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Precipitation Measurements Study - 15 March to 15 May 1952

Kurtyka, John C.; Madow, Lillian 15 May'52 12pp. diagr

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PRECIPITATION MEASUREMENTS STUDY

FIRST QUARTERLY PROGRESS REPORT

for period
15 March 1952 to 15 May 1952

Signal Corps Contract: 15484
Department of the Army Project: 3-36-02-042
Signal Corps Project: 794C-0
Placed by: U. S. Army, Signal Corps Engineering Laboratories
Fort Monmouth, N. J.

from
University of Illinois
and
Illinois State Water Survey
Urbana, Illinois

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PRECIPITATION MEASUREMENTS STUDY

FIRST QUARTERLY PROGRESS REPORT

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Methods of measuring precipitation
for use with the automatic weather station

Signal Corps Contract No.: 15484
Department of the Army Project: 3-36-02-042
Signal Corps Project No.: 794C-0

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G. E. Stout
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Project Supervisor

Table of Contents

1.0 **Purpose:** A study is being made of all known methods of measuring precipitation, both liquid and solid, which may occur in nature, with a view to adapting these techniques of precipitation measurement to unattended automatic weather station operation.

1.1 **Scope of work.** The work has been divided into two tasks, which are reported below as follows:

Task A. Bibliography on Precipitation Measurements. Paragraphs 1.1 - 1.4.

Task B. Statistical analysis of precision requirements for precipitation measurement. Paragraphs 2.0 - 2.4.

TASK A

1.11 Phase 1 - The search phase of the preparation of the bibliography was begun at the libraries of the University of Illinois. A trip by the Project Engineer to the Signal Corps Laboratory, Belmar, N. J.; the American Meteorological Abstracts and Bibliography Section, Library of Congress, Washington, D. C.; and the U. S. Weather Bureau, Washington, D. C., resulted in a large volume of bibliographical material. To date, 309 articles on precipitation measurement have been placed on our reference list. Correspondence has been carried on with other groups using various types of precipitation gages. Dr. C. F. Brooks of Harvard University has been most cooperative in supplying information and data.

1.12 Phase 2 - Tabulation and Publication. Pertinent information on all references has been placed on cards as this will facilitate the publication of the bibliography.

67 of the articles have been reviewed and abstracted. 160 references are not available locally. About 30% of the references are in foreign languages and some of the important ones will be translated.

At the present time the bibliography is about 30% complete. As articles are reviewed, more references are found and in this manner the bibliography is constantly expanding.

1.3 Phase 3 - Review and evaluation of the known methods of measuring precipitation. This work has not begun.

1.31 The following lists contain the precipitation measurement methods that have been found.

I. Non-Recording gages.

A. All of the following gages are similar in operation and have only minor design differences. They are cylindrically funneled gages.

1. 5-inch gage of the Meteorological Office, Great Britain. (Snowdon)
2. 3.57-inch gage of the Canadian Meteorological Division.
3. 8-inch gage of the U. S. Weather Bureau.
4. 7.64-inch U. S. Forest Service Type Gage.
5. Desert type gage.
6. Bradford Gage.
7. Symons Gage.
8. Harvard Gage.
9. Glaisher Gage.

10. Fleming Gage.
11. Stewart Gage.
12. Victor Gage.
13. Hellmann Gage.
14. Seathwaite Gage.
15. Kostlivy Gage.
16. Tonneholt Gage.

B. The next (4) gages have, in addition to a horizontal orifice, orifices that are vertical or at a steep angle. The rotating types face into the wind while the non-rotating types have orifices facing cardinal points of the compass.

1. Haas-Lütschg spherical raingage.
2. Vectopluviometer (non-rotating).
3. Vectopluviometer (rotating).
4. Directional gage (rotating and dipping).

C. The following gages are totalizer or storage type gages that are left unattended for long periods and usually have an oil covered antifreeze solution to melt and preserve precipitation that is caught.

1. Sacramento.
2. Maurer.
3. Bigelow.
4. Mougin.
5. Pollack.
6. Marvin.

D. The following gages are miscellaneous types not too general in use. Their orifices are either unusual in size, or shape.

1. Trough gage.
2. 1/1000 acre gage.
3. Stereo type gage. (elliptical orifice parallel to ground)
4. Concrete catchment gage. (5' dia.)
5. Bin.

