Unlike most parts of the humid tropics, Hawaii is judged by G. A. Macdonald to have adequate areal geologic maps for most purposes in the next several decades. There is a need for detailed mapping of small areas and careful study of the reefs and beaches.

2. Soil Science

The abundance of literature on soils of the humid tropics, which has already been noted (see Section B. 2), is evidence of the attention

*Personal Communication, February 12, 1966.

given to the subject in regions greatly concerned with agriculture and other land use. Nevertheless, Fournier,[20c] after reviewing the knowledge, the gaps in research, and present research trends on soils in Africa, emphasized that "The salient conclusion to be drawn . . . is that there exists an absolute need for fundamental research."

As a background to and source of data required for research on chemical composition, physiology and biology of soils, Fournier advises continued efforts in inventorying and mapping soils. In respect to problems for further investigation, he observes that too little is known about the following in humid-tropical soils:

- Trace elements
- Limits between ferruginous soils, ferrisols, and ferrallitic soils
- Causes and characteristics of ferrallitization
- Soils structure and the water balance
- Maintenance of organic matter in soil

T. Liang[4] found in his study of tropical soils throughout the world widespread nonuniformity and confusion in existing systems of tropical soils classification, a lack of strict definition of nomenclature and, reflecting diversity of interests among investigators who may be soil scientists, geologists or engineers, differences in completeness and manner of treatment of soil information.

R. W. Fairbridge notes, however, that throughout the humid tropics "the paucity of local detail is offset by soil unification (unifying effects of laterite and podsols). The soil is predictable on the basis of rainfall and seasonal climate characteristics, with appropriate modifications for relief contrasts."* The unifying effects of the soils are reflected in the character of the vegetation and physiography.

3. Geomorphology

The relationships between surface configuration, surface materials, and drainage features have implications that are important to engineering, agricultural, and other land use of terrain. The mapping of surface configuration has proceeded at the same or possibly a more rapid pace in countries that also support geologic and soil surveys. However,

* Personal Communication, July 1, 1966.

older topographic surveys tend to be deficient in accuracy and detail, and therefore, re-mapping is required in many areas.

Based on extensive experience in the humid tropics, especially in Brazil, H. O'R. Sternberg identifies the following specific problems of geomorphology of the humid-tropical environment:*

(1) Explanation of geomorphic features in terms of the climatic or zonal frame of reference. Sternberg comments: "The gradual accumulation of observations in the tropics — especially after World War II — came to constitute a body of evidence in favor of a climatic, or zonal, approach to landscapes. The possible significance of such specifically tropical features as the thick mantle of rock, weathered in situ, came to be realized. In the study of erosion surfaces, the universal application of the peneplain concept gave way to a search for climatic-specific explanations, as, for instance, in the case of certain erosion surfaces whose evolution appears to have occurred independently of base level."

(2) Explanation of tropical karst features (kegelkarst). Concerning the problem, Sternberg observes that "obsession with the Davisian concept led students to mentally shoehorn forms produced (in the tropics) into a cycle. It was not difficult to conjure up the hypothetical intermediate forms necessary to establish a complete genetic sequence of cycle. In this way, sinkholes, so-to-speak negative forms, were assigned to the beginning of the series and kegelkarst, or positive forms, were assumed to characterize the closing stages of the cycle. Climatological (i.e., zonal) influences can hardly be disputed. However, studies such as those of Verstappen in the Malay Archipelago, where positive and negative forms were found intermingled, suggest that it would be far too much of a simplification to merely distinguish between 'normal' (or temperate) and 'tropical' karst features."

(3) Research on the characteristics and evolution of the meia-laranja (half-orange) landscapes, as exemplified in Brazil. Sternberg notes several problems in these landscapes: (a) "the surface of the unweathered rock covered by the material weathered in situ is not parallel to the subaerial surface of the land; (b) the extent to which alteration in the plant cover affects evolution of the half-oranges and the formation of 'stone-lines' is not yet quite clear; (c) the long-term evolution of these landscapes with their 'seas of hills' sculpted on weathered material" is not fully explained.

(4) Research on characteristics of plinthite and its geomorphological role. Sternberg comments that it is necessary to determine the extent to which the ferruginous crusts really cover the plateaus and tablelands in the tropics, since R. Feuer showed the crust in the Central

* Personal Communication, April 18, 1966.

Plateau of Brazil to be a peripheral phenomenon. The degree of induration and the exact nature, whether scoriaceous or conglomeratic, of the crust require examination. The protection afforded by the crust in the formation of an erosion surface and its dissection by linear erosion are other problems to be examined.

(5) Explanation of tropical forms of solifluction and mass movements, as, for example, the recent landslides in the area of Rio de Janeiro.

(6) Clarification of the climatic conditions for pediplanation.

(7) Research on cryptodecomposed rocks and geomorphic evolution in the humid tropics.

(8) Explanation of the massive production of kaolin in the tropics and its geomorphological implications.

(9) Research on the geomorphological significance of seasonal variations of moisture in various soil horizons and of the water table.

4. Hydrology

The Ad Hoc Committee on International Programs in Atmospheric Sciences and Hydrology of the (U. S.) National Academy of Sciences - National Research Council[24] in 1963 enumerated and discussed the more pressing problems that should be investigated in an international research program. Those topics that appear to be most relevant to the hydrologic knowledge of the humid tropics are:

- Features of the Hydrologic Cycle

  (1) Interrelationships of land use and water yield
  (2) Dynamics of water movement in soil-plant-atmosphere system
  (3) Clarification of the energy-budget method of estimating evaporation and transpiration
  (4) Role of regolith in storage

- Mechanisms of Transport by Water

  (1) River and atmospheric transport of solutes
  (2) Sediment transport on rivers of different sizes in different terrains and reservoir sedimentation
  (3) Basic characteristics of river mechanics (hydraulic geometry, hydraulic roughness, characteristics of river-bed sediments)
  (4) Circulation of water in lakes and reservoirs
  (5) Littoral drift of sand
  (6) "Rafting" by plants

- Paleohydrology

  Reconstruction of past hydrologic regimens by C-14 dating

This list suggests the broad scope of research needs, but it merely identifies some of the gaps that are recognized by experts. A much longer listing, without discussion, is contained in the report on Scientific Hydrology by the Ad Hoc Panel on Hydrology presented to the (U. S.) Federal Council for Science and Technology[5] in 1962.

The importance of adequate water supply is especially great in island areas. G. A. Macdonald[23] considers the groundwater problems to be of prime concern in the development of the Hawaiian Islands. As examples of specific problems, Macdonald cites: (1) determination of the safe yield of aquifers in critical areas; (2) study of the principles of fresh water-salt water relationships in the Ghyben-Herzberg lens; (3) quantitative hydrology of all the islands; and (4) artificial recharge.

D. BARRIERS TO ADVANCEMENT OF KNOWLEDGE

The main obstacles to closing the gaps in knowledge of the physical features are not inadequacies of the scientific fields involved or the methods and techniques of research. Instead, they are the problems of time, resources, communication, and transportation.

In the authoritative view of Dixey, [20a] "Knowledge of the geology of a region in sufficient detail to be of value for scientific or economic purposes can be acquired only by geological mapping, but this, even with every modern aid, is often a slow and exacting process, in which any one country requires a considerable staff of experienced geologists for many years. In view, therefore, of the general slow opening up of Africa until the last few years, it is not surprising that a considerable part of the continent is still unknown or only slightly known geologically."

Another expert, J. Rodier [20b] has commented that "hydrological knowledge of the equatorial regions (of Africa) is limited mainly because of the recent date of exploration of these regions, the very great difficulty experienced in recruiting observers and the poor communications." In this statement, "communications" means transportation and specifically the conveyance of equipment to the field and of observations to data-collecting centers.

In a recent discussion of the activities of Peace Corps geologists in Ghana, O. Gates[25] noted that "it took them about six months to learn the specialized technique of doing geology under tropical conditions. They had to learn how to keep track of location in thick jungle, how to live with inaccuracies in topographic maps, where to find outcrops, how to identify deeply

weathered rocks, how to handle work crews, how to negotiate with local chief and district commissioners, where to obtain food, and how to set up comfortable camps." He adds that "the scarcity of good exposures of bedrock makes field mapping slow, frustrating and too generalized to permit reasonably confident and detailed geologic conclusions." Gates refers to the relatively short life of jeeps in this region and the expense and difficulty of obtaining repairs, and, in reference to a mineral investigation program, the lack of an access road and suitable drills.

In 1961, J. A. Katili[23] informed the 10th Pacific Science Congress that, despite good equipment, the advance of geologic knowledge in Indonesia is impeded by the lack of funds to publish results of governmental investigations, the refusal of competing oil companies to publish results of their investigations, and the difficulty researchers have in obtaining foreign journals to keep abreast of geologic progress elsewhere. The problem of concealment of knowledge, referred to by Katili, is one of unknown, but presumably large, magnitude in many areas. The problem of poor communication is caused by difficulties of foreign currency exchange in Indonesia and, no doubt, in other countries, too.

Note has been taken of inadequate dissemination of knowledge caused by the apparent failure of UN organizations to publish results of their scientific and technical activities and distribute them so that they will be promptly and readily available (see Section B). The UN and its agencies are not alone in permitting this breakdown in communications. Less easily substantiated, but well recognized by scientific information experts as a cause of poor dissemination of knowledge, is the failure of scientists to make adequate use of available literature. In short, whatever the causes, poor communication leads to stunting of scientific development and needless duplication of effort.

In the 1953 Regional Conference on Mineral Resources Development[26] held in Tokyo under ECAFE sponsorship, it was stated by a Committee on Geological Surveys that "the geological surveys of most countries of the region (Southern Asia and the Far East) were understaffed... (and) that, with some exceptions, training facilities for geologists in the region were inadequate." The shortage of trained scientists is a common problem in the developing countries, despite continuing training programs.

The lack of financial resources is the most compelling barrier to the advancement of knowledge. The committee on geological surveys, reporting to the ECAFE Regional Conference in 1953, felt that "because of the high cost of systematic surveys,... it was primarily the responsibility of governments to undertake this task." The high priority placed on systematic inventories of resources in the scientific investigations of the humid-

tropical regions is well-established (see Section B). It is also clear from the record that many governments of these regions are not able to meet the expense of prolonged, intensive surveys. Massive aid from the more affluent countries, international organizations and foundations has been necessary to activate and sustain the development programs.

It is not surprising that the more purely scientific programs tend to have less certain support. Thus, the current status of the UNESCO Humid Tropics Research Program has become unclear. In its December 1963 meeting, the Advisory Committee for the program, commenting on the UNESCO Proposed Program Budget for 1965-66, "noted the fact that the Humid Tropics Research programme, as such, is eliminated from the new (UNESCO) programme, although some provision seems to be made for most of the principal continuing activities... It notes, however, with considerable concern that by combining the Humid Tropics programme with the Arid Zone (Research) programme and other activities the funds available for attention to humid tropics problems are considerably reduced, even though they have previously been already inadequate to carry out an effective programme."[8]

E. AVAILABILITY OF DATA

1. Authorities

Persons who have conducted significant investigations of some aspect(s) of physical features of the humid tropics, regardless of their present locations, are considered authorities and sources of information. They are listed in Appendix A (Authorities).

2. Depositories

Appendix B (Principal Depositories) of this compendium should be consulted to determine the amount, type and availability of humid-tropical regional research materials located in depositories containing holdings important in quantity, quality, or in both respects.

3. Maps and Aerial Photographs

Appendix C (Inventory of Maps and Aerial Photographs) should be consulted to determine the amount, type, scale, recency, reliability, areas of coverage, and the other pertinent data concerning map and air-photo coverage of the humid tropics. Additional sources and indices are noted there for more detailed information.

4. Research Organizations

This Inventory is supplemented by a Directory of Institutes Primarily Devoted to Humid Tropics Research, compiled by T. L. Hills (McGill University, Montreal) for the International Geographical Union, with the support of the Army Research Office, and issued in 1965. The Directory identifies organizations engaged in special investigations of humid-tropical environment.

Appendix B (Principal Depositories) of the present volume includes research institutions that are also important depositories.

5. Bibliography and KWIC Index

Volume I of this Inventory (KWIC Index – Humid Tropic Environmental Literature), contains the bibliography that was collected at domestic and foreign depositories. The bibliography has been indexed in the KWIC (Keyword in Context) format to assist users in rapid searching of titles.

The volume contains five sections: A — Frequency of Stop Words; B — Frequency of OK Words; C — Author Listing and Index; D — Keyword Listing and Index; E — Bibliographic Listing and Index. The last section (E) is arranged in geographic, subject and author order.

In the category of Physical Features, the Inventory contains 4153 titles. Approximately half deal with surface configuration and the remainder are divided almost equally between titles on surface materials and hydrology. Among the humid-tropical regions, Africa and Latin America have received most attention in the literature.

F. PRINCIPAL NEEDS FOR ADVANCING STATE OF KNOWLEDGE

The special needs in respect to physical features of the humid tropics are common to all the sciences involved and the supporting technologies:

- Complete coverage of the humid tropics with standardized, detailed data
- Development of criteria for application of data to different practical (military, civilian) problems

- Development of tools and procedures for making standardized measurements and interpretations.

- Synthesis of data with other environmental information for definition of regional environmental types and development of analog patterns

- Development of rapid data storage and retrieval systems aimed at permitting special assemblages of data on demand

- Development of mechanisms for efficient, regular exchange of information developed in humid tropics and elsewhere

G. RECOMMENDATIONS FOR ADVANCING THE STATE OF KNOWLEDGE

Some actions necessary to close the gaps in knowledge and make information more readily available are being taken, as the review of current programs has indicated (see Section B). On the whole, it is not the lack of programs that is so serious but the slow rate of progress toward the ultimate goals. Thus, the recommendations that can be made refer both to initiation of action and, where applicable, to continuation and improvement of existing action.

(1) In the developing countries of the humid tropics, aid from the United Nations and its agencies, intergovernmental organizations, and foreign governments is instrumental in producing urgently needed data for economic development and establishing national scientific and technical services capable of acting independently in the future. Where programs have not been started, they should be started promptly; where programs are in progress, every effort should be made to accelerate them.

(2) The training of nationals of the humid-tropical countries to assume the responsibility for scientific and technical investigations is not progressing with commendable speed. This weakness will probably persist until general education becomes widespread and more trainees are available. However, R. W. Fairbridge cautions against placing these nationals in foreign universities in which they are not prepared to compete, partly because of the language barrier.* Instead, he recommends that these students be given an opportunity first to become acclimated by attending schools with special facilities for foreigners for a year or two.

Programs should be initiated or accelerated without delay.

*Personal Communication, July 1, 1966.

(3) Inadequate dissemination of knowledge is an acute problem in all parts of the world, but nowhere more than in the humid tropics. The problems begin with the prolonged delays in publication of reports and maps. More funding is necessary to permit scientific agencies to make their findings available as soon after they have been compiled as is possible. Rapid, full interchange of information among researchers will require cooperation of international organizations (especially scientific unions and societies) in making use of and founding new clearinghouses.

(4) In his recommendations to UNESCO for advancement of geologic knowledge of Africa, Dixey[20a] comments on the need for improvement of conditions of employment for geologists with government surveys and the need for liaison between surveys and universities so as to secure assistance on specialized problems from geologists in the latter institutions.

(5) Dixey emphasizes the need for initiating and expanding photographic and topographic surveys. Topographic base maps are indispensable for geologic and soil surveys. Photographs are needed for photogrammetric production of topographic maps and as a direct source of geologic, geomorphic, and soils data.

For the humid tropics, B. J. Garnier believes that the full value of airphoto surveys has not been gained.* In general, "the value of airphotos as a means of establishing various physical characteristics is well-known; so are their limitations. In the particular context of the humid tropics, however, it should be realized that these photos, if they exist, can be examined outside the area by experts in midlatitude institutions. Thus, it may be possible to make up for (a) the lack of trained local personnel in tropical lands and (b) the reluctance of midlatitude personnel to take on long-term or permanent posts in the tropics where future conditions are uncertain. Garnier feels that possibly "the best contribution which many nontropical countries could make is by having their experts work on data which do not require the interpreter's physical appearance in the tropics. Airphotos would provide such data, allowing always for their limitations in a tropical context." Garnier, therefore, recommends activation of an airphoto program for the humid tropics.

R. W. Fairbridge calls attention to the need for remote sensing, making use of film/filter combinations, infrared and radar imagery, with all systems combined in a single aircraft.** Fairbridge notes that multisensing is necessary, particularly in the tropics, because of the prevalence of haze and clouds which limit surveys in some areas to a few weeks in a year.

*Personal Communication, February 9, 1966

** Personal Communication, July 1, 1966

(6) General development of these regions will be expedited by removal of legal, taxation and communication barriers to the development of already known mineral deposits for foreign trade. It will also be assisted by the development of rock, soil, and mineral resources for local use in building and agriculture.

The well-defined recommendations for the improvement of hydrologic knowledge merit separate comment, although some coincide with those relating to geology, geomorphology, and soil science.

The program recommended by the Intergovernmental Meeting of Experts on Scientific Hydrology in 1964 for the International Hydrologic Decade contains the following basic components:[14]

(1) Appraisal of the state of knowledge of the hydrology of the world and identification of the principal gaps in that knowledge

(2) Standardization of instruments, observations, techniques, and terminology for the collection, compilation, and reporting of data

(3) Establishment of basic networks and improvement of existing networks to provide fundamental data on hydrologic systems ranging in size from small watersheds to the whole world

(4) Research on hydrologic systems in selected geologic, geographic, topographic, and climatic environments, constituting "representative basins"

(5) Research on specific hydrologic problems of such urgency and special nature as to require considerable international effort

(6) Theoretical and practical training in hydrology and related subjects

(7) Systematic exchanges of information

In addition, the following basic operations are considered necessary to execute the program:

(1) Increase in network of observation stations (pluviometric, hydrometric, hydrogeologic, hydrometeorologic) and standardization of measurements

(2) Designation of special Decade stations to obtain data of comparable quality in each country

(3) Designation of representative basins to carry out studies aimed at obtaining a better understanding of the hydrologic cycle

(4) Selection of experimental basins in which natural conditions are deliberately modified

(5) Designation of benchmark stations and basins — in which natural hydrologic regimens are unchanged by man — to provide reference data for interpreting long-term trends in the hydrologic cycle

The Experts on Scientific Hydrology provided explanations of their recommendations and outlined in detail the individual topics to be examined by the Decade program. Their expert opinion is reinforced by the proposals submitted earlier by the Ad Hoc Committee on International Programs in the Atmospheric Sciences and Hydrology of the (U.S.) National Academy of Sciences-National Research Council in 1963[24] and the Ad Hoc Panel on Hydrology of the (U.S.) Federal Council for Science and Technology in 1962.[5]

The Experts on Scientific Hydrology look to national committees in the member states, scientific organizations (such as the International Association for Scientific Hydrology and the International Association of Hydrogeologists), UN organizations (UNESCO, FAO, WMO, and others), and a coordinating council drawn from member states of UNESCO to implement and monitor the Decade program. The NAS-NRC Ad Hoc Committee (full title above) discussed implementation of international programs in much the same vein but mainly from the standpoint of encouragement and assistance that should be provided by the United States.

The recommendations for advancement of scientific knowledge of the humid tropics made by scientific and technical bodies do not refer to military applications, but the accomplishment will be contributory to these special purposes. It is necessary, however, for military research and development agencies to extend their efforts in the direction of improving the conversion of basic data to the needs of military operations if terrain intelligence is to remain viable. It is less the function of military agencies to gather the basic data than to assist the scientific and technical organizations in the development of research tools and techniques. The interplay between military and nonmilitary research objectives was established in World War I and has reached a stage of extensive overlap, as current research projects sponsored by military organizations demonstrate.

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CHAPTER III

PLANT AND ANIMAL LIFE*

A. INTRODUCTION

Approximately two-thirds of the world's plant species are found in the humid tropical one-third of its land area. A considerable part of the biological world of the tropics needs identification as an initial step toward understanding this region. Scientists estimate that some 25,000 plant species in the Amazon Basin alone have yet to be discovered.** Within this same area, the plant ecology and geography remain in the stage of observation under existing conditions.[1] The need for additional extensive and descriptive as well as intensive and analytical efforts into the enormous quantity and diversity of plant and animal life of the humid tropics can be readily appreciated.

1. Systematic Field of Interest

Within the field of tropical plants and animals, this report emphasizes the following:

- Plants

  Forest and shrub associations: distribution patterns of trees and associations, location, principal species, density, height, diameter of trunk or stem, density of canopy, seasonality of foliage, color, albedo, forest litter, root systems, fungi, plants with thorns or spines, cutting edges, irritants, seasonal susceptibility to fire, herbicides, defoliants

  Grasses: location, principal species, seasonal characteristics, color, albedo, heights, density, seasonal susceptibility to fire, plants with thorns or spines, cutting edges, irritants, herbicides, defoliants

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**Maguire, Bassett, 1965: Personal Communication dated Oct. 5.

Crops: location, principal species, heights, density, seasonal aspects, harvesting, color, albedo, use of irrigation, flooding, terracing, spraying, seasonal susceptibility to fire

Utilization: suitability for food, construction material, camouflage

Indicator significance

- Animals

Distribution: geographical distribution or range, specific habitat, movements and migrations, numbers, density

Significance: poisonous, disease vectors (vertebrate and invertebrate) and reservoirs, food sources, destructive, predatory, pests, parasites

Habits: method of locomotion, preferred time of activity, life span, breeding, feeding, phenology

Countermeasures: control measures, repellants, antidotes, disinfestation

2. Limitations

The major limitation to research on tropical plant and animal life may be the wealth of tropical plant, animal taxa and life forms, which imposes a tremendous obstacle to scientists attempting to gain a thorough knowledge of them.

Studies of tropical plants and animals, for the most part, tend to be: (1) studies focused on a single taxon at a specific level; (2) broad studies with geographic scopes covering entire continents and taxonomic scopes covering classes, orders or even phyla.

While many herbaria and zoological gardens in the midlatitudes have tropical collections, seldom can this kind of facility re-create the true natural environment. Complete understanding of the organisms can be achieved only by studies conducted on plants and animals in their native habitat. This lack of field studies has limited the progress of tropical ecological research.

3. Value of Research

a. Importance to the Military

From the standpoint of high-level or tactical decisions knowledge of the plants and animals of the humid tropics is important.

Surface plant cover significantly affects military operations in a variety of ways:

- Facilitates or impedes movement of personnel and mechanized equipment
- Accentuates or conceals evidence of military activity
- Governs ease with which clearings can be made for construction of roads, airfields and military installations
- Serves, on occasion, as a source of fuel, food or construction materials

In addition, certain types of vegetation serve as indicator species to soil type, drainage conditions or other factors of interest to the military. An entire Appendix volume devoted to vegetation was prapared in connection with the ground mobility studies performed in Thailand by the U.S. Army Corps of Engineers.[2] Factors considered included

- Vehicular path length: due to obstacles produced by large plants or clumps of small plants, vehicles may be forced to alter their course in order to proceed toward their objective.
- Frictional impedances: produced primarily by the effect of large numbers of small plants acting as a unit; the energy required to overcome such friction varies with the size, density and strength of the plants involved.
- Vehicle damage: caused by buildup of crushed plants between the inner surface of the vehicle's tracks and the driving sprocket or idler, which can break the tracks; also, thorny plants puncture pneumatic tires, and broken plant parts block airflow to the radiator, causing air-cooled engines to overheat.
- Visibility: the speed at which vehicles can operate is largely dependent upon visibility and the driver's knowledge of the area.

Camouflage, escape, evasion, and sometimes individual or unit survival may depend upon vegetation. The survival capability of soldiers is enhanced by knowledge of surface cover and of edible, medicinal and poisonous fruits, plants and roots.

Research on tropical animals also provides input for another critical element of the environment in the humid tropics. The Anopheles mosquito and the tsetse fly are examples of the many insect disease vectors found in this area. Scrub typhus, a disease carried by mites which occur in grassland areas, was a serious problem for military forces in some areas in the last World War. Recent military operations in Malaya also have been hampered by the occurrence of this disease. There are various other important tropical diseases such as leptospirosis and those due to parasitic worms (hookworm, schistosomiasis, onchocerciasis, etc.). Research on tropical insects has led to limitation and partial control of such diseases as yellow fever, malaria and other zoonoses which once were severe problems to tropical operations.

Among the varieties of poisonous snakes found in the humid tropics are the Australian death adder (Aconthophis spp.), tropical and South African mambas or tree cobras (Dendroapis spp.), and the many species of viperidae such as the bushmaster (Lacheses spp.) which ranges from tropical Brazil to Panama. Relative to other health hazards, however, poisonous snakes are not considered a more serious threat in the humid tropics than in other parts of the world. While snakes are not aggressive generally, their effect on morale may be of more than routine concern. The Arctic, Desert, Tropical Information Center, Maxwell Air Force Base, has produced guides to the distribution, identification and characteristics of the poisonous snakes of many areas of the world.[3]

Studies of the habits of edible animals are needed in order to increase survival capabilities.

b. Importance to Civilians

Living standards and economic status in the humid tropics are directly related to the extent of knowledge of natural resources and how they may be exploited most advantageously. Forests, for example, occupy approximately one-fourth of Africa's total land surface; yet, only one-third of these accessible forests have been or are being worked.[4] Because of the composition of the forests (many species, only a few of which have high economic value), the yield per unit area is low. Also, large areas of forest capable of producing large quantities of timber are burned yearly in the process of shifting cultivation, which is a form of agriculture with relatively low productivity.

Improvement in the field of agricultural production is of vital concern in many tropical areas because the diets of tropical peoples tend to be protein-deficient. Introduction of new and different species of cattle, crops, timber, and grasses into several tropical areas has had limited success, and efforts are being made in West Africa and Malaya to develop sea- and fresh-water fisheries. Lack of application of proper techniques of animal husbandry and veterinary practices has led to failure of development schemes such as the Gambian egg scheme. The East African groundnut experiment failed because of the lack of a pilot experiment preceding the large-scale operations (because of political pressure) and insufficient climatic data. The failures of the Ford rubber estates on the Trapajos river, an area of the Amazonia, occurred where climates are least favorable.

Human diets in most of the humid tropics can be improved significantly by additional botanical and zoological research. Some staples such as rice and bananas already have benefited by research programs, but there is still much work to be done on maize, cassava and other staples, particularly in the area of pest attacks, microbial diseases and parasites.

Except in a few areas, e.g., Java, Thailand, where the soils and climates are unusually favorable, the subsistence crops in humid-tropical countries are grown mainly or entirely on shifting systems of cultivation. These, although fairly satisfactory for small populations, usually are not sufficiently productive and cannot support dense populations. The need is to devise high-yielding permanent agricultural systems which will not lead to soil deterioration.

B. STATUS OF RESEARCH

1. History of the Development

The modern scientific study of tropical plants and animals may be traced back to the 19th century. Charles Darwin (during the expeditionary cruise of the HMS BEAGLE) and A.R. Wallace, working in the tropics of Southeast Asia, gained insights which have strongly influenced subsequent biological studies. Darwin's evolutionary theories began with his speculations on the nature of the fauna encountered in the Galápagos Islands; Wallace's conclusions, based on work in South America (Rio Negro and Upper Orinoco) and Malaya, were essentially identical. In July 1858, a joint paper was delivered before the Linnean Society of London setting forth their evolutionary hypothesis of natural selection. Later, each expanded further on these studies as Darwin wrote The Origin of Species by Means of Natural Selection[5] and Wallace wrote The Geographical Distribution of Animals.[6] These scientists, by their work in the tropics, were able to lay down some of the fundamental hypotheses which remain the keystone of modern evolutionary theory.

a. Plants

Plant geography originated with the travels and writings of Alexander von Humboldt whose essay on the geography of plants was based on the concept of studying the distribution of organic life as related to habitat.[7] He is credited with making the first contribution to what is now termed synecology or study of biological communities. His application of systematic classification and comparison of observed phenomena represents the initial step from qualitative to quantitative description.

The idea of an inevitable sequence of communities leading to a climax characteristic of the climatic conditions of the tropical region was developed. A. F. W. Schimper divided vegetation into tropical, temperate and arctic types by zones of latitude.[8] He then divided the formation types in each zone of latitude and belt of altitude into climatic formations determined by precipitation and edaphic formations determined by the soil or its moisture content. Schimper's work also represents one of the earliest attempts at vegetation cartography using a formation basis. Von Faber's revision of Schimper in 1935 which attempted global classification, recognized 15 formation-classes.[9]

Later classifications were based on other criteria: Warming based his primarily edaphic classification on water balance;[10] F. E. Clements made a great advance when he introduced the concept of the vegetation climax and emphasized the importance of plant succession. Although Clement's ideas still are challenged, they form the basis for many accepted ecological principles.

Other scientists rejected or modified these classifications as they saw fit. Chipp and Tansley[11] outlined concepts modified from those of Clements which are widely used in tropical vegetation work. Tansley, who for many years influenced ecological thought, mainly followed Clements but added a simplification of terms designed to relieve the problems of recognizing and defining biotically controlled climaxes in different geographic regions.[12] In 1939, Tansley joined with Watt and Richards to publish a scheme for recording structure, life form and flora of tropical forest communities as a basis for their classification.[13] Aubreville[14] recognized six main vegetation types in Africa and divided each into climatic, edaphic and degraded formations.[15]

Beard's system of classification by physiognomic characters of the vegetation used extensively in New Guinea involved three levels: floristic (or association) grouped into structural units (formations) and into environmental units (formation series).[16] The system pointed up obvious gaps in the communities recorded and facilitated description when a continuous series of vegetation types was encountered.

Several floristic classifications have been attempted, dating back to Schouw who selected 25 kingdoms and named them for the most characteristic plants.[17] Raunkiaer's floristic approach published in 1903 classified plants on a statistical basis according to the position of their regenerating parts and initiated the practice of grading actual plant communities.[18] His leaf-size classes introduced in 1934 have been a much-employed scale for grading plant communities under contrasting climates. J. Braun-Blanquet developed a system which is based mainly on floristic composition and which pays little regard to physiognomy.[19] The Braun-Blanquet system requires concentrated analysis to reveal the whole structure of the vegetation and relationships between plants of a community.

A more recent floristic classification is that of Good whose objective may be stated as:

> " . . . to divide the land surfaces of the world into a convenient but not too large number of regions, each of which may be regarded as supporting a flora of its own; that is to say, a flora which is characteristic of the region. This essentially historical and phylogenetic conception of the regions is of great importance not only as a step toward the broader understanding of plant geography in general but also because it helps to lessen the problem of treating, as equivalent, floras which are in fact very different in nature, size and richness."[20]

Braun-Blanquet employed a system of vegetation cartography using detailed combinations of colors and symbols for designating vegetation and environment factors. A highly developed vegetation cartographic system also was employed by Gaussen in the French Mediterranean and tropical Tahiti.[21] It produces maps, which serve equally well as climatic or vegetation maps, but requires an immense amount of data for construction. Both Küchler[22] and Dansereau[23] have devised systems of notational symbols to record structural characteristics of the vegetation types portrayed on maps.

M. Y. Nuttonson at the American Institute of Crop Ecology has been producing agroclimatic analogs since 1935. Several of these studies have been conducted in the Southeast Asian tropics.

One of the most outstanding contemporary works on tropical vegetation is Richards' ecological study, The Tropical Rain Forest.[24] H. Walter's standard German work on the vegetation of the tropics published in 1962[64] is the successor to Schimper's Plant Geography. Other contemporary scientists who have made significant contributions to the study of tropical vegetation are F.R. Fosberg, C.G.G.J. van Steenis, B. Maguire, L.R. Holdridge, S. Cain, G. Budowski, C. Troll, F. White, D. B. Fanshawe, and

H. A. Gleason. P.S. Ashton's Ecological Studies of the Mixed Dipterocarp Forests of Brunei State[25] and Schulz's study of the Surinam rain forest are considered important contributions to the knowledge of mixed tropical forests.

While early works are strong in description, more recent works are largely quantitative. Several recent phases of the study of tropical flora are (1) the descriptive phase which flourished as recently as the early forties and (2) the mathematical phase which followed and persisted until the mid-50's. Today, the two approaches to plant geography are the floristic school which attempts to establish the areal extent of a particular species' distribution and the ecological school which studies the species' distribution in relation to its environment.[26]

So far, no entirely acceptable method has been developed for classifying vegetation on the basis of structural properties important in military operations. Structural classifications must consider dimensional characteristics such as height, crown shape and stem diameter; physical properties such as woodiness, deciduousness and leaf characteristics; and distribution such as spacing of stems and coverage of canopy. The most advanced of the few classifications of this type is a modified version of a system developed by Pierre Dansereau under contract with the U.S. Army Engineer Waterways Experiment Station.[27] Dansereau's "Universal System for Recording Vegetation" offers a method for depicting physical characteristics of vegetation and site conditions in terms of simple concepts.

b. Animals

Scientific zoogeography may be said to date from the time of the studies and writings of the Frenchman Buffon and the German E.A.W. Zimmermann during the late 18th century.[28] Through their works on the distribution, description and classification of faunal associations, it became possible to determine that various areas of the world were distinguished by specific groups of animals. In 1778, J.C. Fabricius published his Philosophia Entomologica in which he regionalized the world zoologically. Sclater's work, On the General Geographical Distribution of the Members of the Class Aves, published in 1858, is a significant effort in this field. Sclater divided the world into six major divisions — Palearctic, Nearctic, Ethiopian, Indian (later replaced by Oriental), Neotropical, and Australian.[28] It is this set of divisions which gained the greatest support and, with minor modifications, is used by the present generation of zoogeographers.

Until World War I, historical and regional studies dominated zoogeography, but neither subdivision of the field distinguished itself.[28] Today, there are four approaches to zoogeography: the regional, the historical, the ecological[29], and the cultural recently proposed by Bennett.[30]

Probably the most noteworthy zoogeographical books of recent years are Darlington's Zoogeography,[31] a work on global geographical distributions primarily of vertebrates, and Hesse's Ecological Animal Geography.[32] Other contemporary scientists who have made significant contributions to the study of tropical animal life are S.D. Ripley, J. Marshall, A. Wetmore, T. Borgmeier, F. Bourlière, P. Slud, A. Keast, and E. Wilson.

2. Evaluation of the Development

Most of the data and theories of the botanical field refer to nontropical regions and generally are not applicable to the tropical world without modification. Yet, several of the major advancements in the field have occurred as a result of actual field experience in the tropics.[31] For example, it is very questionable that Schimper would have written his Plant Geography[8] had he never left Germany. Darwin's and Wallace's theories of natural selection and evolution were influenced by visits to tropical areas.

Research in tropical zoogeography and zoology, similar to nontropical studies, tends toward either broad or narrow extremes. Efforts have been concentrated on the study of the entire animal life of a continent or study of the taxonomy, morphology or distribution of a single genus or species in a select area. The extreme taxonomic diversity of tropical animals has led to major gaps of knowledge on tropical faunas. Ideally, studies of entire animal environments of areas smaller than a continent but larger than point locations should be produced.

Much of the research on tropical plants and animals has been associated with economic enterprises. Plantation crops and the vectors of diseases have received a large share of the researchers' and scientists' attention. While many zoologists and botanists have the technical background to conduct research in the tropics, funds and facilities are limited or not available in many instances. Also, there are the difficulties met by the botanists and zoologists who must deal with extremely large numbers of species in the tropics. Darlington has emphasized the need for exposure to the tropical world and its importance by stating : "Any young naturalist who thinks he can understand the world and living things and evolution without experiencing the tropics is, I think, deceiving himself — to his great injury."[31] The Organization for Tropical Studies (1963) was established by a group of American universities to introduce an increasing number of young and active American scientists to the biological problems of the tropics. More programs are needed within the scientific community of nontropical and humid tropical nations alike to encourage biologists to work in the tropics.

C. REVIEW OF CURRENT RESEARCH ACTIVITY AND TECHNIQUES

This review of current research on plants and animals of the humid-tropical environment is based on the program's extensive literature search and contributions of project consultants C.F. Bennett Jr., R.N. Colwell, P. Dansereau, B. Maguire, and P.W. Richards.

1. Survey of Current U.S.-Sponsored Research

Institutions concerned with plant and animal research in the humid tropics include: the Chicago Natural History Museum where the work of the Botany department is concerned almost exclusively with the flora of the American tropics (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Peru); the Milwaukee Public Museum, the work of which involves ethnological studies in the rain forests of Guatemala; the University of Florida where the tropical development program includes plant ecology and forestry studies in Guatemala; and the Organization for Tropical Studies maintained in Costa Rica by the universities of Miami, Michigan, Southern California, and Washington. The University of Wisconsin's African Studies Program includes the biological sciences.

From a survey of 200 institutions (to which 70 replied) reporting on exploratory work completed or planned during the period 1958-1969, it appears that U.S.-sponsored plant research represents approximately 50 percent of total field work in the American tropics.[33]

Tables 2 through 6 present current research activity being sponsored by U.S. Government agencies. Insofar as possible, the information has been organized to reflect selectively the humid tropics areas from which field data were or will be derived and the subject of the investigation. The lists do not pretend to encompass every research project but are representative of the emphasis being placed upon humid tropics environmental research by this country today.

2. Survey of Other Current Research

The UNESCO Advisory Committee for Humid Tropics Research organized and held a symposium at Dacca in 1964 concerning Scientific Problems of the Humid Tropical Zone Deltas and Their Implications. Sections III and IV of the proceedings are concerned with vegetation and biology.[34]

Southern Asia was the main focus of the meeting (e.g., the reports by M. Ahmad on the vegetation of East Pakistan; B.A. Abeywickrama on estuarine vegetation of Ceylon; M. Schmid on the vegetation of Southern Indochina; animal pests and parasites of East Pakistan by H.K. Yosufzai;

Table 2

CURRENT HUMID TROPICS ENVIRONMENTAL RESEARCH IN THE AMERICAS

(U. S. - Sponsored)

PLANTS

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Agronomic evaluation and disease reaction studies of new sugarcanes	USDA	J. E. Stokes Beltsville, Md.	Río Piedras, Puerto Rico
Development of new varieties and improved cultural practices for control of Fusarium root rot in Vanilla	USDA	L. E. Gregory Mayaguez	Puerto Rico
Evaluation of herbicides on tropical plants	USDA	H. J. Cruzado Fed. Expt. Sta. Mayaguez	Puerto Rico
Basic cytogenetic investigations of tropical grass species	USDA	K. F. Schertz Fed. Expt. Sta. Mayaguez	Puerto Rico
Silviculture of native forests and plantations in Puerto Rico and the Virgin Islands	USDA	C. B. Briscoe Río Piedras	Puerto Rico and Virgin Islands
Identification, classification and distribution of forest trees	USDA	E. L. Little Washington, D. C.	Puerto Rico
Physiology and dissemination of the fungus, Darluca filum, a parasite of rust disease fungi	USDA	L. Calpouzos Fed Expt. Sta. Mayaguez	Puerto Rico
Role of plants and soil in shifting cultivation	U. S. Dept. of Health, Education and Welfare	H. Popenoe Univ. of Florida Gainesville, Fla.	Guatemala
Systems of adaptation in a heterogeneous environment	U. S. Dept. of Health, Education and Welfare	R. Levins Univ. of Puerto Rico Río Piedras	Puerto Rico
Functional analysis of plant communities	NSF	P. Dansereau N. Y. Botanical Garden Bronx, N. Y., 10458	Puerto Rico and Tropical Africa
Nuclear radiation effects upon a tropical rainforest environment	USAEC	H. Odum Univ. of Puerto Rico Río Piedras	El Verde Field Sta. Puerto Rico
Radiosensitivity of tropical plants of economic importance	USAEC	C. C. Mok Inter-American Institute of Agricultural Sciences of the OAS Tropical Center of Research and Graduate Training Costa Rica	Central America
Manual of leafy Hepaticae of Latin America	NSF	M. Fulford Univ. of Cincinnati Cincinnati, Ohio	Latin America
American Lauraceae: taxonomy and geographical distribution (Orinoco and Amazon Basins and Coastal Guiana)	NSF	Caroline K. Allen N. Y. Botanical Garden Bronx Park, New York, N. Y.	South America

Table 2 (Contd)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Taxonomic study of the phanerogams of Colombia	NSF	J. Cuatrecasas Smithsonian Institution Washington, D. C.	South America
Study of the Alpine flora of Mexico and Guatemala	NSF	J. H. Beaman Michigan State Univ. East Lansing, Mich	Mexico and Guatemala
Comprehensive orchid flora of Colombia and Ecuador	NSF	L. A. Garay Botanical Museum Harvard Univ. Cambridge, Mass.	Colombia and Ecuador
Revision of Juniperus for the Western Hemisphere	NSF	M. T. Hall Univ. of Oklahoma Research Institute Norman, Okla.	Mexico and Guatemala
Botanical field work in Central America	NSF	L. O. Williams Chicago Natural History Museum Chicago 5, Ill.	Central America (Honduras, El Salvador, Nicaragua, Costa Rica)
Savanna-Bush environments (The savanna ecosystem)	ONR	T. L. Hills McGill Univ. Montreal, Que., Can.	British Guiana
American Myrtaceae, Flora Mexico	NSF	R. McVaugh Univ. of Michigan Ann Arbor, Mich.	Mexico and Tropical America
Bromeliaceae, Bignoniaceae, Xyridaceae, Velloziaceae, Flora Tropical America	SI	L. B. Smith Smithsonian Institution Washington, D. C.	Tropical America
Melastomaceae, Flora South America	SI	J. J. Wurdack Smithsonian Institution Washington, D. C.	Tropical America
Grasses	SI	T. Sachestrom Smithsonian Institution Washington, D. C.	Tropical America
Flora Bolivia		R. C. Foster Gray Herbarium Harvard Univ. Cambridge, Mass.	Bolivia
Flora Lesser Antilles	NSF	R. A. Howard Harvard Herbaria Harvard Univ Cambridge, Mass.	West Indies
Araceae	NSF	B. Hartman Cornell Univ. Ithaca, N. Y.	Tropical America
Leguminosae Flora Brazil	NSF	H. S. Irvin N. Y. Botanical Garden New York City, N. Y.	Tropical America
Chrysobalanaceae Flora Amazonian Basin	NSF	G. T. Prance N. Y. Botanical Garden New York City, N. Y.	Tropical America
Cyperaceae, Monocots Neotropics	NSF	T. Koyama N. Y. Botanical Garden New York City, N. Y.	American Tropics

Table 2 (Contd)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Euphorbiaceae	NSF	E. Jablonski N. Y. Botanical Garden New York City, N. Y.	American Tropics
Guttiferae, Xyridaceae, Rafaleaceae, Theaceae	NSF	B Maguire N. Y. Botanical Garden New York City, N. Y.	American Tropics
Hevea	USDA	R. E. Schultes Harvard Univ. Cambridge, Mass.	South America
Flowering plants		I. K. Langman Univ. of Pennsylvania Philadelphia, Pa.	Mexico

Table 3

CURRENT HUMID TROPICS ENVIRONMENTAL RESEARCH IN THE AMERICAS

(U. S. -Sponsored)

ANIMALS

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Biting flies (Ceratopogonidae, Heliidae)	U. S. Army Tropical Research Medical Lab APO 851 New York, N. Y.	F. S. Blanton Univ. of Florida Gainesville, Fla.	Costa Rica and El Salvador
Periodic field collections of the intermediate snail-host of the **schistosomiasis mansoni** in varied habitats	U. S. Army Tropical Research Medical Lab. APO 851 New York, N. Y.	L. S. Ritchie Puerto Rico Field Sta. U. S. Public Health Serv San Juan, P. R.	Puerto Rico
Histoplasmosis in the American Tropics	Middle America Research & U. S. Army Medical Research Unit (Panama) Balboa, Canal Zone	R. L. Taylor	Panama
Zoogeography in Panama	ONR	C. F. Bennett Univ. of California Los Angeles, Calif.	Panama
Sterilization of Mediterranean fruit fly	USAEC	C. C. Moh Inter-American Institute of Agricultural Sciences of the OAS Tropical Center of Research and Graduate Training Costa Rica	Central America
Systematics and evolution of South American tree frogs (Hylidae and Centrolenidae)	NSF	C. J. Goin Univ. of Florida Gainesville, Fla.	South America
A comparative study of water balance in the Puerto Rican frogs of the genus Eleutherodactylus	NSF	H. Heatwole Univ. of Puerto Rico Río Piedras	Puerto Rico
Carabid beetles of the Australian region and southern South America	NSF	P. J. Darlington Jr Harvard Univ. Cambridge, Mass.	South America
Review of South American spiders of the family Agelenidae	NSF	V. D. Roth California Acad. of Sci. San Francisco, Calif.	South America
Systematics and distributions of Middle American Hylid frogs	NSF	W. E. Duellman Univ. of Kansas Lawrence, Kansas	Mexico and Central America
Taxonomy and distribution of bark and ambrosia beetles (Scolytidae and Platypodidae; Coleoptera) in Central America and Mexico	NSF	S. L. Wood Brigham Young Univ. Provo, Utah	Central America
Pseudoscorpions of Florida and the West Indies	NSF	C. Clayton Hoff Univ. of New Mexico Albuquerque, N. M	West Indies Islands

Table 3 (Contd)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Frogs of Western Brazil and Colombia	NSF	D. M. Cochran U S National Museum Washington, D. C.	Brazil and Colombia
The Drosophilidae (fruit flies) of Colombia	NSF	A. S. Hunter Universidad de los Anges Bogotá, Colombia	Colombia
Comparative rates of evolution of Molluscan faunas; completion of study of Benthic fauna of the continental slope	NSF	R. H. Parker Univ. of California San Diego, La Jolla, Calif.	Tropical Collections at Univ. of Copenhagen, Denmark Zoologiske Museum
Systematics of the fresh-water mollusks of Puerto Rico	NSF	H. W. Harry Rice Univ Houston, Tex.	Puerto Rico
Oonopidae (Araneae) of the West Indies and Central America	NSF	A M. Chickering Harvard Univ. Cambridge, Mass.	West Indies and Central America
Taxonomy and distribution of turtles in Central America	NSF	J. M. Legler Univ. of Utah Salt Lake City, Utah	Central America
Checklist of recent mammals of South America	NSF	P. Hershkovitz Chicago Natural History Museum Chicago, Ill.	South America
Neotropical mammalogical and entomological investigations in relation to arthropod-borne diseases	Dept. of the Army USAMRDC	R G. Van Gelder Amer Museum of Natural History New York, N. Y.	Uruguay, Eastern Bolivia, Northern Argentina
Study of the mammalian ectoparasites and their hosts in Costá Rica	Dept of the Army USAMRDC	F. S. Truxal Los Angeles County Museum Los Angeles, Calif.	Costa Rica
Biting insects of Northern South America and Panama	Dept. of the Army USAMRDC	R. L. Wenzel Chicago Natural History Museum Chicago, Ill.	South America and Panama
White-winged dove — its natural history and management	Dept of the Interior Wildlife Research	G. B. Saunders Patuxent Wildlife Reserach Center Gainesville Field Sta. Gainesville, Fla.	Mexico, Guatemala and El Salvador
Golden Nematode (Heterodera rostochiensis Wellenweber)	USDA	J. E. Wille Estación Experimental Agrícola La Molina, Lima, Peru	Peru, Ecuador, Colombia, Bolivia
Environmental factors influencing parasites and parasitic diseases of ruminants in Peru	USDA	C. E. Chavez Univ. of San Marcos Lima	Peru
Catalog of insects living on plants in Brazil and of the parasites and predators of the insects	USDA	A. G. d'Arango e Silva Ministerio da Agricultura Rio de Janeiro	Brazil

Table 3 (Contd)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Structural and physiological characteristics associated with adaptibility of cattle in tropical and subtropical areas	USDA	J. S. Veiga Univ. of Sao Paulo Sao Paulo	Brazil
Biology, ecology and methods of control of borers attacking sugarcane	USDA	R. G. Dahms Beltsville, Md.	Mayaguez Puerto Rico
Ecology of Arthropod-borne viruses in Panama	U. S. Dept. of Health, Education and Welfare	P. Galindo Gorgas Memorial Lab. Balboa Heights, Canal Zone	Panama
Taxonomic study of the Guano bats, genus Tadarida	U. S. Dept. of Health, Education and Welfare	W. B. David Texas A & M Univ College Station, Tex.	Southern Mexico, Guatemala, South America
Arthropod-borne viruses isolated in Panama	U. S. Dept. of Health, Education and Welfare	E. de Rodaniche Univ. of Panama Panama	Central America
Epidemiological studies of kala-azar in El Salvador	U. S. Dept. of Health, Education and Welfare	A. Trejos School of Medicine San Salvador	El Salvador
Mosquitoes of Middle America	U. S. Dept. of Health, Education and Welfare	I. M. Belkin Univ. of California Los Angeles, Calif.	Central America, Mexico, West Indies, South America
Irradiation effects on the biology of Rhodnius prolixus	U. S. Dept. of Health, Education and Welfare	J. C. Gomes R. Instituto Venezolano de Investigaciones Cientificas Caracas, Venezuela	Venezuela
Chagas' disease in Costa Rica	U. S. Dept. of Health Education and Welfare	J. C. Swartzwelder Louisiana State Univ. Baton Rouge, Louisiana	Costa Rica
North American migratory birds in Panama	U. S. Dept. of Health, Education and Welfare	H. Loftin Florida State Univ. Tallahassee, Fla.	Panama
Investigations on the biology and control of schistosomiasis	U. S. Dept. of Health, Education and Welfare	H. F. Schoof Puerto Rico Field Sta. San Juan, P.R.	Puerto Rico
Ecology of Sylvan yellow fever in Panama	U. S. Dept. of Health, Education and Welfare	G. M. Johnson Gorgas Memorial Inst. Washington, D. C.	Panama
Appraisal of chiggers and other acarines of the American tropics for pathogenic agents	U. S. Dept. of Health, Education and Welfare	J. M. Brennan Middle America Research Unit Balboa Heights, Canal Zone	Canal Zone
Taxonomic study of the Guano bats, genus Tadarida	State of Texas	A&M Agricultural Expt. Sta. College Station, Tex.	Southern Mexico Guatemala South America

Table 4

CURRENT HUMID TROPICS ENVIRONMENTAL RESEARCH IN AFRICA
(U. S. -Sponsored)

PLANTS

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Development and use of improved varieties of the major cereal crops of Africa (2 regional centers for research)	Dept. of State AID	G. F. Sprague U. S. Dept of Agriculture Washington, D. C.	Africa
Biosystematics of the genus Cynodon	NSF	J. M. J. de Wet Oklahoma State Univ. Stillwater, Okla.	Africa

ANIMALS

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Correlation of larvae and adults of terrestrial Parasitengona	NSF	I. M. Newell Univ. of California Riverside, Calif.	Africa
Behavior of Loxodonta africana	NSF	J. O. Buss Washington State Univ. Pullman, Wash.	Uganda
Revision of bats of the Sudan and surrounding areas	NSF	K. F. Koopman Am. Museum of Natural History New York, N. Y.	Africa (Sudan)
Visceral leishmaniasis in experimental animals	NSF	L. A. Stauber Rutgers-the State Univ. New Brunswick, N. J.	Africa (Kenya and Sudan)
Origin and evaluation of temperature control in terrestrial vertebrates	NSF	R. B. Cowles Univ. of California Los Angeles, Calif.	South Africa
Trematodes of fishes	NSF	H. W. Manter Univ. of Nebraska Lincoln, Nebraska	South Africa and Australia
Temperature regulation and water metabolism of East African Ungulates	U. S. Dept. of Health, Education and Welfare	C. P. Lyman Harvard Univ. Cambridge, Mass.	Africa
A behavioral study of lemurs in the field	NSF	Alison Bishop N. Y. Zoological Society New York, N. Y	Africa
Maintenance and development of a baboon colony for research purposes	U. S. Dept. of Health, Education and Welfare	H. Vagtborg Southwest Foundation for Research and Education San Antonio, Tex.	Darajani, Kenya
Research on primates of East Africa	U. S. Dept. of Health, Education and Welfare	L. S. B. Leakey Tigoni Primate Research Center Limuru, Kenya	East Africa

Table 4 (Contd)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Field studies of African primates	U. S. Dept. of Health, Education and Welfare	N. C. Tappen Tulane Univ New Orleans, La.	Nigeria
Field and Laboratory studies of intermediate host snails of **bilharziasis (schistosomiasis)** in Liberia	U. S. Dept. of Health, Education and Welfare	D. M. Levine Amer. Foundation for Tropical Medicine, inc. New York, New York	Liberia
Kala-azar investigations	U. S. Dept. of Health, Education and Welfare	B. McMillan Univ of Sydney Sydney	Southern Sudan
Sterility method for tsetse fly control or eradication	Dept. of State AID	E. F. Knipling USDA Washington, D. C.	Rhodesia,
Epidemiology of **kala-azar**	ONR	L. W. Quate Bernice P. Bishop Museum Honolulu, Hawaii	Sudan
Transmission studies of Phlebotomus (sandfly) species	U. S. Dept. of the Navy	J. H. Boyers U. S. Naval Medical Research Unit #3 Navy No. 540 c/o Fleet P.O. New York, N. Y.	Sudan
Bionomics of Phlebotomus flies (sandfly) in a Sudanese focus of **kala-azar**	U. S. Dept. of the Navy	J. H. Boyers U.S. Naval Medical Research Unit #3 Navy No. 540 c/o Fleet P. O. New York, N. Y.	Sudan
Ticks (Ixodioidea) of Central Africa, their distribution and biology	Dept. of the Army USAMRDC	G. Anastos Univ. of Maryland College Park, Md.	Congo (B.)

Table 5

CURRENT HUMID TROPICS ENVIRONMENTAL RESEARCH IN SOUTH ASIA AND OCEANIA

(U. S. - Sponsored)

PLANTS

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Ecological diversity of temperate and tropical communities	NSF	J. H. Connell Univ. of California Santa Barbara, Calif.	North Queensland
Flora of Formosa (Taiwan)	NSF	Hui-Lin Li Univ. of Pennsylvania Philadelphia, Pa.	Formosa
Taxonomical, anatomical plant sociological and ecological studies of the flora of Indonesia	NSF	A. J. Kosterman Herbarium Bogoriense Bogor, Indonesia	Pentjang Island (SW Java)
Monographic studies of the Discomycetes (local floristic studies)	NSF	Richard P. Korf Cornell Univ. Ithaca, N. Y.	India, Indonesia Pakistan, Philippines Taiwan
Biosystematics of the genus Cynodon	NSF	J. M. J. de Wet Oklahoma State Univ. Stillwater, Okla.	India, Philippines, Australia
Use of auxins in vegetative reproduction of forest plants	USDA	K. K. Nanda Forest Research Inst. and Colleges Dehra Dun	India
Survey of natural enemies of witchweed and of water hyacinth and other weeds affecting waterways in India	USDA	V. P. Rao Bangalore Sta Bangalore	India
Response of various maize germplasm sources to different agronomic practice	USDA	G. W. Baird Indian Agricultural Research Inst. New Delhi	India
Vegetation mapping		A. W. Kuchler Univ. of Kansas Lawrence, Kan.	Hawaii

Table 6

CURRENT HUMID TROPICS ENVIRONMENTAL RESEARCH IN SOUTH ASIA AND OCEANIA

(U. S. - Sponsored)

ANIMALS

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Behavior and ecology of the Red Jungle Fowl (Gallus gallus)	NSF	N. E. Collias Univ. of California Los Angeles, Calif.	SE Asia and India
Biological exploration of New Guinea (collection of mammals, ectoparasites, plants, amphibians, reptiles, insects, and fresh-water fish)	NSF	H. M. Van Deusen Amer. Museum of Natural History New York City, N.Y.	New Guinea (Rawlinson Range, Saruwaged Range and Cromwell Mountains)
Zoogeographic studies of New Guinea insects, particularly the beetle family Chrysomelidae	NSF	J. L. Gressitt Bernice P. Bishop Museum Honolulu, Hawaii	New Guinea
A behavioral study of lemur in the field	NSF	Alison Bishop N. Y. Zoological Society New York City, N. Y.	Malagasy Republic
Ecology, behavior and breeding of tree shrews	NSF	W. W. Howells Harvard Univ Cambridge, Mass.	Malaya
Comparative morphology and phylogeny of the Annonaceae and related ranalean families	NSF	J. E. Canright Indiana Univ. Bloomington, Ind.	Malaysian Region
Termites of Burma and revision of the genus Capritermes	NSF	K. Krishna Amer. Museum of Natural History New York, N. Y.	Burma
Taxonomy, geographical distribution, ecology, social behavior, and evolution of termites (involves collection for American Museum of Natural History, New York City)	NSF	A. E. Emerson Univ. of Chicago Chicago, Ill	New Guinea, Borneo, Malaya, and Ethiopia
Alpheid shrimp fauna of Thailand	NSF	A. H. Banner Univ of Hawaii Honolulu, Hawaii	Thailand
Acarine, a parasitic disease of honey bees	U. S. Dept. of Health, Education and Welfare	S. Singh Government Agriculture College Ludhinana-Punjab	India
Survey for natural enemies of Chermes spp. attacking silver fir and spruce in the Himalayas	U. S. Dept. of Health, Education and Welfare	V. F. Rao Commonwealth Inst. of Biological Control Bangalore	India
Control of the coconut rhinoceros beetle, Dynastine Scarabaeid Oryctes monoceros	U. S. Dept. of Health, Education and Welfare	C Kurian Central Coconut Res. Sta Kerala	India

Table 6 (Contd)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
General medical research (International Center for research and training: cholera, liver disease, small mammals and birds, filariasis and hookworm virology)	U. S. Dept. of Health, Education and Welfare	F. B. Bang Johns Hopkins Univ. Baltimore, Md.	Calcutta, India
Immunological study of South Asian snake venoms	U. S. Dept. of Health, Education and Welfare	S. A. Minton Jr. Indiana Univ. Foundation Bloomington, Ind.	South Asia
Parasites of Philippine food fishes	U. S. Dept. of Health, Education and Welfare	C. C. Velasquez Univ. of Philippines Diliman, Quezon City	Philippines
Siphonaptera of Taiwan	U. S. Dept. of Health, Education and Welfare	E. W. Jameson Jr. Univ. of California Davis, Calif.	Taiwan
Vertical distribution of mammals in Malayan forest	U. S. Dept. of Health, Education and Welfare	R. L. Rudd Univ. of California Davis, Calif.	Malaya
Systematic studies of the malaria parasites of monkeys and apes of Malaya and nearby territories	U. S. Dept. of Health,	D. E. Eyles and McWilson Warren	Malaya and Other Asian Areas
Adaptability of cattle and buffalo for dairy production	U. S. Dept. of Health, Education and Welfare	P. Bhattacharya Indian Veterinary Res. Inst. Izatnager	India
Parasites, predators and pathogens of sugarcane borers	U. S. Dept. of Health, Education and Welfare	V. P. Rao Commonwealth Inst. of Biological Control Bangalore	India
Parasites, predators and pathogens of the European corn borer (Pyrausta nubilalis) and Heliothis spp.	U. S. Dept. of Health, Education and Welfare	V. P. Rao Commonwealth Inst. of Biological Control Bangalore	India
Biology, ecology and natural control of of insect pests attacking trees of genus Pinus introduced from USA	USDA	Yie, Shi-Tao National Taiwan Univ. Taipei	Taiwan
Transequatorial migration (bird migration)	ONR	A. Marshall Monash Univ. Clayton, Victoria	Southern Australia
Changes in Ilocos (physical and biotic environmental characteristics)	ONR	W. L. Thomas Univ. of California Riverside, Calif.	Ilocos Norte, Northwest Luzon
Larval trombiculid mites (chiggers) from Malaya and Borneo	Dept. of the Army USAMRDC	G. W. Wharton Univ. of Maryland College Park, Md.	Malaya and Borneo
Studies of life cycle, pathology and clinical aspects of the hepatic trematrode Opisthorchis viverrini	Dept. of the Army USAMRDC	Suvajra Vajrasthira Bangkok School of Tropical Medicine Univ. of Med. Sci. Bangkok	Thailand

Table 6 (Contd.)

Subject of Investigation	Sponsor	Principal Investigator and Address	Area of Investigation
Schistosomiasis in Thailand, study of etiology, epidemiology and the life cycle	Dept. of the Army USAMRDC	Mongkol Krautrachue Bangkok School of Tropical Medicine Univ. of Med. Sci. Bangkok	Thailand
Radio tracking techniques for use on rats (tracking units to study trans- of leptospirosis and scrub typhus by mammals)	Dept. of the Army USAMRDC	G. C. Sanderson	Malaya
Classification and distribution of snails in Thailand	Dept. of the Army USAMRDC	Tongchai Papasarathorn School of Public Health Bangkok	Thailand

and papers on fish fauna, fish and fisheries, and shipworms of the Sunderbans by M.R. Qureshi, N. Ahmad and M.L. Roonwal), but other tropical areas were discussed. Some of the areas of interest as indicated by presentations of international experts of tropical plant and animal life include: J.M. Pires, Amazonian estuaries; F.R. Fosberg, vegetation as a geological agent in tropical deltas; V.J. Chapman, mangrove establishment; and H. Caspers, the biology of estuaries.

Fosberg's concluding remarks to the Dacca symposium stressed operation of the humid tropics program within the broad field of an interdisciplinary approach to understanding the humid-tropical ecosystem.

a. Central and South America

Organizations sponsoring or engaged in plant and animal research in Mexico include the National Autonomous University of Mexico, the National Herbarium and the Escuela Nacional de Agricultura de Chapingo. At the National Institute of Forestry Research, emphasis is placed on ecology, silviculture and the specific study of Swietenia macrophylla, Cedrela mexicana, and Achras zapota.

Extensive work on the rain-forest area is conducted at the Smithsonian Institution's Canal Zone Biological Area, Barro Colorado Island, Agricultural research is performed at the Escuela Agricola Panamericana, Honduras, and at the Inter-American Institute of Agricultural Sciences of the OAS, Turrialba, Costa Rica. The Tropical Science Center, San José, Costa Rica, is a nongovernmental organization conducting research on plant life. Research on natural history and natural resources is conducted at the Tropical Institute of Scientific Research, San Salvador.

Facilities at the University College of the West Indies include herbaria, libraries and a professional staff involved in studies of tropical ecology, plant physiology, mycology, and plant pathology. At the Commonwealth Institute of Biological Control, Curepe, emphasis has been on Apoidea field studies. The Bellairs Research Institute of McGill University, Barbados, has a continuing research program in tropical biology and marine science. All aspects of forestry are studied by the Forest Department of Kingston, Jamaica. The Institute of Jamaica, Science Museum, is engaged in taxonomic and ecological studies of Jamaican plants and animals.

West Indian crops and weeds are subjects of research at the Imperial College of the West Indies. Neotropical biology, biological control of pests, and field studies on Apoidea are also emphasized. Directing the work of graduate students engaged in biological and ecological studies of several weed species is J.W. Purseglove, president of the Association for

Tropical Biology (ATB) which headquarters at the University of the West Indies. This association, international in scope, emphasizes neotropical biology. The ATB, in collaboration with the National Research Council of Brazil, held an International Symposium on the Biota of the Amazon Basin in June 1966 at Belém, Pará.

ATB's official publication is also the official organ for the Organization for Flora Neotropica, a group formed to prepare and publish floras in monograph form for all plants of the western hemisphere tropics. UNESCO sponsored the organization of Flora Neotropica, which is based at The New York Botanical Garden and is administered by Bassett Maguire. It is envisioned that the "coordinated efforts of the world's leading institutions and the work of generations of their staffs" will be required to complete the flora (an estimated 200,000 species).[33]

Emphasis is placed on sugarcane breeding and cylogenetic research at substations of the British West Indies Central Sugar Cane Breeding Station located in the Dominican Republic, Trinidad and British Guiana.

Research at the School of Tropical Medicine, San Juan, Puerto Rico, includes plants having antibiotic and other medicinal properties. The University of Puerto Rico, Mayaguez, has continuing research programs in marine biology. Included are systematics and ecology of marine algae of the Caribbean; coral reef ecology; systematics of marine copepods; biology of West Indian topshell; and classification of fishes, opisthobranches and other mollusks.

The Institute of Caribbean Science, University of Puerto Rico, Mayaguez, publishes an annual report on the status of zoological research in the Caribbean area. Table 7 lists current projects of biologists of the area.[35] Table 8 lists botanical research in progress in and concerning Central and South America.

Biological and other scientific research is conducted at the Charles Darwin Research Station, Galapagos Islands. In British Guiana, botanical and zoological work has been performed in recent years by scientists from Oxford, Cambridge and other universities abroad (also see Table 2). The Royal Ontario Museum and the Royal Botanic Gardens, Kew, are engaged in similar work in the Guianas. The Department of Forestry and Agriculture and the Botanic Garden at Georgetown have research facilities, and a university located there is being organized. Investigations on plant physiology, plant breeding, soils, etc., are being performed by Booker Bros.

Table 7

CURRENT ZOOLOGICAL RESEARCH IN THE CARIBBEAN ZONE[35]

Subject	Investigator Institution and Address	Area
Origin and distribution of Cuban fauna; systematics and ecology of Antillean terrestrial mollusks	C. G. Aguayo Castro Univ. P.R. Mayaguez	Cuba and Puerto Rico
Biology of pelagic fishes	G. W. Bank Inst. of Marine Biology Univ. P. R. Mayaguez	Puerto Rico, Virgin Islands and Hispaniola
Marine free-living copepods	T.K.S. Bjornberg Instituto Oceanografico São Paulo	Brazil
Ichthyological research (local fauna, hydrobiological and botanical investigations)	M. Boeseman Rijksmuseum van Natuurlijke Historie, Raamsteeg, Leiden, Netherlands	Brokopondo (Surinam) and Barrage Lake
Biology of mullets (Mugil lisa)	A. F. Bottema Caribbean Marine Biological Inst. Curacao	Netherlands Antilles
Taxonomy and ecogeography of littoral and coral-reef invertebrates	G. Candelas Univ. P.R. Río Piedras	Puerto Rico
Distributional pattern of benthic macro-invertebrates	M. J. Cerame-Vivas Univ. P. R. Río Piedras	Continental Shelf
Parasites of reptiles of Puerto Rico	F. Cofresi-Sala Univ. P. R. Mayaguez	Puerto Rico
Behavioral reactions of frogs (Eleutherodactylus) to dessication and environmental gradients of moisture	O. Colon de Aponte Univ. P.R. Río Piedras	Puerto Rico
Physiological studies of Schistosoma mansoni (Platyhelminthes)	R. Cordova-Marquez Univ. P. R. Río Piedras	Puerto Rico
Taxonomic studies of sea anemones (Coelenterata)	D. D. Corrêa Univ. São Paulo	Curacao and São Paulo State, Brazil
Inshore ecology	F. Creutzberg Caribbean Marine Biological Inst., Curacao, N. A.	Netherlands Antilles
Biogeography of plants and animals	L. Croizat Caracas	Venezuela
Endocrinology of Uca rapax	A. M. L. van Delft Caribbean Marine Biological Inst. Curacao, N. A.	Netherlands Antilles
Genetics of Drosophila	A. M. Diaz-Collazo Univ. P. R. Río Piedras	Puerto Rico
Reptiles of Trinidad	J. Duston Arima, Trinidad	West Indies

Table 7 (Contd)

Subject	Investigator Institution and Address	Area
Snakes of Caribbean Islands	M. G. Emsley Univ College of the West Indies Trinidad	Caribbean Islands
Blue marlin gonads; sea birds	D. S. Erdman Lajas, P. R.	Puerto Rico
Taxonomy of neotropical Tabanidae and Phlebotomus	G. B. Fairchild Gorgas Memorial Lab. Balboa Heights, Canal Zone	Panama
Taxonomy of Jamaican robber-flies (Diptera: Asilidae)	T. H. Farr Inst. of Jamaica Kingston, Jamaica, W. I.	Jamaica
Avifauna of Trinidad and Tobago	R. P. French Pointe A. Pierre Trinidad	Trinidad and Tobago, W. I.
Behavioral studies of rhesus monkeys	G. F. Fisler Univ P. R. Río Piedras	Puerto Rico
Molluscicides and insect immunology	I. Fox Univ. P. R. San Juan	Puerto Rico
Bacterial studies of amphibians and reptiles (in collaboration with Organization for Tropical Studies)	M. Fulton LSU-ICMRT San José	Costa Rica
Trematoda of Puerto Rico	J. Garcia-Diaz Univ. P. R. Río Piedras	Puerto Rico
Jamaican Coleptera: Cerambycidae: Caribbean Cerambycidae	E. F. Gilmour Doncaster, Eng	Caribbean
Amphibia of Venezuela	R. Gines Caracas	Venezuela
Ecology of Porites reef community (includes both plant and animal studies)	P. W. Glynn Inst of Marine Biology Univ. P.R. Mayaguez	Puerto Rico
Biological studies of Ascidia nigra, ecological studies of Jamaican Ascidians	I. Goodbody Univ. W. I. Jamaica	Jamaica
Fauna of Surinam	D. C. Geijskes Paramaribo, Surinam	Surinam
Biological studies of frogs, Eleutherodactylus; arboreal snails	H. F. Headwole Univ. of P R. Río Piedras	Puerto Rico
Fauna of Netherlands Antilles	P. W. Hummelinck Zoologisch Laboratorium Utrecht, Netherlands	Netherlands Antilles
Mammals of Surinam (handbook): small rodents of Surinam (identification key); bats of Netherlands Antilles (checklist)	A. M. Husson Rijksmuseum van Natuulijke Historie Leiden, Netherlands	Surinam and Netherlands Antilles
Vertebrates of Nicaragua	J. Inger Managua	Nicaragua

Table 7 (Contd)

Subject	Investigator Institution and Address	Area
Behavioral studies of rhesus monkeys, ecology of bats	C. B. Koford National Inst of Health Playa de Humacao, P R.	Humacao, Parguera, P R
Ecology of tropical sea urchin Diadema antillarum	J. B. Lewis Bellairs Research Inst. Barbados, W. I.	West Indies
Fish ecology	R. H. McConnell British Museum London, Eng.	British Guiana
Taxonomic and zoogeographic studies: Siphonaptera, Streblidae, Nycteribiidae, Cimicidae and Polyctenidae (Acari, Laelaptidae)	C. E. Machado-Allison Univ. Central de Venezuela Caracas	Venezuela
Taxonomy of Neotropical Miridae, Reduviidae	J. Maldonado Capriles Univ. P. R. Mayaguez	Puerto Rico
Systematics, zoogeography and ecology of Tenebrionid beetles	G. Marcuzzi Inst. of Zoology, Univ. of Padova Italy	South America and West Indies
Taxonomy of Caribbean insects	L. Martorell Agr. Expt. Sta. Univ. P. R. Río Piedras	Puerto Rico
Ecology and taxonomy of dung beetles (Coleoptera) of subfamily Scarabaeinae	E. G. Matthews Univ. P.R. Río Piedras	Netherlands Antilles
Biological studies of Mesocoelium sp. Helminths of Jamaican birds and amphibians	D. F. Mettrick Univ. W. I. Kingston	Jamaica
Cantharoidea (Coleoptera)	G. W. Miskimen Fed. Expt. Sta. Mayaguez, R.	Puerto Rico
Behavior of birds and primates	M. H. Moynihan Canal Zone Biological Area Balboa	Canal Zone
Taxonomy and ecology in small mammals Podocnemis expansa	J. Ojasti Univ. Central Venezuela Caracas	Venezuela
Physiological studies of Puerto Rican vertebrates	E. Ortiz Univ. P.R. Río Piedras	Puerto Rico
Mosquito population studies	W. A. Page Univ. W. I. Jamaica	West Indies
Zoogeography and taxonomy of neotropical Odonata	J. Racenis Univ. Central de Venezuela Caracas	Venezuela
Taxonomy of the South American Homoptera auchenorhyncha	J. A. Ramos Univ. P. R. Mayaguez	Puerto Rico

Table 7 (Contd)

Subject	Investigator Institution and Address	Area
Biology of West Indian topshell (Cittorium pica)	H. A. Randall Univ. P. R. Mayagüez	West Indies
Guidebook to fishes of Puerto Rico and Virgin Islands	J. E. Randall Univ. P.R. Mayaguez	Puerto Rico and Virgin Islands
Taxonomy of genus Anteiopus in South America, Eleutherodactylus; E. cooki; and new species of Anolis and Cryptobatrachus	J. A. Rivero Univ. P. R. Mayaguez	Puerto Rico
Homiotherms of Puerto Rico	F. J. Rolle Inter-American Univ San Germán	Puerto Rico
Elapidae of the New World; taxonomy and zoogeography of Venezuelan snakes; also Leptotyphlopidae, caecilians and Podocnemis expansa	J. Roze Univ. Central Venezuela Caracas	Venezuela
Biological studies of mongoose, Herpestes javanicus auropunctatus	G. A. Seaman Christiansted Virgin Islands	Virgin Islands
Genetics of Mullerian mimetic butterflies	P. M. Sheppard Liverpool, Eng.	Trinidad and Surinam
Taxonomy of amphibians, genus Leptodactylus	H. Solano de Chacin Caracas	Venezuela
Biological rhythms, chickens	A. Sollberger Univ. P. R. San Juan	Puerto Rico
Systematics of W.I. Pycnogonida; ecology, systematics and zoography of W. I. crustacea	J. H. Stock Zoological Museum Amsterdam, Netherlands	West Indies
Distribution of amphibians, reptiles and mammals in Colombia	J. R. Tamsitt Univ. de los Andes Bogotá	Colombia
Behavior and ecology of scorpions	F. Torres Univ. P. R. Río Piedras	Puerto Rico and Panama
Taxonomy of ciliata living on echinoderms, particularly the genera Echinometra and Diadema	S. Urdaneta-Morales Univ. Central Venezuela Caracas	Caribbean
Behavior of rhesus monkeys	J. G. Vandenbergh Lajas, P. R.	Islands near Paraguera, Puerto Rico
Taxonomy, distribution and ecology of Diplopoda, Chilopada, Antillean Myriapoda	M. J. Velez Univ. P. R. Río Piedras	Puerto Rico
Cytology and chromosomal evolution of beetles	N. Virkki Agricultural Expt. Sta. Univ. P. R. Río Piedras	Caribbean

Table 7 (Contd)

Subject	Investigator Institution and Address	Area
Ornithological investigations	K. H. Voous Zoologisch Museum Amsterdam, Netherlands	Netherlands
Biology of Donax denticulatus Linne	B. Wade Univ. W. I. Jamaica	Jamaica
Ecology and physiology of Fissurella	J. Ward Bellairs Res. Inst. Barbados, W. I.	Barbados
Migration and movement of Puerto Rican birds by banding	J. B. McCandless Mayaguez, P. R.	Puerto Rico

Table 8

CURRENT BOTANICAL RESEARCH IN CENTRAL AND SOUTH AMERICA

Subject	Investigator Institution and Address	Area
Ecological studies of vegetation formations	A. Aubreville National Museum of Natural History Paris 5e, France	Brazil
Savanna vegetation	M. Cole	Brazil
Surinam vegetation	J. P. Schulz	Surinam
Vegetation	B. Taylor Commonwealth Sci Organization Canberra, Australia	Nicaragua
Vegetation formations	I. Espinal	Colombia
Vegetation	D. R. Harris	West Indies
Inventory and classification of natural habitats	G. Budowski Inter-American Inst. of Agricultural Sciences Turrialba, Costa Rica	Central America
Flora of Jamaica	W. F. Stearn C. R. Proctor British Museum-Natural History Cromwell Rd. London SW 1, Eng.	Jamaica
Flora of Venezuela	T. Lasser, L. Aristeguieta J. Steyermark, F. Foldats V. Vareschi, Z. de Febres Botany Inst. Apartado 2156 Caracas	Venezuela
Botanical studies and flora of Peru	R. Ferreyra F. MacBride San Marcos Univ. Lima	Peru

Work of the Surinam Forest Department, Dutch Guiana, in cooperation with the State University of Utrecht (J. Lanjouw and F. Jonker, investigators) has contributed to ecological and vegetation research in the tropical Americas. Ecological studies of the rain forest in Northern Surinam by J. P. Schulz are important. Some botanical research is performed at the French Institute of Tropical America, French Guiana.

