Present attitude

Value of a Dept of Meteorology

Improvement of Present Methods and Means.

(a) Seasonal estimate of water resources.
Perfecting method of making
Dept's preliminary method now being adopted by W.B. for Nevada.
If adopted will be applied by W.B. to all watersheds as fast as possible.

(b) Study of Nevada Climate with Reference to agriculture.

Mountain State has complex climate.
Relation of Topography & the Occurrence of frost.

The Home Orchard.

1. Comparison of Climatic Elements with those of other states — particularly intensity of temps. day & night, occurrence of frost, and degrees & length thereof, relative humidity, and effect of wind.

Spring killing
Winter killing of fruit & alfalfa.
High winds & low temps.
Air circulation esp. at night during frost season.
Torrents of frost.

[~~It is evident that soil~~ other elements, viz. soil and water are adjustable].

2. Study of Temperatures and Seasons in Basins and where possible on characteristic slopes.

3. ~~Aid~~ Cooperate with Depts of Plant Physiology and Agronomy in determining the relation of climatic factors to plant growth.
(a) In air (b) In soils. for ex. effect of irrig. water in chilling plants.

Recent blanks from U.S.W.B. sent to Agronomist + then to meteorologist.

4. Coop. with Animal Husbandman in effect of outdoor wintering, ~~housing~~ on dairy and beef stock.

Season of rain, and snow and Coop. in mud; north winds, etc.

5. Climates and the Range.

6. Develop instrs that will be self recording and give continuous records. Partic { Temp & humid + wind. cheap, yet handy.

Cox of Chicago studying on Slopes of N. Carolina.

Max + min. temps not sufficient.
Hair hygrometers.

7. Work up four years records for Truckee & Carson Basins.

8. Work up snow records.

9. Teach agricultural ~~meteorology to~~ students the value of instruments and the meaning of climate.

10. Advance the science of meteorology

(a) along agr. lines.

To aid Forest Service + water resources.

Nature of frost phenomena.
Wind currents as affected by mountains + their effect on forest + brush fires.

(b) along pure lines.

Drift of air currents.
Upper air phenomena.
International records.

11. Have much of the equipment necessary, and ability to make it.

12. Make + repair instr for other depts.

Efficiency would dictate use of plant now acquired. Value back to Nevada and semi-arid mountain states.

13. Records of W.B. insufficient.

Max + Min. Therms + raingage.
Some empirical evap. stations to indicate aridity, but all represent too large a unit.

A mountainous state like Nevada is far more diverse even in individual watersheds than in level country.

Pyramid Lake
Truckee Canon
Meadows etc.
Highlands

tests designed to cover state as whole -; whereas more intensive study of typical regions preferable.

Illustration :- (Cooperation)

(a) Study of trees under frost in typical orchards & determine effect of ~~frost~~ weather.
1. Snare 2. Station ~~three~~ 3 univ. farms
climate different at each.

Test general immunity of orchard above 28° (1) when blossoms are white.
(2) when fruit is setting.

Search for frost resistant types.

(b) Equip more complete stations at various farms and where plot testing is carried on, i.e. where same grain is being tested.

{ Soil + water predetermined & equalized.
{ Climate determined by tests during progress of growth.

Support :-

~~X~~ Salary ~~$~~500 from College of Agr.
" 300 " univ. for reps etc
" 1000 or more from Exp. Station.
according to time employed, permission being given to do outside work to make up salary.

Report of the Department of Meteorology
for the year ending June 30, 1916

The Mount Rose Observatory was founded privately by University men in 1906 because of the utter lack of any knowledge of the winter climate of the high mountains along the Pacific Coast. ~~and the intense interest that in 1908~~ From 1906 to 1908 two lines of investigation were developed:

(1) The Possibility of Forecasting Frost from Mountain Tops and
(2) The Relation of Forests to the Conservation of Snow.

Since these two projects were of immediate interest and importance to Nevada and the semi-arid West, in 1908 the observatory was formally made a department of the Experiment Station under the provisions of the Adams Act. These two projects and a third temperature survey of the agricultural lands of the State under legislative appropriations have represent the activity of the department since that time.

1. Forecasting Frost from Mountain Tops.

a vertical triangle of stations was established at Truckee, on Mount Rose, and at Fallon to study the passage of storms to determine whether the fall of temperature on Mount Rose at such times was

followed by a corresponding fall in the temperature in the valleys. Success in a similar experiment but on a far smaller scale on Mount Royal had meanwhile been announced by Professors McLeod and Barnes of McGill College, Montreal, and the verification of their theory would mean much for Nevada and the mountain states.

To accomplish the task without maintaining an observer on the summit, a meteorograph was finally perfected by Professor Ferguson, at that time assistant in Blue Hill Observatory, that would record all of the principal elements of the weather, such as humidity, temperature, pressure, and the direction and velocity of the wind for periods of six to eight weeks without attention. Two duplicate meteorographs of shorter time range were placed in charge of observers. ~~During the past year the~~ Of these observers, Mr. F. B. Headley Superintendent of the U.S. Experiment Farm at Fallon, served without compensation.