II. Recording Type Gage.

A. Float type, without automatic siphon.

1. Negretti and Zambra-Hyetograph. Rain is collected in a funnel and passes down a tube into a float chamber causing the float to rise. A rod extending upward from the float has 8 equally spaced studs on it. These studs engage a pallet on the pen arm and thereby give the pen 8 traverses, one for each stud. The float chamber holds 4 inches of rain and is emptied by pushing the float down.
2. Rossi snow gage that uses oil for the float.

B. Automatic Siphon Gage and Float gages.

1. Negretti and Zambra Natural Siphon Gage. A float chamber is emptied when water reaches a level that will fill the chamber. The siphon

action is automatic and takes about 6 seconds to empty the chamber. The pen arm is attached to a float and records this action.

2. Berlin (Name unknown.). This gage is natural siphon type but the siphon action was transferred to a mercury manometer arrangement with the water siphoning off at a predetermined level. One side of the manometer is in contact with the water and its cyclic action, while the other side has a float with a pen arm attached to it thereby recording such action.

3. Kent syphon.

C. Weight type gages. (Collector of water is weighed.)

1. Hellmann-Fuess.
2. Fergusson.
3. Stevens.
4. Sprung.
5. Tipping bucket gage.

D. Combination types.

1. Rung gage. (Weight and tipping bucket)
2. Nilsson. (Weight and tipping bucket)
3. L. Palazzo. (Siphon and tipping bucket)
4. Jules Richard. (Float and electric valve)
5. Fuess. (Weight and tipping bucket)
6. Jardi. (Float and valve)

7. Sil. (Clock operated valves, 3 containers hold 1 minute's supply, float recording.)

E. Miscellaneous type gages.

1. Radioactive Snow Gage employs radioactive cobalt 60 placed on the ground with Geiger-Mueller tube suspended over it to detect radiation. The strength of the signal (counts) is proportional to the depth of water equivalent between the two.

2. Myers pressure type gage. Employs a "Microsen 0" to 10" pressure transducer" as the sensing element. At the 10" pressure (1" of precip.) an electrically operated dump valve empties the system (10 seconds required) and then the operation repeats itself. U.S. Weather Bureau - A.E.C. design.

3. Williamson gage. (English) As water in a rain gage reservoir begins to rise it comes in contact with a hanging weighted wire. This contact closes a circuit and actuates a small electric motor which in turn hoists the wire until it raises out of the water and breaks the actuating contact.

F. Experimental methods with possible precipitation gaging application.

1. Heating units. The amount of energy necessary to keep a looped rod or round disc dry can

be measured. This energy in turn is proportional to the amount of precipitation striking them.

2. Capillary collector. This instrument uses capillary phenomena to collect and retain water drops striking a small porous surface.

3. Maulard Listening device. (French) A telephone receiver is modified to allow water to run off and to reproduce the effects of raindrops striking a small disc attached to the receiver's membrane.

4. Gunn experiments with falling drops. Two vertically separated rings are so arranged that a raindrop falling through them will induce two pulses on a tape oscillograph which are directly proportional to the velocity of the drop.

5. Stehberger electric nose. Consists of two large cylindrical condensors in a differential circuit to measure the conductivity of the air between the condensors. The conductivity is proportional to the amount of particles in the air.

6. Impactometer - functions on amount of energy departed with by a drop impinging on a surface. (Similar to listening device.)

7. Disdrometer. An instrument for measuring

rain drop size by optical network. The amount of light in a beam varies as the amount of interference by falling drops.

G. Wind protection for rain gages.

1. Nipher Shield.
2. Alter Shield.
3. Pit gaging.
4. Turf-walled pits.
5. Fences.

1.4 Research. Very little has been done here in the way of research on gages. One problem that was briefly investigated was an oil-water separator for rain-snow gages.