Botanical research is emphasized at the Instituto Botanico in Venezuela and at the universities at Caracas and Merida. Bogotá and Medellin botanists who are engaged in Colombia's floras are listed in Table 2.

In Argentina, taxonomic and ecological investigations on mammals are being made by scientists from Instituto Miguel Lillo in Tucuman, Museo Nacional in Buenos Aires and Instituto de Biologia in Mendoza.

Brazilian floristic and ecological studies are emphasized at the Rio de Janeiro botanical garden. An active zoological department is maintained at the Universidade de Brasilia, São Paulo. Agricultural and botanical institutes at Curitiba (Paraná), Belo Horizonte (Minas Gerais), Belém (Pará) and Manaus (Amazonas) are engaged in research and field activity. At the Instituto Agrónomico do Norte, Belém, particular emphasis is given to ecology and applied agriculture and extensive work has involved Brahmin cattle and Indian water buffalo. Genetic research on Brazilian rubber varieties and other tropical plant species has been emphasized, and the institute maintains a network of experimental stations with headquarters in Pará.

A broad study program involving collection of mosquito specimens is active at the Belém Virus Laboratory. Afranio do Amaral of the Instituto Butantan of São Paulo has performed recent research on venomous animals and zootoxicoses. The Departamento de Zoologia, São Paulo, is engaged in mammalogical investigations in Southern Brazil.

The most detailed inventories of the Amazonian forest are those being made under the auspices of FAO*, particularly the work reported by D. Heinsdijk and A. de Miranda Bastos.[36] The Museu Nacional, Rio de Janeiro, has supported taxonomic projects in the Xingu and other parts of Brazil. W. Egler, G. Black, R.L. Fores, and W.A. Ducke have been conducting field research and taxonomic studies in the Amazon Basin. A flora for Rio Grande do Sul is being prepared by R. Reitz and L.B. Smith, and a new "Flora Brasilica," begun by Hoehne, is being continued by A.R. Teixeira, São Paulo.

*e.g., FAO reports 601, 949, 969, 992 (1947-1958); 1284 (1960); 1337 (1961); and 1483 (1962).

b. Africa

Botanical research in Africa south of the Sahara has experienced a recent notable expansion. Koechlin[4] reports a steadily increasing scientific interest under the sponsorship of such agencies as Office de la recherche scientifique et technique d'outre-mer (ORSTOM) in France, Belgium's Institut National pour l'Étude agronomique du Congo, the Centro de Botânica da Junta de Investigações de Ultramar in Portugal, and the Ministry of Overseas Development (British). Such international organizations as United Nations Educational Scientific and Cultural Organization (UNESCO), Commission for Technical Co-operation for Africa (CCTA), Scientific Council for Africa (CSA), Association pour l'Étude taxonomique de la flore d'Afrique tropicale (AETFAT), and the Food and Agriculture Organization of the United Nations (FAO) have contributed to the increased emphasis on cooperative effort among African scientists. Table 9 lists African institutions and areas of plant and animal research.

Complete modern floras are available for only parts of Africa. A revised, second edition of The Flora of West Tropical Africa (Mauritania to the Western Cameroons) by Hutchinson and Dalziel will be published soon. The Belgians are preparing a flora of the former Belgian Congo and Rwanda-Burundi. The Royal Botanic Gardens, Kew, is preparing a Flora Zambesiaca and a Flora of Tropical East Africa, parts of which have been published. Floras are available for a few other areas such as the Sudan but, generally, tropical Africa has rather inadequate modern floras. F. White has been investigating the forest floras of Northern Rhodesia, and M. Cole recently studied the savannas of that area. Uganda is the only nation in East Africa receiving a detailed vegetation survey although one of Southern Kenya was made in 1961. R. Germain recently completed a study of savannas in the former Belgian Congo, and G. Hedberg has made a fine study of African high-mountain plant life in relation to its environment.

Maintained since 1953 at AETFAT is an index to publications on taxonomy in Africa south of the Sahara. In 1960, E.M. van Zinderen Bakker prepared a digest on the palynological research program of various African laboratories. CCTA/CSA maintains a current record on vegetation mapping programs.

Khalil reports that research in "animal ecology . . . is far behind plant ecology" today in Africa.[37] Some recent studies have been performed on the peculiar faunas of the savanna forests. Detailed studies of Noirfalise in the National Park of Garamba and those by Curry-Lindahl in the Eastern Congo deserve mention. The work of G. Williamson and W.J.A. Payne in animal husbandry is notable, as are the research efforts of A.J. Marshall and M.C. Williams on the migratory habits of birds.

Table 9

PLANT AND ANIMAL RESEARCH IN AFRICA

Subject	Investigator Institution and Address	Area
Zoological studies	A. de Barros Machado Museum of Dundo Dundo, Luanda	Luanda
Medicinal plants	Pasteur Inst of Cameroon B.P. 888 Yaoundé	Cameroon
Botanical research, flora	Section of Forestry Research B.P. 194 Yaoundé	Cameroon
Inventory and parasitological studies of rodents and other small mammals; snake identification	Pasteur inst. of Bangui B.P. 923 Bangui, Central African Republic	Central Africa
Investigations into natural and artificial regeneration, tropical rain forest	Forest Res. Inst. P. O. Box 41 Kumasi, Ghana	West Africa
Bush fallows, nutrient cycle in the forest; ecology of forest area; marine algae ecology; biometric and cytotaxonomic studies of indigenous plants; descriptive studies of flora	Univ. of Ghana Legon-Accra	Ghana
Medicinal plants	Dept. of Agriculture Seredou near Macenta, Guinea	Guinea
Botany, plant physiology	Inst. of Teaching and Tropical Res. B.P. 20 Abidjan	Ivory Coast
Ecology of principal forest species; biology	Ivory Coast Tropical Forest Tech. Centre B.P. 4340, Abidjan B.P. 596, Bouaké	Ivory Coast
Marine biology; deep-water fauna	Oceanography Res. Center B.P. 35 Abidjan	Gulf of Guinea
Ecological analysis of plants and animals, savanna environment	Tropical Ecology Lab. of Lamto B.P. 16 Tiassale	Ivory Coast
Taxonomy of natural grasses	Dept. of Agriculture Grasslands Res. Sta. P. O. Box 450 Kitale	Kenya
Silviculture, pathology and entomology; insect pests and parasites	East African Common Services Organization, Forest Dept. P. O Box 300927, Nairobi P. O. Box 21, Kikuyu	Kenya
Game research in tropical forests	Royal College Univ. of East Africa Nairobi, Kenya	East Africa
Tsetse fly	Veterinary Res. Lab. Kabete	East Africa

Table 9 (Contd)

Subject	Investigator Institution and Address	Area
Systematic and ecological study of fauna, vegetation stages; specimen collection	Scientific Res. Inst. of Madagascar B P. 434 Tananarive	Madagascar (and Neighboring Islands)
Migratory locust	International Organization Against the African Migratory Locust Kara-Macina, Mali	Africa
Plant ecology and silviculture	Federal Dept of Forest Res P. M. B 5054 Ibadan, Nigeria	Nigeria
Photogeographical and ecological investigations of tropical forest and savanna	Inst. of Central African Studies Sta. Centrale B. P. 181 Brazzaville	Republic of the Congo
Monographs of flora and fauna	Senegal Res. and Documentation Center B. P. 382 St. Louis	Republic of the Congo
Vegetation surveys	Dept. of Agriculture Kawanda Res. Sta P. O. Box 265 Kampala	Uganda
Vegetation maps	Dept. of Lands and Surveys P O. Box 361 Kampala	Uganda
Arthropod vectors	East African Virus Res. Inst. P. O. Box 49 Entebbe, Uganda	Kenya, Uganda and Tanganyika
Ecological and entomological studies	Forest Dept P. O Box 31 Entebbe, Uganda	Uganda
Fresh-water biology	Makerere College Univ. of East Africa Dept of Zoology P. O. Box 262 Kampala	Uganda
Systematic and ecological studies of flora and fauna	Belgian Royal Inst of the Natural Sci. 31 rue Vantier Bruxelles 4, Belgium	Africa
Tropical zoology and botany	Inst. for Scientific Res. in Central Africa 1 rue Defacqz Bruxelles, Belgium	Central Africa
Systematic study of vegetation	National Inst. for the Agronomic Study of the Congo 1 rue Defacqz Bruxelles, Belgium Substa.: Yangambi Province Orientale, Congo	Congo

Numerous ecological estuary studies have been performed in Africa. Ecological studies on marginal lagoons of Western Nigeria by J. E. Webb and M. B. Hill have contributed to the understanding of biotic factors influencing animal distribution in these areas.

A voluminous ecological study of the Parc National de la Kagera (Rwanda-Burundi) by G. Troupin of the University of Liège will soon be published. D. Muller and J. Nielsen have engaged in an important pioneer study of biological productivity in the Ivory Coast rain forest. R. Paulian has performed important work in animal ecology in the Ivory Coast forest.

There has been only fragmentary research on the invertebrate faunas of Africa— insects and ticks being an exception. Some recent works have been by Luc and de Guiran (1960) on nematodes and by Crowley and Pain (1959) on mollusca. A permanent Inter-African Bureau of Tsetse and Trypanosomiasis (BPITT) publishes reviews of all research conducted in African territories on invertebrates.

P. J. Darlington Jr. has done considerable work on cold-blooded vertebrates in Southern Africa; A. H. Booth's extensive works on African primates and R. Paulian's zoogeographical work on Madagascar and neighboring islands are noteworthy research efforts in this area.

Entomological studies have been extensive, especially where they relate to African host plants of high economic value. For example, an international program of research on desert locust control financed by a special fund of the United Nations and systematic studies of the ecology of locust reproductive zones by FAO and UNESCO are supplementing regional research. Termites [39] and the tsetse fly also have come under extensive scrutiny. K. Hocking of the Colonial Insecticides Research Unit is performing extensive studies of chemical control of the tsetse fly. H. C. M. Parr is engaged in biting-fly research at the Department of Agriculture, Entebbe, Uganda, and the Kawanda Research Station has performed vegetation surveys. At Entebbe, ecological and entomological studies by the Forestry Department are in progress. The WHO Regional Office of Africa has been active in assisting local health departments in their work on pest control, particularly of those which are vectors of human disease. In the area of parasites and predators of insect pests, the work of Ossowski on biological control of the bagworm Katochalia junodi should be mentioned. Meriting attention is the work of Risbec on Chalcid parasites common on Psudococcus bingervillensis and P. njalensis. Jepsen reports that "the extension and coordination of this work, perhaps around a nucleus established by the Commonwealth Institute of Biological Control, would be a project well worthy of international support through FAO."[40]

Work in progress on aquatic animals at South African universities in Cape Town and Grahamstown is reported by the Council for Scientific and Industrial Research (CSIR) in bibliographies published periodically.[41] Postel reports that the South African survey of the pilchard (Sardinops ocellata) is a model work after which similar programs should be patterned on other popular edible species of fish.[42] The work includes a methodical examination of the environment by M. E. L Buys; a bromatological inventory by C. S. de V. Nepgen; a brief ecological description by A E. F. Heydor, mentioning the water indicators; D. H. Davies' study of growth, behavior and reproduction, and analysis of stocks and census and estimate of the significance of predatory animals; and C. G. du Pleissis' historical review of fisheries development. It is Postel's opinion that South African marine biology is well-organized and that the intrastructure for future programs is already in existence. Preliminary plans call for IBP full-scale ecological studies at the University of Elizabethville (Upper Congo Basin), Jinja, Khartoum, Aswan, and Alexandria (Nile system).

c. South Asia and Oceania

Some progress in Pacific Taxa mapping has been made under the direction of C.G.G.J. van Steenis.[43] He anticipates that more than 150 maps will be included in the proposed Pacific Plant Areas. Mrs. J. J. van Steenis-Kruseman gathered material for the first volume which will be entitled Bibliography of Published Maps of Pacific Taxa and contain 26 maps; inclusion of 50 maps is anticipated for a second volume. A grant from the Korthals Fund (Royal Netherlands Academy of Sciences) has been invaluable to the compilation of the second volume, but funds are being sought for map production for some areas. When completed, this work will provide an important tool for Pacific vegetation and floristic research.

Other bibliographies in preparation include: Botanical Bibliography for Australasia prepared by R. D. Hoogland of the Commonwealth Scientific and Industrial Research Organization, Canberra, Australia; E. H. Walker's botanical bibliography of Okinawa and Southern Ryukyus to be included in the Flora of Okinawa and the Southern Ryukyus.

Mona Lisa Steiner, aided by a UNESCO grant, has compiled a list of common names of Pacific plants to be published under the title Compilation of Common Names of Pacific Foodplants.[44] Correlation of scientific names with vernacular terms attacks the problems of communication barriers; the undertaking of similar compilations on timber trees of the Pacific is anticipated for Steiner's work in this area.

Eventually, Flora Malesiana being prepared by van Steenis will be a complete flora (by many contributors) of the Malesian region. Some publication has already appeared, but other work awaits additional funds for publication.

At the 10th Pacific Science Congress, Yen reported an increase in genetic plant research in South Asia and Oceania areas, particularly India's work on economic plants and the emphasis placed on natural floras by Australia.[45] Other plant research of importance is listed in Table 10.

Table 10

PLANT RESEARCH IN SOUTH ASIA AND OCEANIA

Subject	Principal Investigator	Area
Forests	E. Stebbing	India
Vegetation	J. Vidal	Laos
Vegetation map	J. Wyatt-Smith Forestry Dept., Univ. of Ibadan Ibadan, Nigeria	Malaysia
Vegetation survey	T. Kaikira	Thailand
Ecological studies in mixed dipterocarp forest	P. Ashton Forestry Dept. Kuching, Sarawak	Brunei

A Central Card-Index for zoological specimens of South Asia was begun in 1962 at the Zoological Survey of India, Calcutta, under the direction of M. L. Roonwal. This project has had financial assistance from UNESCO and is under the direct management of K. C. Jayaramakrishnan. Data from repositories in India and other South Asian countries are to be accumulated for this index.

The Colombo National Museum, Ceylon, has a continuing collection program of vertebrate and insect specimens, zoological surveys, and an annual publication, Spolia zeylanica.

Szent-Ivany (1963) reported an expansion of entomological research in Hawaii. A. L. Rand's and D S. Rabor's avifaunal studies in the Philippines are noteworthy. Systematic studies of various species in the islands have been performed by A. C. Alcala, R. B. Gonzales, F. Salomonsen, K. C. Parkes, and D. Amadon. A. C. Alcala also has done considerable work on Philippine amphibians and reptiles; some of this work has been performed in collaboration with W. C. Brown. Rabor's additional research projects in progress include studies on the altitudinal distribution of Philippine birds and the biology, ecology, systematics, and distribution of Philippine birds and mammals. Rabor and Rand are collaborating on

studies of the avifauna of Luzon Island; Alcala's project, Herpetology of Negros Island, will encompass the life history and ecological studies of the amphibians and reptiles.

Fishes, containing taxonomic information on all species of Australian fish, has been compiled by the CSIRO Division of Fisheries and Oceanography at Cronulla.

Table 11 lists some zoological investigations in progress.

Table 11

ZOOLOGICAL INVESTIGATIONS IN TROPICAL AUSTRALIA[46]

Subject	Principal Investigator	Area
Grapsid crabs (taxonomic)	B. Campbell	Queensland, Australia
Venom and/or venom apparatus of various cone shells and poisonous fish	R. Endean	Australia
Taxonomic and biological studies of amphibians	A. K. Lee	Queensland, Australia
Evolutionary and population genetics of Drosophila in tropical Australasia	W. B. Mather and D. Angus	Australia
Queensland mysids (taxonomic)	Dinah Ogg	Australia
Queensland mereid worms	Eleanor Russell	Australia
Queensland shipworms	Myra Smith	Australia
Ecology of intertidal environments on coral bays	W. Stephenson	Australia

3. Research of Significant Growth Potential

Flora Neotropica directed by Bassett Maguire is a significant endeavor. This project, under the sponsorship of UNESCO and directed by The Association for Tropical Biology Inc., has received funding from the United Nations Special Fund. It represents a cooperative effort of the scientific community in the United States and Latin America.

F. R Fosberg heads the Pacific Vegetation Project operating under the auspices of the United States Geological Survey. This project promises to provide an updated flora of the coral atolls and of other island areas.

The Humid Tropics Commission of UNESCO is planning a major symposium on the Ecology of the Savanna/Forest Boundary and scheduling it for 1968.

At the UNESCO Toulouse Conference concerning cartographical representation of vegetation, at which participants also discussed the merits of the many different systems of classification, an international program of vegetation mapping was instituted and is being carried out at the Institut français de Pondichery under the direction of H. Gaussen. Since 1961 several "international maps of vegetation and environmental conditions at a scale of 1:1,000,000 and accompanying texts have been produced."[47]

An International Biological Program (IBP) proposed by the International Council of Scientific Unions (ICSU) was formally organized in July 1964 in Paris, and several affiliated nations have formed their own national committees for its implementation. IBP objectives are the encouragement of worldwide ecological studies involving every field of biological science and the acquisition of worldwide data that are reasonably comparable regardless of the area from which derived. Emphasis will be placed on the composition, structure and function of ecosystems, with biotic factors recorded on a quantitative basis using a punch-card system. Vegetation will be described by grouping plant formations into categories according to system size, character of the plants present, and ecosystem dynamics. Humans, avifauna, mammals, reptiles, amphibia, invertebrates, and soil fauna will be indicated as being present, abundant, or markedly affecting environment. The IBP-proposed punch-card system was used successfully for biological surveys in Britain, particularly for preparation of the Atlas of the British Flora.[48] IBP requirements include training facilities, processing centers for handling data, biological sample analysis, and new sources of funds for the less developed countries.

In February 1965, the U.S. National Committee for the International Biological Program (USNCIBP) published the preliminary framework for U.S. participation. Objectives include "encouragement and training abroad, especially in Latin America," and studies that concentrate on the ecosystem function.[49]

One or more centers of intensive study are to be selected on each major continent. The IBP Committee of the Royal Society of England has selected two such centers in the tropics: the savanna of East Africa and the wet tropics of West Africa. The Amazon region has been considered as a desirable site for intensive study in tropical America.[50]

4. Research Gaps

"Among the major gaps in our knowledge of neotropical plant life," writes W. L. Stern, "are the origin, relationships, migrations, and present geographical distribution of flora."[51] Stern also stressed the need for more paleobotanical collecting, including palynological data, and more accurate dating of the geological strata concerned. The importance (and lack) of voucher herbarium specimens was emphasized. Recommendations from the Neotropical Botany Conference held at Fairchild Tropical Garden, Miami, Florida, May 5-7, 1960, indicated a consensus by participants on the following needs: "...repositories (collections and botanical gardens) of dried, fluid-preserved and living plants suitable for studies (should be) expanded... and new ones situated in the neotropics should be established."[52]

Other major gaps needing attention include growth processes in wild plants or their organs, periodic responses (reproductive and anatomical), photosynthetic yield in low and high humidities, physiology of epiphytes and lianas, chromosome counts on tropical plants, fundamental work on micro-organisms, fundamental cytogenetic studies, coordinated programs for systematic inventory of plants and animals, and organized studies of land and marine biota by geographic distribution.

Many authorities indicate need for basic ecological studies of both plants and animals of the humid tropics, and it is agreed that taxonomic work in all of the humid tropic areas is a prerequisite. The work of systematists and biogeographers is imperative for a full study of ecological systems. Study of natural plant communities and wildlife preservation appears to be of great concern to humid tropics experts. "The tropics," states P. W. Richards, "still need more description, not just analysis."* Tropical biota, inadequately studied, are rapidly disappearing so long-term studies in one place are needed.

No significant publications on the plants of Burundi, Cabinda, Chad, Comores Islands, Dahomey, Nicobar Islands, Palau Islands, or Timor were found. In the following countries, there were no significant or recent publications on the animal life: Barbados, Borneo, Dominica (Islands), Dominican Republic, Margarita Island, Martinique, St. Lucia Island, St. Vincent Island, Burundi, Cabinda, Central African Republic, Chad, Comores Islands, Congo (French), Ecuador, Dahomey, Fernando Poo, Gabon Republic, Gambia, French Guinea, Paraguay, Peru, Portuguese Guinea, Rwanda, Senegal, Sierra Leone, Tanganyika, Togo, Zanzibar and Pemba Islands, Andaman Islands, Communist China, Nationalist China, Laos, Nicobar Islands, Brunei, and Palau Islands.

*Oral communication to H. Vogel, project manager, July 28, 1965.

Although there have been specialized vegetation studies by aerial photographic means in some areas, vegetation mapping has serious gaps (Appendix C). Standardization in methods of correlating photographic information with ground studies, however, is necessary for specialized vegetation maps on an ecological basis.

5. Problems of a Barrier Nature

Financing to further research on plant and animal life in all the humid tropics creates a problem. One of the great barriers is the lack of facilities for long-term investigations (5 years or more). This is one reason why there is so little information on (e.g.) the growth rate of slow-growing trees, changes in vegetation as a result of man's activities, and many other subjects.

A major problem is the poor communication between tropical and extratropical biologists. Scientists of the midlatitudes are unable to apply completely their terminology and methodology to the problems of the humid tropics. A standard nomenclature and method of characterization must be agreed upon to effect the desired cooperation between scientists of all participating countries. At the Yangambi Symposium (1956), a small group (British, French, Belgian, Portuguese, South African) reached agreement on the nomenclature of the chief types of tropical African vegetation. Probably, the same thing could be done for the New World tropics and for all of the tropics. Generally, botanical texts used in the midlatitudes do not prepare the student for experiments in the humid tropics environment. Also, there are few field manuals for plant identifications and few areas in the tropics where the researcher can get a guide to plants of the local area.

The political climate found in many developing nations is a serious barrier to the conduct of research. Biological problems, however, are too urgent to wait for gradual development of organizations and personnel capable of tackling them in the "emergent" countries.

Another problem is lack of dissemination of past research results. Valuable information is unavailable to present investigators, but the problem would be avoided in the future if research funds were granted with a stipulation that results be published; however, such a stipulation is not generally acceptable to the scientific community.

6. Major Controversies

Today, there is a significant difference of opinion between vegetation specialists concerning the classification of surface plant cover.

It has been suggested by P. W. Richards that ecology of the tropics is "biased by concepts and ideas appropriate mainly to the study of vegetation in temperate climates and in areas where a very large proportion of the land has long been modified by agriculture and other more or less intensive forms of land usage."[53] At the 1954 International Botanical Congress in Paris, a lively controversy developed about whether plant associations, as understood in temperate countries, exist in the tropical rain forest. Advocates of systems developed by Braun-Blanquet, Bray and Curtis, Schulz, Fosberg, Küchler, Tansley, Beard, Champion, van Steenis, Holdridge, and others have not been able to agree on a set method of categorizing data. To dissolve differences and select a workable classification agreeable to the field were major objectives of the UNESCO conference on world classification of vegetation held in Paris in May 1965. A trial experiment of the IBP Pro Forma for Site Surveys (MK. 111) may prove to be an initial step for uniform data recording which may eventually lead to solution of this controversial point. The IBP experiments are being reported to E. H. Perring, The Nature Conservancy, Monks Wood Experimental Station, Abbots Ripton, Huntingdonshire, England.

7. Review of Field and Laboratory Techniques

Relatively new methods such as airborne electromagnetic remote sensing techniques are being applied to supplement standard air-photo methods.[54] IBP is attempting to develop new procedures to identify surficial plant cover in the field and especially to eliminate the need for submission of fertile specimens to select herbaria which are usually far removed in distance and time from the field.[55] Automatic data processing equipment is being applied to the compilation of bibliographies, to the storage and retrieval of information available at research centers, and to a worldwide system of vegetation classification.

While some new procedures require relatively expensive, sophisticated equipment, P. B. Tomlinson, speaking in Trinidad at the 1962 Conference on Neotropical Botany, stated: "I do sincerely hope that botanists working in remote, underdeveloped areas will not immediately jump to the conclusion that they must have expensive items of equipment such as electron microscopes just because they happen to be fashionable."[56]

D. AVAILABILITY OF DATA

Sources of information consist of depositories, authorities and research organizations.

1. Authorities

Individuals who have conducted significant research in the tropics and who have been or are in residence in a tropical area are considered as authorities. They constitute a personal type of information source and are listed in a matrix and directory (Appendix A, Authorities) of this compendium.

2. Depositories

Appendix B (Principal Depositories) of this compendium should be consulted to determine amount, type and availability of humid tropical biological and zoological research materials located at depositories containing extraordinary holdings, either quantitatively, qualitatively, or both.

3. Research Organizations

Organizations, agencies and institutions engaged in specialized research investigations of humid tropical plants and animals may be found in the separate volume entitled A Directory of Institutions Primarily Devoted to Humid Tropical Research. This directory was published in October 1965 by McGill University for the U.S. Army Research Office and the IGU. Highly specialized holding by organizations acting as both depository and research institutions may also be found in Appendix B of this compendium.

The lack of uniformity of data collection in the fields of plants and animals, as well as the absence of a widely accepted classification scheme for these data, has not permitted the use of EAM format for data storage and retrieval. The IBP is making rapid strides to correct this situation on a global basis.

4. KWIC (Keyword in Context) Index

Volume I of this inventory, KWIC Index-Humid Tropic Environmental Literature, contains the bibliography collected at domestic and foreign depositories. Materials were derived primarily from the literature of the geographic, earth, atmospheric, and biological sciences.

Plant and animal life literature was classified into the following categories based on program specifications:

- Vegetation, General
  - forests and other woody vegetation
  - grasslands
  - crops
  - food plants

- Fauna, General
  - disease carriers
  - food sources
  - pests (including all insects)
  - parasites
  - poisonous animals
  - predatory animals

- Combined Subject Codes
  - climate and vegetation
  - climate, soils and vegetation
  - soils and vegetation
  - flora and fauna

In Section E of Volume I, these topics may be consulted via their code numbers for each area.

E. ASSESSMENT OF THE STATE OF KNOWLEDGE

The cooperation of experts with personal experience in the humid tropics has been sought for this Inventory; they have been asked to review the findings and offer opinions on the state of knowledge of humid tropical plant and animal life generally and in the 108 regional and political units (mainly entire countries) identified for the purposes of the Inventory.

It has been determined that the experts regard the general state of knowledge to range between fair and poor, with tropical plant life not being as far advanced as tropical animal life. Their consensus is that regionally, the plant and animal life of Central America and the Caribbean are best known. They agree that the plant life of Brunei, Ceylon, Uganda, Ivory Coast, Mexico, and the Congo (B) and the animal life of East Africa, Oceania, Congo (B), Ivory Coast, Liberia, Malagasy, Rhodesia, Ceylon, India, and Malaysia have been well-studied.

Analysis of opinions shows that none of the experts claim to have intimate knowledge of plant and animal life throughout the humid tropics and, therefore, in keeping with accepted scientific ethics, regard themselves qualified to rate only those areas they they have studied directly or in connection with their tropical investigations.

The Inventory shows a preponderance of literature on plant and animal life of Central America, South America, and the Caribbean. It appears, as the experts have indicated, that these are areas better known than those of other parts of the humid tropics. However, the state of knowledge of some of the other regions may be better than the Inventory

shows or the experts can certify. American participation in biologic research in the humid tropical portions of the western hemisphere accounts for greater familiarity with research there than in other regions and for greater availability of the published results. Information on non-U.S. research activity decreases with increase in the amount published in foreign journals and books, despite the growth of international abstracting services intended to overcome this obstacle.

It is noted also that local experts differ with those consulted for this project. For example, the high rating given to knowledge of the animal life of Rhodesia must be balanced against the opinion of scientists working continuously in that region, who enumerate countless gaps in knowledge. Similar observations were made on the opinions of American observers and local experts regarding knowledge of the plant life of Southeast Asia. In general, knowledge of plant and animal life of the humid tropics is not considered adequate.

1. Colwell's Analysis of Information Adequacy (Plants)

Professor R. N. Colwell, University of California, has submitted the following analysis of the adequacy of information available on vegetation of the humid tropics:

> "Military commanders need timely, accurate, detailed information as to the type of vegetation that is present in each part of an area within which they plan to conduct military operations. Vegetation maps presently available for humid tropical areas – however detailed and accurate they may be – usually are of only limited value to the military commander for two reasons: (1) the vegetation classes shown on the maps are not the ones which will best satisfy the military commander's needs, and (2) in the humid tropics, vegetation can grow more rapidly than anywhere else in the world, often causing major changes in vegetation types to occur in short periods of time and thereby inducing early obsolescence of the maps. Usually, vegetational data of the type and recency that will suit the military commander's needs must be obtained through the interpretation of recently flown aerial photographs. Therefore, it is pertinent to ask: 'To what extent can the militarily significant vegetation types of the humid tropics be identified on aerial photographs flown to the proper specifications?'
>
> "For one portion of the humid tropics, namely the tropical Pacific area, an authoritative answer to this question can be given as a result of military operations conducted there

during World War II. The answer, in brief, is as follows: The militarily significant wildland vegetation types of the tropical Pacific area can be consistently identified on aerial photographs. Vegetational information presently available for that portion of the humid tropics is quite adequate. These statements are not based on mere conjecture; they are both battlefield-tested and classroom-tested. Some amplification is needed, however, before we can determine the applicability of these statements to vegetation of the humid tropics as a whole.

"In the early stages of World War II, several groups sought to determine what were the militarily significant wildland vegetation types of the tropical Pacific area. These groups included the Allied Geographical Section, Southwest Pacific area; the U.S. Navy Photographic Interpretation Center; and the Military Geology Branch of the U.S. Geological Survey.

"They recognized that vegetation can directly affect the conduct of military operations in four major ways: (1) It may facilitate or impede the movement of personnel and mechanized equipment; (2) it may accentuate or conceal evidence of military activity; (3) it may govern the ease with which clearings can be made for the construction of roads, airfields and other military facilities; and (4) it may serve as a source of fuel, food or construction materials. In addition, they recognized that vegetation may be an important indicator of soil type, soil moisture and other factors which also affect the conduct of military operations. Changes since World War II in types of military equipment and in methods of fighting wars in the humid tropics have done virtually nothing to invalidate these basic premises.

"After many months of concerted effort by these groups, (based on World War II type operations), it was generally agreed that there are 12 and only 12 wildland vegetation types in the tropical Pacific area that are of major military significance. These are: (1) mangrove, (2) nipa palm, (3) sago palm, (4) swamp forest, (5) moss forest, (6) rain forest with undergrowth, (7) rain forest without undergrowth, (8) casuarina, (9) wild cane, (10) tall grass, (11) short grass, and (12) savanna. Virtually all wildland vegetation found in the tropical Pacific falls in one or another of these types.

"Realizing that the mapping of vegetation types in areas of contemplated military activity ordinarily would have to be accomplished through the interpretation of aerial photographs,

these investigative groups determined the aerial photographic recognition features of each of the 12 types. The recognition features were then set forth in the form of either 'photointerpretation keys' or other reference material. The most extensively used of these reference materials was a 'dichotomous' (2-branched) photointerpretation key that was published, together with numerous photographic illustrations, in a manual entitled Pacific Landforms and Vegetation (U.S. Navy Photo Interpretation Report No. 7).[57]

"The accuracy with which photointerpreters equipped with suitable reference materials could identify the 12 vegetation types was tested quite thoroughly, both during and after World War II.[58] (A report on one such series of tests appears in Photogrammetric Engineering, 1958). These tests showed that most photointerpreters, after a suitable period of training, could consistently identify the 12 vegetation types. Since a statement of the military significance of each type (in terms of the four previously listed criteria) constituted part of each student's reference material, he was also able to predict in considerable detail the conditions which military units would encounter when operating in each area.

"Additionally, certain military commanders operating in the tropical Pacific area were asked, at the end of World War II, to assess the adequacy of the vegetational information with which they had been provided. Among those expressing opinions were Adm. Frederick J. Turner (who, as commander of Amphibious Forces Pacific Fleet for approximately 3 years, was in charge of all amphibious assault landings from Tarawa through Okinawa) and Gen. Simon B. Buckner, who was in charge of all forces, both Army and Marine, that participated in the Okinawa campaign. A typical response was that of Adm. Turner who stated: 'Aerial photointerpretation was our most important source of information in the Pacific during World War II. Its importance cannot be overemphasized.'[58] Both he and Gen. Buckner, as well as several other military commanders, specifically mentioned the high degree of accuracy and great value of the vegetation analyses made by photointerpreters in the tropical Pacific during World War II.

"In the light of what has just been stated with reference to the tropical Pacific area, and giving due consideration to the status of vegetational information elsewhere in the humid tropics, the following definitive statements can be made:

"(1) In one portion of the humid tropics, namely the tropical Pacific area, the presently available information on vegetation is quite adequate from the military standpoint.

"(2) In all other portions of the humid tropics, much vegetational research must be performed before a comparable degree of adequacy can be achieved.

"(3) In any given portion of the humid tropics, a logical first phase of this research should seek to determine what are the militarily significant vegetation types in the area.

"(4) Since the mapping of vegetation types in areas of contemplated military activity ordinarily must be accomplished through the interpretation of aerial photographs, a second phase of this research should seek to discover the consistently identifiable aerial-photo-recognition features of each type.

"(5) A third phase of this research should result in the compilation of reference materials which will aid photointerpreters in identifying the vegetation types. One product of this research should be a systematic statement (e.g., in the form of a dichotomous key) of the photo-recognition features for each vegetation type, supplemented with numerous photographic illustrations.

"(6) A final phase of this research should entail the making of operational tests of two types: (a) tests designed to determine the vegetational classification from the standpoint of various military commanders--(specifically, when a potential area of military operations is subdivided in accordance with the classification system, is each subdivision a truly significant entity as judged by the previously mentioned military criteria?); and (b) tests designed to determine the adequacy of the reference materials

from the standpoint of the photointerpreters who must use them. An important aspect of this final research phase will, of course, be the making of any modifications which the operational tests of type (a) and (b) above show to be necessary."*

2. Bennett's Analysis of Information Adequacy (Animals)

"Animal geography is a broad and wonderful subject which almost defies any attempt to define its limits and contents. Obviously the subject has something to do with the study of the geographical distribution of animals but problems arise when one attempts to list or identify the many facets which relate to the basic aspects of the disciplinary area. The basic facts of where individual vertebrate taxa occur on this earth are now pretty well known. A few non-vertebrate taxa are also fairly well known as to gross geographic distributions, but in general our knowledge here is far from adequate. (It is estimated, for example, that a very large number of insects are still awaiting discovery and identification). Animal geography may therefore be said to be largely the study of the geographic distribution of vertebrates. But even in the case of the vertebrates, our knowledge of distribution often is at a rather gross level. For example, we know the gross latitudinal distribution of the bat genus Desmodus (true vampires) but we as yet have very poor ideas as to the exact niche or ecological distribution of this interesting chiropteran. I happened to pick on a bat but this comment might be extended to a very large array of vertebrate taxa. Also, we have very limited ideas or information regarding the autecology and synecology of the tropical vertebrates. Which is to say that many if not most of our ideas regarding why or why not any particular vertebrate taxon disperses are based upon untested assumptions. There has been very little attempt to develop what might be called experimental animal geography in an effort to test some of the more cherished ideas widely held about animal dispersal now and in the past.

"Unfortunately, zoologists do not (the task would be impossible) write things like the complete fauna of Oz. (Botanists do write floras on entire political states or large regions and include therein all the known plant taxa, or at least all the known members of the higher orders.) So one cannot look for the best overall treatment of animal life of a region expecting completeness. It is obvious that an assessment of the literature regarding the fauna of a particular region cannot be made on an across-the-board basis. It is necessary to decide on some one (or a few) facet(s) of the gigantic field and then evaluate the literature in those terms." **

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* Colwell, Robert N., 1965: Personal Communication dated October 8.

**Bennett, C. F., 1966: Personal Communication dated March 27.

3. Richards' Analysis of Information Adequacy (Plants and Animals)

Adequacy from the purely scientific viewpoint has been expressed by Professor P. W. Richards, University of North Wales: "...it is sometimes said that the biological sciences fall into two groups: Those concerned with the ways in which living organisms differ from one another and those concerned with the ways in which they resemble one another...in the tropics, it is the first group of biologies which are most in need of attention." Richards further states:

> "The ecosystems of the tropics are very complex and it is not surprising that we know very little about them as systems in which energy and mineral matter circulate. We know enough to say that they appear to differ considerably from most temperate ecosystems and that if we understood them better we should be further towards solving such pressing practical problems as devising really permanent and satisfactory agricultural systems for the humid tropics---we need to know more about the natural ecosystems of the tropics.
>
> "What then are the fields for tropical biology that claim immediate attention? In the first place the study of the plants and animals themselves. All such work must begin with names and classification, which is the task of the taxonomist. It is difficult to generalize about the present state of the taxonomy of tropical animals and plants because the position is so different in different groups and in different parts of the tropics... Plant taxonomy in the tropics as a whole is probably rather more advanced than animal taxonomy partly because the number of species to be dealt with is smaller, but because it is often possible to give a name to most of the (higher) plants one finds, one should not assume that the taxonomist's task is completed...
>
> "Knowledge of the biology...of a large number of plant and animal species is required if we are to understand the problems of evolution in the tropics...we need not only the kind of general biological information...but also cyto-genetical

information which at present is available for very few tropical species... until something is known about the nature, rate and direction of evolutionary processes in the tropical rain forest, in which many plant and animal lineages are believed to have originated, our picture of organic evolution on a world scale is bound to be misleading. To fill this gap requires the cooperation of taxonomists, cytologists, geneticists and ecologists. When we turn from the study of individual species and the evolutionary problems arising from it, to the study of plants and animals in relation to the tropical environment, that is to study of tropical ecosystems as going concerns, we enter a field which is so extensive and as yet so inadequately explored that it is difficult to know what can be usefully said about it in such a short article...

"The amount of work which has been done on different branches of tropical biology has depended, not on the intrinsic scientific interest or long-term importance of particular fields or problems, but on whether they seemed to have a bearing on some question of urgent economic importance... the history of science shows that the direct pursuit of practical objectives is not always the most successful way of solving practical problems; it is hardly necessary to repeat here examples of scientific researches undertaken for no reason other than intellectual curiosity and scientific interest which have produced results of enormous material benefit to mankind... If more man power and money is to be allotted to tropical biology than in the past, a sizable part of the effort should be devoted to... fundamental biological problems."[59]

F. REVIEW OF PRINCIPAL DEFICIENCIES

Primary contributing factors to the overall deficiency of tropical biological and zoological research include the lack of:

- Field stations or simple field laboratories with small permanent staffs located in the tropics
- Data centers or central locations for collection and dissemination of information
- Preservation of native environments suitable for field studies
- Standard methods, techniques and nomenclature where controversies over these factors inhibit cooperative effort

- A training facility to develop tropical specialists
- Textbooks which include information concerning humid tropic phenomena
- Nature guides for identification of plants and animals

An example of the above deficiencies may be seen in the United States where there is no single college or university offering a major in tropical forestry.

G. DESIRABLE OBJECTIVES

Opinions of the various authorities were considered in a summation of recommendations of the Neotropical Botany Conference held in July 1962 at The Imperial College of Tropical Agriculture, Trinidad. These recommendations included the following:

> "1. That encouragement, guidance and support be given to the preparation of monographic and revisionary studies on both generic and familial levels and to publication thereon.
>
> "2. That encouragement, guidance and support be given to preparation of floras of local, national, and natural physiographic or phytogeographic areas, and to publication thereon.
>
> "3. That encouragement, guidance and support be given to the development of simultaneous and coordinated programmes to effect systematic inventory of natural plant resources and vegetation by field exploration, especially giving attention to proper geographic distribution of such activity.
>
> "4. That encouragement, guidance and support be given to the maintenance and preservation of existing herbaria having an interest in or dealing with neotropical floras, and their records and supporting libraries."[57]

The majority of those convened at Trinidad were plant taxonomists and therefore the recommendations stress needs for taxonomic research.[60] Other biological work, of course, has further requirements.

P. W. Richards places a considerable emphasis on well equipped field laboratories and conservation of nature reserves.[61]

The Kandy Symposium emphasized library and bibliographic facilities, nature reserves, botanical institutions, mapping, cytological surveys of flora, an overall classification of tropical vegetation on a structural basis, taxonomic studies of tropical floras, and glossaries of ecological terms.[62]

A sampling of the opinions of the scientific community indicate the following are desirable objectives:

- Conservation of natural areas and maintenance of natural environments, their plant cover and animal life; development of a plan of availability of these areas and environments for investigators interested in field studies (i.e., Barro Colorado Island)

- Facilitating of information exchange between major research centers and the support of regional scientific information centers (e.g., Pacific Scientific Information Center, B.P. Bishop Museum, Honolulu, Hawaii)

- Addition of an education or training component to biological research projects now being carried out in the tropics to develop trained manpower

- Improvement of existing research facilities in the tropics (e.g., U.S. Army Tropic Test Command Center)

- Sponsoring of conferences and small working parties for actively working scientists who need to meet and discuss well-defined problems

- Application of some coordinating plan should be applied to research and development activities of the U.S. government (all agencies) to prevent duplication of effort

- Development of more regional floras such as Flora Neotropica and Flora Malesiana

- Making of a worldwide map inventory and development of a program to fill in gaps where necessary to make vegetation maps available for the humid tropic areas

- Standardization of nomenclature on vegetation types, etc. should be attempted to permit agreement on terms and concepts applied to the scientific disciplines

- Production of textbooks which treat the plants and animals of the tropics from a tropical viewpoint instead of a midlatitude viewpoint

H. RECOMMENDATIONS FOR ACHIEVING OBJECTIVES

In general the most practical method of achieving the objectives cited in the preceding section and of raising the level of research on tropical plants and animals is to continue and expand certain existing facilities and programs.

P. C. Ritterbush and W. W. Warner of the Smithsonian Institution in their "Recommendation for a National Program" support the following scheme for the new world tropics:

"Recommendations

"1. Wild areas of meaningful size must be established to preserve representative communities of organisms under conditions suitable for study throughout the future. In many cases national park status will be required for effective protection.

"2. The exchange of information about research plans and institutional development should be stepped up. The Smithsonian Institute should prepare a revised list of investigators and institutions for publication by the Association of Tropical Biology. Information about proposed expeditions should be freely circulated to enable scientists to arrange for the collection of materials or to request permission to accompany parties to areas of interest. It is expected that information about study facilities may lead more workers to undertake investigations in the tropics for the first time. Efforts should be made to break through barriers insulating applied from basic research and vice versa. Anthropology and ancillary sciences of man should be included.

"3. Efforts should be made to add an education or training component to much biological research in the tropics: to establish student positions at research facilities and vacancies for students in field parties. Only in this way can serious shortages in trained manpower be overcome.

"4. There should be restraint in setting up new research centers, especially in environments where these already exist or for functions already assumed by others, so that the existing network of institutions may be better developed. All organizations supporting or performing research in the tropics should provide small equipment, library, or facility grants to host institutions chosen by their grantees or personnel.

"5. Support should be made available for small problem-oriented conferences enabling biologists more effectively to focus their plans. These should in the main be held at tropical research centers, as one means of recognizing their work, publicizing their objectives and facilities, exposing biologists to tropical environments, and stimulating the host institution.

"6. Where positions for basic research scientists do not yet exist in host countries these should be financed by outside agencies, perhaps for a renewable term of years, but always in cooperation with a host institution. The ultimate intention of such sponsorship would be to develop staffs capable of operating university departments of larger research organizations than exist at present.

"7. Assistance should be given for the development of ten regional libraries and biological data centers in Latin America at a suitable number of central locations where strong institutions already exist. These will be a means of institutional development and information exchange. A possible list of centers follows:

(1) Amazonian Brazil	Belém, Brazil
(2) Peru	Iquitos
(3) Colombia and Ecuador	Bogota or Cali
(4) Venezuela	Caracas
(5) Panama	Panama City
(6) El Salvador, Costa Rica, Honduras, Nicaragua, Guatemala	San José, Costa Rica
(7) Mexico	Mexico City
(8) Western Caribbean	Kingston, Jamaica
(9) Southern Caribbean	St. Augustine, Trinidad
(10) Northern Caribbean	Puerto Rico

"In each case a suitable nucleus exists, where inexpensive catalogue and reprint exchange arrangements could make tangible contributions to research."

The following recommendations refer both to general and specific objectives:

- Recommendation No. 1

Effort should be concentrated on regional floras such as Flora Neotropica and Flora Malesiana, especially for Africa and South Asia.

- Recommendation No. 2

The U.S. Army Tropic Test Command Center is recommended as a possible mechanism to facilitate an increased research effort specifically oriented to the analysis of the effects of various biological parameters on military operations, equipment and personnel. Specifically, field research and testing facilities need to be increased. This expansion would permit an increased number of research projects, including those of an experimental nature to be carried

out under the diverse ecological conditions that are present in this relatively small area. These steps would speed the development of new techniques, designs and specification for equipment to be employed in humid tropical areas in order to further this region's biological investigations.

- Recommendation No. 3

Symposia on tropical biological sciences, similar to those sponsored by UNESCO at Kandy and Dacca or the Neotropical Botany Conference sponsored by the Association for Tropical Biology, Trinidad, should be supported to bring together research specialists for communication of ideas, theories, techniques, and problems.

- Recommendation No. 4

The following research projects should be given priority for future support since they constitute urgent and basic needs. Support should be on a long-range basis (5-10 years).

- Studies directed toward the determination of the most acceptable method for the classification of vegetation types
- Research on the nitrogen cycle and nitrogen fixation as applied to tropical plants
- An appraisal of the significance of tropical floras and faunas in the evolution of the plant and animal life on the earth.
- Establishment of an Institute for Research on Tropical Drug Plants
- Research directed toward the upgrading of various breeds of domesticated animals
- An inquiry into the effects of near-ground, microclimatological factors on tropical floras and faunas
- Research to determine the significance of natural barriers, i.e., mountain ranges, lakes, etc., on the distribution of various plant and animal species
- Study of the factors which determine tropical ecological succession

- Development of keys permitting field identification of species types, eliminating the need for fertile specimen sample submission to distant herbaria

- An evaluation of capabilities of remote sensing techniques when applied to the description and evaluation of tropical ecology

- Research on the military significance of various ecological sites encountered in the tropics

- An appraisal of the impact of man's activity (e.g. burning) on tropical flora

- An investigation into the salt tolerance of plants that grow in tropical deltas or that might be grown there

- Immediate, detailed floristic and vegetational surveys should be made of all tropical delta areas that still retain natural vegetation, since such vegetation is disappearing or changing rapidly

- Establishment of tropical delta reserve or refuge areas to provide natural unexploited areas for future study of animals

- Recommendation No. 5

Reference to the body of this report will show that the areas for which data are particularly scarce, of limited areal coverage and/or lacking in qualitative substance are those listed below. It is recommended that these areas be given special attention in any research planning.

Area Vegetation Studies

Caribbean Islands (especially Barbados, Dominica, Dominican Republic, Jamaica, Margarita, Martinique, St. Lucia and St. Vincent Islands)

Central America (especially British Honduras and Panama)

Bolivia, Ecuador, Paraguay, and Peru

Amazon Basin and French Guiana

West Africa (especially Dahomey, Fernando Põo, Gambia, Fr. Guinea, Liberia, Portuguese Guinea, Senegal, Sierra Leone, and Togo)

Central Africa (especially Angola, Burundi, Cabinda, Central African Republic, Chad, Fr. Congo, Gabon, and Rwanda) and the islands of Zanzibar, Pemba and the Comores

South Asia (especially Cambodia, Laos, E. Pakistan, Taiwan, North and South Vietnam, and the Andaman and Nicobar Islands

Oceania (especially Borneo, Brunei, New Caledonia, New Hebrides, North Borneo, Palau, Papua, Ryukyu Islands, Sarawak, Solomon Islands and Timor)

Area Animal Life Studies

Caribbean Islands (especially Barbados, Cuba, Dominica, Guadeloupe, Hispaniola, Jamaica, Margarita, Martinique, Puerto Rico, Trinidad, and Tobago)

Central America (especially British Honduras, El Salvador, Nicaragua, and Panama)

Bolivia, Colombia, Paraguay, and Peru

East Africa (especially Tanganyika, Mozambique, Comores, Sudan, Zanzibar, and Pemba Islands)

West Africa (especially Cabinda, Dahomey, Fernando Pōō, Gambia, Fr. Guinea, Ivory Coast, Liberia, Port. Guinea, Rio Muni, Senegal, Sierra Leone, and Togo)

Central Africa (especially Burundi, Central African Republic, Chad, Gabon, Rwanda, and Southern Rhodesia)

South Asia (especially the Andaman Islands, Cambodia, Laos, Nicobar Islands, E. Pakistan, North and South Vietnam

Oceania (especially Brunei, Fiji, New Caledonia, New Hebrides, North Borneo, Palau, Papua, Ryukyu, Sarawak, Solomon Islands, and Timor)

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CHAPTER IV

WEATHER AND CLIMATE*

A. INTRODUCTION

Within the atmospheric sciences, research in tropical weather and climates has been relegated to a relatively minor role. Meteorological data and processing facilities are limited in many humid tropic countries, with available data subject to error and in many cases incomplete. These conditions accompanied by an acute shortage of funds have hindered a thorough research effort.

Much of the early work of collecting data and analyzing results was in connection with the colonization activities of England, France, Germany, Belgium, Portugal, and the Netherlands and is reflected in established meteorological facilities and documented data extending back many years. The majority of these facilities were established around centers of transportation, agriculture and industry.

During and since World War II, renewed interest in the humid tropics has resulted in some basic and applied research, establishment of new meteorological stations and the processing of available data into depositories of sponsoring nations. Largely, this has been an uncoordinated effort instigated by the immediate necessities of transportation, industry and military operations. Research has been sporadic, and observing facilities have been established with inadequate instrumentation, personnel and communications.

During the last 10 years, the excellent work of the World Meteorological Organization and committees of the United Nations, as well as coordinated research sponsored by extratropical nations such as the United States and Great Britain, has been reflected in increased regional planning, standardization of equipment and procedures, and monetary assistance. Within the humid tropics, the East African Meteorological Service, the Meteorological Service of India and the Malayan Meteorological Service, to name a few, have contributed to this renewed interest in solving the problems of meteorology in the tropics.

*Dr. Harry P. Bailey (University of California, Riverside), Dr. Charles F. Bennett Jr. (University of California, Los Angeles) and Prof. Benjamin J. Garnier (McGill University), acting as consultants to Texas Instruments for this program, have critically reviewed this chapter in its draft stages.

1. Topical Fields and Elements

The following fields and elements of weather and climate were selected by the Army Research Office for consideration in this inventory:

- Availability and Adequacy of Weather and Climatic Data
- Climatic Regions and Types
- Tropical Storms
- Microclimatology
- Mesometeorology (subjects between 2 and 400 mi in dia)
- Solar Radiation and Upper-Level Circulation

Factors composing each element, which are considered relevant to the purposes of the inventory, are

- Availability and Adequacy of Weather and Climatic Data

  (1) Current status and listing of weather services
  (2) Extent of weather networks: surface and upper air
  (3) Quality of services
  (4) Tropical forecasting techniques
  (5) Tropical meteorology

- Climatic Regions and Types

  (1) Degree of detail and adequacy of present identifications
  (2) Availability of climatic data
  (3) Techniques used in classifications

- Tropical Storms

  (1) Tropical cyclones, hurricanes and typhoons, data on:

    — distribution and occurrence
    — dynamics
    — effects
    — forecasting

  (2) Thunderstorms and lesser storms

- Microclimatology

Within various tropical regional types, the measurement of

(1) Dew
(2) Air movement
(3) Precipitation
(4) Temperatures
(5) Illumination
(6) Solar radiation, etc.

2. Limitations

The topical elements of weather and climate are in the fields of interest of several sciences. Weather falls mainly in the provinces of meteorology and atmospheric physics, and climatology comes within the disciplines of geography and meteorology.

Knowledge of WEATHER and CLIMATE as defined in this Inventory does not exhaust the full scope of these scientific and technical fields. Thus, specialists in any of them will recognize that (1) the Inventory is limited to those elements and factors enumerated here and that (2) other areas of investigation in these fields in the humid tropics are disregarded intentionally or considered incidentally.

The specifications for the inventory have necessitated some arbitrary decisions with respect to classification of information and discussion of its significance. For example, information on meteorologic investigations in conjunction with hydrologic research can be found in the chapter on PHYSICAL FEATURES.

3. Value of Research

Weather and climate are the two most significant environmental factors affecting man's activity. They influence his clothing, housing, food, work, transportation, and communication. Knowledge of climatic conditions of an area allows man to design or adapt his activities to meet weather extremes.

a. Value to the Military

Knowledge of local weather is vital to the planning of military operations since they are particularly susceptible to the weather effects. Moderate and heavy rains reduce the effectiveness of infantry, ground vehicles and airborne equipment. Floods increase military engineering problems.

Fog and blowing dust or sand hinder mobility and curtail local surveillance and reconnaissance capabilities of field units and airborne operations. Severe storms are often disastrous to amphibious operations. For example, on the average, 20 typhoons a year affect the Philippine Islands; these commonly occur between August and November. Knowledge of the nature and occurrence of these phenomena is essential in planning operations.

Logistical planning such as selecting clothing, storage methods, equipment design, transportation, communications, and housing must take climatic phenomena into account or face a decline in operational effectiveness of both men and materials. High relative humidity can be damaging to delicate electronic equipment so these devices must be protected. Organic materials are subject to swelling and attack by microorganisms in hot, moist climates. Storage or operation of machinery in areas of heavy rainfall can be a severe problem.

Forecasts of atmospheric phenomena are of great importance to the military commander in the field. The existence of good climatological histories and an understanding of the cause and effect of atmospheric phenomena in a particular area will aid forecasting.

b. Value to Civilian Affairs

Weather and climatic information is utilized in the design and construction of facilities, transportation networks and industrial complexes. Utilization of rainfall records in tropical areas where the rainfall may vary markedly from country to country, or between windward and leeward sides of mountains, can expedite selection of the best location for multipurpose hydroelectric projects. Roads can be designed and built to withstand the torrential downpours occurring in tropical areas if there are available data on precipitation characteristics. Industrial complexes require weather information in order to design systems for disposing of atmospheric wastes and to reduce or eliminate air pollution problems.

Agricultural development also benefits from climatic studies and research. One study of the rainfall of Java lists 40 distinct types of rainfall based on amount and annual distribution.[1] In this locale, where even a short period of drought at a critical time will result in crop failure, detailed climatic data can aid the local agronomist in selection of crops and cultivation methods. Other significant problems, the solution of which may be assisted by atmospheric research, include local needs for amenities and comfort provided by airconditioning systems, reduction of property losses in times of flooding or hurricane destruction and loss of life in severe storms or during periods of drought.

B. STATUS AND SIGNIFICANCE OF RESEARCH

Meteorological and climatological research in the humid tropics has undergone a period of renewed interest and activity in the last 15 years. The history and evaluation of this development can be considered from the standpoint of both military and nonmilitary significance and potential applications.

1. Historical Notes on Development of Knowledge

Research on weather and climate of the humid tropics falls far short of research in other geographic regions, particularly the midlatitudes, despite the recognized interaction of tropical weather with weather of the rest of the world. This condition is the result of social, economic and political factors shaping world history and economic development.

The earliest recorded tropical atmospheric investigations occurred during the 17th and 18th centuries and was related to certain Portuguese, Dutch, French, and English shipping lanes along the coasts of the humid tropics. Of particular importance to pioneer research on the humid tropics were the atmospheric circulation studies of George Hadley in the early 18th century and the Asian and Latin American meteorological work of Alexander von Humboldt in the early 19th century.[2] During his field studies in the tropical mountains, von Humboldt devised methods of measuring the temperature at different elevations and, for the first time, used isotherms to show temperature differences on a map. Von Humboldt emphasized climate as directly perceived by man's senses and initially stressed the thermal connotation of the phrase "tropical climates."

In 1887, Julius Hann, the founder of 20th century climatology, in noting the then current emphasis upon the importance of the thermal aspects of tropical climates, stressed the importance of the study of "distribution of the total intensity of solar radiation."[3]

Köppen's climatic classifications influenced regional studies for a time. Some critics, as represented by Thornthwaite, have discouraged use of the classifications while others, e.g., Blumenstock, have supported their use. These classifications in themselves have been of minimal research value, but the regional climatologic contributions of K. Sapper, R. DeCourcy Ward and C.F. Brooks to Köppen-Geiger's Handbuch der Klimatologie[5] are important.

C.W. Thornthwaite's theories of evapotranspiration and climatic classifications have influenced African and Indian climatic studies and are being used for regional climatic studies and mapping in Mexico.

H. von Wissmann has defined the boundary of tropical climates with the 13.5°C isotherm of the coldest month and by the front limit.[6] This well-proved opinion of delimitation continues the work of earlier classifiers who have defined the boundary between tropical and extratropical climates in terms of either the mean annual temperature or the mean temperature of the coldest month. For example, the following boundaries are based on mean annual temperature: 20°C (68°F), de Candolle; 23°C (73.4°F), Ravenstein; 20°C (68°F), de Martonne; 20°C (68°F); 21.1°C (70°F), Miller; and 23.7°C (74.7°F), Thornthwaite. On the basis of coldest-month mean temperature, the tropical boundary was set at 20°C (68°F) by Phillipson, at 21°C (69.8°F) by Gorzynski and, of course, at 18°C (64.4°F) by Köppen.[6]

Wilhelm Lauer's tropical climatic studies have advanced the theory of wet and dry ratios for delimiting major vegetation regions in tropical areas.[7] Lauer's results, based on the comparison of about 4000 climatological stations with their vegetation types, are established by calculating the duration of humid and arid climatic conditions. This seems to be the decisive factor for plant life in the different climatic vegetation belts between the tropical rain forests and tropical desert.

Classifications of climates on an ecological basis by C. Troll,[8] and D.I. Blumenstock's[4] theories of distribution and classification of tropical climates are significant modern advances in the understanding of the climate of the humid tropics.

Visher's pioneering investigations in tropical cyclones of the Pacific during the 20's,[9] studies by H. Regula in Africa,[10] and Dunn's investigations of cyclogenesis in the tropical Atlantic[11] led to the concept of easterly waves developed by Riehl in 1945.[12] During the 30's, significant atmospheric research was performed by Depperman in the Philippines.[13] In 1932, Brooks and Mirrlees published a significant study dealing with atmospheric circulation over tropical Africa.[14] The pioneer Atlas of the Oceans issued by the U.S. Weather Bureau in 1938 allowed W.C. Jacobs, following the methods of H. Sverdrup, to estimate evaporation from most of the surface of the oceans.

C.E. Palmer's evaluation of the field of tropical meteorology appearing in the Compendium of Meteorology 1950 and Riehl's Tropical Meteorology[15] are works which resulted from United States Government support. Both are widely accepted as significant. The Army Signal Corps, USAF Air Weather Service, Geophysics Research Directorate of Air Force Cambridge Research Laboratory, the U.S. Navy's Fleet Weather Facilities and Office of Naval Research, as well as groups within the United States Weather Bureau, were among the supporting agencies.[16]

The study of regional weather and climate on a global basis was undeveloped in the United States prior to World War II. During the war, this country's military activities in the Asian and African campaigns and in the South Pacific pointed up the lack of atmospheric research. The

Naval Air Pilot Studies performed by the U.S. Weather Bureau for the U.S. Navy Hydrographic Office during the war are examples of the work produced.

Following the war, various agencies of the U.S. Department of Defense promoted interest in tropical meteorology by granting research funds to universities and other institutions.[17] The concern of the military for an increased knowledge of weather and climate in the humid tropics resulted in a continuing demand for atmospheric research. The extensive meteorological services required for the Korean war and more recently the Vietnam conflict are examples of the type of support required to accomplish military objectives. Current activity in the Panama Canal Zone Environmental Test Center and the Asian climatic studies of the USAF Air Weather Service are significant developments.

The National Science Foundation also supports tropical meteorology as a major research area. Funds allocated by this agency during the International Geophysical Year (1956-57) permitted sufficient observations in the region of the humid tropics to allow a synoptic analysis of the area.[18]

International symposia, many of which have been an outgrowth of U.S Government support to tropical meteorological research, have examined the status of research on weather and climate in the humid tropics, both from an international and a regional viewpoint. The World Meteorological Organization (WMO) has sponsored four seminars devoted to tropical meteorology and tropical cyclones since 1956, financed by EPTA, the United Nations Expanded Program of Technical Assistance. In 1960, the MUNITALP Foundation of New York sponsored a conference on tropical meteorology in Nairobi, the results of which were edited and published by D.G. Bargman in 1963.[19] W.H. Portig, reporting on the results of the Asbury Park symposium in 1962, declared that tropical meteorology was a "stepchild" of the atmospheric sciences.[20] In 1964, G.J.F. MacDonald, chairman of the Panel on Weather and Climate Modification (National Academy of Sciences, Committee on Atmospheric Sciences), reported: "The tropics have been grossly neglected in meteorological research despite the central importance of the tropical oceans and tropical convection in driving the global general circulation."[21]

The advent of the more sophisticated atmospheric measuring devices such as satellites, remote unmanned weather stations, constant-level balloons and radar and the development of new, improved long-distance communications have enabled world meteorological planners to reconsider the possibility of a global weather system. In 1961, the United Nations approved a 4-point resolution which had been presented to the body by President Kennedy a short time previously. One of the approved points called for an international cooperative effort in weather forecasting and atmospheric research. Specifically, the resolution requested the World Meteorological Organization (WMO), in collaboration with the United Nations Educational

Scientific and Cultural Organization (UNESCO) and the International Council of Scientific Unions (ICSU), to draw up proposals for appropriate organizational and financial arrangements to achieve effective and fruitful cooperation. In response to the UN resolution, the National Academy of Sciences developed an international program which represents the views of American scientists and is intended to provide advice to the appropriate U.S. Government agencies and serve as a basis for discussion with an international forum of interested scientists.

2. Evaluation of the Development

Development of tropical atmospherics as a research discipline has been hindered by a general lack of interest in and methodology for the investigation of environmental conditions in the low latitudes. Observational practices, as well as codes and nomenclatures in use today in tropical areas, are extensions of methods developed in extratropical areas of the world. For example, descriptions of certain tropical phenomena such as clouds lose their identity altogether if coded by descriptors developed for midlatitude phenomena. In many instances, this has seriously hindered the efforts of researchers. These general problems and especially the problem of cloud coding have been recognized. J.S. Malkus Simpson and H. Riehl devised a "Tropical Whole Sky Code" in 1958 to identify undisturbed trade-wind skies, weak or trade-wind type disturbances and strong disturbances with 16 category codes and five variation categories to modify the basic specifications. This scheme needs continued tropical use, refinement and either acceptance or rejection in lieu of a better system.[22]

A lack of well-trained meteorologists and climatologists who have field experience in the tropics is another factor which has hindered research. New theories and terminology, new coding systems, better instrumentation and calibration, more adequate training of regional meteorologists, and better data-gathering communications networks and storage facilities are required before the degree of adequacy exhibited by midlatitude meteorology and climatology can be achieved.

C. REVIEW OF CURRENT ACTIVITY AND TECHNIQUES

1. Introduction

This review considers (1) current tropical research activity being performed in the United States or sponsored by U.S. agencies and (2) reports on the regions composing the area of the humid tropics, i.e., Latin America, South Asia and Oceania, and Africa. Discussed are major controversies, neglected areas of research and problems of a barrier nature.

A review of field and laboratory techniques used in tropical meteorology and climatology show them to be generally extensions of techniques developed for midlatitude meteorology. Also, techniques and instrumentation for the measurement of standard meteorological parameters are essentially the same in the tropics as in midlatitude areas. This chapter summarizes deficiencies and recommendations for improvements which have been noted by major authorities.

2. Current Research Activity

a. U.S.-Sponsored

1) Hurricane Research

There has been emphasis on hurricane and tropical storm research since establishment of the National Hurricane Research Project in 1955. Current work under its director, R.C. Gentry, is devoted largely to development of quantitative descriptions, investigation of the dynamics and energy transformations of various types of tropical storms and development of numerical models of tropical disturbances for use on electronic computers. The Caribbean, Gulf of Mexico and adjacent areas of the Atlantic have been the primary geographic areas of interest. Because of the adverse effect of hurricanes on U.S. economy and on the inhabitants in these areas, the emphasis placed here by U.S. Government support is obvious.

Work on the National Hurricane Research Project is centered at the University of Miami, Coral Gables, Florida, where a 5-story computing center has been constructed for use by the National Hurricane Research Center, the U.S. Weather Bureau and weather units of the Navy and Air Force.

The Weather Bureau receives and analyzes weather data from the following sources: radar having a range of 250 to 300 nmi; reconnaissance aircraft having a range of 2500 to 3000 mi; satellite systems; and both surface and upper-air data from most of the northern hemisphere. At best, weather satellites, while offering a new tool for collecting data on tropical storms, are supplemental and insufficient when used alone. Lack of data from developing storm situations in the tropical areas prohibits full prediction and explanation of the birth of tropical storms.

The following are important topics dealing with analysis of data collected by the National Hurricane Research Laboratory; they were first discussed at an Advanced Science Seminar on Hurricanes held July 6 to August 14, 1964, in Miami:

- Theoretical Approach to Hurricane Development

- Modification Experiments on Convective Clouds and Hurricanes
- Climatology of Hurricane Motion, Formation and Hurricane Forecasting
- Study of Hurricane Rainbands

The following topics which were covered at the Fourth Technical Conference on Hurricanes and Tropical Meteorology at Miami, Florida (November 22-24, 1965) are clues to current interest in the field:

- Hurricane Structure
- Storm Surges and Ocean-Hurricane Interaction
- Dynamics of Tropical Meteorology
- Forecasting Hurricane Motion and Economic Aspects of the Hurricane Problem
- Tropical Circulations
- Theoretical Models of Tropical Circulations
- Theoretical Models of Circulations in Hurricanes
- Case Studies of Tropical Cyclones
- General Discussion on
  - — determination of wind with airborne doppler radar
  - — use of NIMBUS infrared data in tropical analysis
  - — relation of tropical and midlatitude circulations in biennial wind oscillation
  - — forecasting of hurricane motion by climatological statistical technique
  - — kinetic energy transfer and conversion on a global scale between the equator and 40° N
  - — simple method of reducing station pressure to sea level
  - — mechanism of warm core wave in easterlies
  - — mechanism of cold core wave in easterlies
  - — climatological study of storms and depressions in the Indian seas
  - — onset of Asiatic summer monsoons over South East Asia

Statistical and dynamic methods of forecasting the movement of tropical cyclones have been developed and are being evaluated at the National Hurricane Center.

2) Tropical Storms

Other work on the problems of tropical storms includes programs being conducted by Woods Hole Oceanographic Institution (Woods Hole, Massachusetts), Travelers Weather Research Center (Hartford, Connecticut), National Center for Atmospheric Research (Boulder, Colorado), Meteorological Satellite Laboratory of the Weather Bureau, Florida State University (Tallahassee, Florida), University of Chicago, Colorado State University (Ft. Collins, Colorado), University of Miami (Coral Gables, Florida), Massachusetts Institute of Technology (Cambridge, Massachusetts), University of California at Los Angeles, New York University, University of Wisconsin (Madison, Wisconsin), and University of Oklahoma (Norman, Oklahoma).

3) Other U.S. Research in Tropical Meteorology and Climatology

a) The following topics which were covered at the 1965 Army Conference on Tropical Meteorology, the fourth consecutive annual review of tropical research sponsored by the U.S. Army Electronics Laboratories, held at Miami Beach, Florida (6-7 May 1965) indicate recent results and future research plans in the field.[23]

- Tropical Regional Research
  - — East African lake levels
  - — warm core cyclones during the Southeast Asia Summer Monsoon
  - — meteorological program for the new inter-oceanic canal feasibility study
- Tropical Mesometeorology
  - — extremely heavy and prolonged periods of hourly rainfall, tornadoes, funnel clouds, water spouts, and hail in South Africa
  - — tropical rainfall patterns and associated mesoscale systems
  - — relation of subtropical high movements to rainfall in the American tropics
- Tropical Convection and Precipitation
  - — rainfall meso-scale patterns in El Salvador
  - — climatic and synoptic influences on diurnal radiation of rainfall on the Windwards Islands
  - — low latitude hailstorms
  - — diurnal and semi-diurnal variations of sensible and latent heat exchange, cloudiness and precipitation over the western tropical Atlantic
  - — rainfall frequency of the area 0-30°N, 50-100°W.

