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CHANGES IN THE CLIMATE AND VEGETATION
OF THE SONORAN DESERT

FINAL REPORT TO

The Office of Naval Research

on

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by

James Rodney Hastings
Institute of Atmospheric Physics
The University of Arizona
Tucson, Arizona

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Work begun March 1, 1962 under contract NONRG-0065-62, a pilot study of Changes in the Climate and Vegetation of the Sonoran Desert, has been completed, and the final report is herewith submitted.

The project dealt with the hydrologic and vegetative changes that have taken place since 1880 in the arid and semiarid region of southern Arizona and northern Sonora. The general aspects of the phenomena have been known for some time, and have been made the subject of a voluminous literature. The present study sought to clarify some of the points of disagreement among past workers, and had two specific aims:

- 1) To examine the role that man may have played in inaugurating the changes. The principal facts of land use in the region have been gathered from historical materials of the Spanish, Mexican and Anglo-American periods.

- 2) To determine which plant species have been involved, and whether any general patterns might emerge from a more detailed knowledge of the vegetative aspects of the change. The principal technique employed for this phase of the study was that of repeat photography. Some 300 photographs dating back to the 1880's and picturing conditions at elevations from 5 ft. to 5500 ft. have been matched with recent photographs of the same localities. In addition, field studies have been carried out at the photo sites by a plant ecologist.

The combined evidence--photographic and historical--has been assembled as a manuscript, The Changing Mile, which will appear as a publication of the University of Arizona Press. The principal conclusions are as follows:

1) Many of the vegetative changes are systematic in nature and general in extent and point to drier, warmer conditions at all elevations. The lower edge of the oak zone has migrated upward; such desert plants as the palo-verdes (Cercidium floridum and C. microphyllum) have withdrawn from the arid, lower reaches of their former range, and have advanced at the cooler, upper edge.

2) It has been supposed for many years that because widespread cattle-raising began in the 1880's in southern Arizona, and because hydrologic and vegetative changes commenced shortly afterwards, a cause and effect relationship existed. The historical evidence shows that for northern Sonora, an adjacent, climatologically similar region, the events are, in fact, unrelated. Caucasian settlement took place as early as 1650. By 1700 the area was being extensively grazed. Yet hydrologic and vegetative change began in northern Sonora at the same time as in southern Arizona--the 1880's.

3) In light of the historical evidence there is serious doubt that recurrent fires used to sweep the area, or that fire was ever an important ecological influence in shaping the vegetation of the region. The suppression of fire by civilized man does not, therefore, appear to be a factor in the invasion of the desert grassland by shrubby species, as alleged by many observers, including Carl Sauer and Omer Stewart.

4) Associated with the worldwide "recent climatic fluctuation," mean annual temperatures in the region have been rising at the same time that precipitation has been decreasing. Although the local weather records do not extend back far enough to enable

one to determine if the trends began before 1890, evidence from other parts of the world indicates that they may have.

5) These trends toward drier, hotter conditions constitute the basic matrix within which the hydrologic and vegetative changes have occurred. Overgrazing has contributed to the stresses, and may have accelerated the process initiated by a general climatic deterioration.

Although the study has accomplished its initial aims, many questions remain unanswered, and many more have arisen in the course of the project. Almost nothing, for example, is known about the specific microclimatological trends involved; about the mechanisms through which macroclimatic trends are able to induce changes in runoff and plant cover; about the magnitude of the fluctuations in temperature and rainfall needed to displace the range of a plant species. The implications of these questions to paleoclimatology and to the subject of climatic change are obvious. Future work will address itself to them.

The \$5,000 provided by the Office of Naval Research for the project was spent during the summer of 1962 for personal services. A plant ecologist, Dr. Raymond M. Turner, was retained by the Institute. Undergraduate assistance in the field and in the darkroom was also provided.