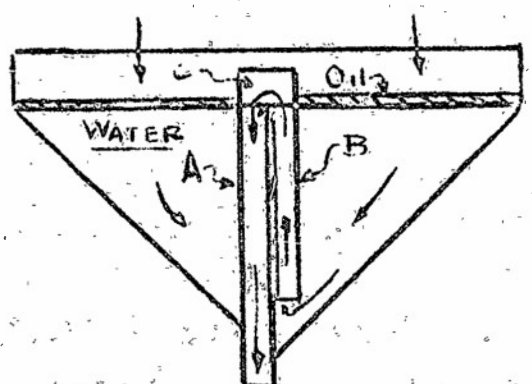

FIGURE I

A problem of melting snow by heating the funnels of recording gages, has been that many small drops of water would cling to the funnel and would therefore be subjected to evaporation caused by the high temperature gradient between the funnel and surrounding air. To sidestep this, a funnel (Fig. I) was partially filled with water covered by a very light oil. A 1/2" tube (A) was placed in the mouth of the funnel and extended above the surface of the oil. Another shorter length tube (B) was soldered to tube (A) with a notch or weir (C) cut between them so that water would flow from (B) into (A). The lower open end of (B) was placed below the oil surface and this affected the separation. Snow would fall onto the oil, be melted, and sink below to the water. This would increase the head at the weir and cause water to flow up tube (B) and down tube (A) to be recorded. Of course the temperature of the water must be kept above freezing by a suitable heating apparatus.

It became immediately apparent that the instrument had large lag characteristics caused by the elasticity of the water film. The addition of deterrgent to the water tended to alleviate this condition but not enough to be satisfactory. Work on the investigation has been temporarily suspended in order to complete the bibliography.

TASK B

2.0 Work completed. The study of the existence of a persistent pattern of precipitation in the data obtained by the State Water Survey in 1948-1951 from raingage network on the Panther Creek watershed (95 square miles) has been completed and a full report of the study will be included in technical report #1. The work on this problem was continued during April 1952 beyond what had been done during March because some questions were raised concerning the earlier results. The technical report now includes parametric as well as non-parametric tests of the hypothesis that no persistent pattern of rainfall exists in the Panther Creek watershed during the summer thunderstorm season.

2.1 The results of the parametric tests of the hypothesis of equal precipitation in the Panther Creek watershed, for 1950 and 1951, the years in which adequate data were available, do not show significance, thereby supporting the previous findings of the non-parametric tests that there was no statistical evidence to disprove the hypothesis of randomness of precipitation within Panther Creek.

2.2 Since a question was raised as to whether there was not, in fact, consistently more rainfall in the southern part as compared with the northern part of Panther Creek, two additional comparisons were made. One was the comparison of the northern and southern parts of Panther Creek, by means of the t-test. The results showed significantly higher precipitation in the southern part for the year 1951 but not for the year 1950, the only two years for which adequate data were available for this study. On the basis of this evidence, it would not be possible to conclude that the southern part of Panther Creek has more precipitation.

2.3 The second comparison made was that between Gridley and Minonk, U. S. Weather Bureau Cooperative stations bordering the Panther Creek watershed just to the south and to the north, respectively. Twelve years, 1940 through 1951, of monthly data were available, and the thunderstorm months of May through September were studied. The non-parametric sign test showed significantly higher precipitation at Gridley than at Minonk, but the t-test taking actual precipitation values into account did not. This suggests that there probably is a significant difference in precipitation between the two stations but that the variability is so great that even 12 years of records are insufficient to establish the significance of the observed difference of .30 inches per month which was observed over the 12 years. It is estimated that it would take about 20 years of data of the kind that were available for the 12 year period to establish the significance of the .30 inches difference in precipitation between the two stations.

2.4 So far as statistical methodology is concerned, with respect to studies of pattern of precipitation, it seems from the present study that the non-parametric tests are more likely to show existence of differences from hypotheses tested than are the parametric tests.

PUBLICATIONS, LECTURES, REPORTS AND CONFERENCES

3.0 Since this project is classified, publications, lectures, reports, and conferences have been held to a minimum.

3.1 A 2-hour seminar on the problems of gaging precipitation was conducted for the Survey's Meteorologic staff.

PROGRAM FOR NEXT INTERVAL

4.0 Plans for the future will be continued expansion of the bibliography with the emphasis being shifted from search to review and evaluation. RESTRICTED

4.1 Work in progress - The calculations of the sampling variance for samples of size 2, 3, 4, 6, 9, 12, and 18 are almost complete for the year 1950, on a storm day basis.

4.11 The sampling variance study for 1951 has only just been started.

PERSONNEL

5.0

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