- Dynamics, Thermodynamics, and Physical Meteorology
  - — structure of rainfall in Entebbe, Uganda
  - — kinematics and dynamics of tropical precipitation
  - — low level gravity waves in off-shore winds
  - — tropospheric wave motions in equatorial latitudes
  - — system of 2-dimensional mesoscale analysis and forecasting with friction and moisture
- Tropical Analysis and Forecasting
  - — development of a tropical analysis center at Miami
  - — automatic satellite picture transmission
  - — precipitation probability estimates

b) Instability Patterns in the Tropics

H. Hiser of the University of Miami is studying the mesoscale and other instability patterns in the tropics. Special emphasis is being given to waves in the easterlies affecting Southern Florida and adjacent waters. In the work, precipitation echo motions are being compared with observations of winds aloft in order to determine parameters to be used in predicting translational motion of the precipitation cells and thus permit accurate weather forecasts.

c) Tropical Precipitating Clouds

E. Kessler III, Travelers Research Center, is conducting an essentially mathematical treatment of the problem. Continuity equations for precipitation, cloud and vapor and the steady-state vertical distribution of cloud in a precipitation-free compressible atmosphere have been derived from this study. The chief purpose is to increase the understanding of the role of cloud conversion, accretion, evaporation, and entrainment processes in shaping water vapor distribution, cloud and precipitation associated with tropical circulations. Two important outgrowths of this investigation are reasons for the persistence of cirrus clouds in the tropics and a series of new-found possibilities of more efficient cloud modification.

d) Observation and Study of Tropical Atmospheric Systems

N. E. LaSeur, Florida State University, is studying the relative contributions of synoptic disturbances and local effects to island rainfall patterns by wind structure investigations over Barbados, West Indies. A Woods Hole Oceanographic Institution ship provided measurements 300 mi east of Barbados and on the island itself. An extension of this work will involve studies of the distribution of meteorological parameters in individual hurricanes.

E. B. Krauss of Woods Hole Oceanographic Institution is involved in an associated study of local convection on islands and the interactions of underlying sea or land surface as factors in determining vertical heat flux and momentum. Objectives of this project were design of an ocean buoy and instrumentation. Also studied were the friction effects over land and water to assess their influence on the development of atmospheric circulation. As an extension of this work, instrumented buoys and aircraft will be used to collect data for studies on air-surface interactions and vertical heat flux.

J. S. Malkus Simpson of the U. S. Weather Bureau [now operating under Environmental Science Services Administration (ESSA)] conducted an extensive observation program in cooperation with Woods Hole Oceanographic Institution to study the possibilities of cloud structure and pattern prediction.

E. Kessler and associates, Travelers Research Center, studied the kinematics of tropical precipitation on the scale of convective clouds to determine the effects of motion in moisture distribution, cloud formation and precipitation.

W. K. Henry and J. F. Griffiths of Texas A&M University, using the contingency table as a tool, have been engaged in studies leading to identification of the activity of mesoscale systems in daily rainfall amounts. J. E. Cook of Texas A&M University has completed a thesis on "An Investigation of the Oceanic Effects on the Climate of Pacific Equatorial South America."

At the University of Miami, J. C. Millas is engaged in climatological studies of Caribbean area cyclones and translations of articles written in Spanish relative to hurricane forecasting and research. The work of R. Endlich of Stanford Research Institute involves adaptation of midlatitude methods to analysis and forecasting for tropical conditions.

e) Upper-Air Tropical Research

T. J. Keneshea, M. E. Gardner and W. Pfister have analyzed ionospheric winds and turbulence over Puerto Rico using correlation analysis-I. This document is available from the Defense Documentation Center, Rpt. No. AFCRL 65-273.

Various aspects of monsoon circulation over Southeast Asia are being studied by H. F. Riehl, Colorado State University. His studies, if successful in providing a framework in which mesoscale phenomena may be understood, may close a significant gap in tropical synoptic meteorology. This work also involves the location of bad weather areas in Southeast Asia and their frequency and succession.

Litton Systems Incorporated used meteorological data from Africa and the Indian Ocean area to study stratospheric structure and stratospheric and tropospheric circulations in the tropics to verify the presence of a biennial cycle and provide the basis for improved forecasting of upper winds. Balloons are to be supplied to radiosonde stations around the periphery of the Indian Ocean to secure better data for extension of this work.

A program of field measurements in moist tropical climate is being conducted for tropical thermal attenuation studies at the Institute of Marine Sciences, University of Miami. The primary objective of this work is to determine the effects of tropical environment on light transmission properties of the atmosphere.

R.J. Reed of the University of Washington developed a provisional model for further studies of the dynamics and structure of the stable 26-month oscillation in his work on middle tropical stratosphere. D.O. Staley, University of Arizona, is engaged in similar studies.

T. Fujita and J. Brown of the University of Chicago are using TIROS pictures for mesoscale circulation studies. Photographs, 8-μ to 12-μ infrared radiation, taken over Central America, are combined with others taken with a normal camera for studying vertical wind shear. E.S. Merritt of Aracon Geophysics Company is conducting easterly wave studies based on TIROS data and time sections of conventional surface and upper-air observations.

R.C. Behn and R.A. Duffee of Battelle Memorial Institute have studied the structure of the atmosphere in and above tropical forests. Prior microclimatic research performed for Battelle's Remote Area Conflict Information Center (RACIC) by ARPA's request was reported in August 1965.

A contribution to fundamental meteorological research has been made by NASA's meteorological satellite NIMBUS I in mapping large-scale weather systems from orbital altitudes. The NIMBUS program's original objective, which was to develop a second-generation operational weather satellite to follow TIROS, has been changed to pure research.

The National Center for Atmospheric Research is contributing to tropical meteorology research by making its facilities available to member universities. Both Krauss and Riehl, who are engaged in tropical storm research, have acted as visiting scientists at the center.

4) U.S. Support of Tropical Meteorological and Climatological Research Outside the U.S.

The Meteorological Institute of the Technische Hochschule, Karlsruhe, Germany, is performing studies using data and observations made in Central Africa and East Africa. This work considers cloud structures,

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rain and formation of precipitation. H. Flohn and W. Eickermann of the Meteorological Institute of the University of Bonn, Germany, are studying water vapor characteristics in the tropical rain belt of North Africa. H. Flohn also is engaged in equatorial meteorological studies involving the tropical easterly jet over Southern Asia, Northern Africa, Peru, and Ecuador. The United States Department of Defense is sponsoring all of these projects.

In cooperation with the Netherlands Organization for the Advancement of Pure Research (ZWO), National Aeronautics and Space Administration (NASA) is launching four sounding rockets which release sodium vapor for experiments to measure winds in the equatorial upper atmosphere. The first of these launchings was made at Coronie, Surinam (Dutch Guiana) in June 1964. NASA provides the sounding rockets and launcher, and ZWO supplies the sodium vapor, high-speed cameras for photographing the sodium vapor clouds, and the launch facilities.

In the Panama Canal Zone, Weather Engineers of Panama, under contract with the U.S. Army Tropic Test Center, is collecting microclimatic data at several sites. This work is part of a detailed environmental investigation sponsored by the Army Research Office and the Advanced Research Projects Agency. Instrumented towers have been erected at both forested and open sites. Meteorological data are being collected also by the U.S. Army Meteorological Team stationed in the Canal Zone.

The National Weather Satellite Center, Washington, D.C., programmed two satellites to make extensive photographic records of the clouds in the Indian Ocean area during the expedition of 1961-1965. The U.S. Weather Bureau and Woods Hole Oceanographic Institution cooperated in activities conducted during the International Indian Ocean Expedition (IIOE). The Weather Bureau assigned to the International Meteorological Center at Colaba Observatory, Bombay, India, two full-time meteorologists, five professional assistants and an IBM 1620 computer. Research aircraft equipped with special meteorological sensors and recorders operated out of Bombay in the investigation of tropical cyclones in the Arabian Sea and the Bay of Bengal (1963-1965). U.S. aircraft operated by Woods Hole Oceanographic Institution concentrated on the Arabian Sea monsoon region.

NASA is engaged in a cooperative program with India's National Commission for Space Research. Experiments will involve the technologies of aeronomy, ionospheric physics and magnetics. Sounding rockets will be launched from the Thumba Equatorial Rocket Launching Station (TERLS) near Trivandrum.

The Hawaii Institute of Geophysics has conducted an exercise to determine the amount of data routinely available for the tropics and the adequacy of the data for performing a reasonable global analysis at standard pressure levels. Member countries of the WMO having meteorological operations in the tropics have been asked to mail a copy of the daily output of their analysis centers for December 10, 1963, and January 10, 1964. The U.S.

Navy Weather Service and the U.S. Air Force Air Weather Service also were asked to contribute. Data from 64 analysis centers representing 44 countries were analyzed. Sufficient data existed for a reliable analysis of the large-scale global circulation of the tropical troposphere twice a day, but the communications necessary to gather them were not available.

Project Stormfury, an interagency cooperative effort between the U.S. Navy and Weather Bureau, in effect since 1962, explores the structure and dynamics of hurricanes through a series of field experiments for the purpose of achieving a better understanding, improving prediction and inquiring into the feasibility of modifying some aspects of these destructive storms.

The Japanese Government, the University of Hawaii and the National Science Foundation sponsored an extensive field program in Hawaii to determine chemical composition, drop-size destruction, electrical charges in raindrops, updraft speeds in clouds, and the change in these variables as functions of height, cloud age, wind destruction, environmental temperatures, and moisture lapse rates.

Professor Herbert Riehl, Colorado State University, Ft. Collins, under contract to the U.S. Army Electronics Command, has been investigating various aspects of the monsoon circulation over Southeast Asia. Riehl's research has examined the onset time of the monsoon and its variability within the season, the correlation of the synoptic and meso-structure of cloud systems as revealed over land by satellite and conventional data, the investigation of the synoptic time sequence of the winds during the monsoon season, and the location of principal bad weather areas and their frequency and succession.

The Foreign Area Section of the Office of Climatology, U.S. Weather Bureau (ESSA), maintains a climatologist in Hawaii who is responsible for climatological matters in the Pacific Ocean Trust Territories. A territorial climatologist stationed at San Juan is responsible for Puerto Rico, the Virgin Islands and, to some extent, the entire Caribbean area. In addition, reference manuals containing data for specific locations including parts of the humid tropics are published in punch-card form by the U.S. Weather Bureau.

The First Weather Wing of the USAF Air Weather Service recently published a series of climatic studies for its area of responsibility which includes a portion of the humid tropics. These studies provide an excellent compilation for a limited number of meteorological parameters from data sources mentioned in this chapter. Some of the more pertinent studies are:

- Special Study 105-3, "Climate Data Summaries for Selected Asian and Pacific Stations"
- Special Study 105-4, "Climate of North Vietnam"
- Special Study 105-5, "Climate of Malaysia"
- Special Study 105-6, "Climatic Atlas of Indochina"

- Special Study 105-7, "Far East Climatic Atlas"
- Special Study 105-8, "Far East Climatic Briefs"
- Special Study 105-9, "Climate of Republic of Vietnam"
- Special Study 105/11 (1-2) "January-December Climate of Southeast Asia"
- Series of 20 "Persistency Summary Studies for Vietnam"

The persistency summaries mentioned above attempt to answer the following two questions: Given a certain weather condition, how many hours will it last? Will the same condition recur on one or more succeeding days at the same hour?

5) U.S. Interest in Tropical Metorological and Climatological Research on an International Scale

U.S. participation in the International Indian Ocean Expedition (IIOE) was planned by the National Academy of Sciences Committee on Atmospheric Sciences. C.S. Ramage of the University of Hawaii spent 20 months in the Indian Ocean area as scientific director of the IIOE meteorology program which was established at Bombay in 1963. The program collected meteorological data from every possible source. All weather parameters over land and sea and in the upper atmosphere were collected and stored on microcard. The data were reduced and displayed on charts and were subject to daily analysis. The staff conducted daily discussions of developing problems, the data analysis and its dynamics. Basic objectives of the activities at Colaba Observatory, Bombay, were to develop forecasting techniques for the area and to describe basic atmospheric processes to fit into a model. C.R.V. Raman reports that one of the most significant results of the research of IIOE's meteorology program has been to dispel the notion that a single meeting line of air from both hemispheres (intertropical convergence zone) exists as a single front migrating with the sun and carrying weather with it but, in reality, is an independent dual series of lows or two distinct troughs, one in each hemisphere, which migrate with the sun. The existence of double troughs is indicated by the evidence of cloud cover, moisture and rainfall distribution.[24]

The International Geographical Union formed a special commission on the humid tropics. B.J. Garnier, a member of this commission, has been engaged since 1957 in a continuing program for delimitation of the humid tropics. In association with F.R. Fosberg and A.W. Küchler, Garnier is engaged in the following work as reported by Hills.[25]

"a) Testing conditions established for humid tropicality by undertaking air mass and other analysis outside West Africa, with the object to see whether the average temperature and humidity values established in West Africa when unmodified mT air dominates an area for 5 days or longer are similar in other parts of the world

"b) Examination of the validity of the periods of duration for temperature and humidity conditions suggested in the above reference as suitable limits for the humid tropics

"c) Refining the position of the boundaries of the humid tropics outside West Africa by examination of local data

"d) Studies of the climate of different parts of the humid tropics with a view to finding out the character of conditions not adequately expressed by the factors chosen to show the limits of the area, e.g., typical day-to-day weather conditions, temperature regimes, water balance studies, sunshine, and radiation character."

Garnier currently is conducting research on: the weather conditions in Nigeria with particular reference to (1) their detailed nature as typifying the conditions of different seasons, (2) their ecological significance and (3) their significance for understanding the physiological climatology of the area; and the water resources of West Africa, investigated from the climate (water balance) viewpoint. As part of the latter study (still in a formative state), he plans to measure runoff in various West African River basins prior to making an overall climatic appraisal of the available water in the catchment basins of West Africa. By 1968, the results of Garnier's study and other tropical weather and climate research by geographers (U.S. and international) are to be reported.

b. Latin America

Cold air invasions to latitudes as low as 14°N have been the subject of study by I.H. Lessman of the National Meteorological Service, El Salvador. C.F. Bennett has been conducting microclimatic studies in Barro Colorado Island in the Canal Zone. Some of his data will be published in 1966. In Costa Rica, efforts are being made to undertake synoptic analyses for that area. Lessman reported that research efforts and research publications were limited throughout Central America. Data are available for research involving the origin of temporals, rainfall variations and the intertropical convergence zone. Facilities of the Institute of Tropical Scientific Investigation of the University of El Salvador, including board and lodging, are free to foreign research personnel.[34]

Other current work in Latin America includes

Climatology; Atmospheric Studies	Instituto de Meteorología Náutica Escuela Náutica Mercante Fernando Siliceo Veracruz, Mexico	Mexico
Climatology; Applied Regional Climatic Studies; Evapotranspiration; Pacific and Caribbean Hurricanes	Ing. Juan Mas Sinta Dirección de Geografía y Meteorología Avenida del Observatorio 192 Tacubaya, Mexico, D.F.	Mexico

Tropical Convergence; Easterly Waves; Polar and Continental Humid Air Masses; Mapping of Agroclimatic Districts of Brazil	J.M. dos Santos R.C. Ferreira, M. Sampaio J.F. Garcia, L.R. Ratisbona Serviço de Meteorologia do Ministério da Agricultura Centro de Pesquisas Rio de Janeiro, Brazil	Brazil
Tropical Meteorology	C. Troll Meteorologisches Institut Rheinische Friedrich-Wilhelm-Universität Bonn Franziskanerstrasse 2 53 Bonn, Germany	Northeast Brazil

c. Africa

H. O. Walker, in discussing current research activity in Africa for UNESCO, has stated:[27]

"There are very few research institutes or universities in Africa with departments devoted to meteorology or climatology. Climatology appears in the list of studies of many geographical departments in institutions of higher learning, but this is scarcely enough. Research in meteorology is usually a function of state meteorological services in Africa. The inclusion of this amongst the attributes of the service is most desirable since it links within one organization those concerned with research and operational application of the data. Unfortunately, shortage of manpower and other resources have all too frequently led to a concentration on operational requirements and most research has been carried out either on a part-time basis or at times which other members of civil services would reasonably consider leisure hours. Under conditions such as these, experimental research and research on a large scale in fundamental meteorology are extremely difficult. Hence, the tendency has been for research to concentrate on analytical work over a limited area. As examples, Grandidier's work on the monsoon in former French Equatorial Africa and Eldridge's work on the disturbance lines of West Africa may be quoted. If the writer's experience is any guide, much research work in Africa that has been started has not been finalized either because of lack of time on the part of the research worker or because he has left the continent to return to the problems of the

metropolitan country to which he belongs. It is even more certain that many investigations which have been completed are only available in manuscript or in a few typewritten copies. The sparsity of aerological observations in Africa is another grave handicap to research in meteorology."

Research by South Africans has been accomplished for some areas in tropical Africa. In Johannesburg, S. P. Jackson, University of Witwatersrand, has prepared a climatological atlas for the entire continent of Africa under the auspices of the Commission for Technical Co-operation in Africa.[28] Ramanasarivo of the Service météorologique, Tananarive, has been concerned with the correlation of polar air cells with the weather in the Western Indian Ocean, tropical cyclones and the application of climatology to hydrology.

The East African Meteorological Service director, B. W. Thompson, reports that the investigation of East African weather systems is of high priority. The East African Forestry Research Organization (EAFRO) is conducting research on atmospheric moisture.

Other significant work includes

Meteorológico	A. S. de Souza Observatório Astronómico e Meteorológico Campos Rodrigues Lourenço Marques, C.P. 256 Mozambique	Mozambique
Climatology	Institut des parcs nationaux du Congo et du Rwanda - Burundi 1 rue Defacqz, Bruxelles, Belgium	Congo
Radiation Balance; Synoptic Study of Energy Balance Factors; Hydrometeorology; Climatological Atlas of Congo Basin; Bioclimates; Climatic Variations	J. van Mieghem, F. Bultot Institut royal météorologique Centre de la météorologie tropicale et de la climatologie Avenue Circulaire 3 Uccle-Bruxelles 18, Belgium	Congo
Tropical Meteorology; Water Vapor; Heat Transport and Divergence; Regional Circulation Anomalies	C. Troll Meteorologisches Institut Rheinische Friedrich-Wilhelm Universität Bonn Franziskanerstrasse 2 53 Bonn, Germany	East Africa

Resistance of Materials to Influences of Tropical Climate	R. Geigy Institut tropical suisse Socinstrasse 57 Basle, Switzerland	Tanganyika
Meteorology	S. J. de Almeida João Capelo Meteorological and Magnetic Observatory Luanda, C.P. 1288, Angola	Tropical Rain Forest and Savanna in Angola

Recent studies in the climatology and meteorology of Africa by M.F. Faha, A.H. Bunting, P.A. Onesta, H. Walker, L. F. North, P. Nisme, and D.J. Bargman are listed in the published literature appearing in Volume I. (Note code numbers 0003-080, 090 of Section E.)

d. South Asia and Oceania

The Malayan Meteorological Service has conducted studies on development of horizontal divergence and vorticity in the low latitude atmosphere, equatorial convergence lines of the Malayan-East Indies area and properties of the upper air over Singapore.

Tropical summer convective cells have been the subject of research by H. Mitra, S.M. Kulshrestha and P.S. Jain of the India Meteorological Department, New Delhi, India. Their investigations, which include the use of radar, cover various characteristics of echo cells such as cell diameters, cell spacing, their distributions, variation with the progress of the season, interrelationship, and height-diameter relationship. Also at the India Meteorological Department, a synoptic study of premonsoon squall lines in Northeast India and East Pakistan is being conducted by D. V. Subramanian and A. K. Banerji employing radar techniques. At Poona University, Poona, India, radiometeorological thunderstorms in the tropics are being studied by M. W. Chiplonakar, R. N. Karekar and P. R. Marwadi.

S. Raghavan of the India Meteorological Department, working on problems of thunderstorm propagation studies, has discovered that anomalous echoes observed on a 3-cm radar beam at Madras, India, in the rear of thunderstorms cannot be satisfactorily explained by processes suggested by previous authorities on the subject.[26]

Recently, an Institute of Tropical Meteorology was established at Poona, India. Equipment and personnel of the International Meteorological Center, Bombay, have been transferred to Poona. P.R. Krishna Rao has overall responsibility for this research facility which will be involved in research on the problems of tropical and subtropical meteorology including monsoons and their forecasting, forecasting and warnings for tropical cyclones, medium-range forecasting for the benefit of agriculture and other allied fields,

flood forecasting, and developing techniques for surface and upper atmosphere observations. A UN Special Fund grant has been made for meteorological equipment, cloud and storm studies equipment, an IBM 1620 computer, and other equipment. This institute is intended to serve as an international center for research in tropical meteorology.

Other work in South Asia and Oceania includes

Climatology	Hugh Ferguson Tocklai Experimental Station P.O. Cinnamara, District Sibsagar, Assam, India	India
Rainfall Forecasting; Climatic Variations	Ir. R. Geonarso Lembaga Meteorologi dan Geofisik Djalan Geredja Inggris 3 Djakarta, Indonesia	Indonesia, especially Java
Forecasting; Jet Streams; Circulation Studies; Cyclonic Storms; Agrometeorology	S.N. Naqvi Pakistan Meteorological Service Central Secretariat Frere Road Karachi, Pakistan	East Pakistan
East Asia and West Pacific Air Streams; Typhoons; Synoptic Indicators	R. L. Kintanar Philippine Weather Bureau Atmospheric Research Unit P. O. Box 2277 Manila, Philippines	East Asia and West Pacific
Evapotranspiration; Climatological Map Revision; Solar Radiation	Burma Meteorological Department 619 Merchant Street Rangoon, Burma	Burma
Cyclones; Climatological Surveys; Rainfall Variations; Agrometeorology	W.J. Gibbs Commonwealth Bureau of Meteorology Box 1289K, GPO Melbourne, Australia	North Queensland Northern Territory

3. Research of Significant Growth Potential

Among the many research activities underway or those about to be undertaken, a few exhibit more growth potential than others. These have been categorized into the following groups:

- Projects dealing with moisture transportation and evaporation from open water surfaces in the tropics
- Projects dealing with the interaction between low and high latitude circulations of the atmosphere. (The first type of research problem is fairly easy to study, while the second type is much more complex and difficult; nevertheless, research activity along both of these lines is not only significant but clearly has great future potential.)
- Water balance studies
- Statistical studies for analysis of regions. (The principal problem to be solved is the spatial characteristics resulting from manifold rather than unitary controls. When it is possible to combine several climatic characteristics in a complex variable such as a "weather type," increased comprehension of region-wide characteristics—now confined to single-station data—will result.)

4. Neglected Areas of Research

Tropical meteorology and climatology in themselves might be classifed as neglected areas of research within the total field of meteorology and climatology. One recent survey showed that research on cloud and precipitation physics, turbulence and diffusion, climatology, micrometeorology, and the upper atmosphere accounted for 45.6 percent of the total research budget at 22 universities and institutions, while tropical meteorology accounted for only 2.5 percent.[17] This is less than half of those funds devoted to polar meteorologic research. The figures for U.S. Government research support indicate a similar lack of emphasis on tropical meteorologic research. Only 1.8 percent of the total funds is available to tropical research. If one then notes the emphasis placed on hurricane studies, one can see why the general field might be considered to constitute a research gap.

Basic research is needed in many areas of the field of tropical meteorology and climatology before meaningful studies of more complex problems can be attempted. In recent symposia on tropical meteorology, participants discussed neglected research problems at length. The following is a list of some of the problems mentioned:

- Development of comprehensive synoptic models of tropical weather-producing systems such as the intertropical convergence zone, high tropospheric vortices, the easterly wave, etc.
- Structure and motion of the intertropical convergence zone
- Steering mechanism of easterly waves and their precipitation patterns, areas of maximum weather potential and speed of movement
- Interrelationships between upper airflow and surface rainfall in the tropics
- Cold-air outbreaks— low-latitude penetration extent and associated weather phenomena in the humid tropics
- Upper tropospheric vortices and their relationships with surface weather, clouds and easterly waves
- Low-latitude jet streams, their associated turbulence and clouds and their possible relationship with localized heavy rains
- Relation between sea surface temperatures and cloudiness, shower frequency and cyclogenesis in the tropics
- Recognition of significant tropical weather types and their temporal and spatial distributions
- Relative importance of horizontal advection and vertical flux of water vapor in determining total moisture content of the air in the tropics
- Diurnal changes in low-level winds and temperature, along with clouds and rainfall, over both land and water in the tropics

- Interactions between hemispheres during different seasons, with particular attention to the resulting weather effects
- Interaction between high- and low-latitude perturbations
- The incidence of hot and cold spells and their relation to altitude, latitude, cloud cover, humidity, and wind
- Frictional stress and its relation to vigor and scale of tropical atmospheric convection (and all other vertical momentum)
- Investigation of climatic distributions as they are related to wind directions at their gradient level
- Development of a system to express numerically geographic areas instead of points in tropical climatology

5. Problems Limiting Research

a. Data Availability

Professor H. P. Bailey, University of California, Riverside, has the following to say regarding the state of climatic data:

"Knowledge of weather and climate is gathered, transmitted, analyzed, and learned in numerical form to a greater degree than is true of most other aspects of the physical environment. Furthermore, it is also true of most aspects of atmospheric behavior that the data fall under, or are approximated by, the Gaussian distribution curve. Thus, the arithmetic mean is a useful indicator of central tendency; also, in the humid-tropical environment, means are stabilized by periods of record short in comparison to those required in higher latitudes. It follows that the predictive value of the climatic record, in whatever form it is presented — means, frequencies or extremes — is optimal in the humid-tropical environment.

"The most important advance in climatology in the last 30 years has been the development of electronic summarizing equipment, which allows the recall and ordering of daily or even hourly weather data according to the needs of specific inquiries. A large amount of experience in military needs relative to the weather factor in planning, equipment, strategic and even tactical operations has shown that such needs are best satisfied by:

"1) Specifying the problem

"2) Interpreting that problem in terms of the weather factors involved

"3) Determining the frequency and severity of those weather factors by summarization of weather records by electronic equipment from a suitable run of daily observations

"4) Making a decision based upon such specific information rather than relying upon generalities derived without reference to the military needs under examination

"Thus, it follows that the most important aspects of the state of knowledge relative to the weather and climate factors in military planning are related to (1) the existence of weather records in the areas of concern, (2) the conversion of those records to punched cards, magnetic tapes or other forms of electrical storage, and (3) the facilities to process such encoded information. This knowledge is 'live,' flexible and subject to enrichment and collation in contrast to published sources of climatic information which are 'dead,' inflexible and beyond recall.

"It is of the greatest importance, therefore, to determine the status of original records, the degree to which they have been encoded for electronic processing equipment, and the programs that have been developed for their interpretation. The facilities of the National Weather Records Center at Ashville, North Carolina, are the center of such information. However, a considerable lead time, as well as essential funding, is needed when deficiencies are discovered in any part of the chain described in the preceding paragraphs. For a proper, useful and complete estimation of the state of knowledge of weather and climate of the humid tropics, it is thus necessary to think not only in terms of the inventory of weather records but the actual state of facilities and personnel needed to process such records for repeated, carefully specified, properly interpreted climatic analyses. The required 'state of knowledge' thus has an important operational dimension as well as a library dimension."*

The density of the data-collecting network is far below the desired level in many nations in the tropics. Raw data for meteorological and climatological studies are available today at most national weather headquarters in the tropics, but many of the data are unreliable. Data are available only at numerous individual centers rather than at a central bank. The expense in time and money of gathering the local data in the proper form for the researchers' specific needs is frequently a formidable barrier.

*Bailey, H.P., 1966: Personal Correspondence dated 11 February.

The inadequacy of the observing network in the humid tropics is shown in Table 12. The total number of weather stations in a country, as well as the area of the country, is presented in order to give an indication of density. Countries with the least density of operating weather stations are shown at the beginning; those with the greatest density, at the end. Also, the data for several extratropical countries are included for purposes of comparison. If these established and functioning observing networks are used as a guide, absolute minimum coverage is not available in the humid tropics except for those countries listed in the table as following Kenya. Distribution and type (surface or upper air) of existing weather stations throughout the various regions is a critical problem not treated here but which must be evaluated prior to locating any new facilities. Weather station locations tend to be concentrated around centers of population, industry and transportation, which may or may not satisfy the requirements of needed meteorological and climatological research.

Table 12

WEATHER STATIONS OPERATING IN THE HUMID TROPICS*

Country	No. of Stations	Area of Country (sq mi)	Density Factor
Liberia	1	43,000	1
Chad	16	495,800	3
Angola	18	481,351	4
Costa Rica	1	19,960	5
Sudan	53	967,500	5
Venezuela	19	352,051	5
Guatemala	2	42,032	5
Brazil	182	3,286,342	5
Peru	32	506,058	6
Bolivia	27	424,060	6
British Guiana	5	82,990	6
Upper Volta	7	105,839	7
Laos	7	91,000	7
Nigeria	28	367,341	8
N. Rhodesia	23	288,130	8
Congo	81	1,037,381	8
Ivory Coast	11	124,503	9
Nicaragua	5	57,128	9
Colombia	41	439,716	9
Indonesia and Malaysia	66	626,573	10
French Guiana	4	34,740	11
Mozambique	34	297,846	11

*From H.O. Pub. No. 119, "Weather Station Index," U.S. Naval Oceanographic Office, USGPO, Washington, D.C.

Table 12 (Contd.)

Country	No. of Stations	Area of Country (sq mi)	Density Factor
Rhodesia	16	150,333	11
Malagasy	27	227,800	12
Paraguay	21	157,006	13
Ecuador	14	104,479	13
Gabon	14	103,100	14
Panama	4	28,745	14
S. Vietnam	10	65,948	15
Cameroon	32	183,333	17
Cambodia	10	54,000	18
Honduras	9	43,232	21
Togo	5	22,200	22
Rwanda	3	20,915	24
Burundi	2		
Kenya, Tanzania, Uganda	55	224,600	24
Puerto Rico, Virgin Islands	9	3,566	25
Pakistan	98	364,737	27
India	362	1,259,991	28
Haiti	3	10,692	28
Thailand	56	198,500	29
Surinam	16	55,145	29
Malaysia	15	51,000	29
Central African Republic	79	238,224	33
British Honduras	3	8,863	34
El Salvador	3	8,257	36
Solomon Islands	6	15,820	38
Dominican Republic	8	18,810	43
Philippines	57	115,000	49

Table 12 (Contd.)

Country	No. of Stations	Area of Country (sq mi)	Density Factor
Cuba	24	44,205	54
West New Guinea	54	94,430	57
Ceylon	20	25,332	79
New Hebrides Islands	5	5,700	88
Jamaica	6	4,408	136
Fiji Islands	15	7,055	213
Taiwan	36	13,885	259
Martinique and Vicinity	2	425	472
St. Lucia Island, St. Vincent Island	5	383	1299
Information for several extratropical countries is provided below for comparative purposes:			
United States (Continental)	1,125	3,675,633	31
Norway	86	125,064	69
Sweden	189	173,622	109
France	156	212,822	73
West Germany	220	95,923	229
Italy	152	116,303	131
TOTAL STATIONS	1,691		
TOTAL LAND AREA		12,451,400	

Note: Australia, Mexico and China (Peoples Republic of) are not included because of incomplete stations and area determination.

b. Coding, Description, Models

The lack of a special coding and descriptor language for tropical weather phenomena is a serious handicap to research. Raghavan reports:

"Gaps exist in detailed cloud information, net radiation data and evaporation data. Without these, we can hardly establish which processes are operative, much less understand them. We also lack adequate synoptic models based on careful observation and physical reasoning."[26]

c. Instrumentation

The lack of adequate instrumentation, calibration procedures and training of personnel contributes to the inaccuracies of data. A much higher accuracy of measurement is required in the humid tropics.

An additional problem for research deals with the evaluation of radiosonde data. A thorough discussion of the problem is contained in a speech given by Koteswaram, Indian Meteorological Service, at a conference on Tropical Meteorology at Asbury Park, New Jersey, May 10-11, 1962.[27] His remarks indicated that some solution must be found to the problem of evaluating radiosonde data discrepancies before any significant progress can be made in tropical meteorology. Proper calibration of the instrument prior to release and a carefully monitored run will do much to alleviate the discrepancies. It is doubtful that the monies presently available to the tropical areas can provide a new instrument with more sensitive sensors, but the project is worth considering because of the minimum variations in the pressure temperature and humidity of the upper atmosphere.

d. Personnel and Equipment

The understaffed, underequipped, poorly organized state of many tropical national meteorological services is a deterrent to good results in analysis, forecasting, climatological studies, and research. When queried on the major problems facing the investigation of tropical meteorology, Professor R.A. Bryson, University of Wisconsin, Center for Climatic Research, gave the opinion that "qualification of personnel and methodology" are major factors of a barrier nature. He stated:

> "There are too few people working in the field, the data are generally not for the important parameters and the data are not collected in a form to reflect the sensitive factors. For example, the difference between light rain or none and heavy rain is often due to slight differences in initial stability. The only sufficiently sensitive indicator of these subtle differences is the clouds themselves; yet the cloud form is not accurately reported, is coded into very gross groups...."*

*Bryson, R.A., 1966: Personal Correspondence dated 29 March.

Acquisition of weather and climatic information has deteriorated in the Caribbean area in the past few years due, in part, to lack of equipment and personnel. For example, many noted atmospheric scientists have migrated from Cuba. In addition, upper-air soundings are no longer taken above Cuba because the U.S. Department of State has halted the U.S. Weather Bureau's shipment of radiosonde units, balloons and helium for these measurements. Formerly, this equipment was available from the Weather Bureau at no cost. Upper-air data from Havana and Camaguey were probably of greater advantage to U.S. meteorologists than to Cuba. In this area and in others, there is a distinct need for an increase in station density in order to increase data inputs. Ship stations or automatic self-monitoring stations are essential to data collection in or near hostile areas.

The Radar Meteorological Laboratory at the University of Miami, Coral Gables, Florida, needs additional and better equipment for its radar program to get areal patterns of "point" weather data. Such requirements include a video tape recorder to study the quantitative pattern of turbulence and an S-band radar with 20-ft reflector to permit narrow beam (10 cm wv) of 1° beamwidth to eliminate atmospheric attenuation.

e. Financing

Lack of funds and their unequal distribution are among significant problems deterring an adequate meteorological operation. Careful planning in the distribution and application of monies by WMO or other qualified international organizations can provide for a scheduled closing of the gap in making data of the tropics available, distributing it and providing the personnel and equipment to process it.

Many promising research ideas may have been allowed to stagnate because funds were unavailable. Bryson, who has the largest graduate meteorology program in the U.S., was asked why so few students at the University of Wisconsin are concerned with the tropical portion of the troposphere. "The data," he replied, "are too difficult to get and too expensive from Asheville (The National Weather Records Center) in addition to the cost of field operation."*

f. Problems of the Environment

Where funds are available, the researcher cannot underestimate the difficulties involved in carrying out research programs under tropical conditions. Portig reported that a disregard for the difficulties involved in tropical working conditions caused the failure of the German IGY expedition.[30] On this subject, Crow reports: "Among the many partially independent but closely interrelated factors involved, most of which are out of control of the researcher, are transportation difficulties, unreliable power sources, lack of suitably trained assistants, enhanced corrosion, and the overall lethargy which affects personnel in tropical regions."[30]

*Op. cit., p. 137

According to Bargman and Johnson, the efforts required to obtain reasonable results — even with nonelectronic equipment — are approximately three times as great in the tropics as they are in midlatitudes. While this opinion was based on experience at African locations, meteorologists who have worked in Latin America — such as Crow, Lessman and Portig — consider the figure an understatement, with even such a factor as pilferage playing a major role in these areas.[30]

6. Major Controversies

Major theoretical controversies appear to be absent from the fields of tropical meteorology and climatology, but there are some minor areas of disagreement. In some instances, the disagreement may stem not from a particular research problem but from the methods by which it was approached. For example, Weickmann, in the production of atmospheric charts, reduced data from the 850-mb level to sea level.[30] Bargman failed "to find any physical significance in the reduction from the general 850-mb level over continental Africa and over the higher parts of continental Asia to sea level in the production of these charts." He added that he found the correlation of the 850-mb level over the continent with sea level over the ocean "physically distressing."

Other differences of opinion occur on the value of data derived from equipment now in use in the tropics. For example, Lally states that "the radiosonde is the single most important meteorological instrument,"[31] but a recent study indicates that "radiosonde ascents in the Caribbean do not satisfy the requirements of the forecaster nor of the research worker."[30] R. H. Simpson of the U.S. Weather Bureau (Meteorological Research), Washington, D.C., raises the pessimistic possibility that radiosonde observations are not being correctly interpreted.[30] Other differences of opinion exist on such subjects as the genesis of hurricanes[22] and the structure of the intertropical convergence zone (ITC).

The differences of opinions referred to above cannot be considered major controversies. Differences of interpretation often occur because of the inadequacy of data, and scientists are unwilling or unable to take a firm theoretical stand.

Today's most significant theoretical controversy in tropical meteorology concerns easterly waves. Questions related to easterly waves have been abundant in current literature. Several types of disturbances within the tropics produce the same surface expression but are quite different aloft. The ability of these systems to penetrate into the upper atmosphere and their expression aloft are important to their ability to sustain themselves.

Other points of controversy include the number of types of easterly waves, their characteristics and whether certain types are confined to specific geographic areas. Pacific meteorologists say that easterly waves never deepen into hurricanes and that they are completely independent of each other. Others such as J.C. Sadler of USAFCRL have even questioned the existence of the easterly wave as a self-sustaining system.[30]

Bryson reports that " . . .practically all research papers on the subject (of easterly waves) limit their concern to 'the 10 strongest of the season' or 'only those which generated tropical storms.' This is like trying to describe the embryo by looking only at adults . . ."*

Atlantic meteorologists contend that certain types of easterly waves deepen into hurricanes. R.H. Simpson thought that Sadler had been misquoted and that the easterly wave definitely did exist.[33] This statement was then rebutted by several tropical meteorologists.[34, 35, 36] Merritt has partially settled the controversy in favor of Simpson.[33] It is known that certain types of easterly waves extend into the upper levels of the atmosphere and that they are self-sustaining.[37] However, still unanswered are other questions: how many types of easterly waves exist?. . .are certain types found only in specific geographic areas and why?...why do some extend aloft and not others? These questions and the overall easterly wave problem are yet to be resolved.

At present, there is controversy in tropical Africa as to the best method of calculating and measuring potential evapotranspiration, be it the radiation-income method, the aerodynamic approach or a combination of both. A discussion of these problems may be found in a report given by J.S.G. McCulloch at the Inter-African Conference on Hydrology at Nairobi (CCTA, 1961).

"Many controversies," reports Bryson, "stem from the size of the tropics and the local viewpoint of the investigator. For example, to go back to pre-WWII days, the Japanese said there were 'fronts' in typhoons, and the Philippinos said there were not. The Japanese used their ship and small island observations and the Philippinos used mountainous island observations. Even if there were 'fronts' over the sea, they couldn't have been seen over the rough islands."*

7. Field and Laboratory Techniques

Methods for observing and measuring tropical meteorological phenomena are essentially the same as those employed in extratropical areas. Although equipment may vary from station to station, country to country, etc., the variation is not critical unless the international technical specifications for this equipment have been ignored.

*Op. cit., p. 137

Rocket probes, radar and meteorological satellites are helping to expand knowledge of weather phenomena. Rocket probes and radar, while adding valuable information on particular areas within and especially on the periphery of the humid tropics, are not widely used in tropical areas due to lack of local funds and technical capabilities. Data derived from meteorological satellites do not receive wide dissemination in the tropics and, at present, are not available to aid forecasting in a greater portion of the area.

Proper measurement of meteorological phenomena requires training and constant checking of procedures. Instrumentation requires periodic calibration and servicing. The minimal meteorologically significant variations in meteorological parameters require close adherence to these requirements.[32] A difference in calibration technique by two observers may amount to as much as three to five times the variation which actually exists between two stations — or even at the same station during two separate recording periods. The coding of meteorological data is another serious problem which is illustrated as follows:

> "The synoptic code assigns two figures $C_L = 3$ and $C_L = 9$ to cumulonimbus (Cb). Neither figure specifies whether there is just one Cb or many Cb's all over the sky, whether it is (they are) isolated or accompanied by cumulus, stratocumulus, stratus or cirrus as the plain language specifications say (U.S. Weather Bureau, 1955). The difference between the number 3 and the number 9 refers only to the fibrosity of the Cb's top."[38]

Since Cb clouds are more common in lower latitudes than in high latitudes, the information given by the synoptic codes is insufficient. Lack of essential features and inadequate description greatly reduce the value of the observation to the forecaster. At a recent conference on tropical meteorology, Dunn (U.S. Weather Bureau) stated: "I challenge anyone to take the plotted land observations from Central and South America and the Caribbean and consistently and accurately locate the ITC (intertropical convergence zone). The cloud and weather code simply don't tell us what the sky looks like."[11]

Bryson feels that the structure of the ITC could be established with a coordinated aircraft observation program.* He agrees with Dunn that calculations from widely scattered standard station observations will never establish ITC structure.

High-latitude analysis techniques also have been adapted from other areas for tropical use. The isobaric method was borrowed from mid-latitude meteorology and is widely used in the tropics. The streamline technique which is also being used in the tropics gives better definitions of tropical weather but, to be done correctly, is time-consuming. Isobaric analysis is difficult in many areas of the tropics due to small pressure variations between stations, the inaccuracy of surface air pressure measurements and the lack of a standard technique for reducing upper air pressures to the surface.

Communications systems for data collection within a region and for exchange between regions are inadequate. Whereas the relative importance of long-range forecasting has been as great as in most extra-tropical areas, this problem of long-range forecasting becomes increasingly critical as more industrial and aeronautical agricultural development takes place. Data from the tropical areas are extremely important to any global weather analysis and forecasting system. At present, there is an insufficient exchange of information between regions or from the tropics to midlatitude areas to allow accurate long-range forecasts. When one compares the system of communications in the northern hemisphere with the accuracy achieved in long-range weather prediction, one begins to realize the vastness of the problem.

D. AVAILABILITY OF DATA

Information concerning the weather and climate of the humid tropics comes in various forms and from many types of sources including depositories, research institutions, conference reports, and authoritative personnel.

1. Amount and Type Available

In comparison with atmospheric research of other areas of the world, humid tropical coverage may be described as limited. Weather and climatic studies on the humid tropics are about half the number of polar studies.

*Op. cit., p. 137

Research material has been encountered in several foreign languages. Usually, important published reports, books or articles have been reviewed and abstracted in U.S. professional journals such as Meteorological and Geoastrophysical Abstracts, a monthly publication of the American Meteorological Society. Climatological information has been found either in the form of actual studies issued by the meteorological services of the various countries or in reference bibliographies such as the U.S. Weather Bureau's Annotated Bibliography of Climate and Annotated Bibliography of Climatic Maps. Appendix B (Principal Depositories) of this compendium should be consulted to determine the amount, type and availability of weather climatic research materials located at depositories containing outstanding holdings, either quantitatively, qualitatively, or both.

2. Special Information Sources

Sources of information in addition to depositories consist of national and international research institutions, agencies, organizations, and authoritative personnel who have done significant research in the local area.

a. Institutions and Agencies

Organizations, agencies and research institutions engaged in specialized investigations of humid-tropical weather and climate may be found in a separate report entitled A Directory of Institutions Primarily Devoted to Humid Tropic Research which was published in October 1965 by McGill University for the U.S. Army Research Office and the IGU.[39]

Highly specialized holdings by organizations that act as depositories of weather and climate materials may be found in Appendix B of this compendium.

Special agencies containing data in an EAM format for storage and rapid information retrieval do not specialize in humid tropic areas. The National Weather Records Center and the Data Control Division, Climatic Center of the Air Weather Service, both located at Asheville, N. Carolina, and the Meteorological Office, Bracknell, U.K., contain essentially domestic data but do have materials on punch cards, microcards, microfilm, etc., concerning the tropics. An inventory of the surface and upper air data available at these two U.S. depositories is available from the U.S. Weather Bureau (ESSA). Their holdings consist of uniform summaries of surface and upper level weather observations.

A catalog of all NIMBUS radiometer observations is available from the Goddard Space Flight Center, Greenbelt, Maryland.

A comprehensive annotated bibliography on climate is contained in "An Annotated Bibliography of Climatic Maps" and "An Annotated Bibliography on the Climate" published by the Foreign Section of the Office of Climatology, U.S. Weather Bureau. These record all known published information. Useful studies and summaries in clouds, evaporation, precipitation, pressure, humidity, temperature, and wind are carefully referenced and indexed and sources are given. A listing of these bibliographies with identification numbers is given in Table 13.

b. Authorities

Authorities who may be considered as information sources of an interview nature are listed in both a matrix and directory in Appendix A (Authorities) of this compendium. They have been selected primarily on the basis of their research and/or residence in the local humid tropical areas.

3. KWIC (Keyword in Context) Index

Volume I of this inventory, KWIC Index — Humid Tropic Environmental Literature (AD-625-426), contains the bibliography that was collected at domestic and foreign depositories. Documents of military significance and scientific value are indicated. Materials were derived primarily from the literature of the geographic, earth, atmospheric, and biological sciences.

The literature was classified into the following categories based on program specifications:

- Weather, General
  - precipitation
  - cyclones
  - hurricanes
  - typhoons
  - storms (inciuding monsoons)
  - micrometeorology
  - temperature
  - wind
  - solar radiation
- Climate, General
  - climatic regions, classification
  - climatic regions, delimitation
  - weather services
  - upper-air information

These topics may be consulted via their code numbers for each area required in Section E of Volume I.

Table 13

BIBLIOGRAPHY FOR CLIMATIC STUDIES
(U. S. Weather Bureau)

Publication No.	Country	Research Completed
WB/BC-1	*Brit. East Africa (also #7)	1955
WB/BC-2	*Cabinda	
WB/BC-3	*Cameroons	
WB/BC-4	*French Equatorial Africa	
WB/BC-5	*Peru	
WB/BC-6	*Rio Muni and Gulf of Guinea Is.	
WB/BC-7	*Brit. East Africa II (also #1)	
WB/BC-8	*Angola	1956
WB/BC-11	*Belgian Congo	
WB/BC-13	*Colombia	
WB/BC-14	*Costa Rica	
WB/BC-15	*Ecuador (also #24)	
WB/BC-16	*Guatemala	
WB/BC-17	*Honduras	
WB/BC-19	*Federation of Rhodesia and Nyasaland	

*In manuscript form and on microfilm (MF)

Note: Intermediate numbers are assigned to non Humid Tropic areas

Table 13 (Contd.)

Publication No.	Country	Research Completed
WB/BC-20	*Panama (revised by #75)	1956 (contd)
WB/BC-21	*Salvador	
WB/BC-22	*Venezuela (also #27)	
WB/BC-24	*Ecuador II (also #15)	
WB/BC-26	*Panama II (revised by #75)	
WB/BC-27	*Venezuela II (also #22)	
WB/BC-29	*Guianas (Brit., French, Dutch)	1957
WB/BC-30	*Indochina (also #38)	
WB/BC-36	Cuba	1958
WB/BC-38	*Indochina II (also #30) (not on MF)	
WB/BC-44	*Australia (not on MF)	1960
WB/BC-47	South Pacific Islands	
WB/BC-48	Brit. Honduras (revised by #52)	1961
WB/BC-51	So. Indian Ocean Is. (revised by #70)	

* In manuscript form and on microfilm (MF)

Revised means brought up to date

Table 13 (Contd.)

Publication No.	Country	Research Completed
WB/BC-52	Brit. Honduras (revised)	1962
WB/BC-54	China (Formosa)	
WB/BC-55	Macao	
WB/BC-56	Hong Kong	
WB/BC-62	The Dominican Republic	
WB/BC-63	Nicaragua	
WB/BC-64	British Borneo	
WB/BC-70	Indian Ocean Islands (revised)	1963
WB/BC-74	Bolivia	
WB/BC-75	Panama and Canal Zone (revised)	
WB/BC-79	French West Indies	1964
WB/BC-80	Sudan	
WB/BC-86	Macao (revised)	1965
WB/BC-87	South China	
WB/BC-88	North Vietnam	
WB/BC-90	Republic of Vietnam	1966

Revised means brought up to date

Table 13 (Contd.)

BIBLIOGRAPHY OF CLIMATIC MAPS

Publication No.	Country	Research Completed
WB/BM-6	*Mexico (revised by #59)	1958
WB/BM-7	*Southwest Pacific Ocean	
WB/BM-8	Western Pacific Ocean	
WB/BM-12	Pakistan (revised by #45)	1959
WB/BM-16	Australia	1960
WB/BM-18	Indochina (to be revised)	
WB/BM-23	Formosa, Hong Kong and Macao (see #41)	
WB/BM-24	Nigeria and Brit. Cameroons	
WB/BM-27	Cuba	1961
WB/BM-30	China (mainland)	
WB/BM-38	Colombia	1962
WB/BM-39	Indonesia	
WB/BM-40	Fed. of Rhodesia and Nyasaland	
WB/BM-41	China (Formosa), Hong Kong and Macao II (see #23)	
WB/BM-43	Sudan	
WB/BM-44	Tanganyika	
WB/BM-45	Pakistan (revised by #71)	
WB/BM-46	Nicaragua	

* In manuscript form

Revised means brought up to date

Table 13 (Contd.)

Publication No.	Country	Research Completed
WB/BM-47	Bolivia	
WB/BM-50	Angola	
WB/BM-56	Mozambique	1963
WB/BM-59	Mexico (revised)	
WB/BM-60	Burma	
WB/BM-65	India	1964
WB/BM-70	Paraguay	1965
WB/BM-71	Pakistan (revised)	
WB/BM-72	Ceylon	

Revised means brought up to date

[Burma, India (revised) in press]

4. Additional Information Sources

- Barbados

The Bellairs Research Institute of McGill Univeristy conducted a project on the Waterford area for a period of 1½ years. The results were published in August 1960.

- Bolivia

The Bolivian Meteorological Service publishes an annual "Bulletin of Statistics" containing data on standard meteorological parameters.

- Brazil

Brazil's Department of Water and Electrical Energy has collected precipitation data for some 200 stations. The Brazilian Meteorological Service has published the "Atlas Climatologico do Brasil" consisting of several large volumes of statistical data.

- Martinique

The National Institude of Statistics of France has published a climatological study with data in "Annuaire de la Martinique" (1952-1956), and J. Cherbonnier published a paper in 1963 entitled "Essai de classification des Differents Climats de la Martinique d'après les Méthodes de Thornthwaite" available through the National Meteorological Service of France.

- Central African Republic

The French Equatorial African Service Météorologique published in 1954 the "Resumé Mensual de Temps en A. E. F." which is a good summary of meteorological statistics.

- Fernando Poo

The Great Britain Meteorological Service has published a regional reference entitled "Weather on the West Coast of Tropical Africa from 20°N to 20°S including the Atlantic to 25°W."

- Ghana

The Ghana Meteorological Service publishes "Monthly Weather Report and Annual Summary of Observations."

- Ivory Coast

The French West Africa Service Météorologique has published "Côte d'Ivoire Resumé de Temps" for the period 1953-1954.

- Nigeria

The British West Africa Meteorological Service has published "Preliminary Notes on Rainfall of Nigeria (1956)" which contains charts and tables for 100 stations.

- Portuguese Guinea

The Lisbon Servicio Meteorologica has published rainfall data in "Annuario Climatologico de Portugal, Part II" for the period 1947-1954.

- Sierra Leone

The Sierra Leone Meteorological Service has published "Statistics Illustrating the Climate of Sierra Leone."

E. ASSESSMENT OF THE STATE OF KNOWLEDGE

This Inventory has sought the cooperation of experts with personal experience in the humid tropics to review the findings and offer opinions on the state of knowledge of humid-tropical weather and climate in general and in the 108 regional and political units (mainly entire countries) identified for the purposes of the Inventory.

It has been determined that the experts regard the general state of knowledge to range between fair and poor, with tropical climatology not as far advanced as tropical meteorology. Their consensus is that regionally the weather and climate of the Caribbean and Hawaii are best known. They agree that the weather of West Africa, East Africa, Mexico, and Congo (B), and the climate of Southeast Asia, Mexico, India, and the Philippines have been well studied.

The analysis of opinions shows that none of the experts claims to have an intimate knowledge of weather and climate throughout the humid tropics and, therefore, in keeping with accepted scientific ethics, each regards himself qualified to rate only those areas that he has studied directly or in connection with his topical investigations.

The Inventory shows a preponderance of literature on weather and climate of the Caribbean, tropical Pacific, India, and the humid tropics in general. It appears, as the experts have indicated, that these areas are better known than other areas of the humid tropics. However, the state of knowledge of some of the other regions may be better than the Inventory shows or the experts can certify. American participation in atmospheric research in the humid-tropical portions of the Western Hemisphere accounts for greater familiarity with research there than in other regions and for greater availability of published results. Information on non-U.S. research activity decreases

with the increase in amount that is published in foreign journals and books, despite the growth of international abstracting services intended to overcome this obstacle.

It is noted also that local experts differ with those consulted for this project. For example, the high rating given to knowledge of the weather and climate of India must be balanced against the opinion of scientists working continuously in that region who enumerate countless gaps in knowledge. Similar observations were made on the opinions of American observers and local experts regarding the knowledge of the weather and climate of Hawaii. In general, the weather and climate of the humid tropics are not considered to be adequately known.

H. P. Bailey has the following to say regarding the state of knowledge of the weather and climate of the humid tropics:

> "The humid tropics are by definition warm and wet places overall. However, much more variability of both temperature and rainfall occurs, both in time and space, than is obvious. Unlike midlatitude localities, temperature is controlled more by cloudiness than season, and the direction of air flow is controlled more by friction than by regional pressure gradients, because of the necessarily weak Coriolis influence. The latter fact prevents the assumption that air will move as it should, according to pressure gradients, and requires direct observation of wind direction and wind speed at all levels. This increased requirement for wind observation is contradicted by the fact that wind-observing networks in the humid tropics are poor, thus reducing the basis of successful weather forecasting. Station records are poor in all respects throughout a large part of tropical Africa and South America, thus reducing the basis for climatic studies as well.
>
> "A fact of large importance in the study of any aspect of the humid tropics is the hugeness of the area concerned. About 40% of the earth's surface lies between the Tropic of Cancer and Tropic of Capricorn, and almost half of that large zone qualifies as being humid as well as tropical. As in the midlatitudes, character is given to the weather of the tropics by irregularities in the form of disturbances, some representing a large degree of organization of the atmosphere around centers or troughs of low pressure, often sensed more accurately aloft than at the surface. Unfortunately, the ultimate cause of such disturbances has as yet not been assigned, and so we do not know whether tropical cyclones, easterly waves, and the like are spontaneously generated from external sources such as the sun or cosmos, or represent reactions within the earth-ocean, -atmosphere system. At present we must depend upon early reports of weather disturbances after they have formed, rather than true prediction of their generation.

"A general statement about the status of knowledge of tropical weather would then necessarily admit that it is poor, in view of the lack of basic knowledge concerning the causes of tropical disturbances, and the sketchy network of observing stations typical of all ocean areas, and large parts of South America and Africa. In any given area, first action toward improving forecast services should include study of the existing weather network, with the object of supplementation if such proves advisable.

"In the case of climatic studies, an immediate return does not occur from enhanced observational networks. First concern should be exerted toward locating all records of synoptic stations (those that report weather for the daily weather map), and converting them to the form of punched cards, or other storage suitable for tabulation by machine.

"Obviously in the case of both forecast and climatic services, it is vital that personnel be trained and available for the two related but essentially distinct specializations. It follows that the best estimate of the status of knowledge concerning the weather and climate of the humid tropics involves the capabilities for weather forecasting, and weather record analysis. The status is thus one more of operational capability than one of assessing the static content of book and periodical.

"I believe that the preceding statements are appropriate to the category of weather and climate, perhaps more so than any other aspect of the tropical region for the reason that numerical treatment is so important in atmospheric science. It should also be pointed out that where conceptual structures are important in thinking, those structures apply to the atmosphere in a more general framework than provided by political boundaries. The country breakdown which is so necessary in bibliographic analysis is therefore less appropriate in the realm of understandings of the humid-tropical climate. As weather services are organized by country, nevertheless, it is essential to recognize the country unit as being the basic source of weather records."*

*Bailey, Harry P., 1966: Personal Correspondence dated 14 March.

F. REVIEW OF PRINCIPAL DEFICIENCIES

Tropical weather phenomena are slighted in research projects being conducted at institutions throughout the nontropical world. At those institutions conducting research on tropical meteorological and climatological phenomena, there is definite emphasis on hurricane/typhoon research.

Investigations reveal the following to be primary factors contributing to the overall deficiency of tropical meteorological and climatological research:

- Lack of adequate funds
- A paucity of researchers who have lived in the tropics
- Inadequacy of the observational network relative to the requirements for analysis, forecasting, climatological studies, and research
- Lack of data
- Inadequate coding and description of tropical weather phenomena
- Lack of standardization of equipment, symbols and procedures and inadequate calibration, checking and maintenance of instrumentation

Steps must be taken to alleviate these deficiencies before tropical atmospheric research can progress toward a state of development comparable to that exhibited today by midlatitude and polar meteorology and climatology.

G. DESIRABLE OBJECTIVES

Alleviating the deficiencies just discussed requires an integrated program for upgrading the basic level of tropical atmospheric research. The broader understanding of the total tropical environment which could result is of utmost significance, militarily and otherwise.

Projects leading to realization of such an objective are important to the regions involved and should contribute to the development of their natural environmental potential. This is an objective in which the United States might well be interested in view of its declared intent to assist the developing nations.

As long as the scientific community must cope with regional deficiencies in its efforts to further research on meteorology and climatology, the advancement of the atmospheric sciences is seriously hindered. Commenting on the problems, P. D. Thompson, president of the American Meteorological Society, recently said:

> "No higher degree of theoretical perfection will be significant or applicable without more complete description. In short, the time has come to strive for adequate observations over the entire northern hemisphere, if not over the whole globe, including the most remote and inaccessible regions."[40]

Determination of what constitutes the most feasible methods for upgrading the basic research level of tropical meteorology and climatology has been the subject for consideration by many authorities. Several methods advanced by W. H. Portig are as follows:*

- Establish international schools to upgrade the quality and quantity of local tropical meteorologists, climatologists and observers
- Make available research grants for the study of broad general problems and specific topics of theoretical and practical importance
- Establish an international weather record center to provide a central research and storage facility for meteorological and climatological data
- Adopt worldwide standards for equipment, symbols, procedures, and methods of coding and recording meteorological data
- Rapidly develop institutes of tropical studies in universities so that the interest generated in those institutes will increase support for research in tropical atmospherics

*Portig, Wilfred H., 1965: Personal Correspondence dated 3 March.

Establishment of international schools to upgrade the quality and quantity of tropical forecasters, observers and researchers will, in turn, increase the amount and reliability of available data. These data will then provide a basis for breadth and depth studies of tropical meteorology and climatology. Such a program also will supply researchers who are native to the tropics and understand its complexities. Thus, the burden of a midlatitude background and its inherent limitations, in terms of applicability to the tropics, will be avoided, granting researchers greater freedom to generate new concepts and theories concerning the nature and significance of tropical atmospheric phenomena.

By funding specific projects and general research programs, the basic level of tropical weather research can be expanded significantly. At the outset, these programs should concern themselves with the overall picture, permitting researchers to obtain a sharp view of specific areas requiring urgent or concentrated study. Feasibility studies must naturally precede projects requiring international cooperation for observation networks, data processing and storage, solution of coding problems, and the like.

Establishment of an international weather record center(s) should be expedited. A center of this type should be supported by regional centers on a continental scale. The tropical weather facility of Poona in India is an example of a facility which could be expanded to act as a central research and record facility for the humid-tropical portion of Asia and possibly Oceania as well. The weather research facility at the University of Hawaii could act as the regional center for the tropical Pacific. There had been some mention of plans to establish an African Weather Institute at Nairobi.[31]

Tropical Central and South America comprise an area where there has been little research. This area could be served best by a regional research and data storage facility established in Central America. These facilities should be the coordinating center for establishing regional weather networks, supervising training of researchers and observers, initiating specific projects and, in general, providing overall administration and support for programs within their regions and integration of local programs. Recommendations for basic intercontinental research objectives would be provided by the international center.

In any program of this type, effective international cooperation is the key factor. As P. D. Thompson states, "in my view, we (the United States) and all nations are now confronted with practical and scientific problems whose answers depend on the creation of new modes of international cooperation and on more comprehensive and quantitative intranational evaluation of costs, resources and economic returns."[40] The administration of this system should rest with an international organization. The World Meteorological Organization appears to be ideally suited for this task. The WMO has been operating in its present form since 1951. Prior to 1951, it

was known as the International Meteorological Organization, the creation of which dates back to 1853.[41] The objective of this organization closely approximates the reasons for establishing international and regional centers for advancement of the fields of tropical meteorology and climatology. They are:

> "(a) To facilitate worldwide cooperation in the establishment of networks of stations for the making of meteorological observations or other geophysical observations related to meteorology and to promote the establishment and maintenance of meteorological centers charged with the provision of meteorological services
>
> "(b) To promote the establishment and maintenance of systems for the rapid exchange of meteorological information
>
> "(c) To promote standardization of meteorological observations and to insure the uniform publication of observations and statistics
>
> "(d) To further the application of meteorology to aviation, shipping, agriculture, and other human activities
>
> "(e) To encourage research and training in meteorology and to assist in coordinating the international aspects of such research and training . . ."[26]

If this organization has been in existence for so long a period of time, why then do we have this problem? Why has not this organization established an international center and initiated procedures to standardize meteorological observations? As Reichelderfer explains:

> "In the early 1950's when the balancing of budgets was a frequent and popular subject, the deputy Finance Minister of one of the most progressive and cooperative of WMO members remarked apropos the financial accounts of WMO, as compared with a few of the larger specialized agencies of UN that, if the others produced as much per dollar spent and were as accountable in their budgeting as WMO, the activities of UN would indeed be economical and efficient. WMO began in 1951 with a 4-year budgetary limit of $1,273,000, only about $300,000 per year for its entire establishment and its operations. The United States has each year advocated and been ready to contribute its share of a considerably larger budget. But the large majority of members stood for minimum budgets, their views conditioned largely by the rigid instructions of their respective finance ministers, by the very meager appropriations allowed them for their domestic meteorological activities, and by the further curtailment of funds for their own domestic services in those cases where their contribution to WMO on a pro rata scale was required by their governments to be taken out of their own meager appropriation." 43

This lack of funds has been the major cause for the limited result produced by the WMO. Given the funds, this organization would be the best qualified to assist in establishing and monitoring a worldwide network of meteorological observation stations, regional data processing and storage centers, and research centers.

With the establishment of a global network under the guidance of a single organization, the adoption of standard practices and equipment would be greatly facilitated. Training programs and rigid specifications soon would produce data in a form which could be utilized with a minimum of effort by researchers in any location on the earth.

As further indication of interest in a global weather system, R.M. White, chief of the U.S. Weather Bureau,* in a recent address to the American Geophysical Union stated [43]

> . . . . ."to meet the shortcoming of the current international meteorological system and to provide an improved base for realizing the full scope of the World Weather System, it would be possible at an early date on the basis of proven and available technology
>
> "1. To achieve a significant improvement in the global observation system to provide better and more complete data for meteorological analysis and forecasting
>
> "2. To achieve a meaningful reallocation of weather analysis forecasting and data processing functions [in order] to make more efficient and more widespread use of available technology and resources to provide basic meteorological products and, where appropriate, user service
>
> "3. To provide an international communication capability adequate to achieve timely exchanges of raw data and timely dissemination of basic meteorological products. . .
>
> "Proven equipment and techniques such as global cloud cover satellite systems, mobile ship surface and upper-air observing systems, world and regional data processing centers, and a worldwide data communications system could be implemented at an early date. Research and development effort could focus on such new elements as synchronous meteorological satellites, constant-density balloons, automatic meteorological ocean buoys, infrared spectrometers, broadcast communication satellites and other technological possibilities..."

* Now administrator, Environmental Science Services Administration, Washington, D.C.

The actions recommended by United Nations organizations, the National Academy of Sciences and R. M. White point toward analysis on a macro- or worldwide scale. However, the assistance to understanding and analyzing the tropical areas would be immense in increased observations from space and inaccessible ocean and land areas and the availability of data and worldwide analyses from established centers throughout the globe.

II. RECOMMENDATIONS FOR ADVANCING STATE OF KNOWLEDGE

Based on its program investigations, Texas Instruments recommends that the following action be taken to expand and support the existing programs listed below as the most feasible method of obtaining the desired objective and of upgrading the basic research level in tropical meteorology and climatology.

- Recommendation 1

One of the foremost problems in large areas of the humid tropics is the lack of meteorological observations to support adequate chart analysis, forecasting and climatological/meteorological research. Because this is an important area and will require extensive study and committee effort at several national and international levels, it is recommended that action be taken to implement the following recommendations at the earliest possible time. Steps should be taken by the United States, in concert with other nations, to explore the international institutional mechanisms that may be appropriate to foster international cooperation and cope with the problems which may be anticipated in the field of tropical weather and climate.

The United Nations and its specialized agencies (e.g. the World Meteorological Organization) are suggested as a possible intergovernmental framework to assist in the establishment within the humid tropics of

- An adequate data collection network of surface and upper-air observing stations with sufficient density to support mesoscale analysis, forecasting and climatological/meteorological research
- An adequate communications system to support the above network and, with sufficient relay and editing facilities, to permit inter- and intraregion dissemination of data

The International Council of Scientific Unions and its associated unions (e.g. the International Union of Geodesy and Geophysics) could be a suitable non-governmental framework for the mechanisms of accurate, timely and representative observations which are the basis of any analysis, forecasting, climatological study, and research effort. To achieve this requires

- Establishment of surface and upper-air measurement stations to fill the gaps now existing in the humid tropics
- Standardization of equipment specifications and in the measuring of all meteorological parameters
- Development of descriptive codes for tropical weather phenomena
- Implementation of rigid checking, calibration and maintenance procedure for all meteorological instrumentation
- Establishment of inter- and intraregion landline or radio communications connecting surface observing stations, upper-air observing stations and forecasting centers with provisions for editing and relaying data between regions
- Establishment of data storage and processing center(s) placed strategically within the humid tropics area and equipped with high-speed computers equal to the computation tasks
- Training facilities for all grades of observers (instructional material in native language)
- Establishment of satellite readout facilities for processing and transmitting data to forecasting and data storage centers
- Storage and processing center(s) centrally located for access to global communications systems and liaison with extratropical centers and equipped with computers equal to the computation tasks
- Training facilities to assure that personnel are schooled in the proper procedures for instrument operation, calibration and maintenance

- Recommendation 2

If an interim measure pending implementation of Recommendation 1 is warranted, the Foreign Areas Section of the U.S. Weather Bureau, ESSA, is suggested as a group to be provided funds to accomplish a more detailed evaluation, collection and storage of climatological studies from countries within the humid tropics. Special attention should be given to acquisition of data falling within militarily significant meteorological parameters and regions of interest.

- Recommendation 3

The review of available research studies—from the recent through the proposed—has shown a wide range of approaches to defining the physics of the atmosphere in the humid tropics. Certain of these approaches discussed in numerous conferences and showing a high interest factor on the part of scientists working on projects in the area are presented below. These projects should be given priority as urgent and basic needs to developing a meteorological capability in the humid tropics.

- Study of coding and nomenclature for uniquely tropical atmospheric phenomena
- Development of synoptic models and analysis of easterly waves, tropical waves, equatorial waves, disturbance lines, surges, shear lines, and the intertropical convergence zone for the different regions
- Climatic appraisal of the water resources of the tropics using the principles and methods of the water balance approach
- Development of an easy, rapid method of applying streamlined analysis, possibly an automated system, to tropical studies
- Investigation of the significance of tropical winds as potentially the single most important factor in tropical atmospheric studies
- Analysis of the climate near the ground
- Microclimatic investigations in a wide variety of lowland humid tropic environments
- Complete detailed vertical analyses on both windward and leeward sides of mountains since upland humid tropical climates are totally lacking in atmospheric research

- Studies of the micrometeorologic changes associated with vegetation removal and other cultural disturbances in the humid tropics
- Investigation of the causes, frequency and global atmospheric implications of the large number of hurricanes that develop in the Pacific west of Panama, move poleward and then dissipate
- Thorough investigation of the nature of tropical systems, their differentiation and characteristic manifestations in different seasons
- Investigation of the significance of synoptic patterns with a view to long-range forecasting in the tropics
- Research on the meaning of climate in a tropical context and reevaluation of existing climatic studies to ascertain climatically significant parameters, especially by comparison with what are assumed to be important parameters in midlatitude regions
- Study of the frequency, distribution and intensity of tropical rainfalls in various tropical environments, treating each occurrence of rain individually and not as a monthly or periodic accumulation
- Study of long-term monthly averages of rainfall, rain frequency, temperature, cloudiness, surface winds, and changes in ocean temperature

- **Recommendation 4**

Areas for which data are particularly scarce are listed on the next page; it is recommended that these areas be given special attention in any planning of basic meteorological and climatological research:

Area Weather Studies	Area Climate Studies
Central America, especially Nicaragua	Middle America, especially between Mexico and Costa Rica
Caribbean Islands, exclusive of Puerto Rico	Caribbean Islands, exclusive of Cuba and Haiti
Brazil, especially the Amazon Basin	Brazil, especially the Amazon Basin
Guianas	Guianas
Ecuador, Bolivia and Paraguay	Bolivia, Paraguay, Peru, and Ecuador
West Africa, exclusive of Nigeria and Ghana	West Africa, exclusive of Nigeria
Western Equatorial Africa, Rio Muni, Northern Congo, and Rwanda, Burundi	Equatorial Africa, exclusive of Cameroon, Congo (B), and Angola
Zambia and Southern Rhodesia, Nyasaland, and Kenya	East Africa from Uganda to Rhodesia, exclusive of Mozambique
Ceylon, Pakistan, Burma, Thailand, Laos, Cambodia, South Vietnam, Malaysia, and Taiwan	Laos, Cambodia, North and South Vietnam, Malaysia, Ceylon, and Pakistan
All of Oceania except the Philippine Islands, Fiji, Indonesia, and Borneo	All of Oceania, exclusive of Timor

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CHAPTER V

COASTAL ZONES*

A. INTRODUCTION

1. Topical Features, Elements and Factors

The following physical and cultural features and elements of the coastal zone were selected by the Army Research Office for consideration in this Inventory:

- Physical Features
  - (1) Coastal plains, terraces, elevated reefs, cliffs, caves
  - (2) Beaches, dunes, beach ridges, marshes, swamps
  - (3) Shorelines, estuaries, deltas, mudflats, platforms
  - (4) Barrier islands, coral reefs, submarine bars, lagoons
  - (5) Nearshore slopes, bottom conditions, water depths, waves, currents
  - (6) Ocean currents, tides, swells, tsunamis
- Cultural Features
  - (1) Port and harbor facilities
  - (2) Engineering structures for protection of coasts
  - (3) Aids to navigation

Concerning the physical features, the Inventory records evidence of information on composition, characteristics, dimensions, origin, past and present processes of formation and alteration, and classification systems. In regard to cultural features, data on characteristics and relationships to the physical features are considered significant.

2. Limitations on Scope of Coverage

The range of physical features of the coastal zone corresponds to that prescribed for Chapter II, which deals with physical features

*Dr. Richard J. Russell (Louisiana State University), Dr. Charles S. Alexander (Illinois University), Dr. Rhodes W. Fairbridge (Columbia University), and Dr. Pierre Gourou (University of Brussels), acting as consultants to Texas Instruments for this program, have critically reviewed this chapter in its draft stages.

of the humid tropics as a whole. The range comprises the geomorphological, geological, pedological, and hydrological phenomena. Botanical, zoological and meteorological phenomena of the humid tropics are treated separately in Chapters III and IV by specification of the sponsor of the Inventory. Reference should be made to the three cited chapters for additional information on the character and development of coastal areas.

3. Present Interest in the Coastal Zone

The UNESCO Advisory Committee for Humid Tropics Research (F.R. Fosberg, chairman) stated in 1961 that delta areas "are in many respects the most important regions of the humid tropics since they are those of greater human concentration."[1] The most prominent development of deltas in the humid tropics is in Southern Asia. Environmental problems seriously affect the suitability of these areas for human habitation and utilization. The urgency of the problems is recognized by governments of the countries immediately concerned, world organizations, and other bodies that are prosecuting research programs in the delta areas.