During the past year the data thus obtained have been analyzed with the following results:

"Of the decided falls of temperature or cold-waves occurring on the summit during four years of observation, about one-half were accompanied by nearly synchronous changes at the base stations; one-third were followed

the summit is falling, are probably due mostly to the presence of clouds or fog below the summit. The one-third, in which a falling temperature on the summit was followed within 48 hours by a lower minimum temperature on the valley floor, represent the clearing up of a storm when radiation lowers the already low temperature to the danger point.

The problem of forecasting temperature seems thus reduced to a study of the forecasting of cloudiness and of phenomena complicated by the peculiar topography of the Great Plateau.

within 48 hours by lower minimum temperatures at the base stations; one-sixth were followed by a slight rise of temperature at the base stations. These synchronous changes occur when the sky is covered with clouds or when the stagnant air on the valley floor is thoroughly stirred up by wind and mixed with the air above. On the other hand, the one-sixth, in which the temperature on the valley floor rises slightly while the temperature on

Insert 3a →

The analysis of the indeterminate occurrences may depend upon the further development of the science of meteorology which is yet young and elusive.

By products

Three important by-products have been obtained from this experiment:

(1) A compact meteorograph of moderate price has been developed for the study of mountain meteorology and the climatology of forests and cattle ranges. This meteorograph is now being considered for use at fire lookout stations in the National Forests.

(2) A considerable amount of data has been accumulated on the action of wind currents in the mountains which has been placed at the service of the forest officials in perfecting their system of fire protection, with consequent conservation of water resources.

(3.) A meteorological pantograph has been perfected which is capable of quickly reducing meteorograph records possessing various scales for time and weather elements to a common standard for visual comparison. This is an important consideration where instruments of various types are necessarily employed, for the time formerly spent in copying and comparing records is reduced two-thirds.

2. The Relation of Mountains and Forests to the Conservation of Snow.

This experiment is the outgrowth of the smaller problem on the Relation of Forests to the Conservation of Snow. On account of the bitter dispute regarding the value of forests for the conservation of moisture and the control of floods, the Department undertook to solve so much of the problem as pertained to the conservation of snow, upon which the existence of the State largely depends. Since the forests were situated generally in the mountains and the influence of the two became easily confused, both were included in the problem.

Not only methods but instruments have had to be devised as the work has progressed.

A snow sampler and weigher has been perfected by which the water content of the snow can be quickly determined to a depth of twenty to twenty-five feet, the greatest depth yet found on the watershed. Altho a sampler was devised in France a year before the present one was invented, so efficient is the latter that it has been purchased for use in the study of the deep snows of the Alps. An evaporation pan also has been perfected for determining the evaporation of the snow on the ground, and a recording thermograph for determining the influence of earth and air temperatures on the melting of snow.

Mount Rose and the Sierra Lake were ideally situated and located for the experiment. To obtain access to them in all weathers, a sandbag hut was constructed at 9000 feet on Mount Rose and an explorers' tent with row and motor boat was used on the lake until prudence and efficiency dictated the construction of a cabin cruiser.

Altho some features of the work yet remain to be investigated and a large amount of data must be analyzed, the general conclusion has been reached that forests are a direct protection

to the snow, those trees being most efficient that allow the snow to reach the ground and yet protect it from the sun and wind. Firs trees have been found most superior to pine as conservers of snow, and forests with glades more satisfactory than continuous forests. Wind breaks on the lips of canons and windswept slopes are indispensable for the holding and the dosing of snow. Young growth because of its hedge-like character seems to be as important as the taller trees for the conservation of snow. Since fir grows best on the shaded northern slopes, where the snow is conserved longest, and pine on the sunny southern slopes where the snow melts early, despite the forest cover, the interests of the lumberman and the irrigationist can be harmonized without great loss to either.

(1) Snow Surveying

One of the outgrowths of the above project is the surveying of the snow cover on watersheds in the spring to determine the amount of water available for irrigation the following season. These surveys consist of determining by means of the snow sampler the water content of the snow in the characteristic parts of the watersheds. In each place definite courses have been laid out along which measurements are

made at intervals of 25 to 100 feet according to the irregularity of the snow and the length of the course. Because of the uneven precipitation that occurs in the Tahoe watershed and the adjoining portions of the ~~basin of the Truckee River~~ Truckee Basin, 33 courses have been laid out, varying in elevation from 6225 to 10850 feet. These courses can be surveyed by two persons in two weeks.