Activities of the inhabitants of island regions of the humid tropics—notably Oceania, the Hawaiian Islands and the West Indies—are linked closely to the coastal environment. In all of these regions, the lack of complete, exact information on the physical features and resources of the coastal zone is, in varying degrees, an obstacle to economic development.

Only in humid tropical Africa have the coasts been relatively unimportant in the settlement and development of countries to the present time. The African coasts have few good natural harbors and possess generally unhealthy and uncomfortable conditions for human habitation and activity.

The present-day military importance of the humid tropics is demonstrated by the abundance of recent military events that have occurred there.* The special military significance of the coastal zone became common knowledge through the examples of amphibious landings during World War II.

Modern seaborne invasion requires detailed knowledge of the coast for use in operational and engineering planning. Such questions as the behavior of landing craft and amphibious or other vehicles on the beach, problems of constructing roads across the beach, resistance of the coastal zone to bombardment, and the availability of sites for harbors are answered with intelligence on the natural features of the sea approach and shore and of the man-made structures, especially defenses and obstacles.

*The general subject is discussed in Chapter II, Section A, Subsection 3.

4. Historical Notes on Development of Knowledge

In his monograph on coasts of the world, H. Valentin [2] states that the subject of coastal geomorphology was formally introduced in 1866 by O. Peschel who, for the first time, explained and compared coastal features. In 1894, in his famous work on morphology of the earth's surface, A. Penck presented methodologic bases for the study of coastal morphology.

The first decades of the 20th century saw the dominance of American concepts in the field of geomorphology, developed largely by the deductive methods of William Morris Davis and Douglas Johnson. Foreign investigators, by contrast, approached the explanation of coastal geomorphology by inductive reasoning. On the whole, the experimental and quantitative procedures adopted by investigators in the United States and elsewhere in recent decades have supported the methodological approach of the foreign geomorphologists.

American interest in the morphology of coasts was accompanied by interest in the processes of denudation and sedimentation acting in the coastal zone. Foreign investigators turned their attention to the study of changes of sea level and movements of the shoreline and features associated with them; however, for the past 30 years, these have occupied an important place in coastal research throughout the world.

The origin and distribution of coral reefs are among the problems which have received special attention in the humid tropics. As long ago as 1778, Reinhold Forster, a member of Capt. Cook's expedition, concluded that the formation of coral reefs was limited to seas of warm climates and offered an explanation for the form of atolls. Although corals are not limited to tropical waters, reefs are primarily features of humid tropical coasts. Countless investigators from the fields of zoology, paleontology and geology have studied these features during the past century; in recent times, expeditions from the United States, France, Great Britain, and Denmark have worked on reefs in numerous areas. The American research, which has been especially intensive, has occurred mainly in Micronesia, an area not included in the definition of humid tropics employed here.

In the last decade, considerable interest has been directed to the problem of beach rock—sandy beach material cemented with calcium carbonate—which is found at the water table in tropical and subtropical coastal areas. The origin of beach rock, however, remains a subject of debate.

A continuing topic of investigation of coasts throughout the world is the determination of types and the establishment of classification systems. More than 30 classifications suggested since 1822 have been

identified. Part of the problem, which obviously has not been solved, is caused by disagreements over definitions of such basic terms as coast, beach, shore, and shoreline. Most classifications are genetic in concept but fail because, as E.C.F. Bird observes,[3] "The difficulty is that a genetic classification can only be applied satisfactorily when the mode of origin of coastal landforms is known; the attempt to use particular types or associations of landforms as indicators of particular modes of origin has frequently led to errors that have been revealed by subsequent coastal research."

J. T. McGill has stated that "Sparsity of information on the coasts of the world is a formidable obstacle to the successful application of any classification, but particularly so for purely genetic schemes. Nearly all coasts are complex in their geomorphic history and thus in the character and associations of their present features. They represent the result of the combined action of many different agents and processes—marine and terrestrial, inorganic and organic—all of which have been highly variable in their effects in time and space..."

Various partially genetic or totally nongenetic classifications have been proposed to overcome the difficulty of using purely genetic classifications for descriptive purposes. In 1866, Richthofen included configuration as an element in his classification of shorelines. A. Penck, in 1894, distinguished coastal types on the basis of configuration, vertical profile, composition, and rock structure. W. C. Putnam[5] and J. T. McGill[6] placed emphasis on descriptive terminology in their "semi-genetic" classification of coastal landforms. A classification of shorelines devised by C.S. Alexander in 1962 considers only vertical profile and outline.[7] Although earth scientists generally regard nongenetic classifications as scientifically unsuitable, descriptive classifications have distinct value for military and other applied purposes.

Early investigators of coasts took a broad interest in all the features of this environment. In tracing the history of coastal research, Valentin comments on the trend away from comprehensive study by physical geographers in the early 20th century to studies of particular elements of the coast by specialists in various environmental fields. Only in recent time has the entire coastal environment, represented as the zone of interaction between land, sea and atmospheric elements, been recognized as the subject of coastal geomorphology.

Systematic investigation of estuaries, harbors, ship channels, and coastal waters has long been the function of official agencies. Two organizations, the U.S. Hydrographic Office and the Royal Navy Hydrographic Office, prepare separate series of publications which cover all parts of the world, region by region. The former produces "Sailing Directions" and

the latter "Pilots." Although the information in both is similar, it differs in scope and content for some regions.

Oceanography merges investigation of the open oceans with that of the coastal waters. Such problems as the processes of sedimentation in the nearshore, the morphology of the shelf and the effects of changes of sea level have a bearing on the understanding of the coastal zone.

The study of oceans has gained momentum since the end of World War I. Echo sounding was introduced by Marti in 1919. Geophysical methods now permit the determination of geological data to depths well beneath the ocean floor. Since World War II, advances have been made in techniques for observation of features of the bottom by bathyscaphe and photography.

Oceanography is recognized as an interdisciplinary science dealing with an environment, rather than an autonomous field. Today, oceanographic institutes dealing with one or more of the following subjects—marine geology, geomorphology, biology, meteorology, and hydrology—exist in several countries and conduct investigations in oceans around the world.

5. Sources of Information

Two international organizations have established bodies to encourage research activity in coastal geomorphology, geography and geology. These bodies are: the Commission on Coastal Geomorphology (Prof. A. Schou, Copenhagen, chairman) of the International Geographical Union (IGU); the Commission for the Study and Correlation of Erosion Levels and Surfaces on Atlantic Coasts (F. Ruellan, Rennes, chairman), also of the IGU; and the Commission on Shorelines (Prof. R.W. Fairbridge, New York, chairman) of the International Association for Quaternary Research (INQUA).

Each of these commissions meets to exchange information among members and discuss research with others, compiles rosters of specialists and summarizes information on research.

The Commission on Coastal Geomorphology has issued several bibliographies covering publications from 1955 to the present. For the Commission on Shorelines, H.G. Richards and R.W. Fairbridge have compiled a bibliography of Quaternary shorelines for the period from 1945 to 1965.[8]

The Commission for the Study and Correlation of Erosion Levels and Surfaces on Atlantic Coasts prepared an extensive report for the 18th International Geographical Congress in 1956. Included were parts dealing with results of research on coasts of Western Africa and Eastern South America.

Since 1950, nine international Conferences on Coastal Engineering have been sponsored by the Council on Wave Research (known since 1964 as the Coastal Engineering Research Council) which was affiliated originally with the Engineering Foundation and is now attached to the American Society of Civil Engineers. The purpose of the meetings is to bring together scientists and engineers with different specialties to exchange information on research and delineate fruitful areas for further research. The Proceedings of these conferences show that attention is given to basic research on waves, tides, currents, winds, and coastal sedimentation and to the applied problems of coastal engineering. In recent conferences, research on humid tropical coasts has been reported. India, Ceylon, Mexico, British Honduras, and Venezuela are represented in this research.

The International Geographical Union's Commission on the Humid Tropics (Prof. T. L. Hills, Montreal, chairman) has a general responsibility for humid tropics research which includes attention to coastal areas. In 1960, this commission issued a bibliography and, in 1965, a directory of research institutions dealing with the humid tropics. A bibliography of coastal geomorphology prepared in 1960 by J. T. McGill[9] and the bibliography and KWIC index issued in 1965 as part of the present Inventory are among other occasional special bibliographies useful for the purpose of surveying the amount and scope of research on humid-tropical coasts.

Two other recent valuable bibliographies are attached to scientific publications. The first accompanies H. Valentin's monograph on worldwide coasts which was published in 1952.[2] The second accompanies H. G. Gierloff-Emden's study of features of tropical low coasts which was published in 1959.[10]

Bibliographic and abstract serials provide the best regular sources of information on recent, and to some extent, current research on humid tropical coasts. The most important of these publications are: in English--Bibliography of Geology Exclusive of North America; Geosciences Abstracts; Geographical Abstracts, A: Geomorphology; Bibliography of North American Geology; in German — Zentralblatt für Geologie und Paläontologie; in French—Bulletin Signalétique; and in Russian—Referativnyi Zhurnal. *

* Further information on these publications appears in Chapter II, Section A. 5.

B. SURVEY OF CURRENT RESEARCH ACTIVITY

1. General Comments

In 1961, the Committee on Geography (R.J. Russell, chairman) of the (U.S.) National Academy of Sciences-National Research Council stated that "Critical as coastal areas are, they have not been studied sufficiently to raise the level of understanding to even the minimum demanded for the public welfare, for proper economic and cultural development, and for military use." [11]

The amount of activity in research on humid-tropical coasts can be judged, in part, from a review of significant worldwide research on coastal topics by A. Guilcher.[12] For 1956 to 1964, Guilcher cites only 25 titles of resulting literature dealing wholly or partly with the humid tropics. The present Inventory indicates that the gross output is not appreciably larger.

Activity in coastal research on the humid tropics is concentrated in programs supported by world organizations and government agencies of non-humid-tropical countries, which are involved in giving technical and financial assistance to the developing nations. Actual performance of investigations is mainly a function of researchers based in the non-humid-tropical countries.

2. Research by Investigators Based in Humid-Tropical Countries

The coastal research role of scientific and technical agencies of humid-tropical countries is confined largely to work connected with systematic surveys of natural features, especially resources. Regional organizations in the humid tropics—such as the Commission for Technical Cooperation in Africa South of the Sahara (CCTA) and the Inter-American Committee for Agricultural Development (CIDA)—are instrumental in stimulating more research by scientists in national agencies and universities.

The following are among examples of investigation of humid tropical coasts in recent years by scientists based in the humid tropics:

- V.A. Zans and T.F. Goreau (University College, West Indies) did intensive research on raised and modern coral reefs of Jamaica.
- M. Diaz Marta (University of Vera Cruz) studied the coastal dunes at Vera Cruz, Mexico, in 1957.

- J.D. da Silveira completed a study of the coastal morphology of Brazil in 1964.
- G. Soares de Carvalho reported his observations on the coastal Quaternary of Angola in 1958.
- P. LeBourdiec studied evolution of the long, straight beaches and lagoons of the Ivory Coast in 1958.
- From India come reports of research by M. Manohar (Birla Inst. of Technology) in 1958 on sediment movement along southern ports, by M.G. Hirandandani in 1960 on the use of radioactive tracers for the study of sediment movement off Bombay harbor, by S.P. Chatterjee (University of Calcutta) in 1961 on fluctuation of shorelines, and by M. Subba Rao (University of Anhdra) in 1964 on continental shelf sediments of the eastern coast.
- The coastal features and sedimentation processes on the eastern coast of Malaysia were subjects of research by J. J. Nossin (University of Singapore), 1961-1964.*
- In South Vietnam E. Saurin (University of Saigon), 1963, performed carbon-14 dating of marine terraces.
- T. L. Hsu published a study of the coastal geomorphology of Taiwan in 1962.
- Coral reefs on the southern shore of Hainan Island were studied by A.J. Chai and S. W. Li in 1964.
- W. L. Tschang reported on beach rock at Hong Kong in 1962.
- In 1965, E.C.F. Bird (Australian National University) prepared a study of coastal landforms of Australia, including those of the northern humid tropical sector.

* Information on the affiliation of investigators refers to the time during which the work was performed. In some cases, the investigator has subsequently changed location or the institution is now known by a different name.

3. Research by and with Investigators from Non-Humid-Tropical Countries*

a. Denmark

A Danish expedition has conducted research on the coral reefs of Northwest New Guinea, New Britain, New Ireland, and smaller islands of the Bismarck Archipelago, on which S. Christiansen (University of Copenhagen) reported in 1963.

b. France

French investigators have been especially active in the study of areal geomorphic problems of the coasts of Africa and Brazil for more than a decade. J. Tricart (University of Strasbourg) has concentrated on the coasts of former French West Africa, Liberia and the Ivory Coast as well as the coast of Eastern Brazil. A. Guilcher (Sorbonne), R. Battistini and L. Berthois have performed investigations in French West Africa and Dahomey but are associated particularly with studies of the coasts of Malagasy. F. Ruellan (University of Rennes) also is known for investigations in Eastern Brazil.

Research on sedimentation in deltas and changes of sea level has been performed by Tricart in the Senegal delta. On Malagasy, Guilcher has studied the Mahavavy delta; Battistini, the Sampirano delta. French work in the Konkouré delta of Guinea also is reported by Guilcher.

Coral reefs of Malagasy are a special subject of investigation by Guilcher, Battistini and Berthois. French expeditions to the Comoro Islands, New Caledonia and the Loyalty Islands (1959-1962) were concerned with the study of barrier reefs and lagoon sediments.

Guilcher authored a volume on coastal and submarine morphology which was published in 1954 (English translation, 1958). It deals especially with the state of knowledge and problems of humid-tropical coasts.

Possibly the most comprehensive coastal study in the humid tropics in recent time was performed by H. G. Gierloff Emden (University of Hamburg). Results of his project were a monograph on the morphologic

* The information is presented under the countries arranged alphabetically rather than by order of importance of different research projects.

and oceanographic features of the coast of El Salvador (1959), a detailed review of knowledge on flat coasts, and several other papers.

H. Valentin (Free University, Berlin), known for his monograph on worldwide coasts and one of the significant modern genetic classifications of coasts, conducted investigations on the coast of Cape York Peninsula, Northern Australia (1959-1961)

c. Great Britain

Recent British activity in the study of humid-tropical coasts has focused on problems in Western Africa and the Caribbean. J.R.L. Allen (University of Reading) has made intensive studies of the beaches and nearshore features of Nigeria and (with J.V. Wells) has investigated the coral banks and subsidence in the Niger delta. J.E. Webb (University College, Ibadan) has worked on problems of beach erosion in Nigeria. In neighboring Ghana, ecological studies by A.S. Boughey have dealt with problems of shore development and changes. Also in Ghana, raised beaches and modern beach erosion have been topics of study by M.M. Anderson (University Coliege) and W. D. Bruckner.

Cambridge University expeditions to British Honduras (1962-1963) were concerned with coral reefs in the adjacent Caribbean. D.R. Stoddart reported the results of the study of these features and the effects of a hurricane on the reefs in 1961.

d. Netherlands

Researchers from Dutch universities have worked mainly on the coasts of Northern South America and Indonesia in the past decade.

J.I.S. Zonneveld, D.C. Geyskes, A. Brouwer, H. Dost, and P.H. de Buisonje conducted detailed investigations of coastal features and processes in Surinam, Curacao, Aruba, and Bonaire. The Royal Dutch Shell Oil Company sponsored the Orinoco Shelf Expedition, which made investigations of the Orinoco estuary, around Trinidad, and in the Gulf of Paria. T. H. van Andel, H. Postma, B.W. Koldewijn, and D.J.G. Nota published studies of the shelf and the hydrographic data resulting from the expedition. Van Andel and J. Laborel reported on the evidence of a recent high sea-level stand near Recife, Brazil (1964).

In Indonesia, H.T. Verstappen followed earlier studies in the Gulf of Djakarta with investigations of the geomorphology of the Aroe Islands and the reef covering much of Moena.

e. United States

Since 1956, Louisiana State University's Coastal Studies Institute (R.J. Russell, director) has conducted research programs in foreign areas, mainly on the humid tropics. This organization is supported in its programs by the Office of Naval Research.*

Initial investigations were made in 1956 by J.P. Morgan and W.G. McIntire in the Ganges-Brahmaputra delta.

A major program for several years has been concerned with the origin, growth and morphology of beach rock. Investigations have been made by R.J. Russell, W.G. McIntire and others in Puerto Rico, the Lesser Antilles, the Hawaiian Islands, Fiji, parts of Australia, and Mauritius.** Russell also has studied the recession of tropical cliffy coasts and their eustatic changes of sea level.

In 1959, the Institute began a program to investigate the long barrier island complex of the southernmost coast of Brazil in cooperation with the University of Rio Grande do Sul (P.J.V. Delaney, chief investigator).

A study of the beach ridge at Tabasco, Mexico, was completed by N.P. Psuty in 1965.

In addition to the Coastal Studies Institute, various individuals and groups have worked on humid tropical coastal problems lately:

The problem of eustatic changes of sea level in the Pacific region, was reviewed by H. L. Stearns in 1961. In reference to the problem everywhere, R.W. Fairbridge (Columbia University) summarized radiocarbon dates from world shoreline information in 1961. In Puerto Rico, C.A. Kaye (U.S. Geological Survey) made an intensive study of coastal features and Quaternary shoreline changes (1959). H.G. Richards (Academy of Natural Sciences, Philadelphia) and W. Broecker (Columbia University) examined apparent sea-level changes of the Caribbean coast of Colombia in 1963.

Regional studies of coastal features and processes have been made of the Pacific coast of Colombia by R.C. West (Louisiana State University)*** in 1955-1956, of the Guianas by J.H. Vann (Louisiana State

* The function of the Office of Naval Research in support of coastal studies is discussed further in Section B, Subsection 4b.

** Mauritius is not included in the humid tropics as defined for this Inventory.

*** Research supported by the Office of Naval Research.

University)* in 1959, of several Latin American countries by J. J. Parsons (University of California, Berkeley)*, of the Virgin Islands and Isla Mona by J. D. Weaver (University of Puerto Rico), of Trinidad by W. W. Speth (University of California)* in 1962, of Tanzania by C. S. Alexander (University of Illinois)* in 1962, and of the Hawaiian Islands by R. A. Moberley Jr. and associates (Hawaiian Institute of Geophysics) in 1963.

Shelf conditions and bottom sediments off the Amazon estuary were studied by F. Ottmann (U. S. Geological Survey) in 1959. K. O. Emery (Scripps Institution of Oceanography) and H. Niino performed research on sediments of the shallow parts of the East and South China Seas in 1961. The Congo submarine canyons were the subject of studies by B. Heezen and others (Columbia University) in 1964.

Port studies have been made in Africa by W. A. Hance and I. S. Van Dongen (Columbia University) since 1956. So far reports have appeared on ports of Angola, former Belgian Congo. Malagasy, Mozambique, and Tanzania. S. C. Rothwell (University of Miami)* made studies of ports of Southern Brazil in 1960.

4. Sponsors of Research

a. World Organizations**

UNESCO has supported a humid tropics research program since 1956. In October 1961, the Advisory Committee for Humid Tropics Research reviewed the program's scope and selected eight subjects suitable for long-term action. As stated previously, one of them was delta areas, which the Committee rated as the most important regions of the humid tropics in many respects.

Action on investigation of the problems of flood control, reclamation and land use in delta areas has been stimulated further by the UN Economic Commission for Asia and the Far East (ECAFE). One of its projects, the development of the Mekong River Basin, is supported financially and technically by governments and organizations of various parts of the world. ECAFE cooperated with UNESCO in sponsoring a meeting of scientific experts in Bangkok in July 1963; it yielded discussions of the ways of studying delta problems.

The Food and Agricultural Organization (FAO), which supports surveys of surface materials for estimations of land use, has sponsored a study of the coastal plain of the Guianas (1962-1964)

* Research supported by the Office of Naval Research.
** Also see discussions of world organizations in Chapter II, Section B, Subsection 2.

by R. Brinkmann and L. J. Pons.

b. Military Organizations

Since 1950, the Geography Branch of the (U.S.) Office of Naval Research has had a program on coastal geography, the purposes of which are to stimulate interest in the coastal zone and support more research on problems of this zone. E. Pruitt, head of the branch, stated in 1962 that progress was being made "toward the goal of understanding the various factors that work together to produce the distinctive characteristics and processes of the coastal zone" by pooling and synthesizing the results of research by geographers, geomorphologists, geologists, ecologists, oceanographers, botanists, and anthropologists.[13]

The major part of the program, according to Pruitt, deals with coastal geomorphology, defined broadly "to mean the study of the nature of landforms and waterways and the processes of sedimentation, water circulation and erosion that are responsible for them and for the configuration of coasts."

The program is concerned also with study of ports and their hinterlands and the total physical and cultural environment of coastal morphology in various parts of the humid tropics including the Caribbean, Central and South America, Eastern Africa, Southern Asia, and Australia, studies of regional characteristics of different parts of Latin America, and port studies in South America and Africa. Research grants for this program have been awarded to investigators associated with American and foreign universities. The major support for work in the humid tropics has been given to the Coastal Studies Institute of Louisiana State University.*

A striking characteristic of the ONR program is the emphasis placed on basic scientific research. Few projects have reported on military applications of the knowledge developed by the investigations.

Direct attention to the military aspect of coastal information has been most evident in the work of W.C. Putnam, J.T. McGill and others of the University of California (Los Angeles) on the nature of worldwide coastal environments (1954-1960). The influence of coastal landforms and vegetation on amphibious landings, vehicular movement on beaches, and cover and concealment was specifically discussed for the different types of environments. However, the military need for knowledge of coasts is acknowledged to be a motivation for the support given. Pruitt states that "World War II brought into clear focus not only the need for specific information on individual coasts but also, and more important from the

* Further identification of research supported by the Office of Naval Research appears in Section B, Subsection 3, of this chapter.

research view, lack of fundamental knowledge concerning coasts in general. Wartime studies, which frequently took on the aspects of expediency, did much to pinpoint and clarify the basic scientific problems." [14]

The Geography Branch sponsored Coastal Geography Conferences in 1954 and 1959 jointly with the National Academy of Sciences-National Research Council Committee on Geography (Advisory to the Office of Naval Research). The first of these conferences presented discussions of projects supported by ONR: the second included discussions by grantees and invited European specialists. In 1961, this office sponsored a study by an Ad Hoc Panel on Coastal Geography (R. J. Russell, chairman), the purpose of which was to fix attention on the major problems of the coastal zone and propose steps in the development of an integrated national research program in coastal geography.

In 1961, ONR and the National Science Foundation sponsored the First National Coastal and Shallow Water Research Conference composed of three regional meetings in Baltimore, Maryland; Tallahassee, Florida; and Los Angeles, California. At this conference, Pruitt presented an account of the coastal research program, including projects in the humid tropics, from its inception.

Other American military agencies have a record of interest and activity in the investigation of coastal features: the U.S. Naval Civil Engineering Research and Evaluation Laboratory, which has performed research on trafficability of beaches; and the U.S. Army Coastal Engineering Research Center (formerly Beach Erosion Board), which "conceives, plans and conducts research and development in the field of coastal engineering in order to provide better understanding of shore processes, flood and storm protection, beach erosion, and shore structures." [15] Neither agency is involved specifically in studies of the humid tropics, but the results of their work have worldwide applications.

C. MAJOR PROBLEMS FOR CONTINUED AND FUTURE INVESTIGATION

During the last decade, various groups of authorities and individual specialists, including the NAS-NRC Committee on Geography,[11] the NAS-NRC Committee on Oceanography,[18] H. Valentin,[16] and J. T. McGill,[4] have emphasized the general lack of adequate data on coasts everywhere and the complete lack of any data on long stretches of some coasts. In essence, therefore, the need for more knowledge is so broad that any new information can be considered useful. However, the Committee on Geography observes also that the exact state of knowledge of coasts cannot be determined until the available data have been critically evaluated.

Each of the two committees mentioned, as well as the Intergovernmental Commission on Oceanography,[17] the Panel on Coastal Geography (K. O. Emery, chairman),[19] and the Hawaii Institute of Geophysics,[20] has gathered opinions on the problems requiring investigation and the particular types of data needed. In addition to the comprehensive statements, particular problems requiring investigation have been discussed by Valentin and Guilcher. The former is concerned with the methodology of coastal morphologic research, which has been unsuited for dealing adequately with the variability of coastal conditions, and with the problems of vertical and horizontal movements of shorelines. Guilcher is interested in the broad problems of shoreline movements, processes and rates of sedimentation, and formation of reefs.

The following list of problems requiring further investigation has been prepared from publications by the cited authorities, determinations of the present Inventory, and direct communications by consultants to the Inventory:

1. General Problems

   - Relationship between bedrock structures and present coastal profiles
   - Effects of shelf width, swell, tides, storms, earth movements, and man-made structures on coastal morphology and regime
   - Chronology, magnitude and effects of Quaternary sea-level changes
   - Occurrence and behavior of tsunamis
   - Data on tidal currents in narrow channels
   - Explanation of contemporary condition of coasts on a worldwide basis

- Establishment of generally accepted classification systems for coasts and standards of coastal terminology

2. Problems of Cliffed Coasts

   - Mechanisms of retreat of headlands and cliffs
   - Processes of formation of coastal platforms
   - Rate and manner of operation of rock-reduction processes in different coastal climatic regimes

3. Problems of Low Coasts

   - Dimensions of beaches and dunes
     — Purpose: indicate protection given backshore from storm action
   - Profile — measurement at least semiannually and after tsunamis
     — Purpose: important in planning maintenance of recreational beaches, control of beaches being exploited for sand, and protection of beaches adjacent to marine engineering works
   - Composition of beach face — mean grain size, mineral composition to nearest 5 percent
     — Purpose: indicates stability of beach face
   - Characteristics of local beach areas with unusually high production of sand
     — Purpose: determination and maintenance of conditions favorable to production of sand
   - Ecology of foraminifera, halimeda, brittle stars, echinoids, corals, and sponges and, in brackish water, dwarf mollusks and ostracods
     — Purpose: determination of importance of shells, spicerles, plates, and fragments in formation of calcareous beaches
   - Moisture content of beaches
   - Determination of zones of fresh-water seepage

- Effect of controlled stream runoff on supply of sand to beaches

  — Purpose: maintenance of supply moved by longshore currents or avoidance of excessive deposition of mud with high organic content on beaches

- Distribution of wave heights, periods and directions of approach

  — Purpose: determination of destructive influences on artificial shore defenses

- Effect of artificial defenses on growth of normal beaches and dunes

  — Purpose: preservation of beaches and improvement of defenses

- Engineering research on washing of dune sands contaminated with organic material, interbedded alluvium or wind-blown dust

  — Purpose: improvement in quality of commercial sources of sand

4. Sedimentation Problems

   - Processes and rate of sedimentation in coastal marshes and estuaries
   - Relationships of saltwater-fresh interface to rates and characteristics of sedimentation
   - Bottom silting conditions

     — Purpose: more accurate prediction for improved harbor construction

5. Problems of Nearshore and Offshore Features

   - Composition from mean sea level to 5 or 6 fm
   - Sand content, dynamic processes and geologic history of sand-bottomed channels crossing reefs
   - Processes of formation and alteration of bars and barrier islands
   - Origin and structure of different types of reefs such as true atolls and annual reefs

- Nearshore wave and current conditions and characteristics of bottom topography
  - — Purpose: determination of rapidity with which sediments are moved along shore
  - — Application: to improve navigation guides and reduce losses of ships through stranding and collision and to establish pipelines stretched from anchored offshore buoys to beach for transfer of bulk cargoes, such as petroleum, along open coasts

6. Problems of Water Properties and Characteristics

- Temperature distribution in surface water — preferably to nearest 0.1°C but useful if only to 1°C
  - — Purpose: determination of horizontal and vertical circulation patterns
- Salinity to determine rate of intermixing of coastal water with inflowing sea water and fresh water
- Acoustical effects and conductivity

7. Pollution Problems

- Physical movement and dispersion of municipal and industrial wastes in coastal environment
- Biological and geochemical interactions of waste components with marine environment
  - — Purpose: for protection of inshore areas (recreational beaches, fishing grounds and and harbors) from deterioration, for positioning best outfall locations for wastes, and for determination of degree of treatment needed for wastes
- Physical dispersion and biological effects of radioactive materials in inshore waters
  - — Purpose: determination of effects of use of water by nuclear power plants as source of condenser coolants and release of radioactive nuclides

- Geographic distribution, life history, physiology, and behavior of different species of marine organisms infesting ships, particularly in tropical ports

  — Purpose: development of antifouling procedures

Detailed information is needed also on the meteorological, climatological, ecological, and cultural aspects of humid tropical coasts to produce a complete understanding of the environment and its relationships to the neighboring hinterland and sea.

From the standpoint of military use of the coastal zone, especially for landings, the following topics require consideration:

- Amplitude and frequency of tides
- Effect of bottom conditions on accessibility of shore
- Anchorages
- Offshore obstacles such as islands, reefs, shoals, bars, and submerged wrecks
- Seasonal and other distribution of storms
- Natural harbors
- Location of beach with respect to approaches
- Dimensions and composition of beach for evaluation of trafficability and suitability for stockpiling
- Conditions for preparing harbors, including availability of materials and opportunity for rapid dredging of channels
- Coastal features such as cliffs, dunes, embankments, woods, and man-made structures to determine their effect on movement and the availability of cover and concealment
- Location, dimensions and trafficability of exits

D. BARRIERS TO THE ADVANCEMENT OF KNOWLEDGE

Knowledge of the coasts is marked by many gaps for the same reasons that other aspects of humid tropical environments are incompletely known. Basically, these are not scientific problems but problems of resources.*

*Further discussion of the basic problems in given in Chapter I: Introduction.

Additionally, some peculiarities of coastal research have affected advancement of knowledge of the humid tropical coasts. An important factor noted by J. L. Davies is "that much of the classical work in coastal geomorphology was carried out in New England and Western Europe."[21] The knowledge of coasts stresses features of these regions and, correspondingly, fails to explain fully or well some of those of the humid tropics. Davies believes the "unfavorable balance has been redressed to some extent by work in California, the Gulf of Mexico and West Africa, but a very great deal remains to be accomplished before a true world picture of shoreline development emerges."

On another subject, A. Guilcher observes that "The problem of shoreline movements is one of the most important and, at the same time, most difficult aspects of geomorphology. The enormous growing bibliography merely increases the confusion. Research methods are complicated and critical, and part of the divergence of opinion results from research incorrectly carried out."[22]

In 1964, the Intergovernmental Oceanographic Commission pointed out that the study of oceans is complicated by their constantly changing condition, the continued inaccessibility of some parts of the oceans, and the small number of observation points.[17]

Concerning the study of behavior and effect of waves, currents, tides, and winds on beaches, C. A. M. King comments on the difficulty caused by the large number of variables.[23] "For this reason," King adds, "the experimental approach to the problems is all the more attractive because the variables can be brought under control and isolated in the controlled conditions of the model wave tank."

H. Valentin draws attention to the practice indulged in by many investigators of using coastal terminology in an unspecified but obviously not a universally accepted sense.[2] The confusion and disagreement caused by this habit are inimical to the orderly advancement of knowledge.

E. EVALUATION OF THE STATE OF KNOWLEDGE

For this Inventory, the cooperation of experts with personal experience in the humid tropics has been sought; they were asked to review the findings and offer opinions on the state of knowledge of humid tropical coasts generally and of the 108 regional and political (mainly entire countries) units identified for the purposes of the Inventory.

The experts, it has been determined, regard the general state of knowledge to be poor. Their consensus is that, regionally, the coasts of Central America including the West Indies are best known. They agree that the coasts of the Hawaiian Islands, Brazil and Puerto Rico have been well-studied. The analysis of opinions shows that none of the experts claim to have intimate knowledge of coasts throughout the humid tropics; therefore, in keeping with accepted scientific ethics, they regard themselves qualified to rate only those areas that they have studied directly or in connection with their topical investigations.

The Inventory shows a preponderance of literature on coasts of Central and South America. It appears, as the experts have indicated, that these coasts are better known than those of other parts of the humid tropics. However, the state of knowledge of some of the other regions may be better than the Inventory shows or the experts can certify. American participation in coastal research in the humid-tropical countries of the western hemisphere accounts for greater familiarity with research there than in other regions and for greater availability of the published results. Information non-U.S. research decreases with the increase in amount that is published in foreign journals and books despite the growth of international abstracting services intended to overcome this obstacle.

It is noted also that local experts differ with those consulted by this project. For example, the high rating given to knowledge of the Hawaiian coasts must be balanced against the opinion of scientists working continuously in that region, who enumerate countless gaps in knowledge. Similar observations were made on the opinions of American observers and local experts regarding the knowledge of Brazilian coasts. The German specialist on coasts, H. Valentin, found on direct inspection that the data on presumably known coasts of Northern Australia were, in reality, limited to old and (by present standards) incomplete and superficial mapping.

Although the humid-tropical coasts in general are not considered to be adequately known, the state of knowledge of coasts in other parts of the world is not necessarily better. R. W. Fairbridge, a long-time student of humid-tropical and other coasts, remarks that it is not necessary to go to the humid tropics to find poorly known coasts, for they are common in our own proximity on the shores of the United States.

F. RECOMMENDATIONS FOR ADVANCING THE STATE OF KNOWLEDGE

Knowledge of the coastal zone is a combination of geologic, oceanographic, biologic, ecologic, hydrologic, geographic, and engineering information. Coordinated interdisciplinary research is required to create a balanced understanding of this environment. Fairbridge observes that the interactions in the coastal zone are so complex that parameters

cannot be fixed on the basis of investigations in localized areas but require worldwide study.[24] By such study, the NAS-NRC Committee on Geography (1961) states that analogous areas can be delimited and defined and the detailed similarities and differences of different coastal areas determined to permit better use of coasts.[11] Regional study of the coastal zone can then lead to future intensive study of smaller areas.

The NAS-NRC Committee on Geography recommends development of instruments and techniques to obtain more complete and accurate data on properties and relationships of land, sea and air in the coastal zone. It encourages improvement in

- Methodology and procedures for design of sampling patterns, frequency and sites
- Equipment for recovery of sediment and water samples and for their rapid and accurate analysis
- Techniques for designing and operating physical models of beaches
- Theoretical models of the action of breaking waves, wave refraction and coast currents, dune structure and behavior, beach structures, tidal flushing, sediment erosion and transport, and other phenomena
- Techniques for stabilizing beaches

The NAS-NRC Committee on Geography notes that about 50 scattered field stations and some universities possess facilities that can serve research on the coastal zone but that these facilities are mainly concerned with limited topical or areal aspects of the coastal zone. "There is a special need for the establishment of reserved natural areas for laboratory research, with facilities provided for scientists to live and study at the sites ... In addition ... it is necessary to establish several centralized facilities to provide services that will increase the effectiveness of research." These services "would relieve the expert from undertaking time-consuming, routine, but necessary operations, and ... would supply him with the newest equipment and instruments (and) would insure greatest efficiency in information recovery."

The specific service facilities recommended by the Committee are:

- For Data Gathering
  - — equipment pools of planes, boats, amphibious vehicles, and measuring instruments
  - — index of equipment available for loan

- center for designing, building and calibrating new specialized equipment (such as sensing devices)
- specialized equipment (such as tanks and physical models) for simulation of complex environmental conditions

- For Sample Analysis
  - sedimentology and chemical laboratories
  - biologic identification laboratory including library of plant pollen found in coastal areas
  - Geochemical dating laboratory
- For Information Processing, Storage and Dissemination
  - clearinghouse for exchange of data-processed programs and advice on programming
  - data center
  - bibliographic and reference center with map and photo libraries and information on all current research in progress on coastal zones

The Panel on Coastal Geography[19] and R. W. Fairbridge[24] in 1965 emphasized the need for coordinating ground studies with investigations by aerial photography and sensing imagery. The panel places priority on the problem of calibrating and evaluating the imagery from available sensors. Fairbridge recommends the organization of a committee of national and international authorities and study groups including such organizations as the International Conference on Coastal Engineering Council for Wave Research; International Association for Quaternary Research Commission on Shorelines; International Geographical Union Commission on Coastal Geomorphology; U. S. Coast and Geodetic Survey; U. S. Army Coastal Engineering Research Center; U. S. Office of Naval Research, Geography Branch; and (U. S.) National Science Foundation, Earth Sciences division, to plan and coordinate research.

In 1964, UNESCO and the Government of Pakistan sponsored the Dacca Symposium on scientific problems of the humid-tropical zone deltas. The symposium was conducted under the leadership of F. R. Fosberg, chairman of the Advisory Committee on Humid Tropics Research.[25] This meeting produced 55 contributions by experts from many countries; they discussed a wide variety of topics embracing the natural and human factors of delta areas, mainly in the humid tropics. The findings and conclusions of this group of experts are corroborated by the previous determinations of the UNESCO committee and this Inventory.

Research recommendations given in this discussion are representative of the problems suggested for study by experts, individually and in groups, who have been cited here and in Chapter II (Physical Features). It is apparent that the needs are far-reaching and fundamental. The state of knowledge is considered to be fair at best for the humid tropical coasts as a whole. The priority of problems to be studied in any given area of these coasts must be based on further discussion between worldwide experts and those currently engaged in research in the area.

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CHAPTER VI

REGIONAL STUDIES OF THE HUMID TROPICS*

A. INTRODUCTION

1. Systematic Field of Interest

Regional research considered in this chapter includes environmental, analog, land use, strategic, tactical, natural resources, and regional delimitation studies. Within the field of tropical regional studies (research of all aspects of the environment in combination for limited areas or regions) emphasis in this report has been placed upon the following:

- Environmental associations and indicator types
- Interrelationships of environmental elements
- Regional studies having military applicability

2. Value of Inventory of Tropical Regional Research

a. Military Applications

Many examples of employing tactics to fit the physical characteristics of the geographic areas are reported. [2, 3]

Minney presented an interesting account of the way in which Clive used his knowledge of monsoon effects on local drainage and behavior of the natives in winning a battle critical for England's conquest of India. [5]

Russell, Booth and Poole, [1] Morton [6] and various military historical studies [7, 8, 9] call attention to the tactical ground war and strategic studies of World War II.

The important periodical Military Engineer[4] often contains brief, but excellent, descriptions of military activities in humid tropic regions from the Mexican War through the present Vietnam conflict. The significance of regional geography (for the humid tropics) is demonstrated

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also in current general literature,[10] trade journals[11, 12, 13] and specialized professional serials.[14]

Recent research, e.g., McCourt,[15] relates humid-tropical regional factors to military problems in the characteristic physiography (e.g., land grain, slope, hydrology); pedology; natural and cultivated flora and fauna; climatology and meteorology; industry; and demography of the areas being studied.

1) Physiography, Pedology, Plant and Animal Life

Collectively, landforms, soils, vegetation, and animal life control or limit surface mobility,[15] as shown by the extensive and thorough research and development work of the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Recently, the use of airborne and ground-based sensor systems, e.g., airborne infrared imaging devices and counterbattery radar and higher-frequency communication systems such as UHF radio, have been found to be strongly influenced by line-of-sight conditions imposed by landforms and vegetation[16, 17] and frequently by the composition and condition of soils.[18] Subsurface conditions also influence remote sensing in many airborne modes and are considered important to aerial seismic and magnetic methods.

As conventional and nuclear warhead yield increases, ground-zero locations become more critical in order to avoid adverse topographic channeling and dissipation of blast effects away from the target. Other significant aspects concerning the importance of physical features and plant and animal life to the military can be seen in detail in this compendium's Chapters II and III.

2) Climatology and Meteorology

The influences of the atmosphere on mobility, comfort, clothing and equipment utility, and other conditions have been described more fully in Chapter IV. Another consideration of significance is the subject effect of the atmosphere on sensor and communication system performances.[16, 17, 18] Typical of these effects are the high rates of attenuation for electromagnetic energy transmission associated with precipitation, atmospheric particle constituents, e.g., H_2O, CO, CO_2, O_2,[19] and any solid nuclei around which fluid particles may have formed. Many of these atmospheric substances, e.g., water vapor, are particularly prevalent in the humid tropic latitudes and specifically in the more heavily vegetated regions.[16, 17]

3) Socio-Economic and Political Considerations

Today, socio-economic and political factors are given a very high level of consideration in U.S. military operations.[11, 12, 13, 15]

Several of these factors which illustrate this emphasis are found in the present Vietnam situation and include the following:

- The Viet Cong have neither physical characteristics nor necessarily uniforms, weaponry or emplacements that identify them as the enemy. They cannot be treated as a collective, continuously cohesive force distinct from the Vietnamese civilian populace. This situation occurs wherever organized and regular forces enter contests with guerrillas, insurgents and infiltrators.

- The irregulars encountered with increasing frequency in military operations during the past 10 years use, to a great extent, local supply sources. They obtain personnel, intelligence, shelter, food, other supplies, and at times, moral support from civilians in their proximity.

These aforementioned factors suggest that military solutions to certain limited warfare problems could be achieved more through socio-economic and psychological rather than only classical (military) physical and engineering approaches. Success of applied socio-economic factors was demonstrated by the British relocation policies in countering the Malayan Communist movement.[20]

Industrial activity is limited in the humid tropics; therefore, industry is relatively insignificant for military objectives or purposes. Such industrial activity which is significant is limited to scattered examples such as the mining industry of Katanga; the oil refineries of Indonesia; manufacturing ranging from electronics to shipbuilding in Hong Kong, Singapore and the Philippines; and the sugar and mineral processing in Cuba.

b. Importance to Civilian Affairs

Regional geographic data are needed but remain sparse for the economic development and furtherance of national aspirations in essentially all humid tropics political units. However, a step forward in alleviation of this situation with regard to the agricultural sector recently has been accomplished by the Pan American Union.[21]

Since humid tropics regional research has long been recognized as critical in establishing the manner in which industrial growth, resources exploitation and the consequent population shift, growth and upgrading can and should develop for achieving national goals, the absence of such regional studies creates the need for their being undertaken.

Simon Baker, University of Arizona, suggests that existing regional studies of the tropics often emphasize agriculture "because this is the dominant human occupation in the tropics. Relationships between agricultural activities and natural and social environments are usually

stressed in these regional studies...the people of tropical Asia... may be able to profit from the experience of other village people in tropical Africa or tropical Latin America."[22] Baker advocates the comparison of regional studies by specialists and the utilization of tropical regional studies on the village level in a program to improve nutrition and living standards for rural tropical people. "Americans involved in overseas aid programs of all types should be made cognizant of the value of the tropical regional studies of geographers. Officials involved with agricultural development within the underdeveloped countries must also be made aware of such studies."[22]

B. STATUS AND SIGNIFICANCE OF TROPICAL REGIONAL RESEARCH

1. Historical Development of Tropical Regional Research

Interest in humid tropic regions can be traced to writings of the ancient Egyptians and Greeks such as Ptolemy and Strabo.[23,24] In most cases, they emphasized human geography possibly because the African and Indian humid tropics were important only as a source of slaves and valuables. Investigations into the humid tropics also was accomplished by Arab merchants, who pioneered African, Indian and Oceanian trade routes, and by Chinese traders. During the 15th century when domestic problems permeated the Chinese empire,[23] the Chinese were followed by adventurers from Western Europe. New World trade was exploited in the Columbian period by the Europeans from which some data, characterized by a coastal zone interest, were compiled. Reference to Chapter V, "Coastal Zones" indicates that little pertinent data was produced by this trade activity. trade activity.

The 16th through 18th century Spanish and Portuguese missionaries provided additional stimulus to drives inland from increasingly exploited Latin American coastal zones. However, from the number and depth of documents available, descriptions apparently fared little better under religion than under commerce. Almost without exception, the scant records available show the error of extrapolating an entire region's characteristics from the few points of observation encountered along the rivers and land trails traversing a region.

Humid tropic regional research did not acquire definition nor was its import appreciated until the 20th century.[24] In fact, the initiation of empirical regional geographic research has been placed as late as 1923 by Whittlesey.[29]

During the second world war, the British Naval Intelligence Division's geographical section under the direction of J.M. Wordie, H.C. Darby, and K. Mason published a series of geographical handbooks and manuals of various areas including the following countries in the humid tropics:[25]

- Indochina (Cambodia, Laos, S. Vietnam, N. Vietnam)
- French West Africa (Senegal, Guinea, Ivory Coast, Togo, Dahomey)
- French Equatorial Africa (Congo, Gabon, Central African Rep. Chad)
- Netherlands Indies (Indonesia)
- Pacific Islands
- Belgian Congo

The handbook series was a revision and expansion of those done during the first world war for the British admiralty. The staff consisted of well-qualified professional geographers, geologists and other scientists.

Each handbook was devoted to an areal unit and considered its physical geography, economic geography, ports, communications, history, peoples, and administration. The manuals are in no way confined primarily to naval affairs and were written with peacetime as well as wartime purposes in view. Wilson claims this series to be "one of the most outstanding and lasting contributions to the geographical literature that has resulted from the war".[25]

The only significant humid-tropical regional research that was performed until shortly before World War II was Robequain's work on Annam in 1929, Gourou's study on the Tonkinese delta in 1936,[27] and Lehmann's studies of Java,[28] and the interdisciplinary research accomplished in Latin America prior to 1941. The last of these examples proved valuable to the Joint Army and Navy Intelligence Studies (JANIS). Russell et al[1] in their discussion of military geography consider the JANIS reports "to be the finest examples of wartime (W. W. II) area reports." Most of the geographic war effort was devoted to the preparation of area intelligence reports bearing on military, economic, or administrative problems.

The content of the JANIS Reports varied from area to area due to differing local requirements although emphasis was placed upon basic descriptions of landforms, soils, vegetation and drainage and on evaluations of cities, roads, railroads, etc. The reports were products of inter-disciplinary teams of scientists trained in geology, pedology, meteorology, etc. whose work was coordinated and directed by geographers. They were compiled largely from the literature however; some of the

topical chapters like Coasts & Beaches were based on air photo-interpretation. These regional studies generally reflected the hurried nature of their composition. The data found therein were rarely more than assemblages of previously recorded, often obsolete and at times erroneous information seldom obtained by first-hand observation.

Tropical regional research by the Japanese was initiated only very shortly before World War II when, in late October 1940, the Total War Research Institute was established. The Japanese army ordered three divisions, then in South China, to begin training for operations in tropical areas in December 1940. During the next few weeks, special studies were made of the geography, terrain and climate of Malaya, Indochina, the Netherlands Indies, Thailand, and Burma, with emphasis on the problems of military operations in those environments.[1]

The Germans, by 1943, had completed production of the Mil-Geo, Mar-Geo and Luft-Geo series of regional studies which included data gathered in specifically oriented field programs begun in 1924 by German intelligence services. The Mil-Geo handbooks (Militärgeographische Angaben) were prepared for all areas into which the German army planned to move. The handbook consisted of separate volumes of descriptive text, selected photographs, a gazetteer, and through-route town plans.[29] The handbook was accompanied by a folder of maps, scaled 1:500,000 or smaller, portraying natural and cultural landscapes. The Mar-Geo group was established in 1942 by the German Naval high command to prepare maps of detailed landforms and underwater conditions of European coasts. The Mil-Geo series emphasized coverage of the Germans' planned ecumene, primarily Europe and Western USSR, and thus anticipated rather than performed a treatment of humid tropic regions (as would have been encountered by movement south into tropical Africa and east toward India).

Limited regional geographic data were assembled in the post-World War II years by the U.S. Air Force. Generally, these data exist as descriptive introductions to possible targets for aerial bombardment, at times becoming more specific, e.g., in relating physiography as an influence on weapons' effects.

The "National Intelligence Surveys" (NIS) series published by the Central Intelligence Agency, Washington, D.C., is classified, but it may be noted here that each of the important volumes contains perhaps

the most extensive and intensive known coverage of geographic regional data found within each (humid tropical) nation's political boundaries. The U.S. Air Force target studies are similar to the NIS volumes in the military orientation of presented geographic data. The fact that geographic regional data are terminated by political boundaries need not be a limitation where volumes on adjoining countries are available.

The advent of Communist North Korean action against the Republic of Korea in 1950 renewed the possibility that the United States might be engaged in scattered global actions in numerous locales and varied environments. Communist-directed or oriented actions against the French in Indochina, the Dutch in Indonesia, the British in Malaya, the Philippine government by the HUKS, the Castro regime in Cuba, plus the Guatemalan, Venezuelan and other Latin American events all served to establish that fulfillment of U.S. obligations could require emphasis on preparedness for humid tropic region operations. Accompanying this awareness was recognition and confirmation of the scarcity of available humid tropic regional data. In the early 1950's, a considerable amount of valuable information on Thailand[2] was assembled, and it reappeared verbatim (except for minor updating of illustrations) in a very recent USTRC publication on the Southeast Asia environment.[30] Only minor attention to change occurring in the region in intervening years was evident. A "classic" tropical regional study was published only 5 years ago by G. Lasserre. His 2-volume work on Guadeloupe[31] has been regarded as the best regional geography ever done for a tropical American area*.

2. Status of Tropical Regional Research Development

Although the importance of tropical regional research was established by the global events of the past 25 years, it can be concluded that little nonmilitary regional geographic work was performed even for those areas convenient to many qualified geographers of North America and Europe. The extent of coverage is, therefore, inadequate in breadth. Only time and a continuation and expansion of the few efforts being performed in depth[32, 33] can alleviate this situation. While this is true of both military and nonmilitary aspects, additional contributions to the field can be expected with the growing awareness of the nonmilitary importance of the subject.[34, 35]

C. REVIEW OF CURRENT ACTIVITY AND TECHNIQUES USED IN HUMID TROPICS REGIONAL RESEARCH

1. Introduction

The term "current" as applied in this section of the report describes regional research activity in progress or that which has been

*Gourou, P., 1966, Personal Correspondence, 21 February.

undertaken and the results published in the period 1964-65. Data are based on this program's literature search and the assistance of project consultants who have reviewed the bibliography and submitted an assessment.

Interest in regional research by geographers in tropical regions is directed toward such applications as land utilization, resettlement, hydrological problems, and resources development. Such regional studies carried out in the tropics reflect the specialties of the geographer and/or objectives of funding agencies. Generally, they can be regarded as primary or supporting data sources for regional studies for military application since data collected for one requirement are sufficiently definitive for multipurpose use. Topical studies as reported in other chapters of this compendium are frequently designed to produce results usable in regional environmental studies.

2. U.S.-Sponsored Current Research Activity

Major tropical regional research activity in this country stems from long-term objectives of the U.S. military to compare world environments with those of principal test sites and to support environmental research and climatic testing projects. In 1965, a facility for empirical research was established[32] at the U.S. Army Tropic Test Center, Fort Clayton, Canal Zone. A 5-year plan for accumulating an environmental data base for regional studies in the humid tropics was initiated to provide meaningful tropical environmental criteria for analog requirements as well as for material development and testing. A similar program is planned for Thailand.

Supplementary to the Advanced Research Projects Agency's (ARPA) Project AGILE, a team of Army ground mobility-environmental specialists conducted a regional study of Southeast Asia. This was an advance party for a projected long-term research effort begun in May 1962.[36] Technical and administrative conduct of the program was assigned to the U.S. Army Engineer Waterways Experiment Station (WES), and field data were collected in Thailand.[37] This work is a major activity of WES's Military Evaluation of Geographic Areas (MEGA) group. Other MEGA activities include environmental data collection programs being conducted in Puerto Rico and the Caribbean (Panama, Colombia, Costa Rica, Nicaragua, and Guatemala) area by WES Tropical Terrain Research Detachment teams.[36]

The physical environments of Southeast Asia have been the concern of Project MERS (OSD/ARPA Mobility-Environmental Research Study) performed under the auspices of U.S. Army Engineer Waterways Experiment Station. Objectives of the MERS program included development of systematic procedures for establishing optimum vehicle design criteria on the basis of environmental factor measurements and tactical deployment considerations. Other objectives included corollary development of techniques for predicting from regional environmental data the mobility characteristics of a given vehicle. MERS study areas in Thailand included Nakhon Sawan,

Lop Buri, Chiang Mai, Pran Buri, Khon Kaen, Chanthaburi, and Hat Yai. A mapping activity was applied to the seven regions by the Photographic Interpretation Research Division of U.S. Army Cold Regions Research & Engineering Laboratory, using photography that primarily was 10 years old.[38]

The Office of Naval Research (ONR) is sponsoring field investigations in Africa, Asia, Oceania, South America, and in the Caribbean (islands and lowlands of the Caribbean, Middle America and northern South America). West African island studies are being made by H.H. Aschmann of the University of California, Riverside, California, and the Caribbean program is being coordinated by J.J. Parsons, University of California, Berkeley, California. M.J. Eden of McGill University recently completed an ONR-sponsored regional study, The Savanna-Ecosystem - Northern Rupununi, British Guiana.[39]

Government-sponsored research at Indiana University, Bloomington, Indiana, in progress or recently completed, includes the work of O.P. Starkey on Caribbean trade geography (ONR-sponsored). At American University, the foreign division has prepared the U. S. Army Area Handbook Series. Many of these studies are on tropical countries (e.g., Thailand, British Borneo, Ghana, Liberia, Nigeria, Ivory Coast, Congo (B), Cambodia, Laos, etc.) At Clark University, a program was begun in 1960 by S. Van Valkenburg for study of machine storage of environmental data collected in central and contiguous portions of Africa. Funding was not available for this program's continuance in 1962/63.

A bio-ecological classification scheme is being evaluated for use in organizing environmental data into a worldwide classification system for regional planning. L.R. Holdridge is the principal investigator of this ARO-sponsored program. Project consultants are A.W. Kuchler, Ta Liang and L.C. Stuart. The project being conducted by Wilson, Nuttall, Raimond Engineers at the Tropical Science Center, San Jose, Costa Rica, is still underway, and it has been reported that "consensus of the consultants was that the Holdridge system offered a promising framework for the military use outlined, but that precise identification of zonal vegetation in qualitative terms was needed for meaningful subdivision purposes."[40] A Marshall University team and WES representatives are cooperating with this program.[41] An opposing view of the Holdridge system appears in Section C.7 of this chapter.

Aberdeen Proving Grounds' Operation Swamp Fox I and II involved environmental studies in Panama by the Human Engineering Labs and target acquisition studies by the Army Ballistics Research Labs. Prior to the start of Swamp Fox III the project was cancelled.

U S. Army Natick Laboratories is sponsoring a program to delimit, classify, map, and characterize the humid tropic environments. These tasks, which are being performed by the University of Denver's

geography department, will involve mapping the humid tropic environments and subregions at prescribed scales.[42]

Through the Inter-American Development Bank (IDB), Washington, D.C., American funds are supporting various regional projects having emphasis on industrial, agricultural, water, and mineral resources development. Allocations have been made to many Latin American countries for technical cooperation activity in the production of comprehensive regional development plans.

Inpact programs supported by the UN Special Fund include land-use studies (surveys, research, training) in humid tropic areas. The following listed countries have been engaged in such regional land- and water-use surveys for agricultural development purposes: Brazil, British Guiana, Burma, Republic of China (2), Congo (Brazzaville), Ecuador, Ghana (2), Haiti, Kenya (2), Malaysia, Nigeria, Northern Rhodesia, Pakistan, Peru(2), Sudan (2), Tanganyika, Togo, Uganda, and Venezuela. The UN also reports that three regional land- and water-use surveys were supported by the UN Special Fund. When it is considered that United States contributions to the UN Special Fund are approximately 40 percent, then it can be deduced that American funds indirectly supported approximately 40 percent of the cost of these surveys.[44]

To assist Latin American countries in national planning, a Resources Inventory Center was established by the Office, Chief of Engineers, Department of the Army, Washington D.C. (temporarily located at Army Map Service facilities) under an agreement between the Agency for International Development (AID) and the Corps of Engineers. The Center provides technical services for resources studies and is organized into a Data Bank and an Analysis and Evaluation Staff. It has primary responsibility for preparing physical resources studies for the republics of Central America and Panama.[45] Studies for El Salvador and Costa Rica were completed recently, and other studies are in various stages of completion.

USAID/GUATEMALA reports that since 1962 a geographic orientation to planning activities has been utilized and a series of analyses developed for seven distinct geographic regions of Guatemala.[46]

Massachusetts Institute of Technology has supplied 17 researchers plus consultants on a 4-year program for economic development in the Guayana region of Venezuela. This work, involving $1,250,000 has been financed by Corporación Venezolana de Guayana, Harvard University.[43]

The Land Tenure Center of the University of Wisconsin has a continuing program in Latin America supported by AID ($1,250,000). This work involves comparative studies and analysis of the economic, social, political, and administrative aspects of landownership, land tenure and agrarian structure in Latin America (Northeast Brazil,

Brazil, Mexico, Peru, Bolivia, and Colombia).

The Organization for Tropical Studies (OTS) evolved from several movements by biologists and other scholars interested in the tropics. It was incorporated in February 1963, having eight member universities: Costa Rica, Florida, Harvard, Kansas, Miami (Florida), Michigan, Southern California, and Washington. Very soon thereafter the University of California (all campuses) and Louisiana State University joined. Three more universities joined recently: Georgia, Indiana and Texas A&M. Although during the past 3 years the training offered has been in tropical biology, advanced botany and zoology on the graduate level with the opportunity for independent research, the OTS will begin a geography program in the summer of 1967.

The Ford Foundation's activities in overseas development programs include supplying consultants to assist Latin American countries in studying their problems and mapping solutions, educational grants, and support of pilot projects. The Carnegie Institution of Washington has made grants for the advancement of knowledge in the astronomical, physical and biological sciences in Latin America. The fundamental research in the American tropics has resulted in several major monographic treatments.

A President's Commission has been set up to study the feasibility of a new sea-level interoceanic canal between the Atlantic and Pacific Oceans in Middle America. It is anticipated that the U.S. Corps of Engineers will request environmental evaluation studies and geologic and photogrammetric surveys for the areas of interest. The Atomic Energy Commission has a contract with Battelle Memorial Institute to do a feasibility study, whose environmental aspects are being advised by Professor C.F. Bennett.

3. Survey of Current Research Activity (by Institutions and Scientists of Humid Tropics Areas)

   a. Central and South America

The most significant current Latin American research activities in this field were reported at the Mexico City IGU meetings. The agenda for this International Geographical Union Latin American Regional Conference scheduled for August 3-8, 1966, included the geographical approach to problems of development, contribution of geography to urban planning, world land-use survey in Latin America, and problems of the geography in Latin America.[47]

Regional research programs in Latin America include the following: Colombia, Caldas regional program (crop diversification and industrial development); Brazil, studies for industrial and infrastructure projects in Bahia; Colombia, development of the Sinu River Basin; Ecuador, comprehensive regional development plan for Azuay, Canar and Morona-Santiago; Haiti, hydroelectric resource development; Mexico, settlement of El Limón area; Bolivia, Caupolican mixed land settlement; feasibility

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of land settlement in Yaguaca; Venezuela, survey of settlement in La Morrocoya, Eastern Guayana, and sectoral development planning; and Guatemala, socio-economic development plans incorporated into existing regional economic integration programs.[43]

A graduate training program strong in resource studies emphasizing the interdisciplinary approach is offered at the Inter-American Institute of Agricultural Sciences of the OAS, Training and Research Center, Turrialba, Costa Rica. Under the direction of Pierre G. Sylvain, the staff assigned to the resources for development program includes a geographer, soils expert, photointerpretation specialist, ecologist, hydrologist, economist, and rural sociologist. Field work by students will emphasize forestry, soils, economic botany, pastures, economics, and sociology in selected microregions.[48] The institute at Turrialba is one of the unique research institutions of its kind in the entire humid tropics. It provides complete facilities for visiting scientists as well as guidance from the residence staff; conducts basic and applied research; trains Latin American students in the classroom and field, etc. G. Budowski (Turrialba) has conducted research on the classification of natural habitats in need of preservation in Central America.

The University Grants Committee of Great Britain has been collecting information on Latin American research in British universities preparatory to establishment of area-study research centers. The World Land Use Survey under the direction of the late L. D. Stamp has produced such regional monographs as Niddrie's environmental study of Tobago.[49, 50]

Biogeography and Ecology in South America is an upcoming volume to be published by the firm, Dr. W. Junk, The Hague, Netherlands, in the series Monographiae Biologicae.

The Venezuelan Development Corporation's geographic unit, directed by Marco Aurelio Vila, has published numerous inventory-geographies of different states of the republic. At the University of Zulia in Maracaibo, Roberto Lizarralde is engaged in full-time regional research. Levi Marrero, a Cuban geographer at the Central University, has published two significant works: La Tierra y Sus Recursos and Venezuela y Sus Recursos.[51]

Weather Engineers of Panama, Corp., WEPCOR, has a "complete-package environmental data base project... underway at various sites in the Canal Zone and the Republic of Panama." They..."operate two field sites for the U.S. Army Tropic Test Center: (1) a soil plot for soil and hydrological measurements and (2) a 150-ft instrumented tower for atmospheric chemical and particulate matter sampling and wind temperature and humidity measurements at eight levels. Additional observations are made visually. Recording is by manual means, strip charts, and digitized

systems with both tape and hard copy readout."[52] Bennett (University of California at Los Angeles) reports that "the project... is off to a poor start due to faulty assumptions made regarding the nature of the several vegetation types which form the bases for environmental variation."* Other recent reports indicate the program is running 16 months behind schedule due to lack of trained supervisory and technical staff and unrealistic micrometeorologic instrumentation requirements.

A staff of 60 geographers, eight of whom are physical geographers, are involved in Brazil's national atlas program at Conselho Nacional de Geografia, Rio de Janeiro. The Brazilian atlas, due for completion in 1966, will include an interpretation of geography, landforms, soils, agriculture, transportation, population, and mineral wealth in addition to their presentation in map form.

b. Africa

In 1961, the National Research Council reported that "descriptive coverage of the area (Middle Africa) was inadequate."[51] There has been very little additional work performed to change that assessment. However, Makerere University College, University of East Africa, is strongly oriented toward this area: "From its inception, the department has provided a focus for research into the nature of the East African environment and into the problems of adjustment to regional conditions."[47]

A geographic study of all regions of Africa, particularly Sierra Leone and Kenya, is represented in the recent work of R.J. Harrison, Church of London School of Economics; J.I. Clarke of the University of Sierra Leone; P.J.H. Clarke, Government Teacher Training College, Kagumo, Nyeri, Kenya; and H.J.R. Henderson of the University College of Swansea. Updated studies, maps and photographs of all regions appear in their Africa and the Islands.[51] Church's Environment and Policies in West Africa contains much generalized information from African surveys. F.F. Ojany, University College, Nairobi, Kenya, is working on Kenya's physiography Another recent publication is W.A. Hance's Geography of Modern Africa, which is oriented toward economic geography.

In connection with his activities as director of the World Land Use Survey, the late L. D. Stamp obtained data for revising his Africa: A Study in Tropical Development and the 7th edition of his A Regional Geography for Advanced and Scholarship Courses, Part 2, Africa.[51] Both P. D. Jungerius and H.J. deBlij have performed extensive regional environmental studies in Africa. Other geographers conducting regional work in Africa include R.P. Moss (S.W. Nigeria); K.M. Barbour (Sudan); E.A. Boateng (Ghana);

*Bennett, C.J., 1966, Personal Correspondence, 14 February.

and M. M. Cole (Rhodesia). In addition, H. P. White of the Royal College of Advanced Technology, Salford, England, recently completed a regional study of Terre de Barre, West Africa.

c. South Asia and Oceania

India's regional land-use plans are based on systematic regional studies of physical conditions, requirements and relationships with other regions. Work in this area, under the auspices of the Indian Statistical Institute, Regional Survey Unit, has centered around South India and the Mysore State. Numerous publications have resulted from work performed under the auspices of the Indian Statistical Institute. Among these are Learmonth, Rao and Bhat's excellent regional work in Mysore State.[53, 54, 55]

S. P. Chatterjee, director of the National Atlas Program, Calcutta, India, is compiling 300 detailed plates on India's geography. The program which is nearing completion has been delayed by other higher-priority printing programs using the only available press in India. To date, only 40 of these plates have been printed and are available from the director.

Dr. H. J. Neubauer of UNESCO has proposed the creation of a commission of research scientists drawn from the Department of Botany of the University of Dacca, appropriate research institutions of Pakistan Council of Scientific and Industrial Research, agriculture and forestry departments of Pakistan, and scientific societies for a program to determine the inter-relationship between climate-vegetation-water and soils of the humid-tropical regions of East Pakistan, particularly the Chittagong area and Mangrove swamp of Sunderbands.[56]

The Pacific Scientific Information Center at the B. P. Bishop Museum, Honolulu, began the first of a series of Pacific articles on the Marshall Islands (by E. H. Bryan Jr.) in June 1965.[57] Other geographic topics in Oceania will be discussed in the forthcoming issues of this new serial. Reference to Volume I of this report will indicate all past B. P. Bishop Muesum monographs dealing with the Pacific region.

Two to four numbers of the Journal of Tropical Geography are published yearly by the Department of Geography, University of Singapore, Singapore. This serial is the leading journal on the area and subject and is almost unique in its regional orientation.

A basic program of land classification for major Hawaiian Islands is in progress at the Land Study Bureau, University of Hawaii. The first of this bulletin series planned for the major islands of Hawaii was H. L. Baker's studies of Molokai. This work was followed by Nelson's report on Oahu in 1963[68] and a series of land use maps of the six major Hawaiian islands at 1:26,500 done in 1965.

The Food and Agricultural Organization of the United Nations (FAO) often performs work from which militarily significant data could be derived. For example, in Vietnam, it was found that FAO survey reports contained information usable in the mobility studies carried out in Thailand, and recommendations were made to support the Thai-FAO soil-mapping activity.[37] The FAO is responsible for an immense list of publications too numerous to mention. Those germane to this report are ordinarily contained in the following series: FAO Agricultural Studies, FAO Agricultural Development Papers, FAO Fisheries Studies, FAO Forestry and Forest Products Studies, FAO Forestry Development Papers and other miscellaneous publications.

Records of geographical research reports are maintained at the National Taiwan University, Taipei, Taiwan, China, and the Fu-Min Geographical Institute of Economic Development, Official Area Agency of the International Geographical Union. Updated lists are compiled periodically.[59] Many of the reports are in English and are readily available from the institute.

Cheng-Siang Chen, director of University Studies in Geography, United College, The Chinese University of Hong Kong, is establishing a geographical institute to study mainland China, especially the southern and tropical portions. Dr. Chen reports that there is an Institute for Research on Tropical Areas at Kunming, People's Republic of China, which has a staff of more than 600 scientists working on tropical research, with staff sections devoted to climatology and medical geography. Much of the work performed at the institute is for military purposes.

F. L. Wernstedt and J. E. Spencer are completing their research on the physical, regional and cultural geography of the Philippine Islands. The results are to be published in late 1966 by the University of California Press.

The Land Research and Regional Survey Division of the Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra, Australia, has a program of continuing environmental and regional research in Australia and Oceania. The organization's excellent publications are listed in the KWIC Index volume of this report.

d. Other Research

The Committee on Humid Tropics of the International Geographical Union was established in 1956. Its purposes are to "stimulate research in the geography of the humid tropics and especially into the nature of the humid tropical environment; to serve as a clearing house of relevant information (publications, techniques, personnel, and research agencies..."). [60] Past programs have been concerned with the definition and delimitation of the humid tropics, climatic factors and ecological

boundaries. The commission is presently chaired by Professor Theo. L. Hills of McGill University, who has just completed the compilation of a directory of humid tropic research institutions.

The scope of the International Biological Programme modified at the IBP General Assembly in Paris (23 to 26 July 1964) provides for environmental and ecological studies of terrestrial communities, both natural and man-modified, on a world scale to support productivity studies. Phase 2 of this program will involve world-wide data collection scheduled over a five-year period and is projected for approximately 1968/69.[61]

4. Research of Significant Growth Potential

Airborne electromagnetic reconnaissance (remote sensing) systems appear, in initial investigations, to have great future potential for gathering data for regional and analog studies of the environment. Their application in the true humid tropics has been scant, and results are classified. Feasibility studies and development of procedures, systems and applications are urgently needed.

Militarily significant data could be developed out of the numerous regional research activities (land-use and resources development surveys) which are supported by American assistance if funding were conditional to reciprocal use of data. Such a plan might require placing geographers familiar with military needs and applications on the advisory and supervisory technical staffs, which are supplied by the U.S., to assure geographic orientation in these regional research activities.

5. Neglected Areas of Research

Bennett (UCLA) speaking about tropical ecology and environmental studies remarked on the following neglected areas of research:

> "It should be evident, however, to even the most cursory investigator, that the entire area of physical ecology has received very little attention. There is also need of animal population studies of virtually all the faunal components not to say that the bio-ecology of very few tropical animals is very well known. Bioclimatology in the tropics has hardly been touched. There is almost everything to be learned about tropical highlands in terms of physical and cultural geography. There isn't as yet even a decent definition of what a tropical highland or upland is. In fact, very little has been done to standardize the terminology employed for tropical phenomena. Even such basic terms as Tropical Rainforest has many - too many-- meanings and has resulted in a vast confusion in the literature on tropical vegetation. A major task ahead is the study of human ecology in the tropics. Among the many aspects of human ecology needing attention are: human nutritional requirements (at present this whole area is a mass of confusion); medical geography-this is

almost a virgin field for investigation and it is surprising that research in this area barely moves along."*

6. Problems of a Barrier Nature

Scarcity of usable data is the greatest problem facing geographers engaged in regional research for military applications, particularly if the effort anticipates use of automation processes for data analysis. In surveying existing data in Southeast Asia for use in the mobility studies conducted in Thailand, it was found that the quantity of usable data was "rather negligible in regard to satisfying the purposes of the preliminary study."[62] This conclusion was reached after having contacted 14 sources whose primary activities required collection of environmental data, and of these sources, three were American agencies: OICC/SEA, USOM and the office of the U.S. Army Attaché. The almost total absence of quantitative data was reported by the investigators.[62]

Existing regional literature is scattered and difficult to use in comparative studies since there is no general agreement on a system of classification of tropical environments. Boundaries applied to regional research projects also pose problems (political, thematic, physiographic, etc.) when attempting to apply research performed for one requirement to research for a particular application.

7. Controversial Aspects of Regional Research

"The regional concept is the holiest of geographic shibboleths, a fact likely due to geography as a discipline having produced so little in the way of new or original ideas. A kind of mystique has come to surround the regional concept as though it were some wonderful and very intricate idea. Which it is not. The treatment given to the regional concept in that unfortunate effort known in shortened form as 'Inventory and Prospect' must rank with some of the more obscure theological writings of the Middle Ages. Of course the idea of the region is useful - and very obvious. It is also clear that geography has no patent claim to the idea. Is this really the best idea that geography has to offer? If the answer is yes we might just as well file academic bankruptcy. But I've indicated that this isn't necessary and have suggested that ecosystematic concepts offer a frame for new study of what we have long been calling the region."**

P. Gourou (CEMUBAC) sharply differs on the value of the ecosystem. He has recently spoken out on this subject, as follows:

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* Bennett, C.F., 1966, Personal Correspondence, 14 February

** Bennett, C.F., 1966, Personal Correspondence, 27 March

"Personally, I do not see the reasons for adopting the ecosystem concept in regional geography. Why? First, because it is a naturalistic concept attached to "natural equilibrium". The regional geographer knows well that there is no natural equilibrium for Man; Man is not a rat or an earthworm, he is a carrier of civilization. Second, because regional geography itself studies a complex of actions and interactions which is not an ecosystem (if it were one, we would not be men) and we would not be there to make geography"*

Bennett continues his commentary by stating:

"For some reason . . . there is a persistent effort to view the concept of the ecosystem as being too abstract to be useful and relevant to ecological (geographical) studies. It seems almost ridiculous to have to mount a defense of the concept since it has been quite well accepted by the more advanced ecologists of the present day as for example Odum and Fosberg to mention only two.

"There isn't anything esoteric about the concept of the ecosystem. The concept merely forces one to view biophysical phenomena distributed spatially as being parts of interacting and functioning natural systems and, therefore, leads one away from the limited descriptive ecology of the past - an ecology that became so intellectually bankrupt as to nearly destroy the discipline. Ecology wasn't destroyed chiefly because the subject is too fundamental to expire no matter how badly used. It is coming back to life now and this new vitality will increase only to the extent that systems theory is rigorously applied to the study of the interactions between living organisms and their environments. There is a striking parallel between the recent condition of ecology and the present moribund condition of physical geography. That is, ecology became comfortable with a handful of untested rules and hypotheses and was content (and too often still is) to deal largely in descriptions and the listing of 'environmental factors' perhaps in the hope that some sort of insight would ultimately result. In the meantime other fields of biology and the physical sciences in general were moving along with the development and testing of new concepts and new methods of data analysis. Recently some ecologists have been 'catching up' and doing well at their task although the usual contents of Ecology, Ecological Monographs, and The Journal of Ecology clearly indicate that ecology has one foot still stuck in the rut of the past." **

* Gourou, P., 1966, Personal Correspondence, (translation) 21 February

** Bennett, C. F., 1966, Personal Correspondence, 27 March

The tropical life zone investigation being conducted at the Tropical Science Center, San Jose, Costa Rica, using Holdridge's classification scheme, has received favorable review from its program consultants (see Section C.2 of this chapter). A dissenting view is stated by Bennett (UCLA):

> "The fundamental assumptions upon which Holdridge bases his system possess approximately the same value as did the assumptions upon which C. H. Merriam established his life zone hypothesis, that is, Holdridge makes certain statements regarding temperature and precipitation in respect to phytogeography which are completely unsupported by experimental evidence. Although Holdridge employs a little more arithmetic than did Merriam this only serves to obfuscate the basic error of the ecological assumptions inherent in the Holdridge System."*

8. Review of Techniques and Methods of Observation and Study

The products of (regional) geographic efforts may be considered as derived from either (a) primary sources of direct observation or (b) secondary sources wherein

- Observed data are reworked to provide new conclusions
- Data serve as a basis for comparison and standard of measurement by analogy

a. Primary Observation

Russell et al [1] and Thornthwaite [63] concur that regional geography has critically suffered from a scarcity of primary observational practices. Possible excuses for this unscientific situation are due to the fact that interest wanes in performing original research in geographic areas already observed, while least scientifically observed areas are generally accessible only with difficulty and at relatively high cost. The lack of sufficient money for fieldwork still stands as a major obstacle to primary observation in the tropics. An additional factor is the circumstance that relatively few original observation processes are classically relegated to geography. For any number of reasons, climatological and weather investigations become categorized in the discipline of atmospheric sciences or meteorology; vegetation and animal life studies as botany and zoology; and landform analysis as geomorphology.

*Bennett, C.F., 1966, Personal Correspondence, 14 February

Use of air photos may be considered as valid as ground studies and a primary source of geographic information in that the direct observation of phenomena may be performed. Use of techniques and expertise have increased markedly in the last two decades. Their value is not only in that observers and analysts can receive primary data, often from areas which are inaccessible politically or financially, but they may use the photos as a temporal base for comparison.

Recent development of remote sensing devices (IR, radar, gamma ray) being used to sample the environment in various portions of the electromagnetic spectrum and the wider use of film-filter combinations for aerial surveillance have permitted the extension of now-conventional air-photo procedures.[64] The remote sensing devices will produce imagery that will highlight a particular environmental feature of interest and its variations from place to place within its natural milieu. These new tools which can extend primary geographic observation not only need further use, experimental programs and refinement but most importantly declassification and lower cost of acquisition to permit free exchange of inherent benefits through the discipline.

Regional geographic processes usually occur or assume a markedly different status over periods of time that are great compared with the lifespan of an observer. At best, a geographer performing an initial regional study can describe for posterity only an observed interplay of physiographic, climatologic and demographic factors immediate to his position in time and space. Of necessity, development of his description into regional and temporal significance requires extraction from data sources which exist most often as records prepared by other scientists or government agencies frequently for purposes other than regional analysis. Consequently, products of such effort may become categorized as something other than primary observational research.

It may be concluded that situations classically considered conducive to pure primary observation have been progressively decreasing. Certainly, reobservation of many regions for a variety of purposes remains to be performed.

b. Secondary Studies

The 1955-1965 decade has seen continuing growth of studies of regional factors by analogy. Specifically, restrictions on cost, time, accessibility, and observer safety have stimulated the use of sites that are both convenient to and have characteristics akin to those of the less convenient regions of interest. While precise relationships of the characteristics of two regions may be impossible in every case, analog comparisons can present additional benefits to the obvious ones mentioned. One such benefit occurs when the analog site exaggerates conditions existing in the area of actual interest. Extension and extrapolation of factors

such as rainfall rate, vegetation density and microrelief could permit relatively short-term study in the analog area to represent long-term spans or most critical limits achievable in the regions of actual interest.

Other secondary sources of regional data consist of maps, statistics and, in many recent instances, data that have been reworked using new quantitative procedures. The basic problem in secondary data is that geographic information, especially that needed for regional study, needs to be oriented spatially. This is not ordinarily the case, as information developed for other purposes is usually not oriented spatially.

Laboratory analysis of the effects of environmental interplay upon mobility and trafficability have been made at the U. S. Army Corps of Engineer Waterways Experiment Station, Vicksburg, Mississippi. For Projects WESTAR[69] and WESTAG, models simulating a miniature environment (incorporating relief, soil types, vegetation, etc.) were designed and constructed. Returns from these samples were displayed on radar and gamma-ray detectors to assist trafficability prediction. Additional and further laboratory study is required to determine the value of these procedures for analysis of other than mobility factors.

D. AVAILABILITY OF DATA

The inventory portion of this chapter discusses the availability of data.

1. Sources of Information

Sources of information consist of depositories, authorities, maps and aerial photographs, research organizations, and the collected bibliography.

a. Authorities

Personnel who have conducted significant regional research in the humid tropics, regardless of their present locations, are considered as authorities and sources of information. They are listed in a matrix and directory (Appendix A, Authorities) of this compendium.

b. Depositories

Appendix B (Principal Depositories) of this compendium should be consulted to determine amount, type and availability of humid-tropical regional research materials located at depositories containing important holdings, either quantitatively, qualitatively, or both.

c. Maps and Aerial Photographs

Appendix C (Inventory of Maps and Aerial Photographs) should be consulted to determine the amount, type, scale, recency, reliability, area of coverage, and the other pertinent data concerning map and airphoto coverage of the humid tropics. Additional sources and indices are noted there for more detailed information.

d. Research Organizations

Organizations, agencies and institutions engaged in specialized research investigations of humid tropical regions may be found in a separate volume, A Directory of Institutes Primarily Devoted to Humid Tropics Research, by McGill University, Montreal, Canada, for the U.S. Army Research Office. The directory, intended to be a part of the Inventory of Geographic Research of the Humid Tropic Environment, was published in October 1965. Highly specialized holdings by organizations that act as both depository and research institutions may also be found in Appendix B of this compendium.

e. KWIC Index

Volume I of this inventory, KWIC Index — Humid Tropic Environmental Literature, contains the bibliography that was collected at domestic and foreign depositories. Materials were derived primarily from the literature of the geographic earth, atmospheric, and biological sciences.

Regional studies literature was classified into the following categories based on program specifications:

- Regional types, general
  - — environmental studies
  - — analog studies
  - — natural resources
  - — delimitation
- Combined and other subject codes
  - — general military information
  - — land use

These topics may be consulted via their code numbers for each geographic area in section E of volume I.

2. Evaluation of Collected Bibliography

A statistical approach to the bibliography without analysis does not accurately reflect the status of humid tropics regional research. For example, the 1050 entries of the bibliography identified as regional research (Table 14) represent 7.23 percent of the total number of humid tropic entries recorded compared with 3 percent for Coastal Zone studies (see Chapter V) and some 25 percent each for plant and animal life (see Chapter III) and Weather and Climate (Chapter IV) studies. A bias is recognized to exist in this comparison, however, in that certain coastal zone studies, for example, also exist as regional geographic and physical features studies. A more accurate evaluation can probably be made with reference to Table 15 wherein efforts uniquely of a humid tropic regional geographic nature can be identified.

Table 14 indicates the dearth of pertinent pre-World War II-developed data, the "flurry" of World War II activity, the slump of post World War II activity and finally, the flurry of activity of the last decade. Table 16 clearly indicates the large number of studies performed in Latin America (428 out of 1050 entries — more than 40 percent of all entries). This is a reflection of sample bias as most works and sources of information are American and U. S. investigations are predominant in the American tropics, due primarily to proximity.

E. ASSESSMENT OF THE STATE OF KNOWLEDGE

The cooperation of experts with personal experience in the humid tropics has been sought for this Inventory; they have been asked to review the findings and offer opinions on the state of knowledge of humid tropical regional studies generally and in 108 regional and political units (mainly entire countries identified for the purposes of the Inventory).

It has been determined that the experts regard the general state of knowledge to range between fair and poor. Their concensus is that Central America and the Caribbean are best known, with Southeast Asia and South Central Asia, following respectively. They agree that regional types of Guadeloupe, Margarita I., Martinique, Mexico, Panama, Puerto Rico, Venezuela, Nigeria, Ceylon, India, Malaysia, the Vietnams, Australia, Fiji Islands, and Hawaii have been well studied.

Analysis of opinions shows that none of the experts claim to have intimate knowledge of regional studies throughout the entire humid tropics and, therefore, in keeping with accepted scientific ethics, regard themselves qualified to rate only those areas they have studied directly or in connection with their tropical investigations.

Table 14

REGIONAL STUDIES — LITERATURE

Period of Publication	No. of Entries in Bibliography	Percent of Total Regional Types in Bibliography
Pre-1914 or unknown	56	5.4
1914-1938	194	18.5
1939-1955	411	39.1
1956-1965	389	37.0
Total	1050	100.0

Table 15

TOPICAL CATEGORIES — LITERATURE

Topical Category		No. of Entries in Bibliography	Percent of Total Regional Types in Bibliography
000	Regional types	461	43.9
001	Environmental studies	440	41.9
002	Analog studies	5	0.5
003	Natural resources	2	0.2
004	Delimitation	13	1.2
200	General military information	34	3.2
050	Land use	95	9.1
Total		1050	100.0

Table 16

REGIONS

Major Region		No. of Entries in Bibliography	Percent of Total Regional Types in Bibliography
1	Humid Tropics	72	6.9
2	Latin America	428	40.7
3	Africa	207	19.7
4	South Asia	194	18.5
5	Oceania	149	14.2
Total		1050	100.0

The Inventory shows a preponderance of literature on Central America and the Caribbean, Southeast Asia and South Central Asia. It appears, as the experts have indicated, that these are areas better known than those of other parts of the humid tropics. However, the state of knowledge of some of the other regions may be better than the Inventory shows or the experts can certify. American participation in regional research in the humid-tropical portions of Latin America and Southeast Asia accounts for greater availability of the published results. Information on non-U.S. research activity decreases with increase in the amount published in foreign journals and books despite the growth of international abstracting services, e.g., Geographical Abstracts, intended to overcome this obstacle.

It is noted also that local experts differ with those consulted for this project. For example, the high rating given to knowledge of the regional studies of India must be balanced against the opinion of scientists working continuously in that area, who enumerate countless gaps in knowledge. Similar observations were made on the opinions of American observers and local experts regarding regional studies of Malaysia. In general, knowledge of regional types of the humid tropics is not considered adequate.

F. REVIEW OF PRINCIPAL DEFICIENCIES

Primary contributing factors to the overall deficiency of tropical regional types of research include the lack of:

- Principles of tropical environmental interaction with military operation
- Predictive methods to determine success or failure of military operation in humid-tropical environments
- Data centers at central locations for collection, storage, retrieval, and dissemination of information
- Training facilities to develop tropical regional specialists
- Field stations or simple field laboratories with small permanent staffs located in the tropics
- Preservation of natural environments suitable for field and analog studies
- Standardization of methods, techniques and nomenclature for tropical investigations to provide maximum use of data
- Clear statements and definition of military needs in order to produce valid environmental test, proper instrumentation and analysis of regional investigation of the humid tropics

G. DESIRABLE OBJECTIVES

Various authoritative personnel have offered their opinions in the open literature to remedy the principal deficiencies of tropical research. Much of the discussion has been hampered by lack of direct contact and interchange of ideas by the participants. In addition, no international agency, symposium, working group, or committee has considered the future of regional, analog, environmental, or ecological research in tropical environments for military purposes and procedures necessary to solve the problems. Competent tropical region experts need to be brought together with military requirements personnel to air their views, discuss current progress, formulate plans for the task ahead and, most importantly, prepare a document that can be used as a guide to the remedial action necessary to fill the gaps in knowledge of humid tropic regionalism required by the military. Such a document should include:

- The military requirement
- The preparation of regional studies for areas that have yet to receive attention
- The preparation and publication of revisionary studies utilizing modern procedures for areas that were studied in the past
- The development of simultaneous and coordinated programs to effect systematic inventories of the natural environment on a regional basis by field exploration
- The development and maintenance of data banks for environmental information in order to create known standards of the tropics from which analogs of inaccessible areas may be developed
- Redefinition of the humid tropics. Standard definitions are climatically based, and investigations of other definitive criteria should be undertaken
- The quantitative evaluation of the several habitats of the humid tropics
- Assessment of man's role in the tropical habitat (what is he doing to the environment and how the changes affect him)
- Development of models of varying tropical ecosystems

There is a need to understand that the tropics are not awaiting a new technology to increase man's comprehension of this area. The tropics consist of old, used land which has been inhabited for two million years. What is seen in the tropics today is a product of temporal change and not a static condition. Thus, scientists should inquire not only as to what man has done in the areas to change them, but to understand and appreciate the processes and mechanics that have produced the present conditions.

At the present time, there are many existing and planned land-use and land resources surveys in the humid tropics. If the military can develop the specifications which they require as environmental data inputs, it may be feasible to include these specifications as a portion of these surveys.

The Ad Hoc Committee on Geography, Division of Earth Sciences of the National Academy of Sciences — National Research Council, has recently reported on urgent needs in this field.[65] The committee stresses the need to extend the work which is developing principles of the related sets of earth processes and features as well as the formal systems method used in portions of their research. Detailed study is needed of "the equilibria of erosion, hydrologic and vegetative processes taken together, considering the parameters provided for them by different cultures and differing densities of land occupance."[65] The committee indicates that the "exact nature of responses of any part of the climate-vegetation-erosion system to changes in the cultural patterns" is not known.[65] The committee treats the assets of regional geography and not only stresses the need for thorough field observational techniques by the practitioner but his indispensable value as a regionalist, one who "understands the direction in which the generalizing clusters are headed and relates his work closely to their growing edges."[65]

The committee makes reference to the regional analog when it considers the region as "a type of system in itself, capable of yielding generalizations significant in the understanding of the worldwide system."[65] To further the work of the science of geography, recommendations[65] are made to include:

- Expanded support of research students, which includes dual doctoral degrees, fellowships for predoctoral scholars, field research funds, postdoctoral fellowships, and a manpower survey
- Joint planning of research within two or more problem areas, which suggests stronger interchange and exchange of related disciplines
- Research institutes in political and physical geography as a more permanent effort to study, among other things, tensions areas, Southeast Asia, Africa, the rainy tropics, hazardous natural environments, techniques of environmental manipulation, etc.
- Establishment of several Geographic Data Centers for storage, retrieval and dissemination of data and training centers for geographers

The Military Evaluation of Geographic Areas (MEGA) advisory group at Waterways Experiment Station, Vicksburg, has called for the solution of the following major problems. [66]

"a. Can the macrogeometry analysis be made simpler and faster? If so, how? If not, should possible alternate systems be examined?

"b. What form should the hydrologic geometry description take? Is the very tentative approach which has been suggested practical? If not, what alternative seems most appropriate?

"c. Is the water-land interface a separate factor family? If so, what definable and measurable factors comprise the factor assemblage?

"d. How can nonrandom distributions be analytically described?

"e. How can population discontinuities be defined and described? How, in fact, can they be recognized in the field without mapping the entire population?

"f. What constitutes a valid environmental test and how does one go about designing one? This question may not be really answerable, because a different solution may be needed for each activity. Nevertheless, it would be helpful if the requirements of a valid test could be clearly formulated. Considering MEGA's commitments elsewhere, it might be wise to give this problem to a university or other research organization for study prior to undertaking a major testing program. The only deterrent is the intuition that this problem can be solved only by trial and error; that it is a 'learn-by-doing' proposition."

The MEGA group further calls for the following as future plans for research into the military geographic realm which may apply to the humid tropics.[66]

"a. Intensive study of the problem of describing and classifying hydrologic geometry.

"b. Intensive study of the water-land interface to develop quantitative descriptive and classification techniques and to provide a data base on the nature of the water-land interface.

"c. Continuation of the field team in Puerto Rico to provide an on-site laboratory in the tropics for testing procedures and techniques as well as to provide data for studies of tropical environments.

"d. Intensive short-term study of environmental gradients in Costa Rica, chiefly to expand the data base on tropical environments . . .

"f. Performance of a limited series of tests, chiefly in temperate climates, to determine the quantitative relations between environmental factors and the type and magnitude of effects they impose on selected military activities. The activities will include small unit operations, visibility and crosscountry mobility. Others may be included if the opportunity presents itself. For example, some experimentation with the effective range of small arms in vegetation assemblages would appear to be appropriate. This is a matter of very real concern, especially in the tropics. The MEGA project would welcome the opportunity to cooperate with Ordnance on this matter.

"g. Concurrent effort to refine descriptive and classification systems, field sampling methods and test control techniques."

Regional environmental studies require the application of the ecosystem as an organizing concept to research practices. The term ecosystem, as defined by Fosberg,[67] "attempts to convey the idea of a functioning, interacting system composed of living organisms and their effective environment both physical and biological." The ecosystem concept is not restrictive areally or by level of complexity. It is delimited, for convenience purposes alone, for ease of examination. Natural boundaries are usually convenient and desirable but not absolutely necessary.

The ecosystem concept permits research not only to describe and inventory the environmental phenomena and to analyze its mechanics but to examine their interrelationships, effects upon men and vice versa, and to predict its stability and potential.

Collection of descriptive information will permit the construction of a model of a particular ecosystem. This model's major value is that it permits clear insight into its structure and functioning and that it can be compared with similar models of other ecosystems, which not only contribute to the understanding of the nature of ecosystems but to the construction of analogs.

Use of the ecosystem approach is of great practical importance. It permits "...the determination of degree of stability or instability of existing ecosystems, the determination of causes of instability, and the prediction of the courses of change in unstable ecosystems." Appreciation of a functioning interacting system of man and his environment may enable planning, development and management of our habitat to replace many exploitive and damaging "development" programs.[67]

H. RECOMMENDATIONS FOR ACHIEVING OBJECTIVES

Based on its program investigations, Texas Instruments recommends that the following action be taken to expand and support the existing programs listed below as the most feasible method of obtaining the desired objective and of upgrading the basic research level in tropical regional types.

- Recommendation 1

One of the foremost problems in large areas of the humid tropics is the absence of an environmental and regional data collection network which not only affords maximum coverage but has site survey densities reflective of the complexity of the local environment. Centralized storage, retrieval and dissemination of this collected data is as important as an educational program for technical training of local and extratropical scientists and the development of local protected field sites as facilities to conduct research. Because this is an important area and will require extensive study and committee effort at several national and international levels, it is recommended that action be taken to implement the following

recommendations at the earliest possible time. Steps should be taken by the United States, in concert with other nations, to explore the international institutional mechanisms that may be appropriate to foster international cooperation and cope with the problems which may be anticipated in the field of tropical regional study. The United Nations and its Specialized Agencies (e.g., The Food and Agricultural Organization) and the International Council of Scientific Unions and its associated unions (e.g., the International Geographical Union) are suggested as possible inter-governmental and non-governmental frameworks to assist in the development, guidance and mechanisms of humid tropic regional research efforts.

- Recommendation 2

If an interim measure pending implementation of Recommendation 1 is warranted, the U.S. Army Tropic Test Command Center, Ft. Clayton, Canal Zone, is suggested as a group to be provided with funds to facilitate an increased research effort specifically oriented to the analysis of the effects of various regional environmental parameters on military operations, equipment and personnel. Specifically, field research and testing facilities need to be increased. This expansion would permit an increased number of research projects including those of an experimental nature to be carried out under the diverse ecological conditions that are present in this relatively small area. These steps would speed the development of new techniques, designs and specification for equipment to be employed in humid-tropical areas.

- Recommendation 3

It is desirable that symposia on tropical regional sciences similar to the UNESCO Humid Tropic Symposia be held so that research specialists may be brought together, facilitating the communication of ideas, theories, techniques and problems.

- Recommendation 4

It is further recommended that the following research projects be given top priority ranking for future support as urgent and basic needs. The listed research projects need support on a long-range basis (5-10 years).

- Studies directed toward the determination of the most acceptable method for developing the principles of tropical environmental and regional effects upon military operations

- Research on the predictive techniques for determination of the operational effectiveness of military personnel and equipment under different humid-tropical stress conditions
- Study of the factors which determine successful tropical analog development
- Development of keys permitting field identification of the characteristics of tropical environment
- An evaluation of capabilities of remote sensing techniques when applied to the description and evaluation of tropical environments

- Recommendation 5

Reference to the body of this report will show that the areas for which data are particularly scarce, of limited areal coverage and/or lacking in qualitative substance are listed below. It is recommended that these areas be given special attention in any research planning.

Area Regional Studies

El Salvador, Honduras and Nicaragua

Brazil, especially The Amazon Basin

Guianas

Ecuador, Bolivia, Paraguay, and Peru

Africa, exclusive of Nigeria, Ghana and B. Congo

East Pakistan, Burma, Laos, Cambodia, Taiwan, and Thailand

Indonesia, Timor, New Guinea, and New Hebrides

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APPENDIX A

A DIRECTORY OF AUTHORITIES

OF THE HUMID TROPIC ENVIRONMENT

APPENDIX A

A DIRECTORY OF AUTHORITIES OF THE HUMID TROPIC ENVIRONMENT

Humid tropic environmental information may be derived from literature, maps aerial photography and other like sources. One of the more important sources is personnel who are more knowledgeable than others concerning humid tropic environments. These specialists, experts and long-term students of these areas and subjects are herein termed authorities.

As no firm criteria exist to aid in the identification of "major authorities," other than that the directory should not include deceased scientists, the listing contains:

- Individuals widely recognized as area/topical authorities
- Scientists who have conducted government-support research programs following proposal evaluation by a board of experts
- Scientists who have published extensively, in breadth and/or depth, on their respective area/topical specialties
- Individuals who have participated in international symposia and scientific meetings through presentations of papers concerning their respective area/topical specialties

The directory is composed of a regional/topical matrix and an alphabetic listing of authorities which permits identification of an authority on geographic or topical basis. The arrangement of areas follows the alphabetic listing of countries of Latin America, Africa, South Asia, and Oceania. This order established in Volume 1 of this report also lists topical fields' subdivisions. No matrix intersect contains more than three authorities. No indication of greater or lessor degree of authoritativeness is implied in the ordination of authorities within a matrix intersect. Separator lines are included between the authorities' names in the matrix intersect. An "X" in the matrix intersect indicates the nonexistence of the subject for the appropriate area (i.e., no coast for Bolivia; no humid tropic coast for Peru or Sudan). The listing, which is alphabetized by authorities' last name, is keyed to the matrix by indicating the authorities' area specialty. For example, to determine the best source of first-hand information concerning surface materials in Guadeloupe, the matrix indicates a D. R. Hoy. D. R. Hoy's address appears in the alphabetic listing that follows, where one may observe that he is also listed for Guatemala. Scanning the matrix for Guatemala, one finds D. R. Hoy in the intersect for Regional Studies.

The directory contains listings for 1,115 authorities. These personnel provide the best first-hand familiarity with ten environmental fields for 101 areas.

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
HUMID TROPICS	G.S. Puri P. Birot C. Troll	R. E. Oltman M. Pardé A. Volker	F. A. van Baren E. C. Mohr D. L. Bramao	F. R. Fosberg P. W. Richards P. Dansereau
CENTRAL AMERICA & CARIBBEAN	J. P. Augelli J. D. Weaver R. Weyl	D. B. Bogart	H. Williams R. Weyl	L. R. Holdridge L. O. Williams G. F. Asprey
SOUTH AMERICA	H. J. Harrington C. O. Sauer	M. Pardé H. Sioli	D. L. Bramão A. Küpper F. Lelong	B. Maguire J. S. Beard L. E. Rodin
BARBADOS			D. Watts	D. Watts R. A. Howard
BOLIVIA	L. Branisa	W. E. Rudolph	C. M. Tschanz G. Pflaker	W. Denevan
BRAZIL	J. V. N. Dorr P. James F. Ruellan	H. Sioli R. E. Oltman H. O'Reilly Sternberg	W. Mendes A. Küpper A. B. Fagundes	M. G. Ferri A. Aubreville M. Takeuchi
BRITISH GUIANA (GUYANA)	R. B. McConnell S. Bracewell D. Bleackley		R. B. McConnell C. Simonson T. A. Jones	T. L. Hills P. W. Richards B. Maguire
BRITISH HONDURAS	E. G. Dixon	E. G. Dixon	E. G. Dixon	
COLOMBIA	A. A. Olsson L. G. Morales A. Journaux	F. A. Forero J. de Porta	M. del Llano H. Jenny R. Vergara	J. A. Cuatrecasas F. R. Fosberg E. Perez Arbelaez

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
C. F. Bennett	J. S. M Simpson	D H K. Lee	R J Russell	P. Gourou	C Troll
P. J. Darlington	H. Riehl	B J. Garnier	R Fairbridge	H. O'Reilly Sternberg	
A Wetmore	H. Flohn			C. Troll	
W. E. Duellmann	L. Alpert	W. Portig	R. J. Russell	G Lasserre	K Rodgers
C F. Bennett	G. Dunn	J. W. Pau ing	C S. Alexander	E Beltrán	F O. Diercks
E. R. Hall	W. Portig	S. L Hastenrath	J J. Parsons	J Thompson	G Dengo
C. F. Bennett	N. E Laseur	L R Ratisbona	A. N Ab'Saber	P James	K Rodgers
	J R. Coyle			H. O'Reilly Sternberg	F O Diercks
	L. R. Ratisbona			R W Richardson	
J. B. Lewis	W. L. Donn	T L. Hills	E. T Price	E. T Price	
L. S. Fonaroff				L. S. Fonaroff	
		J. Munoz-Reys			R Salgueviro
					S del Pozo
J. C. M. Carvalho	R. F Caracciolo	L M. C. Bernardes	J D da Silveira	H O'Reilly Sternberg	L Gama
H. Travassos	L. R. Ratisbona	J. M dos Santos	A N Ab'Saber	P. Monbeig	S da Silva Furtado
D. Batista	J. R Coyle	R C. Ferreira	J J Bigarella	O. Valverde	C R H. Olivei
			J I S. Zonneveld	D. Lowenthal	R. B. McConnell
			J. H. Vann	H. Paul	
			D. R Stoddard		
F. K Hunter	R. van Meerbeke	P. Vila-Dinares	R. C West	J J. Parsons	J S Ramirez
P. Hershkovitz			R E. Crist	R. E. Crist	G Acevedo-Latore
M. Bates			G. Reichel-Delmatoff	E. Guhl	

LATIN AMERICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
COSTA RICA	R. Weyl G. Dengo D. Hennigsen	F. Guttierez Braun	R. Weyl A. Saenz-Maroto	L. R. Holdridge G. Budowski H. L. Mills
CUBA	H. Lehman A. A. Meyerhoff D. Flint	J. Godoy G.	P. J. Bermudez D. Flint F. S. Simons	S. Massip E. E. Smith R. A. Howard
DOMINICA ISLAND	W. Hodge			W. Hodge
DOMINICAN REPUBLIC	O. Cucurullo H. Enjalbert W. P. Woodring	O. O. Perez M. J. A. de la Rosa	W. P. Woodring C. Bowin	H. Enjalbert J. M Jimenez
ECUADOR	H. J. Tschopp J. C Marks W. Sauer	H. Chiriboga G. R. J. del Castillo M. Cevallos	A. Küpper P. Bueno W. van Haerlem	M. Acosta Solis C. F. Swingle W-D Sick
EL SALVADOR	H. G. Gierloff Emden	A. N. Sayre H. G Gierloff Emden D. H. Wozab	H. G. Gierloff Emden	W. Lauer L. O Williams H. Klinge
FRENCH GUIANA	B. Choubert M. Schoubert S. Barruol	J. M. Brugière	E. Aubert de la Rue J. M. Brugière F. Lelong	J. M. Brugière
GUADELOUPE ISLANDS	G. Lasserre		D. R. Hoy	H. Stehle F. J. Gonty
GUATEMALA	G. Dengo T. W. Donnelly S Bonis	A. Obiols G.	C. F. Simmons C H V. Ebert S Bonis	H L. Popenoe W. Popenoe L. O. Williams

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
P Slud		E Coen		J Thompson	M Barrantes Fero
A Jimenez				P L Wagner	
A Wille				P.C. Morrison	F Guttierez Braun
					C Vilchez
G G Aguayo Castro	L Larrangoita-Alonso	S Massip		S. Massip	S. Massip
M. Bates		L Santamaria		A. Schwartz	
				P. Cañas Abril	
C T. Kimber					
	A. Cocco	O Cucurullo	W Barrett	H Enjalbert	J J Hungria Morell
	J. Puig-Tomas			S F Moscoso	O.J. Mera
					J Parejo Moreno
M. Moynihan	C. Blandin L.	E N. Ferdon	D A Preston	J J Parsons	V Avila
G Orces	R.P. Momsen	J.W Villacres		E N. Ferdon	M. Teran
	A. Garcia			M Acosta Solis	
W.H. Burt	L.H Lessmann	W Portig	H G Gierloff	J. Thompson	P A Guzman
	W. Portig	H G Gierloff Emden	Emden	D. Luna Desola	C R Barbier
	A. Pallman				M A Escobar
H.A Floch	M. Perrosset	M Perrosset	J I.S Zonneveld	J. Hurault	
	H. Madec	H. Madec	J H Vann	L. Lowenthal	
E. Courmes	D.R. Hoy	D.R. Hoy		G Lasserre	
	M Perrosset	M. Perrosset		D.R Hoy	
		A. Theveneau			
W.E Duellmann	F.W. McBryde	F. Prohaska	W Dege	E Chinchilla-Aguilar	G. Dengo
	C Urrutia E.				A. Obiols G.
				D R Hoy	P. Garcia Gallont
				C W Minkel	

LATIN AMERICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
HAITI	W.P. Woodring C. Bowin J. Butterlin	G.C. Taylor	W.R. Woodring C. Bowin J. Butterlin	L.R. Holdridge
HONDURAS	J.W. Kenney V. Garton	F. Gonzales S.	A.B. Awan L.E. Wittsell	J.J. Parsons W. Popenoe C. Johannessen
JAMAICA	T. Robinson K. Burke	B.D. Greenwood	G.W. Morgan T. Robinson	C.D. Adams G.F. Asprey R.G. Robbins
MARGARITA I.	G.C. Taylor	C.S. Alexander H. Ginés		G. Marcussi
MARTINIQUE			G. Lassere	C.T. Kimber R.A. Howard
MEXICO	C.O. Sauer J.A. Vivo-Escota E.J. Guzmán	L.L. Blasquez E. Cravioto Guerrero L. del Moral Brunel	H. Aguilera R. Moreno-Dahnke	P.L. Wagner I.L. Villa R. McVaugh
NICARAGUA	R. Weyl		R. Weyl	W.M. Denevan J.J. Parsons V.S.G. Behrendt
PANAMA	R. Terry G. Parmenter A. Zappi	T. Henter T. Guardia	L.E. Guzman R. Ah Chu J. Martini	R.W. Schery L.O. Williams R. Enders
PARAGUAY	H. Putzer E.G. Eckel H.J. Harrington	R. Maack T. Galeano S.R. Alcarez	H.J. Harrington	H. Wilhelmy

LATIN AMERICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
HAITI	W.P. Woodring C. Bowin J. Butterlin	G.C. Taylor	W.R. Woodring C. Bowin J. Butterlin	L.R. Holdridge
HONDURAS	J.W. Kenney V. Garton	F. Gonzales S.	A.B. Awan L.E. Wittsell	J.J. Parsons W. Popenoe C. Johannessen
JAMAICA	T. Robinson K. Burke	B.D. Greenwood	G.W. Morgan T. Robinson	C.D. Adams G.F. Asprey R.G. Robbins
MARGARITA I.	G.C. Taylor	C.S. Alexander H. Gines		G. Marcussi
MARTINIQUE			G. Lassere	C.T. Kimber R.A. Howard
MEXICO	C.O. Sauer J.A. Vivo-Escota E.J. Guzman	L.L. Blasquez E. Cravioto Guerrero L. del Moral Brunel	H. Aguilera R. Moreno-Dahnke	P.L. Wagner I.L. Villa R. McVaugh
NICARAGUA	R. Weyl		R. Weyl	W.M. Denevan J.J. Parsons V.S.G. Behrendt
PANAMA	R. Terry G. Parmenter A. Zappi	T. Henter T. Guardia	L.E. Guzman R. Ah Chu J. Martini	R.W. Schery L.O. Williams R. Enders
PARAGUAY	H. Putzer E.G. Eckel H.J. Harrington	R. Maack T. Galeano S.R. Alcarez	H.J. Harrington	H. Wilhelmy

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
D Cochran	A Goutier	R B Hall	J Street	J Street	
				H Wood	
A Carr	V T Molinero	F. Martinez F.	B A Arnold	C Johannessen	F Gonzales S
	G S C Forsyth				
I H Farr		J E. Guernsey	T F Goreau	D Q Innis	
A. Wetmore					
G. Marcussi	C S. Alexander	A Goldbrunner	C S Alexander	C. S. Alexander	
			H Gines		
R N Mille	M. Perrosset	M. Perrosset		H. Isnard	
				G. Lassere	
A S. Leopold	J Aime	J A. Vivó Escota	A. Gonzales	C. O. Sauer	A Urrutia Sandoval
E. Beltrán	G Rodriquez Alvarez		D. D. Brand	D. Stanislawski	
J. Pino	F. I. Peña-Aguirre	A. Contreras-Arias	P. Guzman-Rivas	E. Beltrán	J. Mas Cinta
		J. L. Page			H. Vasquez Glumer
T. Howells	O. Vannini	O. Vannini		F Teran	
C. F. Bennett	L Alpert	C. F. Bennett	Y. F. Tuan	C. F. Bennett	T Guardia
M. Moynihan	B E. Quate	R. L Anstey		B. L. Gordon	J. A. Saenz
A. Wetmore	J. F. Leszcz	M. A. Fradel		R. M. DeLeon P.	J. A Tejada
W. H. Partridge					F Vega Gaona

LATIN AMERICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIGURATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
PERU	J. A. Broggi W. F. Jenks	E. Zimic V. J. D. Aquila A.	J. A. Broggi M. L. Carmen	J. Tosi C. F. Swingle E. E. Smith
PUERTO RICO	R. Young W. Monroe R. P. Briggs	D. B. Bogart T. Arnow I. G. Grossman	J. D. Weaver R. P. Briggs J. A. Bonnet	P. Dansereau F. Wadsworth W. S. Rushing
ST. LUCIA I.				C. T. Kimber R. A. Howard
ST. VINCENT I.	R. Hay J. F. Lewis			R. A. Howard B. Maguire
SURINAM	J. P. Bakker J. H. van Emden J. I. S. Zonneveld		J. P. Bakker H. Dost J. A. Samson	J. C. Lindeman J. Lanjouw
TRINIDAD & TOBAGO	H. G. Kügler K. W. Barr R. A. Liddle		D. L. Niddrie K. W. Barr	C. T. Kimber J. S. Beard J. W. Purseglove
VENEZUELA	H. H. Renz L. Kehrer H. H. Hess	V. Figuera D. B. Carter P. Aguerrevere	D. S. Hubbell A. B[illegible]tamente B F. C. Westin	T. Lasser G. Budowski E. Foldats
WEST INDIES	E. Doran T. W. Donnelly R. A. Christman		H. H. Hess T. W. Donnelly	C. T. Kimber D. R. Hanes R. A. Howard

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
J. Tosi M. Vegas A Grobman		J Tosi W U Drewes		D W Lathrap H Ugarte J Pulgar V	A Griscome L. Montezuma Dolfin
H Heatwole G. Drewry H. Odum	L. Alpert D Smedley J. Colon	D Netzer L Alpert R J Calvesbert	W Monroe J E Randall	R Pico R B Batchelder	R Pico
				O Starkev	
	J. Emanuels		J C. Lindeman J P. Bakker J I.S Zonneveld	D Lowenthal	I H. van Emden H M Yvel
G.C.A. Yunge D. Vesey-Fitzgerald G Underwood	M. Garstang	G. W R. Smith J. P. Henderson	W. Speth	P James A Dyson D J. Crowley	
P. Hershkovitz J. Ojasti	H. Riehl J C. Sanchez	J.C Sanchez P. Vila Dinares	H Ginés	J. Blaut H. Sterling A. Cardenas C.	A C Romero
D. R. Hanes A. M. Greenhall	R.R Braham A. Bruinenberg K. V. W Nicholls	L. Alpert P. Perrosset	R J. Russell	J. Blaut E. Beltran J Thompson	

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
AFRICA	R. Furon F. Dixey L.C. King	M. Roche J. Rodier J. Tixeront	H. Vine H. Greene J. Fournier	R.W.J. Keay J. Koechlin A. Aubreville
ANGOLA	M.D.H.G. Gouveia	M. Alves	A.J. da Silva Teixeira	A.W. Exell H.K.A. Shaw F.A. Mendonca
BURUNDI	R.B. McConnell M.T. Lepersonne A. Delvaux	E.J. Devroey M. Berenfeld	J.L. d'Hoore M.T. Lepersonne F. Leleng	G. Troupin W. Robyns F. Deuse
CABINDA				
CAMEROON	G. Lasserre M. Gazel	P. Schwoerer J. Guiscafre	J. Susini H. Jacques-Felix R. Marchand	M.R. Letouzey E. Bounougou E W Jones
CENTRAL AFRICAN REP.	R Causse	R. Chartier	M Martin	R. Sillans A. Saccas
CHAD	M. Abadie	A. Bouchardeau M. Abadie T Keiro	A.T. Grove M Borquier	
COMORES ISLANDS				R. Paulian
CONGO [f.] (BRAZZAVILLE)	M. Nicault K. Kocinski	L. Bongou J. Aime		J. Trochain J. Koechlin J.L.J. Groulez

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
F Bourlière F. Khalil A B. Hadaway	B J. Garnier H Flohn H. Mörth	S P Jackson B J. Garnier B W Thompson	C S Alexander A Guilcher	G.H T Kimble W J Talbot E B. Worthington	A Rumeau A Aubreville
V.C. Martins A de Barros Machado	H Flohn S J. de Almeida		R. E Crist I S. van Dongen	R E Crist O Ribeiro R J Houk	A. M. H. P. Bastos
J.B. Gillett E Buyckx P G. Jannsenns	H Mörth J van Mieghem	F. Bultot		P. Gourou M L. van den Berghe J Denis	B R. Banciyeko
				R. J Houk E Dartevelle	
R E. Moreau L. Mvogo A. Gamet	W. Maudengue-Epoy			F Bonnet-Dupeyron J I. Clarke D. Dizain	Y Tual
R E Moreau A. Chippaux P Fiselle	E Nevière	E Nevière			A Rumeau
F Bourlière M Thomé					A Rumeau
R. Paulian					A Rumeau
J. Demarchi R. Paulian			R Bonnefile	G Sautter	A Rumeau

AFRICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
CONGO [b.] (KINSHASA)	L. Peeters L. Cahen M.T Lepersonne	E.J. Devroey E Bernard L J. Tison	R. Devred J. L. d'Hoore M.T Lepersonne	P. Duvigneaud R Germain L. Liben
DAHOMEY	G. Aubert	L. Faboumy E. L. Paraiso	M.R. Ochs M.P. Williams R. Fauck	C.D. Adams J.C. Dubrevil
FERNANDO PÕO		F Abecasis		
GABON	J. Vogt M. Arnould	M. Herbaud M Pepper	G. Course M Pepper	J.B. Sellier P. P. Grassé
GAMBIA			M.I. Ashrif	A.S. Boughey
GHANA	W. Manshard J.M. Hunter T.E Hilton	Tagoe M.W. Morgans E. J Khan	P.M. Ahn P.H. Nye C.D. Adams	P.M. Ahn J.W.C. Mooney Quist-Acton
GUINEA (FRENCH)	R. Maigniem	G Rougerie		J Trochain G. Aubert
IVORY COAST	M.B. Dabin R. Eckert	G. Rougerie N. Leneuf G. Girard	M B. Dabin N Leneuf M Pougnet	J.L. Tournier G Mangenot E Adjanohoun
KENYA	S.M. Cole B.H. Baker F.F. Ojany	J.S.G. McCulloch E.W. Russell C.M. Bristow	P.L. Lehrer E.W. Russell B. H. Baker	I.R. Dale E.W. Russell A.V. Bogdan

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
R E. Moreau	F Bultot	E. Bernard	E Dartevelle	P Gourou	A Yowalole
J. B. Gillett	J van Mieghem	J Lebrun		H Nicolai	F Mbaje
V van Straelen	M. Clerebaut	F Bultot		G Marlier	A Kengebele
R E. Moreau			A Guilcher	R Pelissier	A Rumeau
F. Paraiso				G brasseur	
				A Mondiannagin	
R. E. Moreau	F Abecasis			M M de Terán	
R. E. Moreau				G Lasserre	A Rumeau
P. P. Grassé					
I. A McGregor				H R Jarrett	
R. E Moreau	J. H. Hubbard	J H. Hubbard	A S Boughey	E A Boateng	R J Simpson
F Bourliere	Koveh	M Walters	W D Brueckner	R J Harrison-Church	J E Cudjoe
M I Biol			M. M. Anderson	O Davies	
			L Berthois	J. Gallais	
				M M Houis	
J L Tournier		J. L. Tournier	J. L F Tricart	M Lamotte	A Rumeau
W W Deshler	J F Griffiths	H. W Sansom	J C Moomaw	A Jacobs	D E Warren
M Grzimek	J. M Kenworthy	B. W Thompson		E S Munger	A C Dalgleish
J. O P. Ashe	H Morth	H C Pereira		W T W Morgan	F H Ratzeburg

AFRICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
LIBERIA	R O Jackson D Massaquoi	W. Phillips		M.S Briscoe J.T. Baldwin Y.I. Routo
MALAGASY	J. Dresch F. Dixey R. Battistini	H. Pelleray H Besairie M. Aldegheri	P. Roche J.F. Bussi H. Besairie	C.F Swingle H. Humbert
MOZAMBIQUE	F. Nunes	J.A.B Fernandes J.A da Cunha Gouveia C F Esteves Correia	M D.H.G. Gouveia	F.A. Mendonca
NIGERIA	M.F Thomas J.C. Pugh J.D. Carter	B.J. Garnier D.C. Ledger D. Gersie	H. Vine A T. Grove R.P. Moss	P W. Richards D R.Rosevear R.W J.Keay
NORTHERN RHODESIA (ZAMBIA)	M Cole W.G. Aitken A.M.J de Swardt	A.L. Earle W.J. Scott D. Ecoles	A. Young T.M. Yager	G.H.D. Williams P. G. Adlard F White
NYASALAND (MALAWI)	A. Young	J.G. Pike	A. Young	J.L. Caldwells
PORTUGUESE GUINEA		J.C M. de Beja Neves J. de Araujo Coutinho	A. Teixeira da Mota	J.M. Beliz
RWANDA	R.B. McConnell M T. Lepersonne	E.J. Devroey M. Berenfeld	J.L. d'Hoore M.T. Lepersonne F. Lelong	G. Troupin W. Robyns L. LeBlanc

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
M S Briscoe J. T. Baldwin R Boeppli	W Phillips			P W Porter D. Massaquoi	
R Paulian E.R Brygoo	Ramanisarivo	H Jones	A Guilcher R Battistini	W.A Hance R Battistini H Isnard	A Rumeau E. Tarrade
M C Ferreira J.Pinto-Lopes	S. Gregory A.S de Souza		M Kaik H J Walker I.S van Dongen	J. Gonçalves R W Steel R J Harrison-Church	E.N S Grade
D.R. Rosevear R.E. Moreau A. J. Hopson	N A Akingbehin A Gilchrist A W. Ireland	W S S Ladell B J Garnier R Miller	J C. Pugh D C Ledger J R L.Allen	A L Mabogunje K M Barbour B.N. Floyd	R.O Coker R.K Udo
F F Darling G D. Shaw W S Steel		G M Howe		M Cole A.O Ballantyne	
		G M Howe		A Young G T Rimington	
				O Ribeiro	
P.G. Jannsenns	H. Morth J van Mieghem	F Bultot		P Gourou M L van den Berghe P. Deuse	

AFRICA (CONTD)

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
SENEGAL	T Monod C Toupet J. Tricart	Moussu C. Auvray R Degalbier	R Maignien Y. Dommergues P. Michel	J. Miège J Trochain Assemien
SIERRA LEONE	M. M. Anderson G. J. Williams	S Gregory	H. D. Jordan	J. K. Morton A F A. Lamb
(SOUTHERN) RHODESIA	A. E. Phaup G Bond	I. H. R Shand D F. Edmonds L. L. Hindson	A. Young L. C. King P. M Grant	B N Floyd A. S Boughey F B. Armitage
SUDAN	L. Berry M. A. Futuh M A. Abdullah	A M. S. Graham	L H J Ochtman M A. Abdullah	A. Hoyle D. A. Lane
TANGANYIKA (TANZANIA)	J. H. Harris P. Gould L. Berry	I. L. Ward M. T. Avery J. F. Glennie	D H Turner	B. Verdcourt B. D Burtt P. J. Greenway
TOGO	E. B. Akitani	J. F. G. Millette	J. F. G. Millette A. Bouchardeau	G. Aubert
UGANDA	J. V. Hepworth J. W. Pallister P. H. Temple	M. Grehan A. C. Odell W. G. Owen	J. V. Hepworth H. F Birch W. Rose	J. W. Purseglove D. N. McMaster H. C. Dawkins
ZANZIBAR & PEMBA IS. (TANZANIA)	J W Pallister			R. C. Sangster

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
L Chambon	M Thomas	J Trocham	Mme Aboussouan	R Pelissier	A Rumeau
	H. Masson			G Brasseur	M Gourment
				A Ly	J Darribere
J. Phipps	S. Gregory	P K Mitchell	S Gregory	R W Steel	
	H P Jarrett		M M Anderson	J I Clarke	
	C. A Abayomi				
E Burseil	J. D. Torrance	G M. Howe		R. P Boulton	
A Harrison	J. S Peake	J. D Torrance		H C Pereira	
J. Weir		J. E Stevens			
A. A. El Karib	A. W. Ireland	J. Oliver		K M Barbour	M A Futuh
Y. I. Medani	J. Oliver	J H.G Lebon		J H G. Lebon	
		W. H Terjung			
M Grzimek	J. M Kenworthy	D. J Bargman	C S Alexander	D. N McMaster	A F M Smith
W. W Deshler	D. J Bargman	I. Jackson		A Jacobs	
K. S Hocking	D H Johnson			D J. Crowley	
	G. David			J L F Tricart	A Rumeau
W W Deshler	D H Johnson	J. A Channon		A Jacobs	B B Whittaker
L. C. Beadle	J. M. Kenworthy	R S Odingo		S J K. Baker	C. E Williams
P B.N. Jackson	D J. Bargman	M. Diem		J Schultze	
D Thomas	H. Mörth		C S. Alexander		

AREA \ SUBJECT	SURFACE CONFIG-URATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
SOUTH ASIA	M. Ohya	R. W. Revelle R. E. Oltman A. G. Kovzelj	F. R. Moormann R. Dudal	A. Aubreville H. Gaussen
BURMA	M. S. Krishnan P. Thaung T. Hla	Po E A. Kyi S. Myint	U. K. Win K. Zin T. Hla	J. L. David
CAMBODIA	J. Delvert	H. Dufto	R. Dudal M. Zadrozny	J. Vidal A. Aubreville W. L. Resing
CEYLON	L. D. Fernando P. W. Vitanage	R. Wikkramatileke A. Gunasekera	M. L. M. Saigado B. A. Abeywickrama	G. J. Foster C. H. Holmes K. A. de Rosayro
CHINA (COMMUNIST)	S. Ting J. C. Hou			C. Y. Hu
CHINA (NATIONALIST)	C. C. Lin T. L. Hsu	H. H. Hsu K-C Chou S. H. Sa	H. T. Chang	H-L Li S. Yie C. M. Snen
INDIA	O. H. K. Spate A. Geddes B. C. Roy	J. Ramdas K. K. Framji S. B. Chatterjee	G. S. Puri P. P. Karan R. S. Murthy	G. S. Puri E. K. Janaki-Ammal H Santapau
LAOS	M. Zadrozny	K. Kanhalikhan I. Somphavan		J. Vidal A. Aubreville

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
S D Ripley	H Flohn	H I Ashton		P Gourou	
	C S Ramage	R Ananthakrishnan		K J Pelzer	
J Delacour	Po E	M A Kyi	C Davis	M Y Nuttonson	A Aung
	P Aye	R Tuke	J L David	H Tin	H K Maung
			A Volker	D I Kyi	H P Daniels
J. Delacour		C Davis		C. Saoth	
T H Kim		M Y Nuttonson			
P. E Deraniyagala	D. Jayasinghe	K. Kularatnam	B A Abeywickrama	B H Farmer	C H McFadden
D de Forseka		R Wikkramatileke		C H McFadden	J. L T E. Dessenaike
				K Kularatnam	
	I. E. M. Watts	C-S Chen		F L Hsu	
		C H. Hsieh		I Hsu	
				S G Davis	
T W Lew	K-C Chou	C-S Chen		H-C Sha	
T Chang	P J Tsiang	C S Wang		T-Y Sun	
	S H. Ling			C H Hsueh	
S D. Ripley	C Ramaswamy	S B Chatterjee	D E Sopher	A W Booth	S P Chatterjee
A.P Kapur	H Flohn	J. Ramdas	V N Nagaraja	P.P. Karan	S Mudaliar
M L. Roonwall	C R.V Raman	K N Rao		W C Johnstone	C Singh
	K Kanhalikhan	M. Y. Nuttonson			

SOUTH ASIA (CONTD)

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PAKISTAN (EAST)	A. I. H. Rizvi F. U. Shamsi	A. Hosain B. A. Latif B. M. Abbas	M. O. Ghani M. Amirul Islam E. Brammer	S. Hedayetullah S. H. Hazarika S. M. Ishaq
THAILAND	W. E. Grabau A. A. Rula P. Wushari-wongse	D. Chareonsook B. Kanchanalak D. Jaraswathana	F. R. Moormann A. C. Orvedal G. Immisch	I. Smitinand E. H. F. Brunig K. Suvatabandhu
VIETNAM (NORTH)		D. P. Dinh Y. H. Djang	F. R. Moormann M. Schmid T. C. Tung	M. Schmid A. Aubreville
VIETNAM (SOUTH)	F. Dussart E. Saurin	D. P. Dinh Y. H. Djang B. T. Chu	F. R. Moormann M. Schmid T. C. Tung	M. Schmid J. P. Barry L. C. Kiet

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
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E. Mayr	A. Grimes	D. H. Johnson	J. J. Nossin	R. Ho	B. Procter
J. R. Audy	H. T. Soo	K. Rajendran		E. H. G. Dobby	
H. K. Yosufzai	S. N. Naqvi	S. N. Naqvi	A. I. H. Rizvi	B. H. Farmer	A. Ahad
M. R. Qureshi	G. E. Dunn	K. S. Ahmad	M. I. Chowdhury	Nafis Ahmad	G. H. Khan
Nazir Ahmad	M. Samiullah		S. R. Islam	F. K. Khan	M. Alauddin
K. Vajardpala	C. Charoen-R.	H. I. Ashton	C. Davis	M. Y. Nuttonson	S. Vichitranuja
A. Hubert	T. Pongsapipat	T. Barton		P. Nichols	B. Bhakdikul
	K. Indasaura	K. Buajitti		L. Sternstein	S. Yuhun
	D. P. Dinh	M. Y. Nuttonson	C. Davis	P. Gourou	
	M. H. Sipple			M. Y. Nuttonson	
				F. Hung	
Bui-Van-Quy	N. Hau	M. Y. Nuttonson	J. P. Barry	P. Gourou	X. D. Nguyên
	D. P. Dinh		C. Davis	M. Y. Nuttonson	C. T. Cao
	D. V. Nhan			F. Hung	V. K. Nguyen

AREA \ SUBJECT	SURFACE CONFIGURATION	HYDROLOGY	SURFACE MATERIALS	PLANT LIFE
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AUSTRALIA	E. M. Driscoll G. A. Stewart C. R. Twidale	E. M. Driscoll C. H. Munro A. H. Cooper	G. K. Rutherford C. A. Stewart H. A Haantjens	R. G. Robbins D. A. Herbert L. J. Webb
BORNEO	F. W. Roe F. H. Fitch G. E. Wilford		F. W. Roe P. J. Beaven	A. J. G. H. Kostermans F. G. Browne C. G. G. J. van Steenis
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FIJI ISLANDS	H. S. Ladd		R. G. Ward F. A. van Baren	A. C. Smith
HAWAII	G. A. MacDonald A. T. Abbot H. T. Stearns	D. C. Cox L. S. Lau P. Ekern	G. D. Sherman P. Ekern L. D. Swindale	G. W. Gillett H. St. John D. Mueller-D.
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NEW CALEDONIA	G. A. Stewart F. Doumenge		W. D. Johnston	H. Hurlimann J. Barrau L. Chevalier
NEW GUINEA	D. S. Simonett J. Andrews E. J. Reiner		F. A. van Baren H. Jacques-Felix G. K. Rutherford	J. Womersley B. W. Taylor G. A. Stewart

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
F. L. Usinger	S. Price		R. J. Russell	E. H. Bryan	W. B. Johnston
J. L. Gressitt	C. E. Palmer		R. Fairbridge	J. W. Coulter	
				E. Aubert de la Rue	
A. Keast	H. M. Treloar	D. S. Simonett	H. Valentin	M. Y. Nuttonson	B. P. Lambert
W. V. Macfarlane	A. K. Hannay	R. A. Slatyer	F. H. Bauer	C. S. Christian	J. N. C. Rogers
J. H. Frith	L. J. Webb	E. Fitzpatrick	J. N. Jennings	R. A. Perry	D. Macdonald
T. Harrison				N. Ginsberg	F. W. Roe
B. E. Smythies					
T. Harrison					
G. W. Watkins				K. B. Cumberland	
G. W. Cottle				O. H. K. Spate	
L. D. Tuthill	C. S. Ramage	J. Chang	D. C. Cox	E. H. Bryan	A. Malahoff
R. W. Hiatt	J. C. Sadler	S. Price	R. M. Moberly	A. Piianaiia	H. L. Baker
E. C. Zimmerman	W. E. Hubert	P. Ekern	T. Sakao	C. A. Manchester	
E. Mayr	I. M. Sandy	H. Danoesastro	H. Soerastopo	I. M. Sandy	H. Verstappen
R. Pusponegoro	R. Goernaso	Iskandar	S. Hadizeemarne	J. O. M. Brock	A. Hamid
Z. Arifin			R. J. Russell		G. W. Foeng
			J. Avias	H. Rotshi	
				J. P. Tonnier	
H. M. van Deusen		I. Dordick		H. C. Brookfield	H. A. Haantjens
R. D. Hoogland				R. G. Crocombe	
J. J. H. Szent-Ivany					

OCEANIA (CONTD)

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NORTH BORNEO (SABAH)	P. Collenette R. Maack F.H. Fitch	R.A.M. Wilson	R.A.M. Wilson	W. Meijer P.S. Ashton G.L. Carson
PALAU ISLANDS	G.A. Stewart			F.R. Fosberg
PAPUA	J.A. Mabbutt J.G. Speight		H.A. Haantjens R.M. Scott G.K. Rutherford	J. Womersley K. Paijmans R.D. Hoogland
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RYUKYU ISLANDS				F.R. Fosberg R.W. Simonson E.H. Walker
SARAWAK	J.R.D. Wall G.E. Wilford	J. Whitaker	T.W. Wood P.H.T. Beckett P.S. Ashton	P.W. Richards J.A.R. Anderssen E.H.F. Brunig
SOLOMON ISLANDS	J.C. Grover P.J. Coleman		J.C. Grover	E.J.H. Corner F.S. Walker T.C. Whitmore
TIMOR				C.G.G.J. van Steenis

ANIMAL LIFE	WEATHER	CLIMATE	COASTAL ZONES	TROPICAL REGIONS	GEODESY
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APPENDIX B

A DIRECTORY OF PRINCIPAL DEPOSITORIES OF HUMID TROPIC ENVIRONMENTAL MATERIALS

APPENDIX B

DIRECTORY OF PRINCIPAL DEPOSITORIES OF HUMID TROPIC ENVIRONMENTAL MATERIALS

Sources of information concerning humid tropic environments consist of literature, maps, aerial photography, zoological and entomological specimen collections, herbaria, soils profiles, and other like items, herein termed materials. The importance of locating principal depositories of such sources is as significant as the identification of the sources themselves.

As no firm criteria exist to aid in the identification of "principal depositories," the list contains:

- Depositories widely recognized as containing humid tropic environmental materials
- Libraries with voluminous holdings that include general area/topical materials
- Special collections that are smaller in volume but specifically oriented toward one or more aspects of humid tropic environments
- Specimen collections which are highly specialized in contents (e.g., local weather records, rock samples, radar displays, etc.)

The directory contains the names and addresses of identified principal depositories and a brief description of their pertinent holdings. The depositories are arranged alphabetically by country and within the U.S.A. by state. A total of 333 depositories in 60 countries and 25 states, commonwealths and territories of the U. S. are included. An index of the 40 primary depositories follows.

INDEX OF PRIMARY DEPOSITORIES

The most important, or primary, depositories in the accompanying list of principal depositories are indicated by an asterisk. An index of the 40 primary depositories follows:

1.0 ANGOLA

1.1 Direcção de Agricultura e Florestas
Secção de Botanica e Ecologia
C. P. 1233
Luanda, Angola

6500 specimens, flora of Africa south of the Sahara
7000 volume library

1.2 Serviços de Geologia e Minas
C. P. 1260
Luanda, Angola

Geology; mining
9491 volumes, 55 periodicals

1.3 Serviço Meteorológico de Angola
C. P. 1228-C
Luanda, Angola

Meteorology, climatology
2073 volumes, 298 periodicals

2.0 AUSTRALIA

2.1 Library
Australian National University
P. O. Box 4
Canberra, Australia

General collection with emphasis on Australia and Oceania
280, 000 volumes

2.2 Commonwealth Bureau of Meteorology
Box 1289 K, GPO
Melbourne, Australia

Weather and climatic data and records for Australia and New Guinea

*2.3 Commonwealth Scientific and Industrial Research Organization (CSIRO)
314 Albert St.
East Melbourne, C.2, Victoria, Australia

Library - 40, 000 books, 21, 000 periodicals (211, 000 volumes). 500, 000 reprints and pamphlets and maps, manuscripts, microfilm and photographs

2.0 AUSTRALIA (contd)

Herbarium - 25,000 specimens. Specializes in Australian and exotic Gramineae and Leguminosae; also in N. Australian and Papuan flora. Important collections: Carr. collection of New Guinea plants; A. H. S. Lucas, Australian algae

2.4 National Library of Australia
Canberra, Australia

Australiana Collection. Important map collection.
580,000 volumes, 35,000 pamphlets, 200,000 ft microfilm

3.0 BELGIUM

3.1 Bibliothèque repartitrice
Institut national pour l'étude agronomique du Congo (INEAC)
12-16 rue aux Laines
Bruxelles, Belgium

24,000 volumes, 600 periodicals

* 3.2 Centre scientifique et medical de l'Université libre de Bruxelles en Afrique centrale (CEMUBAC)
87 avenue Adolphe Buyl
Bruxelles 5, Belgium

Excellent research institute and depository (including maps) of Central Africa

3.3 Comité Hydrographique du Bassin Congolais
25 avenue Marnix
Bruxelles, Belgium

3.4 Institut de médicine tropicale Prince Léopold
155, rue Nationale
Anvers, Belgium

*3.5 Institut national pour l'étude agronomique du Congo (INEAC)
1 rue Defacqz
Brussels 5, Belgium

80,000 books, 3400 periodicals, 500 maps, 10,000 photographs

3.6 Library
Musée royal de l'Afrique centrale (MRAC)
13 chausée de Louvain
Tervuren, Belgique

BELGIUM (contd)

Specialized holdings in geology, zoology, of tropical woods of central Africa
30,000 books, 3014 periodicals, numerous photographs

3.7 Jardin botanique de l' État
236 rue Royale
Bruxelles 3, Belgium

General herbarium, herb. of Europe, Belgium, the Congo, and tropical Africa. Coll. of the Congo, Rwanda and Burundi. About 1,600,000 specimens

3.8 Laboratoire de botanique systematique et de phytogéographie
28 avenue Heger
Bruxelles 5, Belgium

Herbarium: Europe and Congo, chiefly Katanga, Argentina and Indonesia; 100,000 specimens

3.9 Centre de la Météorologie tropical et de la climatologie
Institut royal météorologie
Avenue Circulaire 3
Uccle - Bruxelles, 18, Belgium

Specialized library holdings on Congo basin

4.0 BRAZIL

4.1 Biblioteca Central da Universidade de São Paulo
55 rua Helvetia
São Paulo, S. P., Brazil

15,000 publications, 320 periodicals

*4.2 Biblioteca da Ministério da Agricultura
Rio de Janeiro, Brazil

Library controls some 15 different stations and collects works on Brazilian agriculture, soils, rainfall, etc.
210,000 volumes

4.3 Biblioteca do Museu Nacional
Instituto Nacional
Quinta da Boa Vista
Rio de Janeiro, Brazil

BRAZIL (contd)

350, 000 specimen herbarium plus large research collection in other fields of the natural sciences. Tropical phanerogamic and cryptogamic flora, mainly Brazilian
Library: 150, 000 volumes, periodicals (geology, botany, zoology)

4.4 Centro de Pesquisas Florestais e Conservação da Natureza
Estrada da Vista Chinesa, 741
C. P. 3545
Rio de Janeiro, Brazil

Specialized library on forestry, ecology. Herbarium.

4.5 Directoria de Hidrografia e Navegação
Ministério da Marinha
Rio de Janeiro, Brazil

4.6 Herbarium Bradeanum
C. P. 5, Lapa
Rio de Janeiro, Brazil

Small herbarium - 25, 000 specimens
Information especially on the flora of the highlands of central Brazil

4.7 Conselho Nacional de Geografia do Instituto Brasileiro de Geografia e Estatistica (CNGIBGE)
Av. Beira Mar. No. 436
Rio de Janeiro, GB, Brazil

Library 40, 000 volumes, emphasis upon Brazilian geography

4.8 Instituto de Biologia Animal
Universidade Rural
Km 47
Rio de Janeiro, Brazil

4.9 Instituto Agronômico do Norte (IAN)
C. P. 48
Belém, Pará, Brazil

Library: 18000 volumes, emphasis upon soils and plants of Amazonia. Botanical section has 130, 000 herbarium, excellent for the study of lower Amazon plants

BRAZIL (contd)

4.10 Instituto Geográfico e Geológico
São Paulo, S. P., Brazil

Collection of works on Brazilian geology and geography
50,000 volumes, 18,000 maps

*4.11 Instituto Histórico e Geográfico Brasileiro
Avenida Augusto Severo 8
Rio de Janeiro, Brazil

A collection of geographical and historical works with special emphasis on Brazil
280,000 volumes

4.12 Instituto Histórico e Geográfico do Pará
Belém, Pará, Brazil

Lower Amazon materials

4.13 Instituto Nacional de Pesquisas da Amazônia
Rua Guilherme Moreira 102/112
C. P. 478
Manaus, Amazonas, Brazil

Number of specimens: 13,018, Amazonian plants. Library: 5,100 volumes

4.14 Jardim Botânico do Rio de Janeiro
Rua Jardim Botânico, 1008 (Gávea)
Rio de Janeiro, Brazil

The outstanding living collection of tropical plants in the new world. 115,000 specimen herbarium and large botanical library, Brazilian plants

4.15 Museu Paraense "Emilio Goeldi"
Av. Independencia 364
C. P. 399
Belém, Pará, Brazil

Maintains a collection of 10,000 ornithological specimens. Herbarium: Flora of the Amazonian region. Important collections: R. Spruce, E. Ule, Blanchet, Glaziou,

BRAZIL (contd)

J. Heber, A. Ducke. Half of collections collected prior to 1915 and the remainder since 1955, the intervening years of 1915-1955 marking a period when the museum was closed. A good library, 25,000 volumes, especially rich in classical works. A small zoo.
Number of specimens: 33,500

*4.16 Biblioteca Nacional do Rio de Janeiro
Avenida Rio Branco 219-239
Rio de Janeiro, Brazil

General collection with special collection of Braziliana, important map collection.
1,000,000 volumes, 600,000 MSS, 250,000 engravings, 650,000 bound periodicals

4.17 Serviço de Meteorologia
Praça 15 de Novembro 2, 5° Andar
Rio de Janeiro, Brazil

Collection of records, reports and data on Brazilian weather and climate

4.18 Universidade de São Paulo
Departamento de Zoologia
São Paulo, Brazil

Important collection of Brazilian fauna, a good biological library (40,000 volumes)

5.0 BURMA

5.1 Burma Meteorological Department
619 Merchant Street
Rangoon, Burma

Surface and upper air data; climatological maps
Library: 1,000 volumes
Daily weather reports, Trimonthly and monthly weather data, rainfall records (monthly); daily rainfall records, pilot balloon data

5.2 Land Use Bureau
Department of the Commissioner for Settlements of Land Records.

BURMA (contd)

H.Q., Housing Board Buildings
27th Street
Rangoon, Burma

Soil Museum (soil profiles, soil & land use classification maps and survey reports)

5.3 Library
University of Rangoon
University Post Office
Rangoon, Burma

Good collection of botanical, geographical and zoological materials. Map library of Burmese and other Asian Maps

6.0 CAMEROON

6.1 Institut de récherches scientifiques du Cameroun
B.P. 193
Yaoundé, Cameroun

Library has 10,000 books, 56 periodicals.
Specializes in local pedology, hydrology, nutrition and medical entomology

6.2 Laboratoire d' entomologie
Institut Pasteur du Cameroun
B. P. 888
Yaoundé, Cameroun

Maintains a collection of insects and insect vectors of diseases with emphasis on Anopheles mosquito

6.3 Service des Eaux et Forêts du Cameroun
Section de récherches forestières (YA)
B. P. 194
Yaoundé, Cameroun

Herbarium has 10,000 specimens, Cameroun forest flora
Small specialized library

7.0 CANADA

7.1 Geographical Branch
Department of Mines and Technical Surveys
Victoria Memorial Museum Building
601 Booth Street
Ottawa 4, Ontario, Canada

An outstanding collection of geographical materials — including tropics. Good collection of maps

7.2 Library McGill University
Montreal, P. Q. Canada

TheBarbados research station maintained by McGill and the work in Montreal is developing a valuable collection of humid tropical material

8.0 CEYLON

8.1 Forest Department
9 Kew Road
Colombo 2, Ceylon

Herbarium and data on Ceylon forests

8.2 Royal Botanical Gardens
Peradeniya, Ceylon

Herbarium living plant collection of 85,000 specimens with emphasis on Ceylon

8.3 Zoological Gardens
Colombo, Ceylon

Maintains a large collection of tropical fauna

9.0 CHINA, PEOPLE'S REPUBLIC OF

9.1 National Library of Peking
Peking 7. Peoples Republic of China

General collection. Good collection of maps
4,400,000 volumes

9.0 CHINA, PEOPLES REPUBLIC OF (contd)

9.2 Institute for Research on Tropical Areas
Kunming, Peoples Republic of China

Climatology, Medical Geography and Tropical Research
Staff of 600

9.3 Shanghai Library
Shanghai, Peoples Republic of China

General collection
3,500,000 volumes

9.4 Sun Yat Sen University Library
Canton, Peoples Republic of China

Best local collection on South China with large environmental holdings
1,650,000 volumes

10.0 CHINA, REPUBLIC OF

10.1 National Taiwan University
Library
Roosevelt Road
Taipei, Taiwan, Republic of China

General collection, Fu-Min Geographical Institute
120,000 specimens worldwide, mainly ferns and seed plants
715,000 volumes

10.2 Taiwan Forestry Research Institute,
Po-A Road Botanical Garden
Taipei, Taiwan, Republic of China

Number of specimens: 30,347
Herbarium: Taiwan

11.0 COLOMBIA

*11.1 Instituto Geográfico de Colombia "Agustín Codazzi"
Ciudad Universitaria
Carrera 13, No. 48-51
Bogotá, Colombia

11.0 COLOMBIA (contd)

Headquarters for geographic information on Colombia and also of large-scale topographic mapping in collaboration with the Inter-American Geodetic Survey.

11.2 Biblioteca
Universidad Nacional de Colombia
Apartado Postal 2535
Bogotá, Colombia

Collection of mammals, birds, fish, and insects of Colombia. 100,000 specimens in herbarium

11.3 Facultad Nacional de Agronomía e Instituto Forestal
Universidad Nacional de Colombia
Apartado Aereo 568
Medellín, Colombia

Best collection of botanical and agricultural works in Colombia plus good local herbarium and entomological collections.
Specimens: 20,000 herbarium: Colombia, Chiefly Antioquia; parasitic fungi
11,000 volumes

11.4 Instituto de Ciéncias Naturales
Universidad Nacional de Colombia
Apartado Aereo 7495
Bogotá, Colombia

The chief national Colombian center for basic research in the various fields of natural history. Modern institute building houses fine, well-curated, research collections of the very rich Colombian fauna and flora as well as associated library. Collections are particularly strong in the fields of botany (vascular plants), ornithology, ichthyology, herpetology, and mammalogy.

11.5 Universidad Nacional, Facultad de Agronomía del Valle
Palmira, Colombia

23,000 specimens
Herbarium: Territory of Colombia, chiefly state of Valle del Cauca

12.0 CONGO REPUBLIC

12.1 Direction des mines et de la géologie
Haut-Commissariat de la République
B. P. 12
Brazzaville, Congo Republic

Geology, mining, chemistry
500 volumes, 1000 brochures, 60 periodicals

12.2 Bibliothèque centrale
Institut d' études centre africaines (IEC)
B. P. 181
Brazzaville, Congo Republic

Pedology, hydrology, entomology and geography
6,500 volumes and brochures, 500 periodicals

12.3 Institut d' études du Congo
Brazzaville, Congo Republic

Herbarium with 9000 specimens

13.0 CONGO, REPUBLIC OF

13.1 Bibliothèque centrale en Afrique
Institut National pour l' étude agronomique du Congo
(INEAC)
Yangambi, Province Orientale, Republic of Congo

17,000 volumes and brochures, 806 periodicals,
100,000 specimens in herbarium of Congo & Ruanda-Urandii

13.2 Bibliothèque centrale
Service Géologique du government central de la République
démocratique du Congo
44, Avenue des Avileries
B. P. 898
Kinshasa 1, Republic of Congo

Geology, geological maps, mineralogy, and related
sciences
7000 volumes, 600 periodicals, 769 geological maps

13.0 CONGO, REPUBLIC OF (contd)

13.3 Bibliothèque publique
26 Avenue vau Gile
B. P. 410
Kinshasa, Republic of Congo

26,000 volumes

13.4 Institut pour la récherche scientifique
en Afrique Centrale (IRSAC)
Kinshasa, Republic of Congo

Maintains specimen collections of birds, mammals and fish of Central Africa

13.5 Institut pour la récherche scientifique
en Afrique centrale (IRSAC)
Bibliothèque centrale
Centre de Lwiro
Depeche Speciale
Bukavu, Kivu, Republic of Congo

33,000 volumes, 2800 periodicals, 100 microcopies
Separate map and photo department

13.6 Service Meteorologique du Congo
Kinshasa, Republic of Congo

Physical sciences including meteorology
1200 volumes, 2000 brochures, 60 periodicals
Records and data of surface and upper air observations.

14.0 COSTA RICA

14.1 Biblioteca Nacional
Calle 5, Avenidas 1/3
San José, Costa Rica

100,000 volumes

*14.2 Instituto Interamericano de Ciéncias Agricolas (IICA) de la OEA
Tropical Research and Graduate Training Center
Turrialba, Costa Rica

Institute does research and publishes material on tropical agriculture. Has one of the best forestry, agricultural and related sciences libraries in Latin America.
17,000 books, 1200 current periodicals, 180 theses, and 60,000 pamphlets

14.3 Museo Nacional
Apartado 749
San José, Costa Rica

14.0 COSTA RICA (contd)

Herbarium with about 34, 320 specimens

15.0 CUBA

15.1 Biblioteca General de la Universidad de la Habana
Habana, Cuba

100, 000 volumes

15.2 "Herbario de La Salle", Colegio de La Salle
Calle 13 n. 608
Vedado, Habana, Cuba

50, 000 specimens
Herbarium: Cuba and Antilles

16.0 ECUADOR

16.1 Biblioteca "Hispano Americana"
Apartado Postal 133
Cuenca, Ecuador

25, 000 volumes

16.2 Instituto Ecuatoriano de Ciéncias Naturales
Apartado 408
Quito, Ecuador

A bibliographic source of all sorts of generalized scientific information about the natural history of Ecuador. Zoological museum has specimen collections of Ecuadorian fauna.

17.0 ENGLAND

17.1 Bodleian Library
Oxford University
Oxford, England

General book collection and important map collection
2, 250, 000 volumes

17.0 ENGLAND (contd)

*17.2 British Museum Library
Great Russell Street
Bloomsbury, London, W.C.1, England

General book collection and important map collection
6,000,000 volumes

17.3 British Museum - Natural History
Botanical Department
Cromwell Road
London, S.W.1, England

Herbarium, Library

17.4 Bureau of Hygiene and Tropical Diseases Library
Keppel Street, Gower Street
London W.C.1, England

Collection of information on tropical diseases
42,000 volumes

17.5 Cambridge University Library
Cambridge, England

General book collection and important map collection
2,000,000 volumes. Tropical emphasis on Ceylon, Nigeria and Peru.

17.6 CCTA/CSA Publications Bureau
Watergate House, York Buildings
London, W.C.2, England

A collection of specialized reports on conferences on Africa south of the Sahara. Limited number, but useful for learning what is going on, names and addresses of "authorities" and bibliographical lists. Well worth a visit by research workers, although hardly a document center of the size of primary depositories.

17.7 Commonwealth Bureau of Soils
Rothamsted Experimental Station
Harpenden, Herts, England

Clearing house for worldwide information on soils

17.0 ENGLAND (contd)

17.8 Commonwealth Forestry Institute
Oxford University, Department of Forestry
South Parks Road
Oxford, England

Extensive library, map collection and herbarium of 110,000 specimens, mostly woody, mainly from tropical parts of British Commonwealth. Attempts world coverage in forestry. Maintains world bibliography of forests.

17.9 Commonwealth Mycological Institute (CMI)
Ferry Lane
Kew, Richmond, Surrey

Herbarium: 93,500 specimens, mainly Commonwealth microfungi.
Library

*17.10 Directorate of Overseas Surveys
Kingston Road
Tolworth, Surbiton, Surrey, England

Major holding agency for mapping former British colonies

17.11 India Office Library
Commonwealth Relations Office
King Charles Street
London, England

A collection of writings on India, government reports, historical documents, records, etc.
290,000 volumes and MSS

17.12 Liverpool Museum, City of
William Brown Street
Liverpool, England

170,000 specimens, worldwide herbarium
Important collections: Indian collections of John Forbes Royal and others

17.13 Liverpool School of Tropical Medicine Library
Pembroke Place
Liverpool, England

Emphasis on tropical medicine, diseases and prevention
14,000 volumes

17.14 Meteorological Office
London Road
Bracknell, Berkshire, England

17.0 ENGLAND (contd)

Research and published meteorological data on the humid tropics

17.15 National Central Library
Malet Place
London, England

Through a system of interlibrary loans this library has swift access to 20,000,000 volumes. A general collection

17.16 Royal Asiatic Society Library
56 Queen Anne Street
London, England

Library's holdings deal with Asian geography and related topics
78,000 volumes

17.17 Royal Botanic Gardens
Kew, Richmond,
Surrey, England

Herbarium, library, living plant collection
Tropical Africa, Asia and Australia

*17.18 Royal Geographical Society Library
Kensington Gore S. W. 7
London, England

The society also maintains a superior map collection. Its library is geographic in nature, worldwide in scope.
100,000 volumes

17.19 Tropical Division
Building Research Station
Garston, Watford, Herts, England

Maintains information on such subjects as thermal discomfort, painting, building, housing and planning matters in the tropics.

17.20 Tropical Products Institute
Department of Scientific and Industrial Research
56-62 Gray's Inn Road
London, W.C.1, England

17.0 ENGLAND (contd)

A collection of information on tropical plant and animal products

17.21 Tropical Section, Road Research Laboratory
Harmondsworth, West Drayton
Middlesex, England

Maintains information on road building and maintenance in the tropics

17.22 School of Oriental and African Studies Library
University of London
London, England

A collection of volumes with emphasis on African and Asian subjects and of a general topical scope
230,000 volumes

18.0 FIJI

18.1 British Council Library
Fiji Trading Company Building
Suva, Fiji

10,000 volumes

18.2 Fiji Department of Agriculture
Suva, Fiji

Herbarium - number of specimens about 30,000, flora of Fiji, particularly plants of economic importance. Small collection of locally harmful and beneficial insects is maintained.

19.0 FRANCE

19.1 Bibliothèque de la Faculté des lettres et de la Faculté des sciences
17 rue de la Sorbonne
Paris, France

General collection, museum
1,500,000 volumes

19.2 Bibliothèque de l'Institut de géographie
191 rue Saint Jacques
Paris 5e, France

19.0 FRANCE (contd)

Collection of general geographic works, important map collection
86,000 books and maps

19.3 Bibliothèque nationale
58 rue de Richelieu
Paris 2me, France

General collection with some specialized holdings on present and past French colonies, important map collection
6000 volumes

19.4 Centre documentaire pour l'océanie
293 Avenue Daumesnil
Paris 12, France

Library (microfilms, collection of unpublished material of explorers and missionaries)

19.5 Laboratoire de botanique tropicale
Avon (Seine-et-marne)
France

Number of specimens: 20,000
Herbarium: West Africa, Brazil, Guyana, Indochina
Important collections: R. Schnell

19.6 Museum national d' histoire naturelle
57 rue Cuvier
Paris 5e, France

Large herbarium and library
500,000 volumes and 5,000,000 specimens especially from Madagascar, Tropical Africa, Indo-China, Oceania, French Antilles, French Guiana

*19.7 Office de la récherche scientifique et technique d'outre-mer (ORSTOM)
24 rue Bayard
Paris 8e, France

19.0 FRANCE (contd)

Documentation, research and cartographic center for overseas investigations with a useful central library of published and unpublished material. For France outre-mer see also French Guiana and New Caledonia.

20.0 GAMBIA

British Council Library
Clifton Road
Bathurst, Gambia

15,000 volumes

21.0 GERMANY, FEDERAL REPUBLIC OF (WEST)

21.1 Deutscher Wetterdienst
Seewetteramt
Bernhard-Nocht-Strasse 76
2 Hamburg 4, Germany

Punch card archives with data from 1951 for about 140 stations in tropics

21.2 Geographischer Institut
Justus-Liebig-Universität Giessen
Ludwigstrasse 28
Giessen (Hesse), Germany

Library is excellent on West Africa and specializes in air photos and maps

21.3 Hydrobiologische Anstalt der Max-Planck-Gesselschaft 2, F.d.W. (HAMPG)
August Thienemann-Str. 2
Postfach 89
Plön (Holstein), Germany

Library: 17,000 volumes, 40,000 reprints, 300 periodicals
Primary area of emphasis is Amazonia

21.0 GERMANY, FEDERAL REPUBLIC OF (WEST) (contd)

21.4 Ibero-Amerikanische Bibliothek
Gärtnerstrasse 25-32
Berlin-Lankwitz, Germany

Library: 325,000 volumes

21.5 Institut für Geographie und Wirtschaftsgeographie
Universität Hamburg
Rothenbaumchausse 21/23
2000 Hamburg 13, Germany

Library: 60,000 volumes

21.6 Landwirtschaftliche Hochschule Hohenheim
Stuttgart - Hohenheim, Germany

Centre for research in tropical agriculture and ecology. Small, but specialized library holdings

21.7 Lehrstuhl für Welforstwirtschaft
2057 Reinbek,
Bezirk, Hamburg, Schloss, Germany

Centre for research on world forestry. Strong tropical section
Library: 33,000 volumes, 348 current periodicals, International documentation center. Collection of 15,000 wood samples

21.8 Rheinische Friedrich-Wilhelm-Universität Bonn
Geographisches Institut
Meteorologisches Institut
Franziskanerstrasse 2
53 Bonn, Germany

Geographic institute has an excellent library of 50,000 volumes, air photo and map collection with the emphasis upon Tropical Highlands of Latin America, East Africa and Southern Asia. Meteorological library with strong tropical holdings

21.0 GERMANY, FEDERAL REPUBLIC OF (WEST) (contd)

21.9 Staatsinstitut fur allgemeine Botanik und Botanischer Garten
Jungiusstrasse 5,
Hamburg 36, Germany

About 700, 000 worldwide specimens
Important collections are Ule (Brazil), Hans Winkler (Borneo)

22.0 GHANA

22.1 Balme Library
University of Ghana
Legon-Accra, Ghana

After Ibadan, this is probably the best center for documentation and research in former British West Africa.
50, 000 specimens; angiosperms, pteridophytes, algae and fungi of Ghana, the Cameroons and other regions of West Africa
180, 000 books, 3500 periodicals

22.2 Geological Survey
P.O. Box 98
Saltpond, Ghana

Geology and Geophysics
6000 volumes and pamphlets, 20 periodicals

22.3 Soil and Land-Use Survey Department
Private Mail Bag
Kumasi, Ghana

Soil science and general agronomy; chemistry; geology and geomorphology; botany and plant ecology; climatology; hydrology; geography
600 volumes, 1000 pamphlets, 50 periodicals

22.4 University College of Ghana
Achimota, Ghana

22.0 GHANA (contd)

Agriculture, archaeology; botany; chemistry; classics; economics; education; geography; geology; history; mathematics; philosophy; physics; zoology
70,000 volumes and pamphlets, 1500 periodicals

22.5 University of Science and Technology
Library
Kumasi, Ghana

24,000 volumes

23.0 GUATEMALA

Biblioteca Nacional
8a Calle y 5a Ave.
Zona 1
Guatemala, Guatemala

80,000 volumes

24.0 HONDURAS

Escuela Agrícola Panamericana
Agricultural School
Zamorano Valley
Tegucigalpa, Honduras

Has the finest botanical library and herbarium in Central America. A botanical research center. School possesses good library, has staff of research botanists, herbarium and other facilities. 90,000 specimens, tropical and subtropical flora.

25.0 INDIA

*25.1 Botanical Survey of India
Museum House
27 Chowringee
Calcutta, India

Library and herbarium, 1,000,000 specimens
Other botanical survey of India

25.0 INDIA (contd)

Herbaria and centers at:
Coimbatore: 125,000 specimens
Poona: 85,000 specimens (Western India)
Shillong: 70,130 specimens (Eastern India)

25.2 Commonwealth Institute of Biological Control
Indian Station, Bellary Road
P. O. Box 1503
Bangalore 6, India

Maintains large specimen collection and participates in specimen exchanges with many different institutions. Botanical survey of India

25.3 Forest Research Institute
New Forest Post Office
Dehra Dun, India

In its three branches it maintains a large collection of forest insects and pests. More than 300,000 specimens, of India, Pakistan and Burma
Library: 20,000 volumes, 4,000 periodicals, 20,000 pamphlets

25.4 Indian Agricultural Research Institute
Division of Entomology
New Delhi, India

Collection consists of more than 120,000 specimens belonging to various orders of the Class Insecta. Division of botany, number of specimens: 5500

*25.5 Indian National Scientific Documentation Center (INSDOC)
c/o National Physical Laboratory of India
Hillside Road
New Delhi 12, India

A leading research center, long-established with a good tradition for scientific work in tropical conditions

25.6 International Commission on Irrigation and Drainage
Central Office, 184 Golf Links Area
New Delhi 3, India

25.0 INDIA (cont'd)

Commission maintains a technical library on irrigation and drainage and acts as center for answering questions on irrigation and drainage problems.

25.7 Jute Agriculture Research Institute (JARI)
Barrackpore
West Bengal, India

Collection of insects which are damaging to jute and other fibre crops. Library: 4,200 volumes; 115 periodicals

25.8 Malaria Institute of India
22 Alipore Road, Civil Lines
Delhi, India

A large collection of disease-bearing and parasitic insects. Large reference library in entomology

25.9 Meteorological Office, Poona
Government of India
Ganeshkind Road
Poona-5 India

Library: 50,000 volumes, variety of periodicals. Collection of climatological data. Institute of Tropical Meteorology (ITM) is also located here.

25.10 National Atlas Organization
1, Acharya Jagadish Bose Road
3rd Floor
Calcutta 20, India

Library: 5,000 volumes, 80 periodicals
Collection of over 18,000 maps and atlases

25.11 National Library
Belvedere
Calcutta 27, India

General collection with emphasis on India, important map collection
1,030,000 volumes

25.0 INDIA (contd)

25.12 International Society for Tropical Ecology
Botany Department
Banares Hindu University
Varanasi 5, India

Angiosperm collections

25.13 Sugarcane Research Institute
Pusa PO
District Darbhanga
Bihar, India

Collection of insect pests and parasites harmful to sugarcane. Library: 2,000 volumes, journals and periodicals

*25.14 Zoological Survey of India
34 Chittaranjan Avenue
Calcutta 12, India

A collection of over 625 000 zoological specimens is maintained. 30,000 volumes. Library is one of the first zoological collections in Asia

26.0 INDONESIA

26.1 Bibliotheca Bogoriensis
Djalan Raya 20
Bogor, Indonesia

150,000 volumes

26.2 Bogor Botanical Gardens (Lembaga Hortus Botanicus Bogoriensis)
Bogor, Indonesia

Large herbarium, good library. Complete taxonomic and floristic inventory of plants in Indonesia with attention to adjacent countries.

26.3 Bogor Zoological Museum
Bogor, Indonesia

A large specimen collection is maintained.
The collected specimens are mainly from the Indonesian Archipelago, large herbarium, 1,000,000 specimens

26.0 INDONESIA (contd)

26.4 Library
Central Research Institute for Forestry
P. O. Box 606
Bogor, Indonesia

52, 000 volumes and 45, 000 specimens on tree species Indonesia

26.5 Library of the Geological Survey
Djalan Disponego 57
Bandung, Indonesia

40, 000 volumes

26.6 Meteorological & Geophysical Institute (Lembaga Meteorologi dan geofisik)
Tjalan Gereda Inggris 3
Djakarta, Indonesia

Large Library, Records & data on rainfall, sunshine, climatic variations in Indonesia

27.0 ITALY

27.1 Biblioteca Nazionale Centrale
Piazza de Cavalleggeri 1A
Florence, Italy

General book collection and important map collection.
4, 000, 000 volumes

27.2 Instituto Agronomico per l'oltremare
Via Cocci 4
Firenze, Italy

Concerned with agriculture in tropical and subtropical countries. Since W. W. II its major activities relate to Africa in general, Latin America, the middle and near east.
40, 000 books, 720 periodicals, 23, 000 miscellaneous documents, 2300 maps, 60, 000 photographs (52, 000 negatives). Tropical plant index, museum of tropical products.

28.0 IVORY COAST

28.1 Centre des sciences de la nature
Abidjan, Ivory Coast

A good center, formerly attached to IFAN (Dakar) and with close connections with the nearby agricultural and forest research station run by ORSTOM (see 27.2).
Number of specimens: 4500
Herbarium: West Africa

28.2 Institut d' études et de récherches tropicale (IDERT-ORSTOM))
B.P. 20
Abidjan, (Station d' Adiopodonmé), Ivory Coast

Specialized library (2,500 volumes) on tropical regions, entomology, pedology, geology and hydrology

29.0 JAMAICA

29.1 Royal Botanical Gardens
Hope, Kingston, Jamaica, BWI

Aboretum of tropical plants, Elizabethtown

29.2 Library
Institute of Jamaica
Science Museum
Kingston, Jamaica, BWI

Library, herbarium
50,000 volumes, 55,000 specimens from the Caribbean

30.0 JAPAN

*30.1 Tokyo University Library
Motofujicho, Bunkyo-ku
Tokyo, Japan

General collection; broad emphasis on Southeast Asia
Herbarium of the Botanic Gardens, horticultural and alpine plants, 10,000
2,660,000 volumes

30.0 JAPAN (contd)

30.2 Center for Southeast Asian Studies
Department of Geography
Rikkyo University
Toshima-ku
Tokyo, Japan

Small, but specialized library on Southeast Asia

31.0 KENYA

31.1 Coryndon Memorial Museum
Nairobi, Kenya

Maintains large specimen collections of mammals, birds, reptiles, fish and amphibians and insects. (The East African Herbarium, incorporating The Amani Herbarium of the East African Agriculture and Forestry Research Organization and the Coryndon Memorial Museum) Specimens: Mainly Uganda, Kenya, Tanganyika, Zanzibar, Northern Rhodesia and Nyasaland.

31.2 East African Literature Bureau Library
P.O. Box 30022
Nairobi, Kenya

Comprehensive collection on East Africa
40,000 volumes

31.3 East African Agriculture, Forestry, and Veterinary (EAAFRO & EAVRO) Research Organizations
Library
P.O. Box 21
Muguga, Kikuyu, Kenya

Collection of 51,000 specimens mostly insect pests and plant parasites. Large library contains information on agriculture, forestry, botany, soil science, ecology-Africana

*31.4 East African Meteorological Department (EAMD)
P.O. Box 30259
Nairobi, Kenya

31.0 KENYA (contd)

Meteorology; climatology; geophysics
3000 volumes, 20,000 pamphlets, 66 periodicals

31.5 Grasslands Research Station
Department of Agriculture
P.O. Box 450
Kitale, Kenya

Herbarium collection of pressed specimens of East African grasses

32.0 MALAGASY REPUBLIC (MADAGASCAR)

32.1 Institut de la récherche scientifique de Madagascar
B.P. 434
Tananarive, Malagasy Republic

Soil, fauna, flora, hydrology
Specialized library: 1,000 volumes, 420 periodicals
About 50,000 specimens. Herbarium: Madagascar, the Comores, the Mascarenes

32.2 Plan géologique de Madagascar
B.P. 322
Tananarive, Malagasy Republic

Geology, geologic maps
2000 volumes, 10,000 brochures, 150 periodicals

32.3 Service Météorologique
B.P. 1254
Tananarive, Malagasy Republic

Local weather and climatic data, records and reports

33.0 MALAYSIA (Including SINGAPORE)

33.1 Department of Agriculture
Government of Malaya
Kuala Lumpur, Malaya

Maintains a collection of Malayan insect specimens.
Herbarium and mycological collections

33.0 MALAYSIA (Including SINGAPORE) (contd)

33.2 Malayan Forest Research Institute (FRI)
Kepong, Selangor, Malaya

Number of specimens: over 65,000 sheets.
Herbarium: Trees of Malaya, Borneo, Sarawak, Brunei
Library: 4,000 volumes. 3,000 bark and timber specimens

33.3 Library of the University of Malaya in Kuala Lumpur
Puatri Valley
Kuala Lumpur, Malaya

Centre for tropical research (botany, zoology)
56,000 volumes

33.4 Malayan Meteorological Service
Fuller Building
P.O. Box 715
Singapore 1,

Data and records of surface and upper air observations

33.5 National Library
Stamford Road
Singapore 6

170,000 volumes

33.6 Rubber Research Institute of Malaya (RRIM)
P.O. Box 150
Third Mile Ampang Road
Kuala Lumpur, Selangor

Characteristics of holdings: Agricultural aspects of natural rubber, cover crops, soil surveys, plant diseases, etc.
15,000 books, 450 current periodicals, 350 noncurrent periodicals, 300 maps, 200 microcopies

33.7 Singapore Botanical Gardens Herbarium
Singapore 10

About 400,000 specimens
Largest herbarium of Malayan plants, living plant

collections. Malaysian Islands and Malaysia, Philippines and New Guinea
Library: 8,000 volumes, 230 current periodicals

33.8 University of Singapore
Bukit Timah Road
Singapore 10

A long-established center (formerly Raffles College) with a good reference library. Medical school has developed much material on bioclimatology of the tropics.
300,000 books, 3000 periodicals, 11,000 microcopies
Department of Geography produces "The Journal of Tropical Geography".

33.9 Sarawak Museum
Kuching, Sarawak, Malaysia

About 25,000 specimens
Herbarium: Borneo
Library: mainly reference, specializes on Borneo

33.10 Forest Department
Box 311
Sandakan, Sabah (North Borneo), Malaysia

12,000 specimens
Herbarium: Flora of North Borneo with special emphasis on the Dipterocarpaceas

33.11 Geological Survey Department
Box 211
Jesselton, North Borneo, Malay Station

Technical library, airphoto collection. Topographic Geologic and hydrologic map collection

34.0 MARTINIQUE

Bibliothèque Schroelcher
Fort-de-France, Martinique

35.0 MEXICO

35.1 Biblioteca Nacional
República del Salvador 70
Mexico City, Mexico

General collection with emphasis on Mexico.
111,953 MSS, 500,000 volumes

35.2 Instituto Méxicano de Recursos Naturales Renovables (IMRNR)
Dr. Vertiz 724
Mexico 19 D.F.

Library specialized in natural resources of Mexico; 6,000 volumes, 30,000 pamphlets, 120 current periodicals

*35.3 Biblioteca
Instituto Panamericano de Geografía e Historia (IPGH)
Ex-Arzobispado 29
Mexico 18, D. F.

The library at PAIGH headquarters now contains more than 100,000 books, periodicals, documents, maps, atlases and catalogs pertaining to the Americas, and the collections are growing at the rate of 12,000 - 14,000 items per year. It constitutes the most comprehensive and best organized collection, in Latin America, of works pertaining to the cartography, geography and history of that area.

35.4 Biblioteca
Inter-American Association of Sanitary Engineering
Alfonse Herrera 11-103
Mexico 4, D.F., Mexico

Emphasis on problems of sanitation in the tropics.

35.5 Officina de Meteorologia
Dirección de Geografía y Meteorologia
Avenida del Observatorio 192
Tacubaya, Mexico D. F.

Maps, reports, records and data of weather and climate of Mexico

*35.6 Biblioteca
Sociedad Méxicana de geografía y Estadística
Calle de Justo Sierra 19
Apartado 10739
Mexico D. F.

Library has 80,000 volumes with emphasis upon Mexico and Middle America

35.7 Universidad Nacional Autonoma de México
Herbario Nacional del Instituto de Biología
Casa del Lago, Chapultepec, Mexico, D.F.

100,000 specimens
Herbarium: Mexico

36.0 MOZAMBIQUE

36.1 Biblioteca dos Serviços de Agricultura
C.P. 250
Lourenço Marques, Mozambique

30,000 volumes

36.2 Serviço Meteorológico de Moçambique (SMM)
C.P. 256
Lourenço Marques, Mozambique

Astronomy; seismology; meteorology
500 volumes, 120 pamphlets, 60 periodicals

37.0 NETHERLANDS

37.1 Central Library
Royal Tropical Institute (RTI)
63 Mauritskade
Amsterdam, The Netherlands

Mainly on tropical areas held now or in the past by the Netherlands. Photogrammetry, important map collection 55,000 volumes. Emphasis upon soil science, agriculture

37.2 Department for Systematic Botany of the Botanical Laboratory
Gr. Rozenstraat 31
Groningen, The Netherlands

100,000 specimens - Herbarium: Bryophytes of the Malaysian Region

37.3 Flora Malesiana Foundation (FMF)
c/o Rijksherbarium
Scholpenkade 6
Leiden, The Netherlands

Extensive collections of data, large herbarium and library, specializes in Indonesia, Malaysia and Surinam
1,800,000 specimens

37.4 International Association of Soil Science
c/o Royal Tropical Institute
63 Mauritskade
Amsterdam, The Netherlands

Tropical soils

37.0 NETHERLANDS (contd)

37.5 International Institute for Land Reclamation and Improvement
P.O. Box 45
Wageningen, The Netherlands

Institute provides bibliographic information on humid tropic soils

37.6 International Training Centre for Aerial Survey (ITC)
3 Kanaalweg
Delft, The Netherlands

Collection of aerial photographs of tropical forests

37.7 Physical Geography Laboratory
221 Sarphatistraat
Amsterdam, The Netherlands

Collection of field data, soil sections from Surinam and other areas

37.8 Botanical Museum and Herbarium
106 Lange Nieuwstraat
Utrecht, Netherlands

About 350,000 specimens
Herbarium: worldwide, mainly Surinam, Netherlands, Antilles, etc.
Important collections: Miquel, Suriname; collections from N. Guinea. Library specializes in taxonomy and geography of South American plants

38.0 NEW CALEDONIA

38.1 Institut français d'océanie
Office de la récherche scientifique et technique d' outre-mer (ORSTOM)
B.P. 4
Noumea, New Caledonia

Maintains a collection concerned with medical, veterinary and economic entomology; agriculture and the physical environment

38.0 NEW CALEDONIA (contd)

38.2 Library
South Pacific Commission (SPC)
P.O. Box 9
Noumea, New Caledonia

Specialized library (23,000 volumes)

39.0 NEW ZEALAND

Library University of Auckland
Auckland, New Zealand

Provides a useful base from which to work in the South Pacific Area

40.0 NIGERIA

40.1 Federal Dept. of Forest Research
P.M.B. 5054
Ibadan, Nigeria

Forestry and allied subjects
8,500 volumes and pamphlets, 22 periodicals
40,000 specimen herbarium on tropical Africa

40.2 Geological Survey
P.M.B. 2007
Kaduna Junction, N. Nigeria

Geology and cognate sciences
7,000 volumes, 1550 pamphlets, 36 periodicals

40.3 Hydrological Branch
Department of Inland Waterways
Ministry of Transportation and Aviation
Lagos, Nigeria

3,000 volume library, and water supply papers, river flow data, records of water levels and discharges

40.0 NIGERIA (contd)

40.4 Meteorological Office
Lagos, Nigeria

*40.5 Library, University of Ibadan
Ibadan, Nigeria

A collection of probably a million books and journals by now. A magnificent Africana collection. The leading center of research in Nigeria. Depository under Nigeria copyright law for all publications published in Nigeria. Headquarters of the National Archives of Nigeria. Good departmental and institution special collections on Nigeria and West Africa in particular, but most of Africa is well covered.

40.6 University of Nigeria Library
Nsukka, Nigeria

Library contains a fine Nigeriana collection
472,000 volumes

40.7 West African Meteorological Services
Lagos, Nigeria

Meteorology
500 volumes, 1000 pamphlets, 32 periodicals

41.0 PAKISTAN

41.1 Dacca University Library
Dacca, Pakistan

165,000 volumes

41.2 Department of Zoology
University of Punjab
Lahore, Pakistan

An excellent collection of Indo-Malayan termites

42.0 PANAMA

Biblioteca de la Universidad de Panamá
Apartado 3277
Panama

125, 000 volumes

43.0 PARAGUAY

Biblioteca de la Sociedad Científica del Paraguay
Que. España 505
Asunción, Paraguay

30, 000 volumes

44.0 PERU

44.1 Biblioteca Nacional de Agricolas
Centro Nacional de Investigaciones Agropecuario
Apartado 2791
Lima, Peru

National Agricultural Library (50, 000 volumes)

44.2 Museo de História Natural "Javier Prado"
Universidad Nacional Mayor de San Marcos
Apartado 1109, Avenida Arenales 1256
Lima, Peru

The only natural history museum in Peru. A herbarium of 100, 000 specimens of Peruvian plants. Collections of insects, parasites, fishes, amphibians, and reptiles, birds, mammals, and fossils

44.3 Sociedad de Geografia de Lima
Jirón Puno 456
Lima, Peru

Collection of geographic works with emphasis on Peru.
20, 000 volumes

45.0 PHILIPPINES

45.1 Department of Agriculture and Natural Resources
Manila, Philippines

45.2 Division of Documentation
National Institute for Science and Technology
727 Herrán St.
P.O. Box 774
Manila, Philippines

Prior to World War II the best information source on Asian science and technology. Being rebuilt after the war — now has fair collection.
20,000 bound volumes, 2582 current periodicals, Philippine maps

45.3 Library
National Museum
Manila, Philippines

Good herbarium and library
85,000 specimens chiefly of Philippines

45.4 Philippine Weather Bureau
P.O. Box 2277
Marsman Building
Manila, Philippines

Library: summaries of data and records of synoptic and climatological stations

45.5 University of Santo Tomás Library
España St.
Manila, Philippines

Library contains a 72,000 volume Filipiniana collection
174,000 volumes

46.0 PORTUGAL

46.1 Botanical Institute of the University of Coimbra
Coimbra

About 500, 000 specimens
Herbarium: worldwide
Important collections— herbarium of Angola and Mozambique

46.2 Institute of Botany (Museu, Labóratorio e Jardim Botânico),
Faculty of Science
Lisboa

About 500, 000 specimens
Herbarium—collections from overseas provinces

46.3 Junta das Missões Geográficas e de Investigações
Geográficas do Ultramar
Praça Príncipe Real, 21
Lisboa 2, Portugal

9000 map collection for Portugal "Ultramar", also see
Angola and Mozambique

47.0 RHODESIA

47.1 National Archives of Southern Rhodesia
Salisbury
Rhodesia

Collection totals in the region of 50, 000 volumes on the
Rhodesias and (former) Nyasaland
Herbarium, Forestry Department, Ndola, N. Rhodesia.
8000 specimens

47.2 National Museum of Southern Rhodesia
P.O. Box 8540 Causeway
Salisbury, Rhodesia

Collection contains 335, 000 zoological and entomological
specimens, the majority of which were collected in
Southern Rhodesia.

47.0 RHODESIA (contd)

47.3 Library
University College of Southern Rhodesia
Salisbury, Rhodesia

60,000 volumes

47.4 Federal Herbarium, Branch of Botany and Plant Pathology,
Federal Department of Agriculture and Lands
P.O. Box 8100, Causeway, Salisbury, S. Rhodesia

About 140,000 specimens
Herbarium: Flora of Rhodesia and Nyasaland
and other parts of Africa
Important collections: Eyles Herbarium, N.C. Chase
Herbarium. Also maintains a collection of over 125,000
insect specimens.

48.0 SCOTLAND

48.1 Center of African Studies
Edinburgh University
2 Buccleuch Place
Edinburgh 8

Library contains African journals, newspapers, magazines,
microfilms; large amount of Africana in central university
library

48.2 Department of Botany
The University of Aberdeen
Aberdeen

About 60,000 specimens
Herbarium: British flora and flora of Thailand
Important collection: Dr. A.F. Kerr's collections
from Thailand

48.3 Department of Botany
University of Glasgow
Glasgow

48.0 SCOTLAND (contd)

About 170, 000 specimens
Herbarium: worldwide
Important collections: W.J. Hooker, Walker Arnott, Wight (India), Drummond (Australia), Beechey and Gillies (Peru)

49.0 SENEGAL

49.1 Bibliothèque
Université de Dakar
Dakar, Senegal

49.2 Direction locale de Dakar
Bureau de Récherches géologiques et minières
Route de l'Université
B.P. 268
Dakar-Fann, Senegal

Now has charge of the library of the former Geological Bureau of ex-French West Africa.
5000 books, 35, 000 periodicals, 100 geological maps

*49.3 Bibliothèque centrale
Institut français d' Afrique noire (IFAN)
B.P. 206
Dakar, Senegal

Maintains a collection of over 400, 000 specimens collected mainly in West Africa
49, 000 volumes, 3650 periodicals, 1800 maps, 1000 microfilms, 40, 000 photographs

49.4 Laboratory of Parasitology
Faculty of Medicine and Pharmacy
University of Dakar
Dakar, Senegal

Collection of specimens, mainly of medical and veterinary interest

49.0 SENEGAL (contd)

49.5 Office de la récherche scientifique et technique outre-mer (ORSTOM)
Dakar, Senegal

49.6 Service géographique de L' AOF
Dakar-Fann, Senegal

Mathematical geography (geodesy, cartography, geology, and astronomy)
2000 volumes, 1000 brochures

49.7 Service météorologique de L'AOF
Dakar-Fann, Senegal

Meteorology and physics
1005 volumes, 300 brochures, 50 periodicals

50.0 SIERRA LEONE

Library
Fourah Bay University
Freetown, Sierra Leone

Long established college with a useful local and general documentation
30, 000 volumes

51.0 SOUTH AFRICA, REPUBLIC OF

Merensky Library
University of Pretoria
Pretoria, South Africa

Library maintains an Africana collection
240, 380 volumes

52.0 SUDAN

Survey Department
Ministry of Mineral Resources
P.O. Box No. 306
Khartoum, Sudan

53.0 SURINAM

Geologisch-mijnbouwkundige Dienst
Kleine Waterstraat 1
Paramaribo, Suriname

7000 volumes

54.0 SWEDEN

54.1 Biblioteca e Instituto de Estudios Ibero-Americanos
Stockholm School of Economics
Odengatan 61
Fack
Stockholm 6, Sweden

54.2 Botanical Department
Naturhistoriska Riksmuseum
Stockholm 50

About 2,850,000 specimens
Worldwide herbarium
Important collections: Regnellian collections from Brazil, Ekman from West Indies, etc.

55.0 TANGANYIKA (TANZANIA)

55.1 Herbarium of the Tanganyika Forest Department
c/o the Silviculturist
P.O. Box 42, Lushoto, Tanzania

About 4000 specimens, woody plants of Tanganyika

55.0 TANGANYIKA (TANZANIA) (contd)

55.2 King George VI Memorial Library
P.O. Box 391
Tanga, Tanzania

Comprehensive on Tanganyika
12,500 volumes

55.3 Ministry of Agriculture and Cooperative Development
Tengeru, P.O. Box 3020
Arusha, Tanzania

56.0 THAILAND

56.1 Bangkok School of Tropical Medicine
University of Medical Science
Rajvithi Road, Phyathai
Bangkok, Thailand

Collection has emphasis on Southeast Asian medicine
Forestry
34,000 volumes

56.2 Meteorological Office
Royal Thai Navy
Bangkok, Thailand

Records and data summaries of surface and upper air observations

56.3 Botanical Section, Plant Industry Division,
Department of Agriculture, Bangkok

About 55,000 specimens
Herbarium: General flora of Thailand

56.4 The Forest Herbarium, Section of Botany and Zoology,
Forest Products Research Division, Royal Forest Department
Phaholyothin Highway
Bangkok

35,000 specimens
Worldwide herbarium

57.0 TRINIDAD AND TOGABO

57.1 Central Library of Trinidad and Tobago
20, Queen's Park East
Port of Spain, Trinidad

57.2 Imperial College of Tropical Agriculture
University of the West Indies
Trinidad, West Indies

About 25, 000 specimens
Herbarium: Angiosperms, Pteridophytes, Fungi and Algae of Trinidad and Tobago, now being extended to Caribbean area as a whole

58.0 UGANDA

58.1 Department of Lands and Survey
P.O. Box 361
Kampala, Uganda

Air photo library and local special purpose maps (soils, vegetation, rainfall, etc.)

58.2 Geological Survey Department
P.O. Box 9
Entebbe, Uganda

All branches of geology
10, 000 volumes, 3000 pamphlets, 62 periodicals, geologic maps

58.3 Kawanda Research Station
P.O. Box 265
Kampala, Uganda

Maintains a collection of more than 50, 000 entomological specimens
25, 000 specimens—mainly Uganda flora, but some material from other East African territories.
Library: 6, 000 volumes; 125 periodicals - agronomy, pests, soil, vegetation

58.0 UGANDA (contd)

58.4 Makerere Herbarium, Makerere University College Library
Makerere
P.O. Box 262
Kampala, Uganda

Special East Africana collection
6000 specimens—primarily from Uganda, but also some from elsewhere in East Africa, Sudan and N. Rhodesia.
90,000 volumes
Geography department has reference collection of the maps of the East African Surveys (including a set of the 1:?,000,000 series of German East Africa).

59.0 UNION OF SOVIET SOCIALIST REPUBLICS (USSR)

59.1 All Union State Library of Foreign Literature
Ulitsa Razina 12
Moscow, RSFSR

Library contains 2,000,000 volumes in 95 foreign languages
4,000,000 volumes

59.2 A.M. Gorky Scientific Laboratory
Moscow State University
Mokhoraya 9
Moscow, RSFSR

General collection
6,000,000 volumes

*59.3 Central Scientific Agricultural Library
Orlikov Pereulok 1-11
Moscow, RSFSR

Deals with agriculture and soils on a worldwide basis.
2,500,000 volumes

59.0 UNION OF SOVIET SOCIALIST REPUBLICS (USSR) (contd)

*59.4 Lenin State Library
Ulitsa Kalinina 3 and Ulitsa Marksa i Engelsa 14
Moscow, RSFSR

A general library containing 20,000,000 books, magazines and complete files of newspapers in all languages of the Soviet Union and 160 foreign languages plus 2,500,000 manuscripts.
Important map collection

*59.5 Library of the Academy of Sciences of the USSR
Birzhevaya linia 1
Leningrad, RSFSR

6,000,000 volumes
General collection

59.6 Library of the Central House of the Soviet Army
Ploshchad Kommuny
Moscow, RSFSR

Mainly concerned with military and political volumes on a worldwide basis.
3,000,000 volumes

59.7 State Scientific Library of the USSR
Moscow, RSFSR

General scientific library
3,500,000 volumes

60.0 UNITED STATES OF AMERICA (USA)

60.1.0 California

60.1.1 San Diego State College
5402 College Avenue
San Diego, California 92115

Good African holdings, especially former French colonies; 250,000 volumes

60.0 UNITED STATES OF AMERICA (USA) (contd)

60.1.2 San Diego Zoological Society & Library
P. O. Box 551
San Diego, California 92112

Zoo maintains largest collection of live animals in the world.
1148 volumes, 140 bound periodicals, 150 pamphlets

60.1.3 Stanford University Library
Stanford, California 94305

General collection and John C. Branner collection started with 6000 items on Brazil.
2,287,332 volumes

*60.1.4 University of California, Berkeley Library
Berkeley, California 94720

Herbarium, Department of Botany
General collection—major Latin American holdings, very complete biological sciences holdings.
1,225,000 specimens. Worldwide herbarium with specialization in the Americas.
2,596,526 volumes

*60.1.5 University of California, Los Angeles, Library
405 Hilgard Avenue
Los Angeles, California 90024

General collection (2,500,000 volumes) with large holdings on Africa, South Asia and Latin America. This library also contains the largest collection of maps in the Western United States.
Biomedical Library (134,098 volumes)
Has large zoological and botanical holdings.
Herbarium, Department of Botany, 300,000 specimens, worldwide herbarium, emphasis on subtropical ornamentals.

60.1.6. University of California, San Diego, Library
Scripps Institute of Oceanography
La Jolla, California 92037

Maintains a large collection of worldwide oceanographic information
45,851 volumes

60.0 UNITED STATES OF AMERICA (USA) (contd)

60.2.0 Connecticut

Yale University Library
New Haven, Connecticut 06520

General collection, Southeast Asia and Latin America
4,309,882 volumes

60.3.0 District of Columbia

60.3.1 Building Research Advisory Board
National Academy of Sciences
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Reports on housing and building in tropical areas.
10,000 volumes

60.3.2 Institute of Social Anthropology
Smithsonian Institution
Washington, D.C.

Collects and makes available information on health and living conditions in South America

60.3.3 International Monetary Fund Library
International Bank for Reconstruction
and Development Joint Bank Fund Library
19th and H Street, N.W.
Washington, D.C. 20025

Underdeveloped nations (land use, transportation)
50,000 volumes, 60 vertical file drawers

60.3.4 International Road Federation
1023 Washington Building
Washington, D.C. 20005

Serves as a collecting, publishing and distribution agency for technical, economic, statistical, educational and other information on world roads.

*60.3.5 Library of Congress
1st Street & Independence Avenue, S. E.
Washington, D.C. 20540

General collection, best U.S. depository; excellent map library.
12,750,000 books and pamphlets, 3,125,000 photographs, 400,000 technical reports, 20,000 periodicals

60.3.6 Pacific Vegetation Project
2101 Constitution Avenue, N. W.
Washington, D.C. 20037

Limited reference source on coral atolls and Pacific island ecology.

*60.3.7 Pan American Union, Columbus Memorial Library
17th and Constitution Avenue, N. W.
Washington, D.C. 20025

Latin America collection
175,000 volumes, 175,000 unbound periodicals

60.3.8 Tropical Health Office
Division of Medical Sciences
National Academy of Science
National Research Council
2101 Constitution Avenue, N. W.
Washington, D.C. 20418

Reference service on tropical diseases.

*60.3.9 United States Army Map Service Library
6500 Brooks Lane, N. W.
Washington, D.C. 20025

Emphasis on topographic maps.
1,800,000 maps, 130,000 volumes and periodicals

60.3.10 United States Botanical Gardens
245 First Street, S. W.
Washington, D. C. 20024

Maintains specimen collection of worldwide scope.

60.0 UNITED STATES OF AMERICA (USA) (contd)

*60.3.11 National Agriculture Library
14th and Independence Avenue, S.W.
Washington, D.C. 20250

1,212,000 volumes including 20,000 serial titles

*60.3.12 United States Geological Survey
General Services Administration Building
19th and F Streets, N.W.
Washington, D.C. 20025

Geologic books collection and important map collection
385,379 volumes

60.3.13 United States Naval Oceanographic Office
Department of the Navy
Washington, D.C. 20390

Collection consists of books, government reports, technical and scientific data, periodicals, industrial literature, project or administration data and technical correspondence.

*60.3.14 United States Weather Bureau
24th and M Street
Washington, D.C. 20025

Synoptic and summarized data from all the weather services of the world.
145,000 volumes

60.3.15 Research Library Branch
Aeronautical Chart & Information Service
Air Force Office of Research
Washington, D.C. 20025

60.0 UNITED STATES OF AMERICA (USA) (contd)

60.3.16 United States National Museum, Smithsonian Institution
Washington, D.C. 20025

3,000,000 specimens
Worldwide Spec. North and South America

60.4.0 Florida

60.4.1 American Society of Tropical Medicine and Hygiene
3575 Saint Gaudens Road
Miama, Florida 33133

Conducts research and publishes papers on tropical medicine and hygiene.

60.4.2 Everglades Experiment Station Library
University of Florida
P.O. Box 37
Belle Glade, Florida 33430

Specialized library includes subjects of tropical botany, sugarcane and rice.
7000 volumes

60.4.3 Experimental Farm and Tropical Plant Research Laboratories
Department of Botany
University of Miami
Coral Gables, Florida 33146

Conducts research on tropical plants and plant adaptations to the tropics.

60.4.4 Hurst Laboratories
514 37th Street, N.
St. Petersburg, Florida 33713

Laboratory conducts research on tropical plants.

60.4.5 Morton Collectanea
Botany Building Room 114
P.O. Box 8204
University of Miami
Coral Gables, Florida 33146

Plant identification service and case history of plant injuries.

60.4.6 Radar Meteorological Laboratory
University of Miami
Merrick Building, Main Campus
Coral Gables, Florida 33146

A library is maintained for on-site inspection

60.4.7 Marine Laboratory
University of Miami
#1 Rickenbacker Causeway-Virginia Key
Miami, Florida 33149

Engages in basic research in tropical fisheries and oceanography of the Caribbean area.

60.5.0 Georgia

60.5.1 Communicable Disease Center
U.S. Public Health Service
1600 Clifton Road, N.E.
Atlanta, Georgia 30322

Research and published information on many tropical communicable diseases.

60.5.2 Library
University of Georgia
Athens, Georgia 30602

60.6.0 Hawaii

60.6.1 Agricultural Experiment Station Library
University of Hawaii
Honolulu, Hawaii 96814

60.6.2 Library, Experiment Station
Hawaiian Sugar Planters' Association
1527 Keeaumoku Street
Honolulu, Hawaii 96814

Library has material on tropical agriculture, climate, crops, agronomy, botany, plant pathology and physiology, forestry, sugar technology, and entomology.

60.6.3 Library of Hawaii
478 S. King Street
Honolulu, Hawaii 96813

315,000 volumes

60.6.4 Library, Hawaiian Pineapple Company
P.O. Box 3380
Honolulu, Hawaii 96814

Library is restricted to commercial firms and university students. Collects information on tropical agriculture.

60.6.5 Library
B.P. Bishop Museum
Honolulu, Hawaii 96817

Good herbarium and library
About 160,000 specimens; herbarium — Polynesia, Micronesia, Melanesia, Australasia, Indonesia, and related areas. Insect collection

*60.6.6 Pacific Scientific Information Center
B.P. Bishop Museum
Honolulu, Hawaii 96817

Acts as a clearing house for information on the Oceanic Pacific area. Important collection of library materials on Polynesia.

60.6.7 Gregg M. Sinclair Library
University of Hawaii
Honolulu, Hawaii 96814

General collection with specialized collections of Hawaiian and Oriental materials.
317,980 volumes

60.0 UNITED STATES OF AMERICA (USA) (contd)

60.7.0 Illinois

60.7.1 Chicago Natural History Museum
Department of Botany
Chicago, Illinois 60605

Probably the world's largest collection of South American plants; outstanding herbarium for tropical South America; library adequate for advanced work on the tropics

60.7.2 Northwestern University Library
Evanston, Illinois 60201

General collection and an excellent collection of works on Africa.
1,666,200 volumes

60.7.3 University of Illinois Air Photo Repository
Committee on Aerial Photography
University of Illinois
Urbana, Illinois 61803

Annotated aerial photo stereograms of humid tropical (as well as other) areas. Showing vegetation terrain and cultural features

*60.7.4 University of Illinois Library
University of Illinois
Urbana, Illinois 61803

General collection, fine map and geography library subsections with excellent Latin American and Asian, especially Indian, holdings
4,000,000 volumes

60.8.0 Indiana

Indiana University Library
Bloomington, Indiana 47405

Collection of about 1-1/2 million books and journals with a growing special Africana collection as part of the African studies program. Geography map room at library has a collection of African maps that is of exceptionally high quality

60.9.0 Louisiana

*60.9.1 Louisiana State University Coastal Studies Institute
Geology Department
Louisiana State University
Baton Rouge, Louisiana 70803

Maintains a reference file on subjects related to coastal studies.

60.9.2 Louisiana State University Library
Baton Rouge, Louisiana 70803

Tropical emphasis is upon geology, Caribbean and Mexico (especially Yucatan).
701,410 volumes

60.10.0 Maryland

*60.10.1 Foreign Area Climatic Advisory Service
Office of Climatology
U.S. Weather Bureau
U.S. Department of Commerce
FOB #4
Suitland, Maryland 20025

Foreign climatological information.

60.10.2 United States Department of Agriculture
Sugar and Tropical Products Division
Room 6077, Building S
Foreign Agriculture Service
Beltsville, Maryland 20705

Conducts research and has holdings in tropical agriculture.

60.10.3 World Soils Map
Soil Survey Investigations
U.S. Soil Conservation Service
U.S. Department of Agriculture
Hyattsville, Maryland

Worldwide collection of soils profiles.

60.11.0 Massachusetts

60.11.1 American Meteorological Society
45 Beacon Street
Boston, Massachusetts 02108

Society collects data and publishes abstracts and bibliographies from over 100 different countries.

Can provide answers to technical questions on many phases of meteorology, climatology and geography.

60.11.2 Boston University
African Research and Studies Program
154 Bay State Road
Boston, Massachusetts 02115

Research centers on an interdisciplinary review of Africa.

60.11.3 Earth Sciences Division
U.S. Army Natick Laboratories
Natick, Massachusetts 01762

Conducts research and will make information available on the geographic and climatic conditions found in the tropics.
22,000 volumes, 75,000 reports

60.11.4 Harvard University Library
Cambridge, Massachusetts 02138

General collection, important map collection. Library & Gray Herbarium at 22 Divinity Avenue, Cambridge, Mass. and a botanical museum.
6,848,635 volumes and 1,500,000 specimens—especially Mexico and West Indies

60.11.5 Marine Biological Laboratory Library
Woods Hole Oceanographic Institute
Woods Hole, Massachusetts 02543

Tropical oceanography and meteorology
80,000 volumes, 210,000 pamphlets

60.12.0 Mississippi

U.S. Army Research Center Library
Waterways Experiment Station
U.S. Army Corps of Engineers
Box 631
Vicksburg, Mississippi 39181

Special subjects: soil mechanics, flexible pavement hydraulics and concrete research is carried out on a worldwide scale.
60, 000 volumes

60.13.0 Missouri

Missouri Botanical Garden
St. Louis, Missouri 63110

Collection has some emphasis on tropical botany.
Number of specimens: ca. 1, 700, 000.
Herbarium: worldwide
Spec: tropical and temperate America, Africa, Gramineae.

60.14.0 New Jersey

Atmospheric Physics Branch
Meteorological Division
U.S. Army Electronics Research and Development Agency
Fort Monmouth, New Jersey 07703

Branch conducts research and will make information available on tropical meteorology.

60.15.0 New York

*60.15.1 American Geographical Society Library of New York
Broadway at 156th St.
New York, New York 10032

General geographic collection with a worldwide scope. Excellent map collection.
158, 133 volumes, 294, 537 maps, 31, 106 pamphlets, 41, 805 indexed photographs, 4, 211 atlases, 47 globes

60.15.2 American Museum of Natural History
New York, N.Y.

60.15.3 Library
Columbia University
New York, New York 10027

General collection. African, Asian and Latin American Institutes and holdings in these areas. Good geology library.

60.15.4 Cornell University Library
Ithaca, New York 14850

General collection with important zoological holdings.
1,812,826 volumes

60.15.5 Ford, Bacon & Davis Inc.
39 Broadway
New York, New York 10006

Maintains information on power plants, water supplies, water power, and geology on a worldwide basis.
15,000 volumes, 25,000 pamphlets, 110 vertical file units

60.15.6 New York Botanical Garden Library
Bronx Park
Bronx, New York 10058

Herbarium: about 3,000,000 specimens, world-wide, spec. tropical America, Orient, Hawaii, etc. Library specializes in botany, agriculture, herbals, horticulture, and plant pathology.
65,000 volumes, 100 vertical file drawers

*60.15.7 New York Public Library
5th Avenue & 42nd Street
New York, New York 10018

General collection, excellent map collection
7,229,878 volumes

60.0 UNITED STATES OF AMERICA (USA) (contd)

60.16.0 North Carolina

United States Weather Bureau
National Records Center Archives and Library
Grove Arcade Building
Asheville, North Carolina

Herbarium, Meteorological
collection with worldwide scope.
7000 feet of manuscript weather records
1200 linear feet of published material
61, 500 reels of microfilm of manuscript weather records, analyzed synoptic charts, and TIROS photos

60.17.0 Pennsylvania

University of Pennsylvania Library
Philadelphia, Pennsylvania 19104

General collection, with emphasis upon South Asia.
1, 745, 000 volumes

60.18.0 South Carolina

Laboratory of Tropical Diseases Library
U.S. Public Health Service
Drawer 189
Columbia, South Carolina 29202

Collection of information on tropical diseases

60.19.0 Virginia

*60.19.1 Library, Central Intelligence Agency
Langley, Virginia 20505

Excellent collection of essentially classified materials.

60.19.2 Defense Documentation Center (formerly ASTIA)
Cameron Station Building 5
Alexandria, Virginia 22314

Collects and disseminates DOD scientific and technical reports. Classified and unclassified materials.

*60.19.3 Library
Defense Intelligence Agency
Arlington Hall Station, Virginia 22212

Excellent collection of essentially classified materials.

60.19.4 Clearing house for Federal Scientific and Technical Information
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Formerly Office of Technical Services. Center for the collection and sale of technical reports resulting from Government financed research and development.

60.20.0 Wisconsin

Library
Aquarium Research and Experimental Society
P.O. Box 5142
Milwaukee, Wisconsin 53204

Library maintains a collection on tropical fish.

60.21.0 Canal Zone

60.21.1 Canal Zone Library and Museum
Balboa Canal Zone, Panama

Special collection dealing with history of canal and works on Panama.
145,000 volumes

60.21.2 Library, Canal Zone Biological Area
Smithsonian Institution
Balboa, Canal Zone, Panama

Library maintains reference service on the biology, geology, and meteorology of the Canal Zone and Panama.

60.21.3 Panama Canal Company
Balboa Heights, Panama

Meteorological information

60.0 UNITED STATES OF AMERICA (USA) (contd)

60.22.0 Puerto Rico

60.22.1 Institute of Tropical Forestry
U.S. Forest Service
P.O. Box 577
Río Piedras, Puerto Rico 00928

Institute conducts research on tropical forest and watershed management. Library of 10,000 volumes
About 3000 specimens
Herbarium: trees of Puerto Rico and Caribbean

60.22.2 Puerto Rico Agricultural Experiment Station
University of Puerto Rico
Río Piedras, Puerto Rico 00928

Acts as a consulting service on tropical agriculture.

60.22.3 University of Puerto Rico
Institute of Caribbean Studies
Apartado B.M.
Río Piedras, and Mayagüez, Puerto Rico

Río Piedras main facility. Mayagüez center serves as clearing house for geological research in Caribbean.

60.23.0 Virgin Islands

Library
U.S. Department of Agriculture
Virgin Island Agricultural Research and Extension Program
Kingshill Post Office
St. Croix, Virgin Islands 00850

Maintains holdings on tropical agriculture and animal husbandry.

61.0 VENEZUELA

61.1 Instituto Botánico
Apartado 2156
Caracas, Venezuela

100,000 specimen herbarium and a good basic library.
Herbarium: Venezuelan plants

61.2 Biblioteca Nacional
Caracas, Venezuela

General collection with special emphasis on Venezuela.
300,000 volumes

61.3 Herbarium and Library
Universidad de Los Andes
Mérida, Venezuela

61.4 Biblioteca
Instituto de Zoología Tropical (IZT)
Facultad de Ciéncias
Universidad Central de Venezuela
Apartado Sabana Grande 10098
Caracas, Venezuela

Library: 7,000 volumes, collections of neotropical animals

APPENDIX C

AN INDEX OF AERIAL PHOTOGRAPHY AND MAPPING COVERAGE OF THE HUMID TROPICS

TABLE NO. 1 - AERIAL PHOTOGRAPHY

TABLE NO. 2 - TOPOGRAPHIC & PLANIMETRIC MAPS

TABLE NO. 3 - GEOLOGIC MAPS

TABLE NO. 4 - SOILS AND LAND CAPABILITY MAPS

TABLE NO. 5 - VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

APPENDIX C

AN INDEX OF AERIAL PHOTOGRAPHY AND MAPPING COVERAGE OF THE HUMID TROPICS

Initial steps in the attempts to assess the state of knowledge of the humid tropic environment include a complete inventory of already existing basic data. Inasmuch as aerial photography is an excellent source of data concerning the physical landscape, and maps are one of the most common and effective methods of depicting environmental information, the following index is essential to the evaluation of the humid tropics.

The index presents information concerning the extent of areal coverage, date of most recent coverage, scales, main holding agencies, sources of additional and more detailed information and other remarks for each country in the humid tropics for each of the following categories:

1 - Aerial photography

2 - Topographic and planimetric maps

3 - Geologic maps

4 - Soils and land capability maps

5 - Vegetation, land use, ecology and forest inventory maps

Values indicating extent of areal coverage refer only to that portion of each country that is within the humid tropics (Note Figure 1, Chapter I).

Climatological, hydrologic, transportation, city plan, and other pertinent maps have been omitted because of the great difficulty and complexity of obtaining and indexing such information, due primarily to the lack of compiled index materials.

National and special purpose atlases are listed on page D-16 of the KWIC Index, Humid Tropic Environmental Literature, Volume I of this report. Special purpose maps, map catalogues and reports concerning map coverage are listed on pages D-122 through D-126 of the same volume.

Important compilations of environmental maps are indicated in the body of the report. Reference should be made to these special purpose listings for additional information, such as the series noted in

Chapter IV WEATHER AND CLIMATE. ("An annotated bibliography of Climatic Maps of . . . . . .") This series is produced by the Foreign Area Section, Office of Climatology, U. S. Weather Bureau, ESSA, Washington, D. C.

Such small scale map series as the World Aeronautical Charts (1:250,000) and the USAF Operational Navigation Charts (1:1,000,000), both published by the USAF Aeronautical Chart & Information Center, St. Louis, Missouri, cover the entire humid tropics and are not considered in the following tables.

Primary sources for actual examination of the maps and aerial photographs are noted in Appendix B of this report. Individuals most knowledgeable of the extent, status and availability of map and aerial photography in the humid tropics are noted in Appendix A of this report under the heading, Geodesy.

Plate No. I indicates the order of arrangement of the following index. The alphabetic order of countries by continent is that which was established for Volume I of this inventory. The plate also shows the page number location for each country and the presence or absence of data according to subject.

PLATE I

INDEX OF AIR PHOTO AND MAP COVERAGE

LATIN AMERICA	Tables 1	2	3	4	5	Page
Barbados	x		x	x	x	374
Bolivia						374
Brazil						376
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British Honduras						378
Colombia						380
Costa Rica						381
Cuba	x					383
Dominica Island	x		x	x	x	384
Dominican Republic						385
Ecuador						386
El Salvador						388
French Guiana						389
Guadeloupe Island	x			x	x	391
Guatemala						391
Haiti						393
Honduras						394
Jamaica				x	x	396
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Martinique	x			x	x	398
Mexico						399
Nicaragua						401
Panama						402
Paraguay						404
Peru						405
Puerto Rico						407
St. Lucia Island	x		x	x	x	408
St. Vincent Island	x		x	x	x	409
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AFRICA	Tables 1	2	3	4	5	Page
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Burundi				x	x	416
Cabinda (Angola)				x	x	417
Cameroon						418
Central African Republic				x	x	419
Chad						420
Comores Islands	x		x	x	x	422
Congo, French				x	x	422
Congo, Belgian						423
Dahomey				x		425
Fernando Poo	x			x	x	426
Gabon						427
Gambia				x		428
Ghana						429
Guinea				x	x	431
Ivory Coast					x	432
Kenya						433
Liberia				x	x	435
Madagascar	x					436
Mozambique				x		437
Nigeria						438
Northern Rhodesia						440
Nyasaland						441
Portuguese Guinea				x	x	443
Rio Muni	x			x	x	444
Rwanda	x			x	x	444
Senegal				x		445
Sierra Leone						447
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Sudan				x		450
Tanganyika						451
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x - No Data

PLATE I (CONTD)

SOUTH ASIA	Tables 1	2	3	4	5	Page
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Burma						458
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China (Communist)	x		x	x		462
China (Nationalist						463
India				x		465
Laos				x	x	466
Malaysia						467
Nicobar Islands	x		x	x	x	468
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Thailand						470
Vietnam (North)	x			x	x	471
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OCEANIA

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Brunei				x		476
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Indonesia	x			x		477
New Caledonia	x				x	478
New Guinea	x					479
New Hebrides	x		x	x	x	481
North Borneo				x		481
Palau Islands	x			x		482
Papua	x			x		483
Philippines	x					484
Ryukyu Islands	x	x	x	x	x	485
Sarawak				x		485
Solomon Islands	x			x	x	486
Timor	x	x	x	x	x	487
Hawaii					x	487

x - No Data

LATIN AMERICA

BARBADOS

AREA	TABLE NO. 2
BARBADOS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1960				

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

The large scale mapping consists of D.O.S. series E749 (#418) at 1:50,000 completed in 1960 and D.O.S series E 8412 at 1:10,000 completed in 1956

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

BOLIVIA

AREA	TABLE NO. 1
BOLIVIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
0.1%	1962	1%	1961	55%	1964

MAIN HOLDING AGENCIES

(1) Instituto Geografico Militar
Miraflores
La Paz, Bolivia

(2) Yacimientos Petroliferos Fiscales Bolivianos
Edificio YPFB
La Paz, Bolivia

REMARKS

The photography is for the most part at a scale of 1:40,000. There is very little large scale photography. The 0.1% indicated is at 1:8,000 of the municipal area of La Paz.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Bolivia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 14p.

AREA
BOLIVIA

TABLE NO. 2
TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
8%	1963	5%	1960	35%	1960

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Militar
Miraflores
La Paz, Bolivia

(2) Yacimientos Petrolíferos
Fiscales Bolivianos
Edificio YPFB
La Paz, Bolivia

REMARKS

The IGM (1) series as projected will cover all current and potential areas of economic development. This includes the entire country except for the eastern lowlands near the Paraguay and Brazil borders. The remainder of the country is scheduled for coverage at 1:250,000.

There is an old IGM series at 1:250,000 which was compiled between 1939 and 1951 from field reconnaissance and other map sources. It covers most or all of the country, but is not considered in this table.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Bolivia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 14p.

AREA
BOLIVIA

TABLE NO. 3
GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE		SMALL SCALE (1:250,001 - 1:500,000)	
7%	1963	45%	1961	3%	1960

MAIN HOLDING AGENCIES

(1) Departamento Nacional de Geología
Avenida 16 de Julio No. 1769
Casilla Correos 2749
La Paz, Bolivia

(2) Yacimientos Petrolíferos
Fiscales Bolivianos
Edificio YPFB
La Paz, Bolivia

REMARKS

Although there has been a large amount of geologic mapping by various private oil companies, very little of it is available to the general public.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Bolivia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 14p.

AREA
BOLIVIA

TABLE NO. 4
SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
0.1%	1962	2%	1963		

MAIN HOLDING AGENCIES

(1) Servicio Agrícola Interamericano
Colón 290
La Paz, Bolivia

REMARKS

Nearly all land capability maps are at a scale of 1:40,000 based on aerial-controlled photo-mosaics. They are basically working instruments for colonization activities, and do not exist in published form.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Bolivia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 14p.

AREA:
BOLIVIA

TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1963

MAIN HOLDING AGENCIES

(1) Servicio Agrícola Interamericano
Ministerio de Agricultura, Ganadería y Colonización
Colón 290
La Paz, Bolivia

REMARKS

Virtually no mapping on these subjects for Bolivia. SAI (1) field parties performed a forest inventory with their land capability surveys.

A Mapa Fitogeográfico de Bolivia (Agrommadol was reproduced in blueprint by the SAI in 1963 at the scale of 1:2,000,000 showing 14 mapping units.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Bolivia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 14p.

BRAZIL

AREA	TABLE NO. 1
BRAZIL	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
2%	1964	30%	1964	45%	1965

MAIN HOLDING AGENCIES

(1) Conselho Nacional de Geografia
Instituto Brasileiro de Geografia e Estatística
Av. Franklin Roosevelt 166
Rio de Janeiro, Brazil

(2) Diretoria do Serviço Geográfico do Exército
Rua Major Daemon, 81
Praça Mauá
Estado Guanabara,
Brazil

REMARKS

About 75% of Brazil has been covered by some form of vertical-aerial photography. A small map produced by agency (1) indicates that virtually all of the Northeast and South are covered by small scale photography.

The most important project now underway is one being carried out by the U.S. Air Force in cooperation with the Brazilian Government, designed to produce 1:60,000 scale coverage of all territory south of 14°S and east of 51°W. This was reported to be 48% complete as of October, 1965.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Brazil: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

AREA	TABLE NO. 2
BRAZIL	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,000 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
13%	1963	7%	1962	50%	1963

MAIN HOLDING AGENCIES

(1) Conselho Nacional de Geografia
Instituto Brasileiro de Geografia e Estatística
Av. Franklin Roosevelt 166
Rio de Janeiro, Brazil

(2) Directoria do Servico Geografico do Exército
Rua Major Daemon, 81
Praça Mauá
Estado Guanabara
Brazil

REMARKS The entire country is covered by a 1:1,000,000 maps series with 100 meter contour intervals, published by agency (1). Approximately 45% of the country is covered at 1:500,000 with coverage over additional areas at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Brazil: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

AREA	TABLE NO. 3
BRAZIL	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
1%	1965	30%	1963	35%	1963

MAIN HOLDING AGENCIES

(1) Departamento Nacional da Produção Mineral
Ministério da Agricultura
Rio de Janeiro, Brazil

(2) Conselho Nacional de Geografia
Instituto Brasileiro de Geografia y Estatística
Av. Franklin Roosevelt 166
Rio de Janeiro, Brazil

REMARKS The entire country is covered at a scale of 1:5,000,000 on a general geology map published by agency (1) in 1960. There is a great deal of mapping at scales ranging from 1:5,000,000 to 1:200,000. Work in process in 1962 included a joint project by agency (1) and another agency to compile a 1:1,000,000 geological series for the entire country.

Very little large-scale mapping has been done in Brazil

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Brazil: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

AREA	TABLE NO. 4
BRAZIL	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
1%	1961	1%	1964	5%	1964

MAIN HOLDING AGENCIES

(1) Divisao de Pedologia e Fertidade do Solo
Centro Nacional de Ensino e Pesquisas Agronômicas
Ministério da Agricultura
Rio de Janeiro, Brazil

REMARKS Major maps of the entire country range in scale from 1:15,000,000 to 1:5,000,000. Maps ranging in scale from 1:5,000,000 to 1:200,000 cover portions of the country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Brazil: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

AREA:	TABLE NO. 5 VEGETATION, LAND USE,
BRAZIL	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
1%	1960	1%	1960	10%	1962

MAIN HOLDING AGENCIES

(1) Conselho Nacional de Geografia
Instituto Brasileiro de Geografia e Estatistica
Av. Franklin Roosevelt 166
Rio de Janeiro, Brazil

(2) Servico Florestal
Ministerio de Agricultura
Jardim Botânico
Rio de Janeiro, Estado da Guanabara, Brazil

REMARKS Among the best small scale vegetation maps are the Mapa Fitogeográfico do Estado de Paraná at 1:2,000,000 by Reinhaard Maack, a phytogeographical map of Pernambuco at 1:1,000,000 based on air photo interpretation, and several maps at 1:5,000,000 published by agency (1). There was an Amazon forest inventory in which 17,000,000 hectares were mapped at a preliminary scale of 1:40,000 and published at 1:2,000,000, between 1953 and 1961. Aside from the preliminary maps at 1:40,000, there are no outstanding medium or large-scale vegetation maps in Brazil.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Brazil: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

BRITISH GUIANA

AREA:	TABLE NO. 1
BRITISH GUIANA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
				15%	1961

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooke Lane
Washington, D.C. 20315

(2) Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

REMARKS Aerial photography at a scale of 1:60,000 being flown for the Army Map Service was 15% complete as of 1961.
Trimetrogon photography at a scale of 1:40,000 taken between 1942-1947 also exists for approximately half of British Guiana

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

1. Index of Aerial Photographic Coverage: Photographic Records and Services Division, Aeronautical Chart and Information Center, United States Air Force, 2nd & Arsenal, St. Louis, Mo. 63118

AREA	TABLE NO. 2
BRITISH GUIANA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1953	100%	1957		

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale map cover is D.O.S. Series Y 791 at 1:50,000 and A.M.S. photomap series E091 completed in 1965 at 1:25,000.

Medium Scale cover consists of AMS photo map series E092 at 1:62,500

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys: Directorate of Overseas Surveys, Kingston Road, Tolworth Surbiton, Surrey, England

AREA	TABLE NO. 1
BRITISH GUIANA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		100%	1961	100%	1962

MAIN HOLDING AGENCIES

(1) Geological Survey of British Guiana
Georgetown, British Guiana

(2) United States Army Map Service
6500 Brooke Lane
Washington, D C.

REMARKS

Small-scale coverage is at 1:1,000,000. Provisional Geological Map of British Guiana. Geol. Surv. British Guiana (1962).

Geological Survey of British Guiana has produced maps which cover 49% of the country (particularly mineral districts) at varying scales from 1:5,000 to 1:200,000 between 1934 and 1954. Medium-scale coverage is complete at 1:125,000 and 1:200,000 by Geol. Serv. Brit. Guiana.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA:	TABLE NO. 5 VEGETATION, LAND USE,
BRITISH GUIANA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		100%	1960	100%	1961

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS Small-scale mapping is area: lease map D.O.S. (mis.) 315A at 1:2,000,000 (1961) and forest surveys map D.O.S. (misc) 315B.

Series G.S.G.S. 4811 covers agriculture and vegetation completely at 1:50,000.

There is no available land use map of the country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

BRITISH HONDURAS

AREA	TABLE NO. 1
BRITISH HONDURAS	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:50,000)		SMALL SCALE (1:50,001 AND SMALLER)	
		40%	1959	100%	1947

MAIN HOLDING AGENCIES

(1) Aero Service Corporation
Philadelphia, Pennsylvania
(2) Aeronautical Chart and Information Center
United States Air Force
2nd & Arsenal
St. Louis, Mo. 63118

REMARKS

Small scale coverage is trimetrogon photography

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart and Information Center
United States Air Force
2nd and Arsenal
St. Louis, Mo. 63118

AREA	TABLE NO. 2
BRITISH HONDURAS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1958+			100%	1:48

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale mapping is D.O.S. series Z 757 (misc.) 8
Small scale mapping is at 1:250,000. D.O.S. 6490 series E552

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
BRITISH HONDURAS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1958

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Small scale map is D.O.S. (misc.) 241-K at scale of 1:1,000,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA:	TABLE NO. 4
BRITISH HONDURAS	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE 1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	1959

MAIN HOLDING AGENCIES:

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS:

Soils coverage consists of 2 sheets at 1:250,000 by D.O.S. Series (Misc.) 241-A

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA: BRITISH HONDURAS	TABLE NO. 4 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1959

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Small scale mapping consists of D.O.S. series (Misc.) 241-B (vegetation) and D.O.S. (misc.) 241-C (potential land use). 2 sheets each at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

COLOMBIA

AREA: COLOMBIA	TABLE NO. 1 AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 & SMALLER)	
1%	1962	12%	1962	55%	1963

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Agustín Codazzi
Carrera 30, No. 48-51
Ciudad Universitaria
Bogotá, Colombia

REMARKS

Photography of the Andean section of the country is well advanced. The largest unphotographed region is the Amazonian territory. Priorities are to complete the more developed regions first.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Colombia. Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1963, 16p.

AREA: COLOMBIA	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 & SMALLER)	
25%	1963	70%	1963	15%	1963

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Agustí. Codazzi
Carrera 30, No. 48-51
Ciudad Universitaria
Bogotá, Colombia

REMARKS

The IGAC (1) is concentrating on two topographic series at 1:25,000 and 1:100,000, also an extensive planimetric program at 1:20,000 and 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Colombia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1963, 16p.

AREA	TABLE NO. 4
COLOMBIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
3%	1961	10%	1963	50%	1961

MAPS HOLDING AGENCIES

(1) Servicio Geológico
Nacional de Minas y Petróleos
Ciudad Universitaria
Bogotá, Colombia

REMARKS

Since 1956, the SGN (1) has been publishing a 1:200,000 series entitled Mapa Geológico de la República de Colombia, of which 5 sheets had been published as of 1963.

In 1962, the SGN published a 1:1,500,000 geologic map of the country, compiled from published and unpublished sources. It portrays geologic eras, periods, and major lithologic types.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Colombia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20036, 1963, 16p.

AREA	TABLE NO. 4
COLOMBIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
1%	1962	8%	1961	39%	1963

MAPS HOLDING AGENCIES

(1) Soils Department
Instituto Geográfico Agustín Codazzi
Carrera 30, No. 48-51
Ciudad Universitaria
Bogotá, Colombia

(2) Lic. Fernando Irusta, Ingeniero Agrónomo
Carrera 29, No. 35-56
Bogotá, Colombia

REMARKS

FAO is carrying out a Special Fund project to make a reconnaissance soil survey of the Llanos Orientales, to result in the production of a series of 1:250,000 soils maps. In addition to this, the most extensive and important reconnaissance studies are those of the Río Magdalena-Norte Colombia region.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Colombia: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1963, 16p.

AREA:	TABLE NO. 5 VEGETATION, LAND USE,
COLOMBIA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1963

MAIN HOLDING AGENCIES

(1) Sección de Estudios Ecológicos
Soils Department
Instituto Geográfico Agustín Codazzi
Carrera 30, No. 48-51
Ciudad Universitaria
Bogotá, Colombia

REMARKS

A small amount of vegetation mapping has been done, but there is presently no agency with sufficient funds to carry out the vast amount of work necessary.

Agency (1) was completing an ecological map of the country at 1:1,000,000 in 1963, using the system of Holdridge. It was to be published as funds became available.

Some land use information is correlated with soils-mapping units. Land use mapping as such is not in evidence in Colombia.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Colombia: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1963, 16p.

COSTA RICA

AREA
COSTA RICA

TABLE NO. 1
AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		25%	1961	95%	1961

MAIN HOLDING AGENCIES

(1) Instituto Geográfico de Costa Rica
Ministerio de Transportes
Apartado 2272, San José

REMARKS

A current program will obtain photography of large portions of the central part of Costa Rica at a scale of 1:20,000.

Small scale photography taken by the United States Air Force covers most of the country.

Medium scale photography covers seventeen urbanized areas.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Costa Rica: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 14 p.

AREA
COSTA RICA

TABLE NO. 2
TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
85%	1960			100%	1957

MAIN HOLDING AGENCIES

(1) Instituto Geográfico de Costa Rica
Ministerio de Transportes
Apartado 2272, San José

(2) Compañía Petrolera de Costa Rica
San José

REMARKS

A series of 1:50,000 scale topographic maps is in production that will cover the entire country. Agency (1)

Agency (1) has also published a three sheet map of Costa Rica at a scale of 1:500,000 and many minor civil divisions at 1:50,000.

Agency (2) has produced an unpublished series of planimetric maps at a scale of 1:40,000. It covers most of the country east of 84°W longitude.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Costa Rica: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 14 p.

AREA
COSTA RICA

TABLE NO. 3
GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
6%	1963	6%	1964	100%	1963

MAIN HOLDING AGENCIES

(1) Instituto Geográfico de Costa Rica
Ministerio de Transportes
Apartado 2272, San José

(2) Departamento de Geología, Minas y Petróleo
Ministerio de Industrias
San José

REMARKS

The United States Geological Survey published the "Geological Map of Central America" in 1967 at a scale of 1:1,000,000. It is one of the major geologic maps of Costa Rica.

At the present time there is no national geological mapping program in Costa Rica. However, funds have been requested to support a 1:50,000 geologic series.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Costa Rica: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C., 20006, 1965, 14 p.

AREA
COSTA RICA

TABLE NO. 4
SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:20,000 - LARGER)		MEDIUM SCALE (1:20,001 - 1:50,000)		SMALL SCALE (1:100,000 - 1:500,000)	
5%	1964	15%	1964	100%	1964

MAIN HOLDING AGENCIES

(1) Departamento de Conservación de Suelos
Ministerio de Agricultura y Ganadería
Edificio Marshall
San José

(2) Facultad de Agronomía
Universidad de Costa Rica
Ciudad Universitaria
San José

(3) Instituto de Tierras y Colonización
Edificio Pozuelo
San José

REMARKS

The government agencies (2) and (3) are not involved in a systematic soil mapping program. However, agency (3) conducts a mapping program with its colonization projects

A land capability map of the country was published at a scale of 1:500,000 in 1964 by the Organización de las Naciones Unidas para la Agricultura y la Alimentación.

Numerous unpublished reports and maps are available at agency (2).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Costa Rica: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C., 20006, 1965, 14 p.

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
COSTA RICA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:500,000)		SMALL SCALE (1:500,001 AND SMALLER)	
1%	1964	10%	1964	100%	1960

MAIN HOLDING AGENCIES

(1) Instituto Interamericano de Ciencias Agrícolas
Turrialba

(2) Instituto de Tierras y Colonizacion
Edificio Pozuelo
San Jose

(3) Instituto Geográfico de Costa Rica
Ministerio de Transportes
Apartado 2272, San Jose

REMARKS

An ecologic map of Costa Rica was published by agency (1) in 1960 and revised in 1964. Numerous unpublished maps and reports are available at the library of this agency.

The Food and Agriculture Organization of the United Nations has scheduled a forest inventory study for Costa Rica.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Costa Rica: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C., 20006, 1965, 14 p.

CUBA

AREA	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS
CUBA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500,000)		SMALL SCALE (1:500,001 - 1:999,999)	
100%	1962			100%	1933(?)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D C 20025

REMARKS

Small-scale is 1:500,000 by Engineer Reproduction Plant, U.S. Army, 1931. Large scale coverage is photomap series at 1:25,000 by A.M.S. done in 1962

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 3 GEOLOGIC MAPS
CUBA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:999,999)	
				100%	1955

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping is a 1:1,000,000 geologic sketch map published by the Ministerio de Agricultura, Direccion de Minas (?)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
CUBA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooke Lane
Washington, D.C., 20025

REMARKS

A soils map of Cuba at 1:500,000 exists at the A.M.S. (1328) (?)
Havana Province was completely covered at a scale of 1:40,000 in 1955.
Maps are held by A.M.S.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
CUBA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1949

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping is at a scale of 1 inch to 12-1/2 miles. Map of the vegetation types of Cuba, by Gerardo Canet.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

DOMINICA ISLAND

AREA	TABLE NO. 2
DOMINICA ISLAND	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1963			100%	1964

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale map cover is at 1:25,000, D.O.S. Series E 847, 1960, and D.O.S. series E703, 1963.

Small scale map cover is at 1:122,500 (D.O.S. #998)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

DOMINICAN REPUBLIC

AREA	TABLE NO. 1
DOMINICAN REPUBLIC	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:19,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
4%	1955	18%	1958	100%	1960

MAIN HOLDING AGENCIES

(1) Instituto Cartográfico Universitario
Calle El Conde No. 2
Santa Domingo, D.N.

REMARKS

The Dominican Republic is well supplied with small scale, recent air photo coverage. There have been three projects on a national scale which have in each case produced 80-100% coverage. The first was trimetrogon photography taken by the USAAF (1942-1944). The second was 1:40,000 vertical coverage taken by the USAF (1947-1948). The third project was 1:60,000 photography taken by Spartan Air Services Ltd., Toronto, Canada, (1956-1960) for the ICU (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of the Dominican Republic: Natural Resources Unit, Dept. of Economic Affairs Pan American Union, Washington, D. C., 20006, 1964, 10p.

AREA	TABLE NO. 2
DOMINICAN REPUBLIC	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:19,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
12%	1961	100%	1962	100%	1962+

MAIN HOLDING AGENCIES

(1) Instituto Cartográfico Universitario
Calle El Conde No. 2
Santo Domingo, D.N.

REMARKS

The ICU (1) is presently compiling a national topographic map series for publication at 1:50,000. No sheets available yet, but compilation work is farthest advanced on the sheets that will cover the southwest portion of the country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of the Dominican Republic: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

AREA	TABLE NO. 3
DOMINICAN REPUBLIC	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:19,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
30%	1955	20%	1962	100%	1959

MAIN HOLDING AGENCIES

(1) Dirección de Minas
Secretaría de Industria y Comercio
Santo Domingo, D. N.

REMARKS

The most active program of geologic mapping now in progress is sponsored by the Department of Geology of Princeton University

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of the Dominican Republic: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C., 20006, 1964, 10p.

AREA	TABLE NO. 4
DOMINICAN REPUBLIC	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
6%	1963				

MAIN HOLDING AGENCIES

(1) Corporación Azucarera
Santo Domingo, D. N.

(2) La Grenada Company
Santo Domingo, D. N.

(3) Central La Romana Corp.
La Romana, Seybo
Dominican Republic

REMARKS

All of the soils survey work of this country has been done by the sugar companies on their own lands. Maps are essentially unpublished.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of the Dominican Republic: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
DOMINICAN REPUBLIC	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
2%	1949			100%	1963

MAIN HOLDING AGENCIES

(1) Instituto Cartográfico Universitario
Calle El Conde No. 2
Santo Domingo, D. N.

REMARKS

Mapping in these fields is extremely scarce. Available are some small scale reconnaissance maps that delineate forest or vegetation type zones and a small scale map of principal crop areas which cover the entire country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of the Dominican Republic: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

ECUADOR

AREA	TABLE NO. 1
ECUADOR	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
1%	1963	4%	1963	45%	1964

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Militar
Ambato 326
Quito

(2) Aeronautical Chart & Information Center
U.S. Air Force
2nd and Arsenal
St. Louis, Missouri 63118

REMARKS

The United States Air Force is currently photographing the country at a scale of 1:60,000. More than 20% of this program has been completed.

Older photography ranging in scale from 1:10,000 to 1:70,000 dates back to 1942.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Ecuador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 18p.

AREA: ECUADOR

TABLE NO. 2

TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
20%	1965	60%	[illegible]	100%	1957

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Militar
Ambato 326
Quito

REMARKS

IGM (1) is presently producing a topo map series of the coast and Sierra region at the scale of 1:50,000 based on aerial photography. Twenty-five (25) sheets have been published others are in final stages. Area east of Sierra region to be covered at 1:100,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Ecuador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 18p.

AREA: ECUADOR

TABLE NO. 3

GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
				100%	1964

MAIN HOLDING AGENCIES

(1) Dirección General de Recursos Mineros e Hidrocarburos
Ministerio de Fomento
Quito

REMARKS

There is a very limited amount of geologic mapping available for Ecuador. Most of what has been produced is of small scales and by foreign geologists, often working for oil exploration companies.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Ecuador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 18p.

AREA: ECUADOR

TABLE NO. 4

SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
1%	1964			12%	1964

MAIN HOLDING AGENCIES

(1) Departamento de Suelos
Ministerio de Fomento
Quito

(2) Caja Nacional de Riego
Calle Riofrio 314
Quito

(3) Instituto Nacional de Colonización
Quito

REMARKS

There is no current program of national soil survey, although some field work is being conducted. The soils work of the CNR (2) is of high quality but confined to the agency's irrigation project which consists of relatively small areas.

The INC (3) does some soils mapping as a part of its program in colonizing virgin areas.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Ecuador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 18p.

AREA: ECUADOR

TABLE NO. 5

VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
1%	*	2%	1961	100%	1964

MAIN HOLDING AGENCIES

(1) Dirección General de Fomento Forestal
Ministerio de Fomento
Quito

(2) Desarrollo Forestal de Noroccidente
Washington 958
Quito

REMARKS

The DGFF (1) and the DFN (2) have major programs of land investigation and mapping. The major project to date has been the compilation of the Mapa Ecológico Preliminar del Ecuador, completed in 1962 based on Holdridge's classification system.

Land use at the scale of 1:2,000,000 was completed in 1963 for the coast and Sierra regions by the DGFF (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Ecuador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 18p.

EL SALVADOR

AREA	TABLE NO. 1
EL SALVADOR	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
5%	1961	76%	1963	100%	1954

MAIN HOLDING AGENCIES

(1) Dirección General de Cartografía
Avenida Juan Bertís, 59
San Salvador

(2) Compañía Mexicana
Aerofoto, S.A.
Obero Mundial, 338
Mexico, D.F.

REMARKS

Entire country covered at scales 1/60,000 (1954) and 1/40,000 (1969) for (1) by the U.S. Navy. Supplemented in 1962-3 by 1/20,-22,000 photography covering over 3/4 of El Salvador by (2). All important urban areas are available at large scales, irrigation projects and highway construction at various scales from (2).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of El Salvador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 15p.

AREA	TABLE NO. 2
EL SALVADOR	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE		SMALL SCALE	
40%	1964	100%	1964	100%	1961

MAIN HOLDING AGENCIES

(1) Direccion General de Cartografía
Avenida Jua. Bertís, 59
San Salvador

REMARKS

DGC (1) has a good 1:100,000 scale planimetric base of the country done in 1961 and 46 sheets of the 1/50,000 scale topo series covering 90% of country already published. Remaining sheets for northern border area are due in 1966. Large scale maps compiled by DGC exist for all important urban areas and recent irrigation projects.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of El Salvador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1969, 12p.

AREA	TABLE NO. 3
EL SALVADOR	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
10%	1963	60%	1954	100%	1961

MAIN HOLDING AGENCIES

(1) Centro de Estudios e Investigaciones Geotécnicas (CEIG)
Ministerio de Obras Públicas
La Calle Poniente No. 925
San Salvador

REMARKS

CEIG (1) plans to compile a geologic base map of the country at scale of 1:200,000. All of El Salvador is covered at scales of 1/400,000 to 1/1,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of El Salvador: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1969, 12p.

AREA	TABLE NO. 4
EL SALVADOR	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
2%	'	40%	1966	100%	1964

MAIN HOLDING AGENCIES

(1) Dirección General de Investigaciones Agronómicas (DGIA)
Ministerio de Agricultura y Ganadería
Nueva San Salvador

REMARKS

DGIA (1) is producing a series of soils maps at 1:50,000 of entire country. All field work complete and 19 (33%) sheets published.

FAO of UN produced a land capability map of entire country at scale of 1:300,000 in 1964.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of El Salvador. Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 12p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
EL SALVADOR	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1959

MAIN HOLDING AGENCIES

REMARKS

1954 Atlas Censal contains a 1:500,000 scale vegetation map by Wilhelm Lauer. In 1959 the IAIAS published L. R. Holdridge's Mapa Ecológico de El Salvador at the scale of 1:1,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of El Salvador. Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 12p.

FRENCH GUIANA

AREA	TABLE NO. 1
FRENCH GUIANA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Aeronautical Chart and Information Center
United States Air Force
2nd and Arsenal
St. Louis, Mo 63118

REMARKS

About 60% of French Guiana is covered by trimetrogon photography taken between 1946-1947

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Aeronautical Chart and Information Center
Photographic Records and Services Division
United States Air Force
2nd & Arsenal
St. Louis, Mo. 63118

AREA	TABLE NO. 2
FRENCH GUIANA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	?	100%	?	100%	?

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

REMARKS

Large scale coverage is at 1:50,000
Medium scale coverage is at 1:100,000
Small scale coverage consists of two series
1) 11 sheets at 1:200,000, and
2) 2 sheets at 1:500,000
All of the above four series individually provide complete coverage.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog des Cartes de l'I.G.N.
Institute Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

AREA	TABLE NO. 3
FRENCH GUIANA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
		25%	1962	50%	1949

MAIN HOLDING AGENCIES

REMARKS

Geology of northern French Guiana is covered at 1:500,000
Medium-scale coverage consists of two series at 1:100,000 and 1:200,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
FRENCH GUIANA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		20%	1961		

MAIN HOLDING AGENCIES

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
FRENCH GUIANA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1942

MAIN HOLDING AGENCIES

REMARKS

The forests of French Guiana were covered completely at 1:2,500,000 in 1942

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

GUADELOUPE ISLANDS

AREA	TABLE NO. 2
GUADELOUPE ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - SMALLER)	
100%					

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

REMARKS

Large scale coverage consists of two series

1) 36 sheets at 1:20,000 and
2) 9 sheets at 1:50,000

Both series provide complete coverage

3) AMS E033 at 1:25,000, photomap series in 1962 covers entire island also.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog des Cartes de l'I.G.N.
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

AREA	TABLE NO. 3
GUADELOUPE ISLANDS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - SMALLER)	
10%	1965(?)				

MAIN HOLDING AGENCIES

REMARKS

A geologic map of Guadeloupe at 1:50,000 was in preparation and scheduled to appear in 1965.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

GUATEMALA

AREA
GUATEMALA

TABLE NO. 1
AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 AND LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
0%		17%	1965	100%	1964

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Nacional
Ministerio de Comunicaciones y Obras Públicas
Avenida Las Américas 5-17
Guatemala

REMARKS

All of Guatemala is covered at a scale of 1:60,000 and over 3/4 at 1:40,000. Almost all of the 1:60,000 photography is more than 10 years old, but the 1:40,000 dates from 1961-1964.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Guatemala: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 13p.

AREA
GUATEMALA

TABLE NO. 2
TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
40%	1961			100%	1965

MAPS HOLDING AGENCIES

(1) Instituto Geográfico Nacional
Ministerio de Comunicaciones y Obras Públicas
Avenida Las Américas 5-17
Guatemala

REMARKS

IGN (1) is publishing two topographic map series, one at 1:250,000, the other at 1:50,000. The published sheets of the first cover all of Guatemala south of 15°N. The second presently covers the S W and S E portions of the country plus a band extending across the center of the country and a portion of the central Petén region.

Large scale maps have been prepared at 1:5,000 for more than 40 urban regions by the Dirección General de Caminos.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Guatemala: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 13p.

AREA
GUATEMALA

TABLE NO. 3
GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
7%	1963	60%	1964	100%	1960

MAIN HOLDING AGENCIES

(1) Dirección General de Minería e Hidrocarburos
Ministerio de Economía
Guatemala

(2) Instituto Geográfico Nacional
Ministerio de Comunicaciones y Obras Públicas
Avenida Las Américas 5-17
Guatemala

(3) Instituto Nacional de Electrificación
Guatemala

REMARKS

In 1961 the DGMH (1) and the Dirección General de Caminos, in collaboration with USGS, initiated a joint geologic mapping program to produce 1:250,000 and 1:50,000 scale geologic maps. The major purpose of the program is the investigation of non-metallic mineral resources.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Guatemala: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 13p.

AREA
GUATEMALA

TABLE NO. 4
SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
1%	1963			100%	1959

MAIN HOLDING AGENCIES

(1) Instituto Agropecuario Nacional
Ministerio de Agricultura
La Aurora, Guatemala

(2) Dirección General de Recursos Hidráulicos
Ministerio de Agricultura
Guatemala

REMARKS

In 1959, the IAN (1) published a soils maps of Guatemala at a scale of 1:250,000. The text which accompanies the map gives information on soils, climate, vegetation, population distribution, land use, etc.

Both IAN and DGRH (2) have done some detailed soil studies, accompanied by 1:10,000 soils maps, as well as infiltration and irrigation capability maps, of existing or contemplated irrigation projects.

An FAO team recently completed a preliminary land capability map of Guatemala at 1:750,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Guatemala: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 13p.

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS				
GUATEMALA					
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		4%	1961	100%	1961

MAIN HOLDING AGENCIES

(1) Empresa Nacional de Fomento y Desarrollo Económico del Petén
Ministerio de Defensa
Guatemala

REMARKS

The major program in progress is a forest evaluation project being carried out by technicians of FAO. It will cover 36,000 km² in the Department of El Petén, Huehuetenango, Totonicapán, El Quiché, and Izabal. It is scheduled for completion in 1968 or 1969.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Guatemala: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 13p.

HAITI

AREA	TABLE NO. 1 AERIAL PHOTOGRAPHY				
HAITI					
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
7%	1955	10%	1957	100%	1957

MAIN HOLDING AGENCIES

(1) Service de Géodésie et de Cartographie
Département des Travaux Publics, des Transports et Communications
Boulevard Harry Truman
Port-au-Prince, Haiti

REMARKS

The entire country has been photographed at a scale of 1:40,000 by Hycon Corp. in 1956-57. There is also medium and large scale photograph, taken between 1954-57 of a number of population centers and areas of intensive agriculture, as well as 1:16,000 scale photography of the entire Département du Nord.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Haiti: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

AREA	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS				
HAITI					
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001-1:100,000)		SMALL SCALE (1:100,001-1:500,000)	
100%	1962	100%	1961	100%	1963

MAIN HOLDING AGENCIES

(1) Service de Géodésie et de Cartographie
Département des Travaux Publics, des Transports et Communications
Boulevard Harry Truman
Port-au-Prince Haiti

REMARKS

In 1961, the SGC (1) published a 1:100,000 topographic series which covers the entire country. In 1960-61, it published a 1:50,000 topographic series which covers the area west of longitude 72° 45'. Between 1959-1962, it published a 1:25,000 series covering the remainder of the country to the east.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Haiti: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

AREA	TABLE NO. 3
HAITI	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 AND LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
5%	1950	100%	1963	100%	1956

MAIN HOLDING AGENCIES

(1) Service Géologique
Naturelles et du Développement Rural
Département de l'Agriculture, des Ressources
Damien, Port-au-Prince, Haiti

REMARKS There have been two major geologic reconnaissance projects carried out in Haiti. The first, 1918-1920, resulted in a 600-page report and a map of the entire country at 1:500,000, published in 1924. The second was that of J. Butterlin between 1946-1955. His report and a 1:250,000 scale map were published in 1960.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Haiti. Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

AREA	TABLE NO. 4
Haiti	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		8%	1961	1.8%	1963

MAIN HOLDING AGENCIES

(1) Département de l'Agriculture, des Ressources Naturelles et du Développement Rural
Centre de Recherches Agricoles
Damien, Port-au-Prince, Haiti

(2) École National de l'Agriculture
Université d'Haiti
Damien, Port-au-Prince, Haiti

REMARKS

There is only a small amount of soils mapping available for Haiti, and this is of a reconnaissance nature. The best available soils maps are reconnaissance maps of the Artibonite and Gonaives Plains (1926 and 1928), the Cul-de-Sac Plain (1926 and 1956), the Département du Nord (1963), and the entire country (1955).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Haiti: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
HAITI	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		100%	1963	13%	1963

MAIN HOLDING AGENCIES

(1) Département de l'Agriculture, des Ressources Naturelles et du Développement Rural
Damien, Port-au-Prince, Haiti

REMARKS Very few maps of this type exist for Haiti. One of the few projects is L. R. Holdridge's ecologic survey, which was compiled on the Service de Géodésie et de Cartographie 1:100,000 scale topographic series using Holdridge's system of classification of world plant formations.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Haiti: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 10p.

HONDURAS

AREA	TABLE NO. 1
HONDURAS	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
1%	1962	30%	1963	65%	1957

MAIN HOLDING AGENCIES

(1) Dirección General de Cartografía
Ministerio de Communicaciones y Obras Públicas
Tegucigalpa

(2) Departamento Forestal, Ministerio de Recursos Naturales
Tegucigalpa

(3) Ministerio de Recursos Naturales, Tegucigalpa

REMARKS The United States Air Force between 1954 and 1961 photographed about 85% of the country at a scale of 1:50,000. Most of Valle and Choluteca Departments were also photographed by the U.S.A.F. during 1960 and 1961.
A forest inventory program provided 1:20,000 scale photography of three large areas in central Honduras between 1959 and 1963.
Additional 1:20,000 scale photography is planned for approximately 17,000 square miles located along the north coast and in the Southeastern Section of the country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Honduras: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 12p.

AREA	TABLE NO. 2
HONDURAS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:80,000)		SMALL SCALE (1:80,001 - 1:250,000)	
20%	1960				

MAIN HOLDING AGENCIES

(1) Dirección General de Cartografía
Ministerio de Comunicaciones y Obras Públicas
Tegucigalpa

REMARKS By late 1964, fifty-nine sheets of a 1:50,000 scale topographic map series had been printed. The entire series will have 287 sheets.

Plans have been made to publish a 1:250,000 scale series based on the 1:50,000 series.

The Zona de San Pedro Sula y La Lima is covered by one topographic sheet at a scale of 1:25,000 (1960)

Two planimetric sheets at a scale of 1:5,000 cover the city of Tegucigalpa. (1964)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Honduras: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 12p.

AREA	TABLE NO. 3
HONDURAS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - [illegible])	
1%	1954			100%	1957

MAIN HOLDING AGENCIES

(1) United States Geological Survey
Washington, D. C. 20325

REMARKS
There is no government agency responsible for geologic mapping. Most of this work has been done by private exploration companies, university and consulting geologists and by the United States Geological Survey.

The most recent source of information on the geology of Central America is "Die Geologie Mittelamerikas", by R. Weyl, published in Berlin, 1960.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Honduras: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 12p.

AREA	TABLE NO. 4
HONDURAS	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:460,000)	
		35%	1962	100%	1964

MAIN HOLDING AGENCIES

(1) Departamento de Suelos, Ministerio de Recursos Naturales

(2) Organización de las Naciones Unidas para la Agricultura y la Alimentación, Misión de Operaciones en Honduras, Apartado 245, Tegucigalpa

(3) Ministerio de Recursos Naturales, Tegucigalpa

REMARKS Agencies (1) and (2) since 1959 have been compiling a soil associations map of Honduras. Following completion of field work in 1965 a map at scale 1:250,000 will be published.

In 1964 agencies (2) and (3) completed compilation of the Mapa del Uso Potencial de la Tierra at a scale of 1:460,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Honduras: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 12p.

AREA	TABLE NO. 5 VEGETATION, LAND USE
HONDURAS	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
20%	1962	5%	1964	100%	1962

MAIN HOLDING AGENCIES

(1) Departamento Forestal
Ministerio de Recursos Naturales
Tegucigalpa

(2) Organización de las Naciones Unidas para la Agricultura y la Alimentación
Misión de Operaciones en Honduras
Apartado 139, Tegucigalpa

REMARKS

Agencies (1) and (2) have cooperated since 1962 on a pilot forest inventory project. Work was suspended in 1964.

In 1962 the OAS published the Mapa Ecológico de Honduras by L. R. Holdridge.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topographic and Natural Resources of Honduras. Natural Resources Unit, Department of Economic Affairs. Pan American Union, Washington, D. C., 20006, 1965, 12p.

JAMAICA

AREA	TABLE NO. 1
JAMAICA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:50,000)		SMALL SCALE (1:50,001 AND SMALLER)	
*	*	100%	1958 (*)	15%	1947

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

(2) Aeronautical Chart and Information Center
United States Air Force
2nd and Arsenal
St. Louis, Mo. 63118

REMARKS

Small scale photographs are of trimetrogon type

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart and Information Center
United States Air Force
2nd and Arsenal
St. Louis, Mo. 63118

AREA	TABLE NO. 2
JAMAICA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 & LARGER)		MEDIUM SCALE (1:10,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:400,000)	
100%	1952 *	100%	1962	100%	1953

MAIN PUBLISHING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

(2) United States Army Map Service
2500 Brooke Lane
Washington, D.C. 20025

REMARKS

Large scale cover is D.C.S. 9 410 at 1:50,000.
Small scale cover is D.O.S. 9 662 at 1:250,000.
Medium scale cover is A.M.S. series at 1:62,500

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 1
JAMAICA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
		100%	1954		

MAIN HOLDING AGENCIES

1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Medium scale coverage is D.O.S. (Geol) 1099 at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

MARGARITA ISLAND
(VENEZUELA)

AREA	TABLE NO. 1
MARGARITA ISLAND	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 30,000)		SMALL SCALE (1:30,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Dirección de Cartografía Nacional
Ministerio de Obras Públicas
Cabo Amarillo a Estación
Edificio Santa Inés
Caracas, D.F.

REMARKS

No coverage

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

AREA	TABLE NO. 2
MARGARITA ISLAND	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		100%	1962+	100%	1954+

MAIN HOLDING AGENCIES

(1) Dirección de Cartografía Nacional
Ministerio de Obras Públicas
Cabo Amarillo a Estación
Edificio Santa Inés
Caracas, D.F.

REMARKS

The Carta Topográfica del Estado Nueva Esparta at the scale of 1:125,000 produced in 1948 by the DCN, (1) the DCN's 1:500,000 sectional aeronautical chart series of 1954 and the 1:250,000 topo map series of 1948 by the DCN are all that is available for small scale coverage of Margarita Island.

The DCN has covered the island at 1:100,000 scale in their 1948 and 1962 series.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

AREA	TABLE NO. 3
MARGARITA ISLAND	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
15%	1949	100%	1959	100%	1962

MAIN HOLDING AGENCIES

(1) Dirección de Geología
Ministerio de Minas e Hydrocarburos
Torre del Norte
Centro Simón Bolívar
Caracas, D.F.

REMARKS

The small scale maps are primarily tectonic and mineralogic. The medium scale mapping consists of Mapa Geologica del Estado Nueva Esparta (1953) at 1:100,000 and the Mapa Geologica de la Isla Margarita done in 1959 at 1:75,000 by C. C. Taylor, Princeton Univ.

The large scale coverage is a single sheet (1:25,000) Macanao region.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

AREA	TABLE NO. 4
MARGARITA ISLAND	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
50%	1946	100%	1959	100%	1948

MAIN HOLDING AGENCIES

(1) Sección de Suelos, Centro de Investigación Agropecuarias
Dirección de Investigación Agropecuarias
Ministerio de Agricultura y Cría, Maracay

(2) Consejo de Bienestar Rural
Ministerio de Agricultura y Cría
Torre del Este
Avenida Francisco Miranda Chacao
Caracas, D.F.

REMARKS

The small scale coverage is a single sheet at 1:150,000 of agricultural types done in 1948.

The medium scale cover is a 1:100,000 soils map done in 1959 that covers 956 Km² of western Margarita and a land capability map at 1:65,000 done in 1948 of the eastern portion of the island.

In 1946 a reconnaissance soils map was published at 1:25,000 of the eastern portion of the island by F. Loseme for the CBR(2).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
MARGARITA ISLAND	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		50%	1946	50%	1948

MAIN HOLDING AGENCIES

(1) Consejo de Bienestar Rural
Ministerio de Agricultura y Cría
Torre del Este
Avenida Francisco Miranda Chacao
Caracas, D.F.

REMARKS

The entire island is covered by a 1:200,000 sheet by G. Buchowski (1948) of the eastern half of Margarita and a 1:65,200 sheet of the western half by F. Leeson (1948). Both are land use maps.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

MARTINIQUE

AREA:	TABLE NO. 2
MARTINIQUE	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
100%	-	100%	-		

MAIN HOLDING AGENCIES

(1) Institut Géographique National
136 bis, rue de Grenelle
Paris 7e, France

REMARKS

Large scale coverage consists of three series
1) 23 sheets at 1:20,000, and
2) 4 sheets at 1:50,000 (both series provide complete coverage)
3) AMS series E041 at 1:25,000, photomaps

Medium scale mapping is at 1:100,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog des Cartes de l'I.G.N.
Institut Géographique National
136 bis, rue de Grenelle
Paris 7e, France

AREA	TABLE NO. 3
MARTINIQUE	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
100%	19-				

MAIN HOLDING AGENCIES

REMARKS

Large-scale mapping is at 1:50,000 and may be purchased through Reise- und Verkehrsverlag, Stuttgart, Postf. 730.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA:	TABLE NO. 1
MEXICO	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
5%	1963	25%	1964	95%	1964

MAIN HOLDING AGENCIES

(1) Departamento Cartográfico Militar, Secretaría de la Defensa Nacional, Lomas de Sotelo, D.F.
(2) Compañía Mexicana Aerofoto S.A., Obrero Mundial 38, Mexico 12, D.F.
(3) IFEX Geotécnica S.A., Escobedo 525-527, Sur Monterrey, Nuevo Leon
(4) Estudios y Proyectos S.A., Paseo de la Reforma 503 Mexico, D.F.

REMARKS

The U.S. Air Force obtained trimetrogon photography over the entire country between 1942-1946. It is held by and only available to the Departamento Cartográfico Militar (1).

Most of Mexico has been photographed at a scale of 1:60,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping on Topography and Natural Resources of Mexico. Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

MEXICO

AREA	TABLE NO. 2
MEXICO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500,000)		SMALL SCALE (1:500,001 - 1:5,000,000)	
20%	1964	55%	1964	100%	1964

MAIN HOLDING AGENCIES

(1) Departamento Cartografía Militar, Secretaría de la Defensa Nacional, Lomas de Sotelo, D. F.
(2) Secretaría de Recursos Hidráulicos, Paseo de la Reforma 69, Mexico 1, D.F.
(3) Petróleos Mexicanos, Gerencia de Exploracion, Lafragua 16, Mexico, D. F.
(4) Dirección General de Geografía y Meteorología, Avenida Observatorio 192, Tacubaya 16, D. F.

REMARKS Both DCM (1) and DGGM (4) have produced national topographic map series at a scale of 1:500,000 in 1957-8 and 1949-64 respectively. Both series available from DGGM. DGGM(4) publishes an annual Catalogo de Publicaciones.

DCM(1) has published 131 sheets of the 1:100,000 series, Carta General de la Republica Mexicana and 45 sheets of the 1:25,000 series Carta Tactica del Valle de Mexico. Maps from this series available only from DCM (1) following a written request.

SRH (2) has large scale maps for all its irrigation and water control projects mostly in unpublished form.

PEMEX (3) has compiled a 1:50,000 planimetric series which covers virtually all of the gulf coastal region.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Mexico: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

AREA	TABLE NO. 3
MEXICO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:5,000,000)	
10%	1966	6%	1963	2.5%	1958

MAIN HOLDING AGENCIES

(1) Consejo De Recursos Naturales No Renovables
Esquina Dr. Navarro y Niños Héroes
Mexico, D.F.

(2) Instituto de Geología
Universidad Nacional Autónoma de Mex.
6a Calle del Ciprés 176
Mexico 4, D.F.

(3) Petróleos Mexicanos
Gerencia de Exploración
La fragua 18
Mexico, D.F.

(4) Sección de Geología
Secretaría de Recursos Hidráulicos
Paseo de la Reforma 69
Mexico 1, D.F.

REMARKS

IG (2) is producing a geologic map series at 1:100,000, since 1959, 3 sheets already published and 4 near completion. The IG also published a 1:2,000,000 geologic map of Mexico in 1962.
SRH (4) produces hydrogeologic maps and has a large number of unpublished large scale geologic maps for various dam and irrigation projects.
PEMEX (3) is completing a 1:50,000 scale geologic map covering the Isthmus of Tehuantepec and large portions of eastern Mexico.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Mexico: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

AREA	TABLE NO. 4
MEXICO	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:5,000,000)	
5%	1964	2%	1964	2%	1954

MAIN HOLDING AGENCIES

(1) Departamento de Agrologico
Secretaría de Recursos Hidráulicos
Paseo de la Reforma 69
Mexico 1, D.F.

REMARKS

DDA (1) primarily concerned with soils mapping and collection of soils data for irrigation projects. Very few of the many maps produced are published and are to be found only in the files of the DDA. The DDA published a Carta de Suelos de la República Mexicana at the scale of 1:4,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Mexico: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 34 p.

AREA:	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
MEXICO	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
1%	1964	100%	1963	100%	1964

MAIN HOLDING AGENCIES

(1) Instituto Nacional de Investigaciones Forestales
Avenida Progreso 5
Coyoacan, D.F.
(2) Dirección General de Geografía y Meteorología
Secretaría de Agricultura y Ganadería
Avenida Observatório 142
Tacubaya 16, D.F.
(3) Dirección de Aprovechamientos Hidráulicos — Paseo de la Reforma 69
Secretaría de Recursos Hidráulicos — Mexico 1, D.F

REMARKS DHF (1) with cooperation of FAO is conducting a national forest inventory with a pilot inventory study for tropical forests in Quintana Roo. The DGGM (2) compiled an agricultural zone map of the entire country in 1963-4 at the scale of 1:500,000. The 31 sheets have not yet been published. 706 sheets at the scale of 1:100,000 entitled Carta de Aprovechamiento de Aguas y Suelos were published in 1963 by the DAH (3). This series that covers the entire country indicates terrain types and natural vegetation.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Mexico: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 34p.

NICARAGUA

AREA	TABLE NO. 1
NICARAGUA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:19,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
6%	1962	35%	1965	82%	1964

MAIN HOLDING AGENCIES

(1) Dirección General de Cartografía
Ministerio de Fomento y Obras Públicas
Edificio Cerna, Calle Central
Managua, D.F.
Nicaragua

REMARKS About 80% of the country is covered with 1:60,000 vertical aerial photography. The USAF continues to take photography at this scale for the Dirección General de Cartografía (1).

The Departamento de Suelos and the Instituto de Fomento Nacional are using medium and large scale aerial photography for semi-detailed soils mapping in the Pacific coastal area. The Departamento Nacional de Servicios Municipales is using large scale aerial photography for making town plans. The Dirección General de Caminos is using photography for laying out roadways.

FAO is using 1:15,000 scale aerial photography for an agriculture and forestry development project in the northeastern portion of the country.

Another program presently in progress involves 1:20,000 scale aerial photography of the western third of the country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Nicaragua: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

AREA	TABLE NO. 2
NICARAGUA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
25%	1961+	35%	1955+	100%	1962

MAIN HOLDING AGENCIES

(1) Dirección General de Cartografía
Ministerio de Fomento y Obras Públicas
Edificio Cerna, Calle Central
Managua, D.F.
Nicaragua

REMARKS Agency (1), with technical assistance from the Inter-American Geodetic Survey, has produced a 1:100,000 scale planimetric series and a 1:50,000 scale topographic series, both of which presently cover the western third of the country. Completion of the topographic series is contemplated within 8 to 15 years. 25 sheets of the planimetric series have been produced for the western region, and 2 sheets for an area along the Atlantic Coast in NE Nicaragua.

Very large scale maps are being produced for some urban areas, and in 1965, the agency was to publish 3 sheets of a 1:250,000 scale topographic series.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Nicaragua: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 14p.

AREA	TABLE NO. 3
NICARAGUA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
1%	1961	7%	1962	100%	1958

MAIN HOLDING AGENCIES

(1) Servicio Geológico Nacional
Ministerio de Economía
Managua, D.F.
Nicaragua

REMARKS Over the past decade, agency (1) has published reports with geologic maps ranging in scale from 1:400,000 to 1:50,000 of scattered areas in the northwest, Pacific coast, and southern Atlantic coast.

In 1957, the same agency published the Mapa Geológico de Nicaragua at a scale of 1:1,200,000. This is a generalized map based on earlier work by Karl Sapper and more recent work by the agency.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Nicaragua: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14pp.

AREA	TABLE NO. 4
NICARAGUA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
4%	1962	1%	1963+	100%	1964

MAIN HOLDING AGENCIES

(1) Departamento de Suelos
Ministerio de Agricultura y Ganadería
Managua, D.F.
Nicaragua

(2) Instituto de Fomento Nacional
Ministerio de Economía
Managua, D.F.
Nicaragua

REMARKS

In 1964, FAO compiled a land capability map for the entire country at a scale of 1:500,000. This map is part of a study of the five Central American countries, sponsored by the Secretaría Permanente del Tratado General de Integración Económica Centroamericana (SIECA).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Nicaragua: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1965, 14p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
NICARAGUA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		2%	1960	100%	1962

MAIN HOLDING AGENCIES

(1) Instituto de Fomento Nacional
Ministerio de Economía
Managua, D.F.
Nicaragua

REMARKS

A project co-sponsored by agency (1) and by the U.N. Special Fund is utilizing aerial photography at a scale of 1:15,000 in an inventory of land capabilities for agriculture and cattle raising. An ecological land use map is being prepared on the basis of aerial photographic interpretation and field investigation. An area of about 10,000 km.^{2} between the Huahua and Prinzapolca rivers is included in the study, which should be complete by late 1966.

In 1962, the U.S. Agency for International Development published L. R. Holdridge's Mapa Ecológico de Nicaragua, A.C. at a scale of 1:1,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Nicaragua: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

PANAMA

AREA	TABLE NO. 1
PANAMA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		40%	1962	55%	1956

MAIN HOLDING AGENCIES

(1) Dirección de Cartografía
Ministerio de Obras Públicas
Apartado 5267
Panama

(2) U.S. Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

DC (1) holds negatives of all air photos taken in Panama. 85% of the country has been photographed at scales that range between 1:16,000 to 1:50,000. Most of the overlap exists in the provinces of Colón, Panama and Chiriquí.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Panama: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

AREA	TABLE NO. 2
PANAMA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
50%	1963			100%	1960

MAIN HOLDING AGENCIES

(1) U.S. Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

(2) Dirección de Cartografía
Ministerio de Obras Públicas
Apartado 5267
Panama

(3) Instituto de Recursos Hidráulicos y Electrificación
Apartado 5285
Panama

REMARKS AMS Topo series E762 at 1:50,000 scale covers the South Coast, the peninsula west of Panama City and the islands in the Gulf of Panama. 17 sheets of this series is published; 56 additional sheets in preliminary form with materials held by DC(2)IHE(3) holds originals to 1958 series at scales of 1:12,500 and 1:25,000. In 1962 DC began production on 1:10,000 series of topo sheets based on aerial photography. Only 1 sheet published to date. The small scale mapping consists of the 3 sheet AMS series E461 at 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Panama: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

AREA	TABLE NO. 3
PANAMA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		5%	1964	100%	1957

MAIN HOLDING AGENCIES

(1) Departamento de Recursos Minerales
Ministerio de Agricultura Comercio e Industria
Apartado 1631
Panama

(2) U.S. Geological Survey
Washington, D.C. 20025

REMARKS

DRM (1) is responsible for geologic mapping in Panama and is the repository of geologic data developed by mineral concessionaires. USGS (2) published a geological map of Central America in 1957 at 1:1,000,000 that covers the country. R. A. Terry's geologic map at 1:500,000 scale (1956) was published in a report entitled "A Geological Reconnaissance of Panama" by the California Academy of Sciences.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Panama: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

AREA	TABLE NO. 4
PANAMA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
1%	1961	25%	1963	100%	1954

MAIN HOLDING AGENCIES

(1) Departamento Forestal y de Suelos (DFS)
Ministerio de Agricultura, Comercio e Industria
Apartado 1631
Panama

REMARKS

Most soils and land capability maps are restricted to S W Chiriquí province, the Llanos de Coclé and the eastern part of the Azuero peninsula on a reconnaissance or semidetailed basis. These are at the scale of 1:50,000. Darien Province was covered in 1954 at a scale of 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Panama: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
PANAMA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1959

MAIN HOLDING AGENCIES

(1) Departamento Forestal y de Suelos
Ministerio de Agricultura, Comercio e Industria
Panama

REMARKS

Other than the Holdridge ecologic map 1959, 1:1,000,000 by IIAS (OAS), no mapping of vegetation, ecology or land use of Panama exists.

Many regional maps that cover Central America or Caribbean at very small scales have Panamanian vegetation mapped. The Dept. of Geography, University of Kansas, Lawrence, has an excellent collection of these types.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Panama: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1965, 14p.

PARAGUAY

AREA	TABLE NO. 1
PARAGUAY	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:20,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:99,000)		SMALL SCALE (1:100,000 AND SMALLER)	
2%	1961	20%	1964	55%	1959

MAIN HOLDING AGENCIES

(1) Instituto Geográsico Militar
Avenida Artigas y Vía Férrea
Asunción, Paraguay

REMARKS The trimetrogon photography taken by the United States Army Air Force between 1943-1945, which covers all but the northeastern corner of Paraguay at 1:40,000, is still the only existing photography for large portions of the country. There is no government or commercial entity in Paraguay equipped to take aerial photography. From 1953 to the present, small amounts of vertical photography have been taken for the Instituto Geográfico Militar by foreign government and commercial agents, who generally hold the negatives and prints.

Since 1962, the Instituto has been working in cooperation with the Inter American Geodetic Survey with the goal of producing a national topographic map at a scale of 1:100,000. Work is presently being concentrated on the triangular area in the southeastern portion of the country, demarcated by the cities of Asunción, Encarnación, and Puerto Stroessner.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Paraguay: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1964, 10p.

AREA	TABLE NO. 2
PARAGUAY	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:20,000 & LARGER)		MEDIUM SCALE (1:20,001 - 1:99,000)		SMALL SCALE (1:100,000 - 1:999,999)	
12%	1965	11%	1958	100%	1958

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Militar
Avenida Artigas y Vía Férrea
Asunción, Paraguay

REMARKS

Large scale topographic mapping in Paraguay is scarce. It covers only Asunción and surrounding area at 1:50,000, with some unpublished maps over small areas at 1:10,000 and 1:20,000, and mapping of the Colonia Iguazú at a scale of 1:50,000.

Adequate 1:500,000 reconnaissance maps are available in the form of aeronautical charts published by the Instituto Geográfico Militar de Argentina and by the Aeronautical Chart Service in Washington, D.C.

A 1:100,000 topographic series is to be produced by agency (1) with the assistance of the Inter American Geodetic Survey. The first sheets should be published by 1967, with the complete series taking a number of years to publish.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Paraguay Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1964, 10 pp.

AREA	TABLE NO. 3
PARAGUAY	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		5%	1960+	100%	1959

MAIN HOLDING AGENCIES

(1) Dirección de Recursos Minerales
Ministerio de Obras Públicas y Comunicaciones
Asunción, Paraguay

REMARKS The agency above is presently occupied with producing a geologic map of Paraguay at a scale of 1:200,000. Field work has been completed on two sheets thus far.

The most important compilation and summary of geologic information for the entire country is Edwin Eckel's Geology and Mineral Resources of Paraguay: A Reconnaissance, published in 1959 as USGS Professional Paper 327. Accompanying this report are a 1:1,000,000 geologic map with some cross-sections and a 1:2,000,000 coals map by Pedro Prado Salsoma.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Paraguay: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1964, 10p.

AREA	TABLE NO. 4
PARAGUAY	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) United States Geological Survey
Washington, D.C.

REMARKS The only published soils map in Paraguay is the one by Pedro Tirado Sulsona, compiled between 1948-1952 at a scale of 1:2,000,000. It accompanies a report by Edwin Eckel, Geology and Mineral Resources of Paraguay A Reconnaissance, published in 1959 as USGS Professional Paper 327.

There is no land capability mapping in Paraguay.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Paraguay Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1964, 10p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
PARAGUAY	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				9%	1959

MAIN HOLDING AGENCIES

REMARKS The only published mapping on any of these subjects is the Mapa Fisiográfico e Fitogeográfico das Bacias Hidrográficas dos Rios Monday e Acaray, by R. Maack for Hidroservice Ltda., in 1959, at a scale of 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Paraguay Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1964, 10p.

PERU

AREA	TABLE NO. 1
PERU	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
5%	1963	17%	1963	85%	1962

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Militar
Avenida Arequipa 310
Lima
Peru

(2) Servicio Aerofotográfico Nacional
Las Palmas
Lima
Peru

REMARKS Between 1961 and 1963, the United States Air Force photographed the western 2/3 of Peru north of latitude 14°S for agency (1). Most of the region south of 14°S has been photographed for agency (1) by the Hycon Aerial Survey Corporation

Agency (2) is the aerial photo depository for the government. It maintains a photo library, reproduces photos for sale to the public, and makes available blueline index maps of aerial photographic projects.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Peru: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D.C. 20006, 1964, 28p.

AREA
PERU

TABLE NO. 2
TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
6%	1953	17%	1963	100%	1960

MAIN HOLDING AGENCIES

(1) Instituto Geográfico Militar
Avenida Arequipa 310
Lar
Perú

(*) Servicio Aerofotográfico Nacional
Las Palmas
Lima
Perú

REMARKS A planimetric map at a scale of 1:500,000 covers the entire country. The most complete topographic series currently available is a discontinued series consisting of 96 sheets at a scale of 1:200,000, covering the coast, the western sierra, and the south of Perú.

There is at present no medium or large scale topographic map series that covers the entire country. Agency (2) has produced considerable scattered topographic mapping, mostly at large scales. Much of it is available for purchase by the public.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Perú: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 28p.

AREA
PERU

TABLE NO. 3
GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
1%	1962	18%	1964	100%	1960-(series)

MAIN HOLDING AGENCIES

(1) Comisión de la Carta Geológica Nacional
Dirección de Minería
Ministerio de Fomento y Obras Públicas
Avenida 28 de Julio
Lima
Perú

(2) Instituto Nacional de Investigación y Fomento Mineros
Ministerio de Fomento y Obras Públicas
Avenida 28 de Julio
Lima
Perú

REMARKS Agency (1) is currently producing a 1:100,000 general geologic series, based on a new 1:100,000 topographic series being produced by the Instituto Geográfico Militar.

Agency (2) has published a large number of regional maps.

A great deal of the mapping carried out under government auspices has been printed in the Boletín de la Sociedad Geológica del Perú.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Perú: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 28p.

AREA
PERU

TABLE NO. 4
SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
5%	1963	45%	1964	5%	1962

MAIN HOLDING AGENCIES

(1) Departamento de Suelos
Oficina Nacional de Evaluación de Recursos Naturales
Instituto Nacional de Planificación
Jirón Lampa 277
Lima
Perú

(2) Dirección de Irrigación
Ministerio de Fomento y Obras Públicas
Avenida 28 de Julio
Lima
Perú

REMARKS Most of the work of the number of agencies involved in the production of soils maps in Perú over the past decade has been indexed and annotated in the Inventario de Estudios de Suelos del Perú (Primera Aproximación) published by agency (1) in 1963. Only a few of the soils maps indexed in this report have been published, most of the maps and their accompanying reports are in manuscript form and may be found in the files of producing agencies or their successors.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Perú: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 28p.

AREA
PERU

TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
1%	1963	1%	1963	100%	1962

MAIN HOLDING AGENCIES

(1) Servicio Forestal y de Caza
Ministerio de Agricultura
Avenida Cuba 552
Lima
Perú

REMARKS In 1957, the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica, prepared a Mapa Ecológico del Perú, based on Holdridge's classification of world plant formations. The scale of the map is 1:1,000,000. It was printed in Perú in 1958 by the Instituto Geográfico Militar.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Perú: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 28p.

PUERTO RICO

AREA	TABLE NO. 1
PUERTO RICO	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:20,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
?	?	100%	1963	?	?

MAIN HOLDING AGENCIES

(1) Department of Public Works of Puerto Rico
San Juan, Puerto Rico

(2) United States Army Map Service
6500 Brooks Lane
Washington, D. C. 20025

REMARKS Complete aerial photographic coverage of the Island of Puerto Rico was accomplished in 1936 at a scale of approximately 1:13,200 by a subcontractor of the Puerto Rico Reconstruction Administration. In 1941, another subcontractor of the Department of Public Works of Puerto Rico, in cooperation with USGS, made a complete aerial mosaic of the Island at a scale of 1:15,000. In 1951, a new flight of the whole Island at 1:15,000 was made by the Pennsylvania Aerial Survey, Inc., sponsored by USGS and the Department of Public Works.

In 19[illegible] and the Department of Public Works photographed the northeastern part of the Island and the area around Ponce at a scale of 1:20,000. In 1963, the Soil Conservation Service continued to photograph the rest of the Island at the same scale.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Pico, Rafael, 1964, Cartography in Puerto Rico: Government Development Bank for Puerto Rico, Starpress Litho, 20p.

AREA	TABLE NO. 2
PUERTO RICO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:[illegible])	
100%	1963	1-	[illegible]	[illegible]30%	1955

MAIN HOLDING AGENCIES

(1) United States Geological Survey
Washington, D. C.

(2) Department of Public Works of Puerto Rico
San Juan, Puerto Rico

(3) American Geographical Society
156th at Broadway
New York, N. Y.

REMARKS In 1935, the Puerto Rico Department of Public Works, in cooperation with USGS, began preparation of the topographic map of Puerto Rico at a scale of 1:30,000. Since that time, new editions of the map have been published at various scales: in 1948 at a scale of 1:10,000; in 1952 at 1:120,000 with a modification at 1:240,000, in 1956-1960 at 1:20,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Pico, Rafael, 1964. Cartography in Puerto Rico: Government Development Bank for Puerto Rico, Starpress Litho, 20p.

Index to Topographic Mapping in Puerto Rico and the Virgin Islands, U. S. Geological Survey, Map Information Office, Washington, D. C. 20025.

AREA	TABLE NO. 3
PUERTO RICO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:[illegible],000,000)	
47%	1964	100%	1965	100%	1948

MAIN HOLDING AGENCIES

(1) United States Geological Survey
Washington, D. C.

REMARKS As of June, 1964, USGS, using its own personnel as well as graduate students of Princeton University, under the direction of Watson H. Monroe, had completed mapping 47% of Puerto Rico at a scale of 1:20,000.

A geologic map of Puerto Rico, at a scale of 1:240,000 was completed by Reginald P. Brigge in 1961, revised in 1962, and published in 1964 as the Provisional Geologic Map of Puerto Rico and Adjacent Islands.

A Hydrogeologic Map of Puerto Rico and Adjacent Islands was published by R. P. Brigge and J. P. Akers in 1965 as U.S.G.S. Atlas HA-197 (1:240,000)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Pico, Rafael, 1964. Cartography in Puerto Rico: Government Development Bank for Puerto Rico, Starpress Litho, 20p.

AREA	TABLE NO. 5
PUERTO RICO	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 TO 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
%	1956	100%	1982		

MAIN HOLDING AGENCIES

(1) United States Department of Agriculture
Washington, D. C.

REMARKS Since its publication in 1982 the basic soil survey of Puerto Rico carried out in Puerto Rico has been the map resulting from the detailed soil survey of Puerto Rico between 1928-1936 by the Soil Survey Bureau of Chemistry and Soils of the U. S. Department of Agriculture in cooperation with the Agricultural Experiment Station of the University of Puerto Rico under the direction of Dr. R. O. E. Davis. The soil map is published in colors at a scale of 1:240,000 and is composed of four sheets: West Central, Eastern Western, and East Central.

The most important soil capability map is the Generalized Land Capability Map of Puerto Rico, published at a scale of 1:600,000 by Servicio de Agricultura de Puerto Rico, New York, Jan. to Dec. 1951.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Place, Robert, 1964, Cartography in Puerto Rico: Government Development Bank for Puerto Rico, Harperprese Litho, 20p

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
PUERTO RICO	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 TO 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
10%	1951				

MAIN HOLDING AGENCIES

(1) United States Department of Agriculture
Washington, D. C.

REMARKS Maps at a scale of approximately 1:30,000 have been prepared of each of the municipalities and each of the federal forest areas of Puerto Rico.

A Rural Land Classification Survey carried out in Puerto Rico from 1948-1951 resulted in the publication of the rural land use map of Puerto Rico at a scale of 1:10,000.

Puerto Rico has a detailed map for each one of its urban communities at a scale of 1:2,000. In 1951, these maps were printed for participation at a scale of 1:5,000. Revision was begun in 1962 at a scale of 1:6,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Place, Robert, 1964, Cartography in Puerto Rico: Government Development Bank for Puerto Rico, Harperprese Litho, 20p

ST. LUCIA ISLAND

AREA	TABLE NO. 2
ST. LUCIA ISLAND	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 TO 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
100%	1959				

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooke Lane
Washington, D. C. 20025

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

There is an A. M. S. photomap series at 1:25,000 done in 1962 which provides 100% coverage

D. O. S. 345 covers St. Lucia at 1:25,000 in 3 sheets (1959)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

ST. VINCENT ISLAND

AREA ST. VINCENT ISLAND	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:00,000)		SMALL SCALE (1:100,001 - 1:000,000)	
100%	1959				

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingstone Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale mapping is at 1:25,000

(D.O.S. 3173) in 2 Sheets.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

SURINAM

AREA SURINAM	TABLE NO. 1 AERIAL PHOTOGRAPHY				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
10%	1960	20%	1960	100%	1960

MAIN HOLDING AGENCIES

(1) Department of Development
Central Bureau for Aerial Mapping
P. O. Box 971
Paramaribo, Surinam

REMARKS The northern half of Surinam was shot between 1947 and 1949 at a scale of 1:40,000, the southern half between 1956-1960 at the same scale.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Central Bureau for Aerial Mapping, 1966, Catalog of Maps and Air Photos.

Stone, Kirk H., 1961, World Air Photo Coverage, 1960, Photogrammetric Engineering, V.XXVII, No. 2, p. 214-227.

AREA	TABLE NO. 2
SURINAM	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
50%	1960	95%	1960	95%	1966

MAIN HOLDING AGENCIES

(1) Department of Development
Central Bureau for Aerial Mapping
P. O. Box 971
Paramaribo, Surinam

REMARKS By 1966, topographical maps at scales of 1:100,000 and 1:200,000 will be available for all but the southwestern and southeastern corners of Surinam, for which no aerial photography is available.
Large scale coverage is at 1:40,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Central Bureau For Aerial Mapping, 1966, Catalog of Maps and Air Photos.

AREA	TABLE NO. 4
SURINAM	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
-	-	-	-	45%	1962

MAIN HOLDING AGENCIES

(1) Department of Soil Survey
Saramaccastraat 7
Paramaribo, Surinam

REMARKS The region of northern Surinam is covered at 1:50,000 by a soil map. The entire country is covered at 1:1,000,000.
There is a land classification map at 1:1,000,000 of Northern Surinam by the Department of Soil Survey in 1965.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Dienst Bodemkartering, Overzichtsbodemkaart Suriname, schaal 1:1,000,000: Ministerie Van Opbouw, Surinam.

Soil Survey Dept., 1962, Preliminary Soil Map of Northern Surinam, scale 1:500,000: Ministry of Development, Surinam.

TRINIDAD AND TOBAGO

AREA	TABLE NO. 1
TRINIDAD & TOBAGO	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:20,000)		SMALL SCALE (1:20,001 AND SMALLER)	
?	?	?	?	100%	1954

MAIN HOLDING AGENCIES

(1) Aeronautical Chart and Information Center
United States Air Force
2nd & Arsenal
St. Louis, Mo. 63118

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart and Information Center
United States Air Force
2nd & Arsenal
St. Louis, Mo. 63118

AREA	TABLE NO. 2
TRINIDAD & TOBAGO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE	
100%	1948			100%	

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale mapping consists of D.O.S. 216 (Trinidad) and 207 (Tobago) at 1:10,000 and D.O.S. 316 (Trinidad) and 307 (Tobago) at 1:25,000. A 9 sheet series at 1:50,000 also exists.

Small-scale mapping consists of 1 sheet of Trinidad at 1:150,000 and one of Tobago at the same scale.

A.M.S. series E042 covers all of Trinidad at 1:25,000 (photomaps, 1942). Port of Spain is covered at 1:10,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
TRINIDAD & TOBAGO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (250,001 - 1:1,000,000)	
90%	1960	90%	1961		

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Medium-scale mapping is a geologic map of Trinidad at 1:100,000 compiled by H. G. Kugler. It is available from Edward Stanford Ltd., London WC2.

Large-scale mapping is at 1:50,000, D.O.S. (Geol) 1129, and covers all of Trinidad.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
TRINIDAD & TOBAGO	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		99%	1954		

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Medium scale is the Soils Series of D.O.S. (Misc.) 55 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 5 VEGETATION, LAND USE,
TRINIDAD & TOBAGO	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				90%	1952

MAIN HOLDING AGENCIES

REMARKS

Small-scale coverage is 1:146,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

VENEZUELA

AREA	TABLE NO. 1
VENEZUELA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10 000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30 000)		SMALL SCALE (1:30 001 AND SMALLER)	
1%	?	5%	1950	60%	1962

MAIN HOLDING AGENCIES

(1) Dirección de Cartografía Nacional
Ministerio de Obras Públicas
Cano Amarillo a Estación, Edificio Santa Inés, Caracas, D.F.

REMARKS

A current project will provide new 1:50,000 scale mapping photography north of 6° N. Latitude.

Photo mosaics at a scale of 1:50,000 exist for two large regions east of meridian 68° E.

Photography and mosaics at scales of 1:50,000 and larger that are held by the Dirección Cartografía Nacional are available to international agencies by permission of the Ministerio de Defensa.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

AREA	TABLE NO. 2
VENEZUELA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
1%	1962	40%	1962	100%	1963

MAIN HOLDING AGENCIES

(1) Dirección de Cartografía Nacional, Ministerio de Obras Públicas, Edificio Santa Inés, Caracas, D. F.
(2) Dirección de Obras Hidráulicas, Ministerio de Obras Públicas Torre del Sur, Centro Simón Bolívar, Caracas, D. F.
(3) Instituto Nacional de Obras Sanitarias, Ministerio de Obras Públicas, Edificio Las Mercedes, Esquina de Tienda Honda, Caracas, D. F.
(4) Dirección de Minas, Ministerio de Minas e Hidrocarburos, Torre del Norte, Centro Simón Bolívar, Caracas, D. F.

REMARKS The DCN (1) is producing map series at 1:100,000, 1:250,000 and 1:500,000. Maps at scales of 1:50,000 and larger that the DCN has produced are considered classified by the Government of Venezuela.

The DOH (2) produces topographic maps as part of its irrigation projects.

The INOS (3) produces some large scale maps in urban areas.

The MMH (4) produces topographic maps as a base for its minerals-mapping program. This agency also holds much of the map coverage produced by the oil companies.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

AREA	TABLE NO. 3
VENEZUELA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
4%	1964	3%	1963	100%	1962

MAIN HOLDING AGENCIES

(1) Dirección de Geología, Ministerio de Minas e Hydrocarburos, Torre del Norte, Centro Simón Bolívar, Caracas, D. F.

REMARKS

Systematic mapping has been conducted through collaboration between the DG (1) and Princeton University at scales of 1:50,000 and 1:100,000. The DG offers for sale small scale geologic and minerals maps. There are some 1:1,000,000 maps covering all of Venezuela and 1:500,000 maps for most of the states.

The Ministerio de Minas e Hydrocarburos holds copies of unpublished maps compiled by the oil companies.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964 30p.

AREA	TABLE NO. 4
VENEZUELA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
1%	1963	5%	1962	70%	1961

MAIN HOLDING AGENCIES

(1) Sección de Suelos Centro de Investigación Agropecuarias
Dirección de Investigación Agropecuarias
Ministerio de Agricultura y Cría, Maracay
(2) Dirección de Recursos Naturales Renovables, Ministerio de Agricultura y Cría, Centro Simón Bolívar, Torre del Norte, Caracas, D. F.
(3) Consejo de Bienestar Rural Ministerio de Agricultura y Cría, Torre del Este, Avenida Francisco Miranda Chacao, Caracas, D. F.
(4) Division de Estudios Agroeconomicos, Dirección de Obras Hidráulicas Torre del Sud, Centro Simón Bolívar, Caracas, D. F.

REMARKS

SDS (1) has a large file of soil surveys, mostly unpublished, that were done during the last 20 yrs. In 1960 the section published the map, Suelos de Venezuela (1:1,000,000) showing 24 soil groups.

The DRNR (2) sponsors reconnaissance soil survey and capability and use work by private firms.

The CBR (3) sponsors studies similar to the DRNR (2).

The DEA (4) map soils for the purpose of determining soil capabilities in areas to be irrigated.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Dept. of Economic Affairs, Pan American Union, Washington D. C. 20006, 1964, 30p.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
VENEZUELA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
-	-	10%	1962	65%	1963

MAIN HOLDING AGENCIES

(1) Dirección de Recursos Naturales Renovables, Ministerio de Agricultura y Cría, Centro Simón Bolívar, Torre del Norte, Caracas, D. F.

(2) Consejo de Bienestar Rural Ministerio de Agricultura y Cría, Torre del Este, Avenida Francisco Miranda Chacao, Caracas, D. F.

REMARKS

The DRNR (1) and CBR (2) have sponsored vegetation and forest inventory study maps produced usually at scale of 1:250,000, and, at present are inventorying forests of Venezuelan Andes. Results are unpublished but available at DRNR (1). DRNR (1) has published in 1960 the Atlas Agricola de Venezuela and in 1961 the Atlas Forestal de Venezuela.

DRNR (1) is currently compiling an Ecological Map of Venezuela based on the Holdridge classification. A map of Zonas Ecologicas of the Andes Region of Venezuela covering the provinces of Tachira, Merida and Trujillo and contiguous areas was prepared by L. R. Holdridge at the scale of 1:650,000 as part of CBR (2) report in 1955.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Annotated Index of Aerial Photographic Coverage and Mapping of Topography and Natural Resources of Venezuela: Natural Resources Unit, Department of Economic Affairs, Pan American Union, Washington, D. C. 20006, 1964, 30p.

WEST INDIES

AREA	TABLE NO. 2
WEST INDIES	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

D.O.S. Maps 17/17 cover the entire area topographically at 1:1,000,000 and 1:2,500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalogs of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AFRICA

ANGOLA

AREA	TABLE NO.
ANGOLA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 40,000)		SMALL SCALE (1:40,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Photographic Records & Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

(2) Serviços Geográficos e Cadastrais de Angola

REMARKS There is some photography at scales of 1:25,000 and 1:60,000 flown between 1953-1955. The film is held by the Government of Angola.

Approximately 75 percent of humid tropical Angola was scheduled to be covered by aerial photography flown by various firms between 1959-1964. The scales are not definately known, but are probably 1:100,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
ANGOLA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
—	—	30%	1964	10%	1954

MAIN HOLDING AGENCIES

(1) Overseas Ministry
(Junta das Missões Geográficas e de Investigações do Ultramar)
Lisbon, Portugal

REMARKS As of 1963, the geographical and cadastral service of Angola was preparing to carry out an aerial photogrammetrical survey of the whole territory at a scale of 1:100,000. The first sheet, Environs of Luanda, had already appeared

One hundred thirty nine sheets of a 472-sheet topographic map series at 1:100,000 are in existence but not yet on the market, as of 1964

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent· Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
ANGOLA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Direcção Provincial dos Serviços de Geológica e Minas
Caixa Postal No. 1290
Luanda, Angola

REMARKS

Angola is 109% covered at scales of 1:2,000,000 and 1:3,000,000.

There is some geologic mapping at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

BURUNDI

AREA	TABLE NO.
BURUNDI	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:20,001 TO 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Institut Geographique du Congo
45, Av. Vallée-Léopoldville
B.P. 3036
Léopoldville-Kalina
Republic of the Congo

REMARKS

Burundi is 100% covered by aerial photographs for which the scale is not given

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique du Congo, Catalogue au 1er Janvier 19[illegible].

AREA	TABLE NO. 2
BURUNDI	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 TO 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
30%	1948	170%	1959	100%	1957

MAIN HOLDING AGENCIES

(1) Institut Géographique du Congo
45, Av. Vallée-Léopoldville
B.P. 3036
Léopoldville-Kalina
Republic of the Congo

REMARKS

In addition to the above data, A.M.S. Series 421 (1962) covers all of Burundi at 1:500,000 and A.M.S. Series 340 (1964) covers 40 percent of the country at the same scale

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent, Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
BURUNDI	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 TO 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Service Geologique du Ruanda-Urundi
Usumbura, Ruanda-Urundi

REMARKS

The country is 100% covered at 1:2,000,000 and 1:3,000,000.

Basic mapping is to be done at scales of 1:50,000, 1:100,000 and 1:200,000, according to local requirements.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent, Columbia Univ. Press, New York, 437 p.

CABINDA (ANGOLA)

AREA	TABLE NO. 1
CABINDA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10 000 AND LARGER)		MEDIUM SCALE (1:10 001-1:50 000)		SMALL SCALE (1:50 001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1)Serviços Geograficos e Cadastrais de Angola

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 2				
CABINDA	TOPOGRAPHIC AND PLANIMETRIC MAPS				

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 & LARGER)		MEDIUM SCALE (1:50 001 - 1:100 000)		SMALL SCALE (1:100 001 - 1:500 000)	
				100%	1904

MAIN HOLDING AGENCIES

(1)Overseas Ministry
(Junta das Missoes Geograficas e de Investigações do Ultramar)
Lisbon, Portugal

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
CABINDA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Direcção Provincial dos Serviços de Geológica e Minas
Caixa Postal No. 1260
Luanda, Angola

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

CAMEROON

AREA	TABLE NO. 1
Cameroon	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 AND LARGER)		MEDIUM SCALE (1:50 001 - 1:250 000)		SMALL SCALE (1:250 001 AND SMALLER)	
				95%	1955

MAIN HOLDING AGENCIES

(1) Service Géographique du Cameroun
Avenue Mgr. - Vogt
B. P. 157
Yaoundé, Cameroon

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

Stone, Kirk H., 1961, World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227.

AREA	TABLE NO. 2
CAMEROON	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100 000)		SMALL SCALE (1:100 001 - 1:500 000)	
15%	1954+	100%	1956	100%	1959+

MAIN HOLDING AGENCIES

(1) Service Géographique du Cameroun
Avenue Mgr. - Vogt
Yaoundé, Cameroun

REMARKS

Small-scale is 1:250,000
Medium-scale is 1:100,000
Large-scale is 1:50 000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
CAMEROON	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250 000)		SMALL SCALE (1:250 001 - 1:1,000,000)	
				100%	1963

MAIN HOLDING AGENCIES

REMARKS

Cameroon is 100% covered at 1:1,000,000. The western Cameroons was covered at 1:1,000,000 in 1963.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
CAMEROON	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The Atlas du Cameroun (1956) contains a pedologic map of the country at 1:2,000,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
CAMEROON	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	

MAIN HOLDING AGENCIES

REMARKS

A forest and agricultural products map of French Equatorial Africa and the Cameroons covers the country at 1:3,000,000

The Atlas du Cameroun (1956) contains a phytogeographic map at 1:2,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

CENTRAL AFRICAN REPUBLIC

AREA:	TABLE NO. 1
CENTRAL AFRICAN REPUBLIC	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		10%	?	90%	1959

MAIN HOLDING AGENCIES

(1) Phototheque Nationale
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
CENTRAL AFRICAN REPUBLIC	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:99,999)		SMALL SCALE (1:100,000 & SMALLER)	
5%	1954+	100%	1956	90%	1956

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique
Brazzaville, Congo Republic

REMARKS

Small scale is 1:250,000
Medium scale is 1:100,000
Large scale is 1:50,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO.
CENTRAL AFRICAN REPUBLIC	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
				100%	1963

MAIN HOLDING AGENCIES

(1) Direction des Mines et de la Géologie
B. P. 24
Bangui, Central African Republic

REMARKS

There is detailed mapping for certain areas at scales of 1:200 000 1:100,000 and 1:50 000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

CHAD

AREA	TABLE NO. 1
CHAD	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001-1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
				100%	1955

MAIN HOLDING AGENCIES

(1) Phototheque Nationale
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA
CHAD

TABLE NO. 2
TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
10%	?	40%	?	100%	1959

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis rue de Grenelle
Paris - 7e France

(2) Service Géographique
Brazzaville, Congo Republic

REMARKS

Small-scale mapping is 1:200,000

Medium-scale (1:100,000) and large-scale (1:50,000) coverage taken together provide 50% coverage.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

AREA
CHAD

TABLE NO. 3
GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 AND LARGER)		MEDIUM SCALE (1:25,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

(1) Direction des Mines
Ministère des Travaux Publics et des Communications
B.P. 431
Fort Lamy, Chad

REMARKS

There is detailed mapping of certain areas at scales of 1:200,000, 1:100,000 and 1:50,000.

Small-scale coverage is 1:1,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

AREA
CHAD

TABLE NO. 4
SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
?	1958	100%	1961	?	1957

MAIN HOLDING AGENCIES

REMARKS

Medium-scale coverage is at 1:50,000

There is some coverage at 1:20,000 (1958), 1:100,000 (1956) and 1:200,000 (1957)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA
CHAD

TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		100%	1961		

MAIN HOLDING AGENCIES

REMARKS

Medium-scale coverage is a vegetation map series at 1:100,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

COMORES ISLANDS

AREA	TABLE NO. 2				
COMORES ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE [illegible] & LARGER)		MEDIUM SCALE [illegible]		SMALL SCALE [illegible]	
[illegible]	[illegible]	—	—	100%	196[illegible]

MAIN HOLDING AGENCIES

(1) Institut Géographique National
136 bis, rue de Grenelle
Paris - 7^e, France

(2) Service Géographique de Madagascar
B. P. 456
Tananarive, Madagascar

REMARKS

Large scale is 1:50,000.

Small scale is 1:500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service. 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

CONGO, FRENCH

AREA	TABLE NO. 1				
(FRENCH) CONGO	AERIAL PHOTOGRAPHY				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,000 - 1:50,000)		SMALL SCALE (1:50,000 AND SMALLER)	
—	—	[illegible]%	?	55%	1959

MAIN HOLDING AGENCIES

(1) Photothèque Nationale
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7^e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

Stone, Kirk H., 1961: World Air Photo Coverage, 1960. Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227.

AREA	TABLE NO. 2
(FRENCH) CONGO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
?	1954+	100%	1956	70%	1959+

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique
Brazzaville, Congo Republic

(3) United States Army Map Service
6500 Brooke Lane
Washington, D.C 20025

REMARKS

Small-scale is 1:200,000

Medium-scale is 1:100,000

Large-scale is 1:50,000 (A.M.S. Series G071 photomaps produced in 1962-63)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
(FRENCH) CONGO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	?

MAIN HOLDING AGENCIES

(1) Direction des Mines et de la Geologie
B.P. 2124
Brazzaville, Republic of Congo

REMARKS

There is detailed mapping for certain areas at scales of 1:200,000, 1:100,000 and 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

CONGO, BELGIAN

AREA	TABLE NO. 1
(BELGIAN) CONGO	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
?	1959	?	1958	(?) 25%	1958

MAIN HOLDING AGENCIES

(1) Institut Géographique du Congo
45, Av. Valcke-Léopoldville
B.P. 3086
Léopoldville-Kalina
Republic of the Congo

REMARKS The Belgian Congo is approximately 85% covered by aerial photography for which the scale is not given.

The 25% small-scale coverage indicated above consists of photomosaics at a scale of 1:50,000. It is probable that the actual percent of the area covered by small-scale photography is much higher than is given here.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique du Congo, Catalogue au 1er Janvier 1961.

AREA	TABLE NO. 2
(BELGIAN) CONGO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 & LARGER)		MEDIUM SCALE (1:50 001 - 1:100 000)		SMALL SCALE (1:100 001 AND SMALLER)	
30%	1948	4%	1936	100%	1959

MAIN HOLDING AGENCIES

(1) Institut Géographique du Congo
49, Av. Valcke-Léopoldville
B.P. 3086
Léopoldville-Kalina
Republic of the Congo

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
(BELGIAN) CONGO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 AND LARGER)		MEDIUM SCALE (1:250 000 - 1:1 000 000)		SMALL SCALE (1:2 000 000 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Ministere des Mines, de l'Energie et de la Geologie
Leopoldville, Republic of the Congo

REMARKS

The country is 100% covered at 1:2,000,000 and at 1:3,000,000

Basic mapping is to be done at scales of 1:50,000, 1:100,000 and 1:200,000, according to local requirements

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
(BELGIAN) CONGO	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 & LARGER)		MEDIUM SCALE (1:25,000 - 1:100 000)		SMALL SCALE (1:100 001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

For a complete list of published soils and vegetation maps write to:

INEAC
5, rue Belliard
Brussels, Belgium

Some of the Congo are 100% covered at 1:1,000,000 (Exact).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
(BELGIAN) CONGO	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 & LARGER)		MEDIUM SCALE (1:25,000 - 1:100,000)		SMALL SCALE (1:100 001 AND SMALLER)	

MAIN HOLDING AGENCIES

REMARKS

For a complete list of published soils and vegetation maps write to:

INEAC
5, rue Belliard
Brussels, Belgium

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

DAHOMEY

AREA	TABLE NO. 1
DAHOMEY	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
—	—	—	—	100%	1955

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique Nationale, Avancement des Travaux Géographiques à la date du 1-1-1966: Paris (5 maps)

AREA	TABLE NO. 2
DAHOMEY	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
20%	1958	5%	1951	99%	?

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique de Dakar
C.P 4016
Dakar, Senegal

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Institut Géographique Nationale, Advancement des Travaux Géographiques a la date du 1-1-1966 Paris (5 maps)

AREA	TABLE NO. 3
DAHOMEY	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
		35%	1962 (?)	100%	1969

MAIN HOLDING AGENCIES

(1) Service des Mines et de la Géologie
Ministère des Travaux Publics, des Transports et des Postes et Télécommunications
B.P. 249
Cotonou, Dahomey

REMARKS

In addition to 100% coverage at scales of 1:1,000,000 and 1:500,000, there is detailed mapping of certain areas at 1:200,000, 1:100,000 (Central Dahomey, 1962, 4 sheets) and 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 1 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
DAHOMEY	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	

MAIN HOLDING AGENCIES

REMARKS

There is an agriculture map of Dahomey at 1:1,000,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

FERNANDO PÓO

AREA	TABLE NO. 2
FERNANDO PÓO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 & LARGER)		MEDIUM SCALE (1:50 001 - 1:100 000)		SMALL SCALE (1:100,001 - 1:500 000)	
100%	1957	100%	1958	—	—

MAIN HOLDING AGENCIES

(1) Servicio Geografico del Ejército
Madrid, Spain

REMARK

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
FERNANDO PÓO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 AND LARGER)		MEDIUM SCALE (1:50 0[illegible] - 1:250,000)		SMALL SCALE (1:250 001 - 1:1,000,000)	
				100%	?

MAIN HOLDING AGENCIES

(1) Instituto Geológico y Minero de España
Madrid, Spain

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Petroleum Developments and Generalised Geology of Africa and Middle East: Munger Map Book, 3865 West Boulevard, Los Angeles 43, California, October 1960, 115 p.

GABON

AREA	TABLE NO. 1
GABON	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10 000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:90 000)		SMALL SCALE (1:90 001 AND SMALLER)	
—	—	75%	?	35%	1958

MAIN HOLDING AGENCIES

(1) Phototheque Nationale
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

The small-scale photography is at 1:50, 000.

The medium scale is 1:25, 000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

Stone, Kirk H., 1961, World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227.

AREA	TABLE NO. 2
GABON	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500 000)		SMALL SCALE (1:500,001 - 1:1 000 000)	
10%	1954+	100%	1956	100%	1959

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris -7e, France

(2) Service Geographique
Brazzaville, Congo Republic

REMARKS

Small scale is 1:200, 000

Medium scale is 1:100, 000

Large scale is 1:50, 000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York. 437 p.

AREA	TABLE NO. 3
GABON	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 AND LARGER)		MEDIUM SCALE (1:50 001 - 1:250,000)		SMALL SCALE (1:250 001 - 1:1,000 000)	
?	?	100%	1956	100%	?

MAIN HOLDING AGENCIES

(1) Direction des Mines
B P 576
Libreville, Gabon Republic

(2) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS There is detailed mapping for certain areas at scales of 1:200, 000, 1:100, 000 and 1:50, 000.

There is complete coverage of the country at scales varying from 1:10, 000 to 1:500, 000, most recent coverage in 1952.

Northern Gabon and the Booué region are covered at 1:200, 000. South Central Gabon and the Makokou region are covered at 1:100, 000. Western Gabon is covered at 1:125, 000 and 1:500 000 (1958)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
GABON	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

This country is 100% covered at scales varying from 1:5,000 to 1:5,000,000. Latest coverage is 1961.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
GABON	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				1963	1962

MAIN HOLDING AGENCIES

REMARKS

Small-scale coverage is a forestry map at 1:1,000,000, and vegetation maps at 1:1,000,000 and 1:4,000,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

GAMBIA

AREA	TABLE NO. 1
GAMBIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
—	—	100%	1946	100%	1949

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Small-scale photography is 1:40,000.

Medium scale is 1:30,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

Stone, Kirk H., 1961, World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 3, p. 215-227.

AREA	TABLE NO. 2
GAMBIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1963	—	—	100%	1956

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale coverage is D.O.S. Series G724 at 1:50,000.

Small-scale coverage is D.O.S. Series G624 at 1:125,000 on 5 sheets.

All of The Gambia is covered at 1:250,000 on A.M.S. Series G504.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic & Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
GAMBIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		100%	?	100%	1947

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooke Lane
Washington, D.C. 20025

REMARKS

Small-scale coverage is at 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Petroleum Developments and Generalized Geology of Africa and Middle East: Munger Map Book, 5865 West Boulevard, Los Angeles 43, California, October 1960, 115 p.

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
GAMBIA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
100%	1958				

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

A land-use map at a scale of 1:25,000 covers The Gambia (D.O.S. Series G823)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

GHANA

AREA	TABLE NO. 1
GHANA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		30%	1946	95% (TRIMET)	1947

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

Stone, Kirk H., 1961, World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 216-227.

AREA	TABLE NO. 2
GHANA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
20%	1953	42%	*	95%	1964 (?)

MAIN HOLDING AGENCIES

(1) Survey of Ghana
P.O. Box 191
Accra, Ghana

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS The only large-scale mapping consists of sheets prepared for the Volta Dam project, and 55 uncontoured sheets covering an area east of the Volta and south of latitude 6° 30'N. The large-scale cover indicated is D.O.S. Series G751 at 1:50,000.

Small-scale coverage is A.M.S. Series G504 at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
GHANA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1955

MAIN HOLDING AGENCIES

(1) Geological Survey Department
P.O. Box M 80
Ministry Branch Post Office
Accra, Ghana

REMARKS

Basic mapping of Southern Ghana is now being published as quarter-degree sheets at a scale of 1:62,500.

Coverage of Ghana is complete at 1:500,000, 1:1,000,000 and 1:2,000,000 in 1934, 1955 and 1962, respectively.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent, Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
GHANA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

Soils are covered at 1:1,500,000 and 1:2,000,000 by Ghana, Great Soils Groups mapping in 1958 and 1962, respectively.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
GHANA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1962

MAIN HOLDING AGENCIES

REMARKS

Vegetation zones maps of Ghana at 1:1,500,000 in 1958 and 1:2,000,000 in 1962 cover the country.

There is a forest-reserves map of Ghana at 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

GUINEA

AREA	TABLE NO. 1 AERIAL PHOTOGRAPHY
GUINEA (FR.)	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
—	—	—	—	100%	1957

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris -7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique Nationale, Advancement des Travaux Géographiques a la date du 1-1-1966 Paris (5 maps)

AREA	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS
GUINEA (FR.)	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
40%	1958			100%	1964 (?)

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique de Dakar
C.P. 4016
Dakar, Senegal

REMARKS

There are 67 special sheets at 1:50,000 of stereotopographical surveys according to agency (1) vertical coverage, 1956-58.

Small-scale coverage is in part A.M.S. Series G504 at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 1
GUINEA (FR.)	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
				100%	?

MAIN HOLDING AGENCIES

(1) Service des Mines et de la Géologie
Conakry, Guinea

REMARKS

In addition to 100% coverage at scales of 1:1,000,000 and 1:500,000, there is detailed mapping of certain areas at 1:200,000, 1:100,000 and 1:50,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

IVORY COAST

AREA	TABLE NO. 1
IVORY COAST	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:32,000)		SMALL SCALE (1:30,001 AND SMALLER)	
–	–	–	–	100%	1957

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique Nationale, Advancement des Travaux Géographiques a la date du 1-1-1966 Paris, (5 maps)

AREA	TABLE NO. 2
IVORY COAST	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
41%	1966			100%	1965

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique de Dakar
C.P. 4016
Dakar, Senegal

REMARKS

Small-scale coverage is in part A.M.S. Series G504 at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

Institut Géographique Nationale, Avancement des Travaux Géographiques a la date du 1-1-1966 Paris (5 maps)

AREA	TABLE NO. 3
IVORY COAST	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
?	?	?	?	100%	?

MAIN HOLDING AGENCIES

(1) Direction de la Géologie et de la Prospection Minière
B.P. 1368
Abidjan, Ivory Coast

REMARKS

In addition to 100 percent coverage at scales of 1:1,009,000 and 1:500,000, there is detailed mapping of certain areas at 1:200,000, 1:100,000 and 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 430 p.

AREA	TABLE NO. 4
IVORY COAST	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The country is covered at a scale of 1:2,000,000 (1960).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

KENYA

AREA:	TABLE NO. 1
KENYA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
?	1958	37%	1958	40%	1963

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

(2) Director of Surveys
Survey of Kenya
P.O. Box 30046
Nairobi, Kenya

REMARKS Series SK41 E and SK41 F of agency (2) are index maps showing airphoto cover of Kenya. Each is in two sheets, north and south. SK41 E shows "large-scale" air photographic cover to November 1963 (scales down to 1:25,000). SK41 F shows "small-scale" air photographic cover to November 1963 (scales of 1:30,000 and smaller). The cover shown has been done by the R.A.F. and by contract photography.

Nearly all of Kenya has been photographed since 1954 at scales varying from 1:50,000 to 1:10,560.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
KENYA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
95%	1949*	10%	1959	100%	1953

MAIN HOLDING AGENCIES

(1) Survey of Kenya
P.O. Box 30046
Nairobi, Kenya

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale mapping is Survey of Kenya (D.O.S.) Y 731 Series at 1:50,000 Medium scale is (D.O.S.) Y 633 Series at 1:100,000 Small scale is (D.O.S.) Y. 503 Series at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
KENYA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		(?) 95%	1963	100%	1962

MAIN HOLDING AGENCIES

(1) Mines and Geological Department
Ministry of Commerce, Industry and Communications
Box 30009
Nairobi, Kenya

REMARKS

There are 43 published sheets of a modern series of quarter-degree sheets at a scale of 1:125,000.

The Atlas of Kenya contains a geological map of Kenya at 1:3,000,000 compiled by the Survey of Kenya in 1959.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
KENYA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The soils of Kenya are mapped on A Provisional Soil Map of East Africa at 1:2,000,000 by G. Milne et al, published in 1936 by the East African Agricultural Research Station, Amani, Tanganyika.

There is also some soil mapping of Kenya at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5. VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
KENYA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Vegetation of the country is shown on a map of East Africa at 1:4,000,000, published by agency (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Directorate of Overseas Surveys, Vegetation Map of East Africa, Scale 1:4,000,000: D.O.S. (Misc.) 299E.

LIBERIA

AREA	TABLE NO. 1
LIBERIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
–	–	–	–	100%	1949

MAIN HOLDING AGENCIES

(1) Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

REMARKS

All of Liberia is covered at 1:40,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart and Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
LIBERIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
–	–	–	–	100%	1955

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

The coverage indicated is at 1:250,000 of West Africa, Series G.501 and G.504.

A planimetric series at 1:125,000 in 1953 covers the country.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
LIBERIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	?

MAIN HOLDING AGENCIES

(1) Bureau of Natural Resources
Monrovia, Liberia

REMARKS

Liberia is covered at a scale of 1:1,000,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Petroleum Developments and Generalized Geology of Africa and Middle East: Munger Map Book, 5865 West Boulevard, Los Angeles 43, California, October 1960, 115 p.

MADAGASCAR

AREA	TABLE NO. 2
MADAGASCAR	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
5%	?	100%	1960	100%	1962

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique de Madagascar
B.P. 456
Tananarive, Madagascar

REMARKS

Large-scale mapping is at 1:50,000 by agency (1).

The medium-scale coverage is 1:100,000. The series, just recently completed, is comprised of 453 sheets.

Small-scale coverage is at 1:500,000 by agency (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalogue des Cartes de L'I.G.N.
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

AREA	TABLE NO. 3
MADAGASCAR	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		100%	?	100%	1956

MAIN HOLDING AGENCIES

(1) Direction des Mines et de l'Énergie
Ministère d'État à l'Économie Nationale
B.P. 550
Tananarive, Madagascar

(2) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

Basic mapping has been completed and published on 127 sheets at a scale of 1:200,000.

Basic detailed mapping at a scale of 1:100,000 is now well-advanced.

Small-scale mapping consists of I.G.N. Series at 1:500,000 (1956) on 13 sheets and 1:1,000,000 on 3 sheets (1951)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalogue des Cartes de l'I.G.N.
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris -7e, France

AREA	TABLE NO. 4
MADAGASCAR	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris -7e, France

REMARKS

A one-sheet series at 1:2,500,000 covers Madagascar's soils (1960)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalogue des Cartes de l'I.G.N.
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

AREA	TABLE NO. * VEGETATION, LAND USE,
MADAGASCAR	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1959

MAIN HOLDING AGENCIES

REMARKS

There is a forest map of Madagascar at a scale of 1:1,000,000 and a vegetation map in three sheets at 1:1,000,000. Carte Internationale du Tapis Végétal.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

MOZAMBIQUE

AREA	TABLE NO. 1
MOZAMBIQUE	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:50,000)		SMALL SCALE (1:50,001 AND SMALLER)	
				10%	1953

MAIN HOLDING AGENCIES

(1) Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

REMARKS

As of 1960, all of Mozambique was scheduled to be covered by aerial photography of unknown scale, by 1968.

Approximately 50% was also scheduled to be covered at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart and Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
MOZAMBIQUE	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		?	1942	100%	1954

MAIN HOLDING AGENCIES

(1) Overseas Ministry
(Junta das Missões Geográficas e de Investigações do Ultramar)
Lisbon, Portugal

(2) Missão Geográfica de Moçambique
Lourenço Marques, Mozambique

REMARKS

Small-scale cover is in part (50%) the A.M.S. Series T461 at 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 5
MOZAMBIQUE	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		20%	1959		

MAIN HOLDING AGENCIES

(1) Direcção dos Serviços de Geologia e Minas
Caixa Postal 217
Lourenço Marques, Mozambique

REMARKS

Mozambique is 100 percent covered at scales of 1:2,000,000 and 1:3,000,000

Medium-scale coverage indicated is at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York. 437 p

AREA	TABLE NO. 5 VEGETATION, LAND USE,
MOZAMBIQUE	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1947

MAIN HOLDING AGENCIES

REMARKS

The country is covered by a phytogeographic map at 1:6,000,000 by F. Mendonca in 1947

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 1
NIGERIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		30%	1959	80% (TRIMET)	[illegible]

MAIN HOLDING AGENCIES

(1) Survey Division
Federal Survey Department
Lagos, Nigeria

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri

Stone, Kirk H., 1961, World Air Photo Coverage, 1956: Photogrammetric Engineering, v. XXVII, no. 2, p. 224-227.

NIGERIA

AREA: NIGERIA

TABLE NO. 2

TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500,000)		SMALL SCALE (1:500,001 - 1:1,000,000)	
100%	1954+	35%	1954+	75%	1954+

MAIN HOLDING AGENCIES

(1) Federal Survey of Nigeria
5 Tafawa Balewa Square
Lagos, Nigeria

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale cover is D. O. S. Series G762 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA: NIGERIA

TABLE NO. 3

GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
?	?	45%	?	?	?

MAIN HOLDING AGENCIES

(1) Geological Survey
Private Bag 2057
Kaduna Junction
Northern Nigeria

REMARKS

Nigeria is 100% covered at scales of 1:2,000,000, 1:3,000,000 and 1:5,000,000 in 1956, 1959 and 1957, respectively. Scales of 1:250,000, 1:100,000 and 1:50,000 have now been adopted for basic mapping. Percent of area covered by each is not known.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA: NIGERIA

TABLE NO. 4

SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

There is a provisional soil map of Nigeria at a scale of 1:5,700,000 by the Survey Department of Nigeria, compiled in 1952.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA: NIGERIA

TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:150,000)		SMALL SCALE (1:150,001 AND SMALLER)	
				1695	1959

MAIN HOLDING AGENCIES

REMARKS

There is a vegetation map of Nigeria at 1:3,000,000. Various forestry, agricultural and vegetation maps exist at 1:3,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 2
NIGERIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500,000)		SMALL SCALE (1:500,001 - 1:5,000,000)	
100%	1954*	35%	1954*	75%	1959*

MAIN HOLDING AGENCIES

(1) Federal Survey of Nigeria
5 Tafawa Balewa Square
Lagos, Nigeria

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale cover is U. S. Series G762 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
NIGERIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:5,000,000)	
?	?	45%	?	?	?

MAIN HOLDING AGENCIES

(1) Geological Survey
Private Bag 2057
Kaduna Junction
Northern Nigeria

REMARKS

Nigeria is 100% covered at scales of 1:2,000,000, 1:3,000,000 and 1:5,000,000 in 1956, 1959 and 1957, respectively. Scales of 1:250,000, 1:100,000 and 1:50,000 have now been adopted for basic mapping. Percent of area covered by each is not known.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
NIGERIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:5,000,000)	

MAIN HOLDING AGENCIES

REMARKS

There is a provisional soil map of Nigeria at a scale of 1:5,730,000 by the Survey Department of Nigeria, compiled in 1952.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
NIGERIA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:150,000)		SMALL SCALE (1:150,001 AND SMALLER)	
				100%	1959

MAIN HOLDING AGENCIES

REMARKS

There is a vegetation map of Nigeria at 1:3,000,000. Various forestry, agricultural and vegetation maps exist at 1:3,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

NORTHERN RHODESIA

AREA	TABLE NO. 1
NORTHERN RHODESIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:20,000 TO 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
?	?	?	?	?	?

MAIN HOLDING AGENCIES

REMARKS

Stone's article states that, as of 1959, approximately 90% of the former Federation of Rhodesia and Nyasaland was covered by single-lens vertical aerial photography ranging in scale from 1:40,000 to 1:5,000. The information was not further broken down.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Stone, Kark H., 1961, World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227.

AREA	TABLE NO. 2
NORTHERN RHODESIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:63,360 TO 1:250,000)		SMALL SCALE (1:253,440 AND SMALLER)	
50%	1949+	2%	1945	100%	1959

MAIN HOLDING AGENCIES

(1) Department of Trigonometrical and Topographical Surveys
Government of Zambia
Lusaka, Zambia

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

By the end of 1959, four sheets of a new general series at 1:250,000 had been published for Northern Rhodesia.

Large-scale mapping is D.O.S. Series 2744 at 1:50,000

Army Map Service Series 7841 at 1:50,000 covers all of Zambia on nine sheets (3 were based on those of the Northern Rhodesia Survey Department

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent, Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
NORTHERN RHODESIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 TO 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		?	?	100%	?

MAIN HOLDING AGENCIES

(1) Geological Survey Department
P.O. Box RW. 135, Ridgeway
Lusaka, Zambia

REMARKS

Northern Rhodesia is 100% covered at 1:1,000,000 and 1:2,000,000

Quarter-degree sheets are being published also, at a scale of 1:250,000.

The Atlas of the Federation of Rhodesia and Nyasaland contains a geologic map covering Northern Rhodesia at 1:2,500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent, Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
NORTHERN RHODESIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The country is covered by a scale map at 1:2,500,000 in the Atlas of the Federation of Rhodesia and Nyasaland

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
NORTHERN RHODESIA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	

MAIN HOLDING AGENCIES

REMARKS

The country is covered at 1:2,500,000 by a vegetation map in the Atlas of the Federation of Rhodesia and Nyasaland.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

NYASALAND

AREA	TABLE NO. 1
NYASALAND	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
?	?	?	?	?	?

MAIN HOLDING AGENCIES

REMARKS

Stone's article states that, as of 1959, approximately 90% of the former Federation of Rhodesia and Nyasaland was covered by single-lens vertical aerial photography ranging in scale from 1:40,000 to 1:5,000. This information was not further broken down.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Stone, Kirk H., 1961. World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227.

AREA	TABLE NO. 2
NYASALAND	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
90%	1950 •	—	—	95%	1959

MAIN HOLDING AGENCIES

(1) Department of Trigonometrical and Topographical Surveys
Government of Malawi
Zomba, Malawi

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

At the end of 1959, seven sheets of a federal series being prepared by agency (1) covered nearly all of Nyasaland at 1:250,000

Large-scale coverage is D.O.S. Series Z742 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
NYASALAND	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
		?	?	100%	?

MAIN HOLDING AGENCIES

(1) Geological Survey Department
P.O. Box 27
Zomba, Malawi

REMARKS

Nyasaland is 100% covered at 1:1,000,000.

Basic mapping is published as quarter-degree sheets at a scale of 1:100,000. Percent of area covered is unknown

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Petroleum Developments and Generalized Geology of Africa and Middle East. Munger Map Book, 5865 West Boulevard, Los Angeles 43, California, October 1960, 115 p.

AREA	TABLE NO. 4
NYASALAND	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The country is covered by a preliminary soil map at 1:2,000,000, published in 1960

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
NYASALAND	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	

MAIN HOLDING AGENCIES

REMARKS

The Atlas of the Federation of Rhodesia and Nyasaland contains a vegetation map of the country at 1:2,500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

PORTUGUESE GUINEA

AREA	TABLE NO. 1
PORTUGUESE GUINEA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
–	–	100%	?	(TRIMET) 100%	1947

MAIN HOLDING AGENCIES

(1) Overseas Ministry
Lisbon, Portugal

(2) Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
PORTUGUESE GUINEA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1957 +	–	–	100%	1964 (?)

MAIN HOLDING AGENCIE

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C.

(2) Overseas Ministry
Junta das Missões Geográficas e de Investigações do Ultramar)
Lisbon, Portugal

REMARKS

Small-scale coverage is in part A M.S. Series G504 at 1:250,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
PORTUGUESE GUINEA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1954

MAIN HOLDING AGENCIES

(1) Secção de Geologia e Minas
Caixa Postal 399
Bissau, Portuguese Guinea

REMARKS

Portuguese Guinea is 100 percent covered at a scale of 1:1,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

RIO MUNI

AREA	TABLE NO. 2
RIO MUNI	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
—	—	100 %	1952	100%	1959

MAIN HOLDING AGENCIES

(1) Servicio Geografico del Ejercito
Prim 8
Madrid, Spain

REMARKS

Small-scale mapping is at 1:200,000. This is the Mapa Itinerario (Topográfico y Forestal) de la Guinea Española, four sheets in color.

Medium-scale mapping is at 1:100,000, Mapa Topográfico Forestal de Guinea, 15 sheets in color.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 1
RIO MUNI	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1946

MAIN HOLDING AGENCIES

(?) Instituto Geologico y Minero de España
Madrid, Spain

REMARKS

The 1946 map is at a scale of 1:400,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

RWANDA

AREA	TABLE NO. 1
RWANDA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Institut Géographique du Congo
45, Av. Valcke-Léopoldville
B.P. 3086
Léopoldville-Kalina
Republic of the Congo

REMARKS

Rwanda is 100% covered by aerial photography for which the scale is not given.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique du Congo, Catalogue au 1er Janvier 1961.

AREA	TABLE NO. 2
RWANDA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
65%	1948	100%	1959	100%	1957

MAIN HOLDING AGENCIES

(1) Institut Géographique du Congo
45, Av. Valcke-Leopoldville
B P 3086
Leopoldville-Kalina
Republic of the Congo

REMARKS

In addition to above data, A M.S. Series Z421 (1962) covers all of Rwanda at 1:500,000 and A M.S. Series Y401 (1964) covers 40 percent of the country at the same scale.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
RWANDA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Service Geologique du Ruanda-Urundi
Usumbura, Ruanda-Urundi

REMARKS

The country is 100% covered at 1:2,000,000 and 1:3,300 000.

Basic mapping is to be done at scales of 1:50,000, 1:100,000 and 1:200,000, according to local requirements.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

SENEGAL

AREA	TABLE NO. 1
SENEGAL	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:40,000)		SMALL SCALE (1:40,001 AND SMALLER)	
				100%	1955

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Géographique Nationale, Avancement des Travaux Géographiques a la date du 1-1-1966 Paris (5 maps)

AREA	TABLE NO. 2
SENEGAL	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
30%	1959			100%	1966

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

(2) Service Géographique de Dakar
C P. 4016
Dakar, Senegal

REMARKS

Small-scale mapping is in part A.M.S. Series G504 at 1:250,000.

Large-scale mapping is at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Institut Géographique Nationale, Avancement des Travaux Géographiques a la date du 1-1-1966 Paris (5 maps)

AREA	TABLE NO. 3
SENEGAL	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001-1:250,000)		SMALL SCALE (1:250,001 - 1:600,000)	
?	?	?	?	100%	1962

MAIN HOLDING AGENCIES

(1) Direction des Mines et de la Géologie
B P 1238
Dakar, Senegal

REMARKS

In addition to 100 percent coverage at scales of 1:1,000,000 and 1:500,000, there is detailed mapping of certain areas at 1:200,000, 1:100,000 and 1:50,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
SENEGAL	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1950

MAIN HOLDING AGENCIES

REMARKS

Small-scale coverage is the West African Vegetation Map series at 1:200,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

SIERRA LEONE

AREA	TABLE NO. 1
SIERRA LEONE	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
–	–	–	–	95%	1949

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Small-scale coverage is of trimetrogon type

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
St. Louis, Missouri 63118

AREA	TABLE NO. 2
SIERRA LEONE	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1961	100%	1947	100%	1955

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

(2) Survey and Lands Department
Government of Sierra Leone
Freetown, Sierra Leone

REMARKS

Small-scale mapping is in part AMS series G504 which covers 70% of Sierra Leone at 1:250,000. All of the country is covered by six sheets of the West African D.O.S. series at the same scale. The country is also completely covered by 111 form-lined sheets at 1:62,500 by Agency (2).

Large-scale coverage is D.O.S. series G742 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 3
SIERRA LEONE	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
40%	1962			100%	1960

MAIN HOLDING AGENCIES

(1) Geological Survey Department
Freetown, Sierra Leone

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Sierra Leone is 100% covered at scales of 1:500,000 and 1:1,000,000 (D.O.S. [GEOL] 1120).

D.O.S. (GEOL) 1139, at 1:50,000, 1962, is large-scale cover.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 4
SIERRA LEONE	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

( ) Surveys and Land Department
Freetown, Sierra Leone

REMARKS

The country is 100% covered at 1:1,000,000 by a (1949) soil map by agency (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
SIERRA LEONE	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
25%	1959	35%	1960	100%	1954

MAIN HOLDING AGENCIES

( ) Surveys and Land Department
Freetown, Sierra Leone

REMARKS

There is a vegetation map of Sierra Leone at 1:1,000,000. Also covering the country are forestry and cultivation maps at the same scale.

D O S 3003 Sierra Leone Land Use, 1:16,000, 1959, is the large-scale coverage.

D O S 3004 and 3005 Land Use maps, 1:40,000, 1960, is medium-scale coverage.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

(SOUTHERN) PHODESIA

AREA	TABLE NO. 3
SOUTHERN RHODESIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
–	–	99%	1954	53%	1964

MAIN HOLDING AGENCIES

(*) Department of Federal Surveys
P. O. Box 8181
Causeway
Salisbury, Rhodesia

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Charts & Aerial Photographs (& supplements), 1965
Ministry of Mines and Lands
Department of the Surveyor General
P O Box 8094
Causeway, Rhodesia

AREA	TABLE NO. 2
SOUTHERN RHODESIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500,000)		SMALL SCALE (1:500,001 - 1:1,000,000)	
48%	1959	18%	?	100%	1959

MAIN HOLDING AGENCIES

(1) Federal Department of Trigonometrical and Topographical Surveys
Salisbury, Rhodesia

(2) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

By the end of 1959, three sheets of a new federal series at 1:250,000 had been published for Southern Rhodesia.

A.M.S. Series Z442 at 1:500,000 covers all of Rhodesia

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

Catalogue of Maps, Charts & Aerial Photographs (and Supplements), 1965,
Ministry of Mines and Lands
Department of the Surveyor General
P.O. Box A999,
Causeway, Rhodesia

AREA	TABLE NO. 3
SOUTHERN RHODESIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 250,000)		SMALL SCALE (250,001 - 1,000,000)	
		?	?	100%	1946

MAIN HOLDING AGENCIES

(1) Geological Survey Office
Box 8039, Causeway
Salisbury, Rhodesia

REMARKS

Southern Rhodesia is 100 percent covered at a scale of 1:1,000,000.

Maps of mineralized areas, mainly at scales of 1:119,000 and 1:100,000 are published with collection of agency (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
SOUTHERN RHODESIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The country is covered at a scale of 1:2,500,000 by a soils map in the Atlas of the Federation of Rhodesia and Nyasaland.

There is also a provisional soils map of the country at 1:1,000,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
SOUTHERN RHODESIA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:150,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

REMARKS

The country is covered by an agro-ecological survey in 1961 by the Ministry of Agriculture, and by a vegetation map at 1:2,500,000 in the Atlas of the Federation of Rhodesia and Nyasaland

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

SUDAN

AREA	TABLE NO. 1
SUDAN	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
5%	1954			40%	1954

MAIN HOLDING AGENCIES

(1) Sudan Survey Department
Ministry of Mineral Resources
P. O. Box 309
Khartoum, Sudan

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

Stone, Kirk H., 1961, World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227

AREA	TABLE NO. 2
SUDAN	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
?	1955	100%	1955	100%	1955

MAIN HOLDING AGENCIES

(1) Sudan Survey Department
Khartoum, Sudan

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Sudan Survey Department, 1956, Catalogue of Topographical Maps, 1956: Survey Dept., Khartoum.

AREA	TABLE NO. 3
SUDAN	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		?	?		

MAIN HOLDING AGENCIES

(1) Geological Survey Department
Ministry of Mineral Resources
Box 410,
Khartoum, Sudan

REMARKS

The Sudan is 100% covered at 1:4,000,000

Part of the basic mapping program is to be a geological map of the Sudan at 1:1,000,000, now in process.

Basic mapping on a scale of 1:250,000 is also progressing.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent, Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 5 VEGETATION LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
SUDAN	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1954

MAIN HOLDING AGENCIES

REMARKS

The vegetation of the country is mapped at 1:4,000,000
(Sudan Survey Department, 1954)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

TANGANYIKA

AREA	TABLE NO. 1 AERIAL PHOTOGRAPHY
TANGANYIKA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
				15%	1955

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

The information above, on percent coverage at various scales, is taken from source (1). Source (2) states that approximately 50% of Tanganyika is covered at unknown scales

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

(1) Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

(2) Stone, Kirk H. 1961. World Air Photo Coverage, 1960: Photogrammetric Engineering, v. XXVII, no. 2, p. 214-227.

AREA	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS
TANGANYIKA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001-1:100,000)		SMALL SCALE (1:100,001-1:500,000)	
100%	1959	?	1959	99%	1949

MAIN HOLDING AGENCIES

(1) Survey Division
Ministry of Lands, Forestry and Wildlife
Dar es Salaam, Tanzania

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale mapping is D O S. Series Y742 at 1:50,000.

Small-scale mapping is A M.S. Series Y401 at 1:500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 433 p.

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
TANGANYIKA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		?	?		

MAIN HOLDING AGENCIES

(1) Geological Survey Division
Ministry of Commerce and Industry
Box 69
Dodoma Tanzania

REMARKS

Tanganyika is 100% covered at 1:2,000,000.

Basic mapping is being published at scales of 1:250,000 and 1:125,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent Columbia Univ. Press, New York, 437 p.

Petroleum Developments and Generalized Geology of Africa and Middle East Munger Map Book, 5855 West Boulevard, Los Angeles 43, California, October 1956, 145 p.

AREA	TABLE NO. 4
TANGANYIKA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The soils of Tanganyika are mapped on A Provisional Soil Map of East Africa at 1:2,000,000 by G. Milne et al, published in 1936 by the East African Agricultural Research Station, Amani, Tanganyika.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
TANGANYIKA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Vegetation of the country is covered on map of East Africa at 1:4,000,000 published by agency (1)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Direct from Overseas Surveys, Vegetation Map of East Africa, 1:4,000,000 (Misc.) 243

TOGO

AREA: TOGO

TABLE NO. 1

AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:50,000)		SMALL SCALE (1:50,001 AND SMALLER)	
—	—	—	—	100%	?

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris - 7e, France

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Institut Geographique Nationale, Avancement des Travaux Géographiques a la date du 1-1-1966: Paris (5 maps)

AREA: TOGO

TABLE NO. 2

TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
40%	1958	20%	1959 (?)	100%	?

MAIN HOLDING AGENCIES

(1) Institut Geographique Nationale
136 bis, rue de Grenelle
Paris -7e, France

(2) Service Géographique de Dakar
C.P. 4016
Dakar, Senegal

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963, A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Institut Géographique Nationale, Avancement des Travaux Géographiques a la date du 1-1-1966. Paris (5 maps)

AREA: TOGO

TABLE NO. 3

GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
?	?		?	100%	

MAIN HOLDING AGENCIES

(1) Direction des Mines et de la Géologie
Ministère des Travaux Publics, Mines, Transports, des Postes et Telecommunications
B P 355
Lomé, Togo

REMARKS

In addition to 100% coverage at scales of 1:1,000,000 and 1:500,000, there is detailed mapping of certain areas at 1:200,000, 1:100,000 and 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 196 , A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA: TOGO

TABLE NO. 4

SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	

MAIN HOLDING AGENCIES

REMARKS

Soils are covered at 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UGANDA

AREA	TABLE NO. 1
UGANDA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		85%	1952	20%	1956

MAIN HOLDING AGENCIES

(1) Director of Surveys
P. O. Box 1
Entebbe, Uganda

REMARKS

100% of Uganda is covered by aerial photography of varying scales.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage: Photographic Records and Services Division, Aeronautical Chart & Information Center, United States Air Force, 2nd & Arsenal, St. Louis, Missouri 63118

AREA	TABLE NO. 2
UGANDA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:99,999)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1959	100%	1963	100%	1959

MAIN HOLDING AGENCIES

(1) Department of Lands and Surveys
P.O. Box 361
Kampala, Uganda

(2) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large-scale coverage is D.O.S. Series Y732 at 1:50,000.

Small-scale coverage is in part the A.M.S. Series Y401 at 1:500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963. A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

Catalog of Maps, Geodetic and Topographical Surveys. Directorate of Overseas Surveys, Kingston Road, Tolworth, Surbiton, Surrey, England.

AREA	TABLE NO. 3
UGANDA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
?	?	100%	1961	?	?

MAIN HOLDING AGENCIES

(1) Geological Survey of Uganda
P.O. Box 9
Entebbe, Uganda

REMARKS

Uganda is 100% covered at a scale of 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963. A Review of the Natural Resources of the African Continent: Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
UGANDA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	?

MAIN HOLDING AGENCIES

REMARKS

The soils of Uganda are mapped in A Provisional Soil Map of East Africa at 1:2,000,000 by G. Milne et al, published in 1936 by the East African Agricultural Research Station, Amani, Tanganyika

Small-scale mapping indicated is at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE,
UGANDA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Vegetation of the country is covered on a map of East Africa at 1:4,000,000, published by agency (1).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Directorate of Overseas Surveys, Vegetation Map of East Africa, scale 1:4,000,000: D.O.S. (Misc) 299E

ZANAIBAR AND PEMBA ISLANDS

AREA	TABLE NO. 1
ZANZIBAR AND PEMBA ISLANDS	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
—	—	—	—	100%	1953

MAIN HOLDING AGENCIES

(1) Lockwood Survey Corporation Ltd.
1459 O'Connor Drive
Toronto 16, Canada
(Refer to Hunting Aerial Survey Catalog)

REMARKS

Zanzibar is covered at a scale of 1:36,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index of Aerial Photographic Coverage
Photographic Records and Services Division
Aeronautical Chart & Information Center
United States Air Force
2nd & Arsenal
St. Louis, Missouri 63118

AREA	TABLE NO. 2
ZANZIBAR AND PEMBA ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
100% (Zanzibar)	1937	100%	1953	100%	1944

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Zanzibar and Pemba Islands are covered at scales of 1:125,000 and 1:63,360 (D.O.S. Series Y774, on two sheets; Zanzibar is also covered by a series of 50 contoured sheets at a scale of 1:10,560 by the Survey Department of Zanzibar (1933-37).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963. A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

Catalog of Aerial, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
ZANZIBAR AND PEMBA ISLANDS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
–	–	100%	1924	–	–

MAIN HOLDING AGENCIES

REMARKS

Zanzibar and Pemba Islands are 100% covered at a scale of 1:126,720

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, International Documents Service, 1963. A Review of the Natural Resources of the African Continent. Columbia Univ. Press, New York, 437 p.

AREA	TABLE NO. 4
ZANZIBAR AND PEMBA ISLANDS	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

The soils of Zanzibar are mapped on A Provisional Soil Map of East Africa at 1:2,000,000 by G. Milne et al. published in 1936 by the East African Agricultural Research Station, Amani, Tanganyika

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

SOUTH ASIA

ANDAMAN ISLANDS

AREA	TABLE NO. 2
ANDAMAN ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	?

MAIN HOLDING AGENCIES

(1) Aeronautical Chart and Information Center
U.S. Air Force
2nd and Arsenal
St. Louis, Missouri 63118

REMARKS

Small-scale mapping is of Operational Navigation Chart-PC Series (1:500,000) - #679 B, C, D and #798 A.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 1
ANDAMAN ISLANDS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		3%	?		

MAIN HOLDING AGENCIES

(1) Geological Survey of India
27 Chowringhee Ave.
Calcutta, India

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

BURMA

AREA	TABLE NO. 1
BURMA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		30%	1954		

MAIN HOLDING AGENCIES

REMARKS

Medium-scale coverage is generally at 1:24,000, except for some large towns, done at 1:6,000. The photography was accomplished under a contract between the Burmese Government and the World Wide Survey Institute.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 2
BURMA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				92%	1964 (*)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

(2) American Geographical Society
156th Street at Broadway
New York, New York

REMARKS

Small scale coverage is AMS Series U542 at 1:250,000 in 46 sheets.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog: U.S. Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 3
BURMA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Burma Geological Department
Rangoon, Burma

REMARKS 80% of the country is mapped at a scale of 1:2,027,560 (1961) by Drg. No. 204 of the BGD.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
BURMA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) Land Use Bureau
Department of the Commissioner for Settlements of Land Records
Housing Board Buildings
27th St.
Rangoon, Burma

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
BURMA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

CAMBODIA

AREA	TABLE NO. 1 AERIAL PHOTOGRAPHY
CAMBODIA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
10%	1958			100%	1958

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

REMARKS

In 1957 and 1958, all of Cambodia was photographed at a scale of 1:40,000 by World Wide Inc., a United States company. The same company photographed certain regions of Cambodia at a scale of 1:10,000 in 1958

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960 Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment. Mineral Resources Development Series No. 12, Bangkok, p.24-25.

AREA	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS
CAMBODIA	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
35%	1957	100%	Pre-1954 ?	100%	1964?

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

(2) United Sates Army Map Service
6500 Brooks Lane
Washington, D.C. 20065

REMARKS

Medium scale coverage is official French government Series at 1:100,000.
Small scale coverage is AMS Series L509 at 1:250,000.
Large scale coverage is AMS Series 2805 at 1:25,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog: U.S. Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 1
CAMBODIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1961

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping is at 1:500,000 on a map covering Vietnam, Laos, and Cambodia.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index to Geological Map of Vietnam-Laos-Cambodia 1:500,000 scale edition 1960-1961.

AREA	TABLE NO. 5
CAMBODIA	VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1955

MAIN HOLDING AGENCIES

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

CEYLON

APEA	TABLE NO. 1
CEYLON	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
				100%	1956 (?)

MAIN HOLDING AGENCIES

(1) Survey Department of Ceylon
P. O. Box No. 506
Colombo, Ceylon

REMARKS

Small scale coverage is at 1:40,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960, Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12, Bangkok, p. 24-25.

AREA	TABLE NO. 2
CEYLON	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:500,000)		SMALL SCALE (1:500,001 - 1:5,000,000)	
		100%	*	100%	*

MAIN HOLDING AGENCIES

(1) Survey Department of Ceylon
P. O. Box No. 506
Colombo, Ceylon

REMARKS

Medium scale is 1:63 360 in 72 sheets.
Small scale is 1:253 440.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960. Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment. Mineral Resources Development Series No. 12. Bangkok, p. 24-25.

AREA	TABLE NO. 3
CEYLON	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Edward Stanford Ltd.
12-14 Long Acre
London, W-2, England

REMARKS

There is a provisional geological map of the country at a scale of 1:1,520,640.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
CEYLON	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	*

MAIN HOLDING AGENCIES

REMARKS

Small Scale Mapping is a land use map in 4 sheets at 1:253,440. A 1:1,000,000 sheet covering the entire island is in press at Pondicherry for the series Carte International du Tapis Végétal.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

CHINA (COMMUNIST)

AREA	TABLE NO. 2
CHINA (COMMUNIST)	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	1964 (?)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooke Lane
Washington, D.C. 20025

(2) American Geographical Society
156th at Broadway
New York, New York

REMARKS

Hong Kong and the New Territories are mapped at 1:25,000 (GSGS 1..8811) on 24 sheets and in 2 sheets at 1.100,000

Small-scale coverage is Army Map Service Series L500 at 1.250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog: United States Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 5 VEGETATION, LAND USE,
CHINA (COMMUNIST)	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		1%	1958		

MAIN HOLDING AGENCIES

REMARKS

The medium scale map is of Hong Kong and New Territories at 1:50,000 and is part of T. R. Tregear's Monograph #1 for the World Land Use Survey

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

CHINA (NATIONALIST)

AREA	TABLE NO. 1
CHINA (NATIONALIST)	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
				100%	?

MAIN HOLDING AGENCIES

REMARKS

The entire island is covered at a scale of 1:40,000 with larger scale photos in some critical areas

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East. 1960. Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12 Bangkok, p. 24-25.

AREA	TABLE NO. 2
CHINA (NATIONALIST)	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1964 (*)

MAIN HOLDING AGENCIES

[1]United States Army Map Service
6500 Brooks Lane
Washington, D. C. 20025

[2]American Geographical Society
156th St. at Broadway
New York, New York

REMARKS

Small scale coverage is AMS Series L594 at 1:250,000 (6 sheets)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 3
CHINA (NATIONALIST)	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1953

MAIN HOLDING AGENCIES

Geological Survey of Taiwan
P.O. Box 31
Taipei, Taiwan

REMARKS

Small scale mapping is - sheets at 1:399,000 by Chang Li-Shu.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
CHINA (NATIONALIST)	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:1,000,000)	
		100%	1953		

MAIN HOLDING AGENCIES

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Barrera, Alfredo 1961 Soil Classification and Conservation in Taiwan: 10th Pacific Science Congress Committee on Soil and Land Classification p. 375-378

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
CHINA (NATIONALIST)	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	

MAIN HOLDING AGENCIES

REMARKS

See also the 1950 Atlas of Land Utilization of Taiwan 121 maps primarily at 1:5,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

INDIA

AREA	TABLE NO. 1
INDIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 TO 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) Surveyor General's Office
Survey of India
Post Box No. 37
Dehra Dun, U. P.
India

(2) Air Survey Division
Geological Survey of India
27 Chowringhee Road
Calcutta, India

REMARKS

Several hundred thousand square miles have been covered by photographs at scales ranging from 1:10,900 to 1:63,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960, Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12, Bangkok, p. 24-25.

AREA	TABLE NO. 2
INDIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 TO 1:100,000)		SMALL SCALE (1:100,001 TO 1:500,000)	
				100%	1964 (*)

MAIN HOLDING AGENCIES

(1) National Atlas Organization
1, Acharya Jagadish Bose Rd.
3rd Floor
Calcutta 20, India

(2) Surveyor General's Office
Survey of India
Post Box No. 37
Dehra Dun, U. P.

(3) United States Army Map Service
6500 Brooks Lane
Washington, D. C. 20025

REMARKS

Small-scale coverage is AMS Series U502 at 1:250,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog
U.S. Army Map Service
Washington, D.C. 20025

AREA	TABLE NO. 3
INDIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 TO 1:250,000)		SMALL SCALE (1:250,001 TO 1:500,000)	
		65%	?	25%	?

MAIN HOLDING AGENCIES

(1) Geological Survey of India
27 Chowringhee Rd
Calcutta, India

REMARKS

The country is 100% covered at a scale of 1:2,000,000 by the 6th edition of the Geological Map of India published in 1961 on 4 sheets.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Government of India, Geological Survey, 1961, Geological Map of India, Sixth Edition, Explanatory Notes.

AREA: INDIA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

(1) Botanical Survey of India
14 Madan Street
Calcutta, India

REMARKS

The Indian Council of Agricultural Research published in 1961 an International Map of Vegetation & Environmental Conditions of India, 1:1,000,000.

The Carte Internationale du Tapis Végétal, 1:1000 000 Series, produced at L'Institut Français de Pondicherry have published the Madras, Jagannath and Godavari sheets with Cape Comorin, Mysore and Ceylon in press.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

LAOS

AREA LAOS	TABLE NO. 1 AERIAL PHOTOGRAPHY				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE [illegible]		SMALL SCALE [illegible] AND SMALLER	

MAIN HOLDING AGENCIES

(1) Institut Géographique National
136 bis, rue de Grenelle
Paris 7e, France

(2) National Geographical Service of Laos
Vientiane, Laos

REMARKS

Aerial coverage flown by agency (1) in 1954-56 covers most of Laos. The area not yet covered is the northwestern zone towards Ban Houei-Sai, Sayaboury. Coverage consists of 18,000 photographs at scales between 1:40,000 and 1:50,000.

The United States Army Map Service carried out photography for the government of Laos in 1957-58 at a scale of 1:40,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1966, Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12, Bangkok, p. 24-25.

AREA LAOS	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE [illegible]		SMALL SCALE [illegible]	
		100%	Pre-1954	100%	1964 (?1)

MAIN HOLDING AGENCIES

(1) Institut Géographique National
136 bis, rue de Grenelle
Paris 7e, France

(2) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

Medium scale coverage is official French government series at 1:100,000.

Small scale coverage is AMS Series L504 at 1:253,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog - U.S. Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 1
LAOS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,500,000)	
				100%	1961

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping is at 1:500,000 on a map covering Vietnam, Laos, and Cambodia.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Index to Geological Map of Vietnam-Laos-Cambodia
1:500,000 scale,edition 1960-1961.

MALAYSIA

AREA:	TABLE NO. 1
MALAYSIA	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:40,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		95%	?		

MAIN HOLDING AGENCIES

REMARKS

Medium scale is approximately 6 inches to the mile

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 2
MALAYSIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
30%	1965	100%	?	100%	?

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

(2) Survey Department
Federation of Malaya
Kuala Lumpur, Malaya

REMARKS

Large-scale coverage indicated is at 1:25,000

Medium-scale coverage is at 1:63,360

Small-scale coverage is at 1:253,400

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 3
MALAYSIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		100%	1950	100%	?

MAIN HOLDING AGENCIES

(1)Geological Survey Department
Kuala Lumpur,
Malaya

REMARKS

Small-scale mapping is at 1:760,320

Medium-scale mapping is at 1:63,360

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
MALAYSIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				(?)100%	1965 (?)

MAIN HOLDING AGENCIES

REMARKS

According to the "best source" below, a reconnaissance survey program, on a state basis, was scheduled for completion by 1965. The final reports were to be accompanied by maps at 1:500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Ho, Robert, 1961, Status of Soil and Land Classification in Malaya, 1961: 10th Pacific Science Congress, Committee on Soil and Land Classification, p. 39?.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
MALAYSIA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		10%	?	100%	1960

MAIN HOLDING AGENCIES

REMARKS

Singapore land use is 100% mapped at 1:63,360, that of Malaya 100% at 1:2,000,000.

The U.S. Army Map Service published in 1960 a generalized map of Malaya and Singapore vegetation and land utilization at 1:1,350,000.

There is a forest resources map of Malaya at a scale of 1,760,320, published by the Malaya Federal Survey Dept.

The state of Malacca and Penang Settlement's land use is mapped at 1:63,360.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

NICOBAR ISLANDS

AREA	TABLE NO. 2
NICOBAR ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	•

MAIN HOLDING AGENCIES

REMARKS

Small scale mapping is primarily Indian government Sea-Navigational Charts at 1:500,000 and ACIC, ONC-PC Series 1:500,000 - #798 A, B and #11 B.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

PAKISTAN (EAST)

AREA	TABLE NO. 2
PAKISTAN (EAST)	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	1964 (?)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

(2) American Geographical Society
156th St. at Broadway
New York, New York

REMARKS

Small scale coverage is AMS Series U502 at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog: U.S. Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 3
PAKISTAN (EAST)	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Geological Survey of Pakistan
P.O. Box 15
Quetta
West Pakistan

REMARKS

The country is mapped at a scale of 1:2,000,000 (1964).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

THAILAND

AREA: THAILAND	TABLE NO. 1 AERIAL PHOTOGRAPHY					
PERCENT AND DATE OF LATEST COVERAGE						
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
				100%	1962

MAIN HOLDING AGENCIES

(1) Royal Thai Survey Department
Armed Forces Supreme Command
Bangkok, Thailand

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA: THAILAND	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS					
PERCENT AND DATE OF LATEST COVERAGE						
LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:60,000)		SMALL SCALE (1:100,001 - 1:400,000)	
				100%	1964

MAIN HOLDING AGENCIES

(1) Royal Thai Survey Department
Armed Forces Supreme Command
Bangkok, Thailand

(2) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

Small scale mapping is at 1:250,000. Below 9°N, Thailand is mapped at the scale of 1:253,400.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog, U.S. Army Map Service Washington, D.C. 20025

AREA: THAILAND	TABLE NO. 3 GEOLOGIC MAPS					
PERCENT AND DATE OF LATEST COVERAGE						
LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) U.S. Superintendent of Documents
Washington, D.C.

REMARKS

The country is covered by a reconnaissance geologic maps (1951) at a scale of 1:2,500,000. The map is plate 5 of U.S.G.S. Bull 904.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
THAILAND	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

R. L. Pendleton's Map of the Soils and Surface Rock of the Kingdom of Thailand at 1:1,000,000 covers the country. (1961).

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

AREA:	TABLE NO. 5 VEGETATION, LAND USE,
THAILAND	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

REMARKS

Forest types of Thailand were mapped in 1961 at 1:1,000,000 by the Thailand Forest Dept. and the Royal Thailand Survey Department.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFOSMATION

VIETNAM (NORTH)

AREA	TABLE NO. 2
VIETNAM, NORTH	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
50%	1957	100%	Pre-1954 ?	100%	1964 (?)

MAIN HOLDING AGENCIES:

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7°, France

(2) United States Army Map Service
.500 Brooke Lane
Washington, D.C. 20045

REMARKS

Medium scale coverage is official French government Series at 1:100,000.

Small scale coverage is AMS Series L509 at 1:250,000

Large scale coverage is AMS Series L805 at 1:25,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION.

Map Depository Catalog: U.S. Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 1
VIETNAM, NORTH	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1961

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping is at 1:500,000 on a map covering Vietnam, Laos, and Cambodia.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index to Geological Map of Vietnam-Laos-Cambodia 1:500,000 scale edition 1960-1961

AREA	TABLE NO. 3
VIETNAM, SOUTH	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:30,000 AND LARGER)		MEDIUM SCALE (1:30,001 - 1:80,000)		SMALL SCALE (1:80,001 AND SMALLER)	
				100%	1959

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

(2) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

Small-scale coverage is at 1:40,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United States Army Map Service and Institut Géographique Nationale, Index Map to Aerial Photo Coverage, mean scale 1:40,000.

AREA	TABLE NO. 2
VIETNAM, SOUTH	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
78%	1965	100%	Pre-1954	100%	1964 (*)

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

(2) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

Medium-scale coverage is official French government series at 1:100,000.

Small-scale coverage is AMS series L509 at 1:250,000

Large-scale coverage is AMS series L805 at 1:25,000 and L701 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog
U.S. Army Map Service
Washington, D.C. 20025

AREA	TABLE NO. 3
VIETNAM, SOUTH	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
				100%	1961

MAIN HOLDING AGENCIES

(1) National Geographic Service
Department of Defense
Republic of Vietnam
Saigon

REMARKS

Small-scale mapping is at 1:500,000 on a map covering Vietnam, Laos and Cambodia.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index to Geological Map of Vietnam-Laos-Cambodia 1:500,000 scale, edition 1960-1961.

AREA	TABLE NO. 4
VIETNAM, SOUTH	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

REMARKS

There is a general map of soils of the Republic of Vietnam at 1:1,000,000 published in 1961 by the Food and Agricultural Organization of the United Nations.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
VIETNAM, SOUTH	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1961

MAIN HOLDING AGENCIES

REMARKS

A South Vietnam land-use map at a scale of 1:3,400,000 was published in 1961 by the American Geographical Society of New York. There is an Army Map Service vegetation map of South Vietnam at 1:4,200,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

OCEANIA

AUSTRALIA

AREA	TABLE NO. 2
AUSTRALIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	*

MAIN HOLDING AGENCIES

(1) Edward Stanford Ltd.
12-14 Long Acre
London, WC2, England

REMARKS The country is mapped topographically at 1:5,000,000 (1960). There is a geographical series at 1:1,000,000 and a planimetric series at 1:253,440. There are photomap series with restricted sale at scales of 1:253,440 and 1:63,360. There is a topographical hill-shading map of the Northern Territory (1953) at a scale of 1:2,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

AREA	TABLE NO. 3
AUSTRALIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Edward Stanford Ltd.
12-14 Long Acre
London, WC2, England

REMARKS There are geological map series being produced at scales of 1:250,000 and 1:63,360. It is not possible to determine what area these cover at present.

The entire country is covered at 1:6,336,000. There is a geological map of Queensland (1953) and a sketch map of Western Australia at 1:2,500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

AREA	TABLE NO. 4
AUSTRALIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) Division of Soils
CSIRO
314 Albert Street
E. Melbourne C.2
Victoria, Australia

REMARKS
The soils of Australia are 100% mapped at a scale of 1:5,000,000 on a map compiled under the editorship of C. F. Stephens.

The Atlas of Australian Soils will eventually cover the continent at 1:2,000,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Taylor, J.K., 1961, Progress in Soil and Land Classification in Australia, 1957-1961: 10th Pacific Science Congress, Committee on Soils and Land Classification, p. 384-396.

BRUNEI

AREA: BRUNEI	TABLE NO. 1 AERIAL PHOTOGRAPHY				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001 - 1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		100%	1957		

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

All of the air cover is here indicated as medium scale. Most photographs are at 1:25,000. A few, however, those of remote areas, are at 1:35,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960, Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12, Bangkok, p. 21-22.

AREA: BRUNEI	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1964			100%	?

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale coverage is D.O.S. Series T795 at 1:50,000
Small-scale coverage is at 1:500,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA: BRUNEI	TABLE NO. 3 GEOLOGIC MAPS				
PERCENT AND DATE OF LATEST COVERAGE					
LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
(?) 100%	1960	(?) 100%	1960	100%	1960

MAIN HOLDING AGENCIES

(1) State Information Office
Brunei

REMARKS

Departmental Memoir 10 is The Geology and Mineral Resources of Brunei and Adjacent Parts of Sarawak, by G.E. Wilford. It contains geological maps at 1:125,000 and 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Borneo Region Malaysia Geological Survey, 1964, Annual Report: Departmental Publications

AREA	TABLE NO. 5 VEGETATION, LAND USE,
BRUNEI	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping indicated is C.G.G.J. Van Steenis' Vegetation Map of Malayana at 1:5,000,000, published in collaboration with UNESCO in 1958.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, Humid Tropics Research, 1958, Study of Tropical Vegetation: Proceedings of the Kandy Symposium, 226 p.

FIJI ISLANDS

AREA	TABLE NO. 2
FIJI ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	1959

MAIN HOLDING AGENCIES

(a) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Small-scale mapping is in 7 sheets at 1:250,000, (D.O.S. Series X554) and at 1:150,000 (D.O.S. 4448)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

INDONESIA

AREA	TABLE NO. 2
INDONESIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	
				90%	1964 (?)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

Small-scale mapping is the Army Map Service series 7505 at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog
U.S. Army Map Service
Washington, D.C. 20025

AREA	TABLE NO. 3
INDONESIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 AND SMALLER)	

MAIN HOLDING AGENCIES

(1) United States Geological Survey
Branch of Foreign Geology
Room 5269, Interior Bldg.
Washington, D.C. 20025

REMARKS

A 1965 Geologic Map of Indonesia at a scale of 1:2,000,000 covers the country, with approximately 15% of the area left blank. The map was prepared by the Direktorat Geologi Indonesia from data compiled by Th.H.F. Klompé in 1954 and updated to 1965. It was published by agency (1) under the auspices of the Agency for International Development of the U.S. Department of State.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Direktorat Geologi Indonesia, 1965, Geologic Map of Indonesia, scale 1:2,000,000: U. S. Geological Survey, 2 sheets.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
INDONESIA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping published in C.G.G.J. Van Steenis' Vegetation Map of Malaysia at 1:5,000,000 published in collaboration with UNESCO in 1958.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, Humid Tropics Research, 1958, Study of Tropical Vegetation: Proceedings of the Kuala Symposium, 226 p.

NEW CALEDONIA

AREA	TABLE NO. 2
NEW CALEDONIA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	*	*	*	100%	1964 (*)

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

REMARKS

Small-scale mapping is the AMS Series X402. This consists of a one sheet topographic map at 1:400,000.

Large-scale mapping is at 1:50,000 on 51 sheets.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Catalogue des Cartes de l'I.G.N.
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

AREA	TABLE NO. 3
NEW CALEDONIA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
		(?) 60%	1965		

MAIN HOLDING AGENCIES

REMARKS

6 sheets are available of a ten-sheet series at 1:100,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

AREA	TABLE NO. 4
NEW CALEDONIA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	

MAIN HOLDING AGENCIES

REMARKS

Small scale mapping of the country is a soils map at a scale of 1:300,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

NEW GUINEA

AREA	TABLE NO. 2
NEW GUINEA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
?	?	?	?	100%	1964 (?)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooke Lane
Washington, D.C. 20025

REMARKS

Small-scale mapping is Army Map Service Series T401 at 1:500,000 consisting of 49 sheets.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog: U.S. Army Map Service, Washington, D.C. 20025

AREA	TABLE NO. 3
NEW GUINEA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Bureau of Mineral Resources
Childers Street, Turner
Canberra City
Australia

REMARKS

There is a geological sketch map of Australian New Guinea (1950) at a scale of 1:2,500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
NEW GUINEA	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	

MAIN HOLDING AGENCIES

(1) Soils Department
Agricultural Research Station
The Hague
The Netherlands

REMARKS

As of 1961, about 1.8% of the total land surface of 410,000 square kilometers had been surveyed.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Schroe, Hendrik, 1961, Soil Survey and Land Classification in Netherlands New Guinea: 10th Pacific Science Congress, Committee on Soil and Land Classification

AREA	TABLE NO. 5 VEGETATION, LAND USE,
NEW GUINEA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

REMARKS

The territory is 100% covered at a scale of 1:4,000,000 on a vegetation map published in 1961 by the Australian Department of National Development, and at 1:4,000,000 in C.G.G.T. Van Steenis' Vegetation Map of Malaysia, published in collaboration with UNESCO in 1958.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO Humid Tropics Research, 1963, Study of Tropical Vegetation, Proceedings of the Kandi Symposium, 226 p.

NEW HEBRIDES

AREA: NEW HEBRIDES	TABLE NO. 2 TOPOGRAPHIC AND PLANIMETRIC MAPS					
PERCENT AND DATE OF LATEST COVERAGE						
LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)		
(?) 100%	?	100%	1949			

MAIN HOLDING AGENCIES

(1) Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

REMARKS

Medium scale coverage is at 1:100,000 on 15 sheets

The U.S. Army Map Service (Washington, D.C.) Series X321 is a one sheet topographic map at 1:1,000,000 compiled in 1917.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalogue des Cartes de l'I.G.N.
Institut Géographique Nationale
136 bis, rue de Grenelle
Paris 7e, France

NORTH BORNEO

AREA: NORTH BORNEO	TABLE NO. 1 AERIAL PHOTOGRAPHY					
PERCENT AND DATE OF LATEST COVERAGE						
LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)		
		87%	1957			

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

All of the air cover is here indicated as medium scale. Most photographs are at 1:25,000. A few, however, those of remote areas, are at 1:35,000. Some trimetrogon photography taken by the USAF during the Second World War is also available. It covers mostly remote interior areas for which vertical photography may not yet have been taken.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960, Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12, Bangkok, p. 21-22

AREA	TABLE NO. 2
NORTH BORNEO	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
100%	1950+				

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale mapping is at 1:50,000 in 122 sheets (D.O.S. Series T735)

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Catalog of Maps, Geodetic and Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
NORTH BORNEO	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:500,000)	
10%	1960	100%	1965	100%	1960

MAIN HOLDING AGENCIES

(1) Geological Survey Dept.
Box 211
Jesselton, North Borneo

REMARKS

Most medium-scale mapping is at 1:125,000

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Borneo Region Malaysia Geological Survey, 1964, Annual Report: Departmental Publications.

AREA	TABLE NO. 5 VEGETATION, LAND USE,
NORTH BORNEO	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
		100%	*	100%	1958

MAIN HOLDING AGENCIES

(1) Working Plans and Surveys Section
Forest Department
Sandakan, North Borneo

REMARKS

Small-scale mapping indicated is C.G.G.J. Van Steenis Vegetation Map of Malaysia at 1:5,000,000, published in collaboration with UNESCO in 1958.

A provisional vegetation map of the colony was compiled at 1:250,000, prior to 1953, by G.S. Brown. Since 1953, mapping of vegetation has been completed at a scale of 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, Humid Tropics Research, 1958. Study of Tropical Vegetation: Proceedings of the Kandy Symposium, 226 p.

PALAU ISLANDS

PAPUA

AREA	TABLE NO. 2
PAPUA	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		100%		100%	?

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

REMARKS

Small-scale mapping is at 1:500,000. Medium-scale is at 1:63,360. Topographic maps are also in preparation at 1:50,000, and at 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 3
PAPUA	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) Edward Stanford Ltd.
12-14 Long Acre
London, WC2, England

REMARKS

A geological map covers Papua at a scale of 1:2,500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA:	TABLE NO. 5 VEGETATION, LAND USE,
PAPUA	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

REMARKS

The territory is 100% covered at a scale of 1:4,000,000 on a vegetation map published in 1951 by the Australian Department of National Development, and at 1:5,000,000 by C.G.G.J. Van Steenis' Vegetation Map of Malaysia, published in collaboration with UNESCO in 1958.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, Humid Tropics Research, 1958, Study of Tropical Vegetation: Proceedings of the Kandy Symposium, 226 p.

PHILIPPINES

AREA	TABLE NO. 2
PHILIPPINES	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
				100%	1964 (*)

MAIN HOLDING AGENCIES

(1) United States Army Map Service
6500 Brooks Lane
Washington, D.C. 20025

(2) Bureau of Coast and Geodetic Survey
421 Barraca St.
Manila, Philippines

REMARKS

Small scale mapping is the AMS series S501 at 1:250,000 on 55 sheets.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Map Depository Catalog: U.S. Army Map Service, Washington, D.C. 20025

Bureau of Coast and Geodetic Survey, Manila Topographic Maps, Nautical and Aeronautical charts and Technical Publications: Manila, Philippines

AREA	TABLE NO. 3
PHILIPPINES	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	1963

MAIN HOLDING AGENCIES

(1) Philippine Bureau of Mines
Department of Agriculture and Natural Resources
Manila
Philippines

REMARKS

Small-scale mapping is at 1:1,000,000 on a map prepared by the Geological Survey Division of Agency (1) with the cooperation of some private oil exploration companies.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
PHILIPPINES	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE 1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
(*) 8%	1961 (*)	?	?	(*) 92%	1961 (*)

MAIN HOLDING AGENCIES

(1) Bureau of Soil Conservation
P.O. Box 1848
Manila, Philippines

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION:

Barrera, Alfredo, 1961, Methods and Extent of Soil Classification and Mapping in the Philippines: 10th Pacific Science Congress, Committee on Soil and Land Classification.

AREA	TABLE NO. 5 VEGETATION, LAND USE, ECOLOGY AND FOREST INVENTORY MAPS
PHILIPPINES	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001-1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
?	?	?	?	100%	1958

MAIN HOLDING AGENCIES

[illegible]

Small-scale mapping indicated is C.G.G.J. Van Steenis' Vegetation Map of Malaysia at 1:5,000,000, published in collaboration with UNESCO in 1958.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, Humid Tropics Research, 1958, Study of Tropical Vegetation: Proceedings of the Kandy Symposium, 226p.

RYUKYU ISLANDS

AREA:	TABLE NO. 1 AERIAL PHOTOGRAPHY
SARAWAK	

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:30,000)		SMALL SCALE (1:30,001 AND SMALLER)	
		81%	1957		

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

All of the air cover is here indicated as medium scale. Most photographs are at 1:25,000. A few, however, those of remote areas are at 1:35,000. Some trimetrogon photography taken by the USAF during the Second World War is also available. It covers mostly remote interior areas for which vertical photography may not yet have been taken.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

United Nations Economic Commission for Asia and the Far East, 1960, Proceedings of the United Nations Seminar on Aerial Survey Methods and Equipment: Mineral Resources Development Series No. 12, Bangkok, p. 21-22.

SARAWAK

AREA	TABLE NO. 2
SARAWAK	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 & LARGER)		MEDIUM SCALE (1:50 001 - 1:100 000)		SMALL SCALE (1:100 001 - 1:500 000)	
100%	1955			100%	

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale coverage is D.O.S. series T735 at 1:50,000
Small-scale coverage is at 1,500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic & Topographical Surveys - Directorate of Overseas Surveys Kingston Road, Tolworth Surbiton, Surrey, England

AREA	TABLE NO. 3
SARAWAK	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50 000 AND LARGER)		MEDIUM SCALE (1:50 001 - 1:250 000)		SMALL SCALE (1:250 001 - 1:1,000,000)	
10%	1960	100%	1962	100%	1960

MAIN HOLDING AGENCIES

(1) Geological Survey
Kuching, Sarawak

REMARKS

Medium-scale mapping is at 1:125,000 or 1:250,000. Small-scale is at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Borneo Region Malaysia Geological Survey, 1964, Annual Report: Departmental Publications.

AREA	TABLE NO. 4 VEGETATION, LAND USE,
SARAWAK	ECOLOGY AND FOREST INVENTORY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25 000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 AND SMALLER)	
				100%	1958

MAIN HOLDING AGENCIES

(1) Edward Stanford Ltd.
12-14 Long Acre
London, W.C.2, England

REMARKS

Small-scale mapping indicated is L.G.G.J. Van Steenis Vegetation Map of Malaysia at 1:5,000,000, published in collaboration with UNESCO in 1958.

In addition, the Survey Department was hoping to complete a general land-use map of Sarawak at 1:250,000 in 1956.

A land use map of Sarawak exists at 1:1,500,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

UNESCO, Humid Tropics Research, 1958, Study of Tropical Vegetation: Proceedings of the Kandy Symposium, 226 p.

SOLOMON ISLANDS

AREA	TABLE NO. 2
SOLOMON ISLANDS	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
50%	1959				

MAIN HOLDING AGENCIES

(1) Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

REMARKS

Large scale mapping is D.O.S. 459 and D.O.S. (Misc.) 91 at 1:50,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Catalog of Maps, Geodetic & Topographical Surveys
Directorate of Overseas Surveys
Kingston Road, Tolworth
Surbiton, Surrey, England

AREA	TABLE NO. 3
SOLOMON ISLANDS	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	
				100%	

MAIN HOLDING AGENCIES

REMARKS

Small-scale mapping is at 1:1,000,000, and can be purchased from Reise-und Verkehrsverlag, Stuttgart Postf. 730.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

TIMOR

HAWAII

AREA	TABLE NO. 1
HAWAII	AERIAL PHOTOGRAPHY

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:10,000 AND LARGER)		MEDIUM SCALE (1:10,001-1:90,000)		SMALL SCALE (1:90,001 AND SMALLER)	
*	*	*	*	(*) .00%	*

MAIN HOLDING AGENCIES

(1) Map Information Office
U.S. Geological Survey
Washington, D.C. 20242

REMARKS

Hawaii is 100% covered by aerial photography of scales somewhere between 1:5,000 and 1:60,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 2
HAWAII	TOPOGRAPHIC AND PLANIMETRIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 & LARGER)		MEDIUM SCALE (1:50,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
80%	1965	100%	1965	100%	1952

MAIN HOLDING AGENCIES

(1) Map Information Office
U.S. Geological Survey
Washington, D.C. 20242

(4) American Geographical Society
156th at Broadway
New York, N.Y.

REMARKS

Surface relief is depicted on topographic maps published by the U.S. Geological Survey at scales of 1:24,000, 1:62,500 and 1:250,000.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

Index to topographic mapping of Hawaii American Samoa & Guam, U.S. Geological Survey, Map Information Office, Washington, D.C. 20242.

AREA	TABLE NO. 3
HAWAII	GEOLOGIC MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:50,000 AND LARGER)		MEDIUM SCALE (1:50,001 - 1:250,000)		SMALL SCALE (1:250,001 - 1:1,000,000)	

MAIN HOLDING AGENCIES

(1) U.S. Geological Survey
Washington, D.C. 20242

REMARKS

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

AREA	TABLE NO. 4
HAWAII	SOILS AND LAND CAPABILITY MAPS

PERCENT AND DATE OF LATEST COVERAGE

LARGE SCALE (1:25,000 & LARGER)		MEDIUM SCALE (1:25,001 - 1:100,000)		SMALL SCALE (1:100,001 - 1:500,000)	
		100%	1955		

MAIN HOLDING AGENCIES

(1) U.S. Department of Agriculture
Washington, D.C. 20025

REMARKS

The Soil Survey of the Territory of Hawaii, by agency (1) and the Hawaii Agricultural Experiment Station in 1955, classified the soils of Hawaii and was accompanied by soil survey maps at 1:62,500.

BEST SOURCE OF ADDITIONAL & MORE DETAILED INFORMATION

U.S. Department of Agriculture and Hawaii Agricultural Experiment Station, 1955, Soil Survey of the Territory of Hawaii.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final Report

5 AUTHOR(S) (Last name, first name, initial)
VOGEL, HARVEY

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13 ABSTRACT

An evaluative inventory of research activities and the status of current knowledge of the humid tropic environment was performed through comprehensive critical review of the published literature and through appraisals by outstanding scientific specialists. Technical chapters of this report discuss Physical Features, Plant and Animal Life, Weather and Climate, Coastal Zones, and Regional Studies. Significant gaps in current knowledge of these five topical fields and recommendations to fill these gaps are indicated. Particular attention has been paid to studies and research having direct military application.

Three appendices to the compendium present: a Directory of Authorities; a Directory of the Principal Depositories; and an Index of Aerial Photography and Maps.

Vol. I (KWIC Index - Humid Tropic Environmental Literature) of this report presents a 14,515-document bibliography of the area/subject in key-word in context format (AD 625-426).

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Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Humid Tropics						
Environment						
Geography						
Geology						
Hydrology						
Soils						
Vegetation						
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