The method of making estimates based upon the snow survey is shown in the following bulletin issued the present season to the users of the waters of Lake Tahoe and the property owners around the Lake:

The usual snow scale method, by which a few graduated sticks are set up on each watershed to show the depth of the snow, is extremely inefficient not only because the sticks give no clue to the water content of the snow but also in windswept regions afford little evidence regarding the average depth of the snow. The following measurements made consecutively every hundred feet on Mount Pisgah will illustrate: ~~34 inches, 66.5, 72.7, 74.8, 69.3, 52, 36.6, 7.2, 18.6, 8.6,~~ 15.3, 47.8, 71.5, 113, 46, 19.5, 19, 88.6, 29.3, 35.9, 88.6, 70.6, 31.2, 89.6, 14.2, 55.8, 98.6, 112.5, 57, 80.5, 119.3, 94.2, 88.7, 26.6, 25.6, 13.1, 23.6, 50.2, 48.2, 72.2, 85.5, 42.6, 42, 66.6, 43, 86.5, 34.1, 7, 16.6, 24.1, 136.1, 100.4, 67.3, 54.5, 19.5, 8.2, 71.8, 73.8, 27, 35.7, 80; average depth 56.4 inches. Of these measurements only a few approximate the average depth of the entire course. The water content of the snow was 22.2 inches, the relative density being .39.

~~263.8 191.3 73.4 126.8~~

88.7 66.6
26.6 43.0 X
25.6 627.9
13.1
23.6
50.2
48.2
72.2
85.5
42.6
42.0 X

86.5 27.0 X
34.1 35.7
7.0
16.6 30.0 X
24.1 ~~106.6~~
136.1 797.6
100.4
67.3
54.5
19.5
8.2
71.8
73.8

Owing to the unusually slow melting of the snow caused by the late spring and to the long evaporation which the snow fields and lakes surface were exposed, the rise of the lake level was several tenths of a foot below the estimate made. The second estimate has usually been accurate within two tenths of a foot.

Insert 8a:

~~13. The Temperature Survey.~~

3. The Temperature Survey.

In 1911 under state appropriation, a temperature survey of the agricultural lands of the State was begun to determine the intensity and duration of frost on the with a view to finding more satisfactory sites for orchards or the amount of heating that must be done to save a crop. So pessimistic had the Nevada ranchers become regarding the possibility of saving his fruit, that little effort was put forth to protect it.

This survey is being made by means of a series of recording thermometers placed at strategic points from the highest land under ditches irrigation ditches to the lowest lands of the valley. Thus far the survey has been confined to the basin of the Truckee River and to the Truckee-Carson Project. Since the

The instruments are cared for and the record sheets changed mostly by voluntary observers. At the end of four years the stations are moved to a new location except that a central station is maintained in each district surveyed to correlate the temperature therewith that at the University. In connection with the survey semi-official experiments have been made by the Department in orchard heating to determine the feasibility of protecting against frost.

The results obtained early in the survey were published in Bulletin 79 on the Avoidance and Prevention of Frost which has found an unexpectedly wide demand in this country and abroad. Later data confirm the earlier conclusions, that with elevation there is a diminution both in the occurrence of frost and in the number of hours of orchard heating required, the decrease (in the occurrences of frost with an elevation of 250 feet) ~~reduction~~ in the Lucerne Valleys having been found to be from fourteen to five and a decrease in the duration of freezing temperatures from at least forty to sixteen hours. Moreover, that except in abnormal years, or in the coldest places, an average of two heatings each season will save

the fruit. Furthermore, that it seems probable that no heating at 28°F. or higher, except possibly when the fruit is setting, will be necessary to assure a moderate crop. The selection of late blooming trees of good quality, which some have been found already acclimated during the survey, should make it comparatively easy for the Nevada rancher to establish at least a home orchard that would require but little protection.

The temperature survey of the Truckee Meadows has been adapted by the local U.S. Weather Bureau as a basis for issuing frost warnings.

Publications

The Value of High-Level Meteorological Data in Forecasting Changes in Temperature — Station Bulletin. S. P. Fergusson. Ready for Publication.

For conclusions, see p. —.

Snow Survey Provides Basis for Close Forecast of Watershed's Yield: Rapid and Economical Methods of Measuring Large Areas of Snow at High Altitudes. J. E. Church Jr. Engineering Record, April 17, 1915.

Proves useful at Lake Tahoe, Nevada

Invent. 10a]

Suggested Changes and Extension of the U.S. Weather Bureau Service in California: a Discussion.

J.E. Church Jr. To be published in Proceedings of American Society of Civil Engineers.

This article discusses favorably a report by engineers of Southern California that the U.S. Weather Bureau reorganize its snowfall and temperature service so as to obtain data in each of the large watersheds of California on precipitation, evaporation, and melting rates; the relation of topography and forests to melting and run off; and on the mountain snow available each spring for irrigation and power; also that the temperature records of the voluntary observers receive closer inspection. The successful experience of the Department in establishing such a service in the Tahoe Basin is related and suggestions for reorganization are made.

Motor Boating 6200 Feet above Sea Level; a Defoe Cruiser, Built for Winter Cruising in Winter.

Arthur L. Smith. Motor Boating, March 15, 1915.

Describes the construction of a home built cabin Cruiser and its value for snow studies in the winter on Lake Tahoe.

Instruments Designed

a Meteorological Pantagraph for reducing the records on any linear record sheets to a common standard for comparison.

a Snow Thermograph; ~~for use in~~ this instrument can also be used for obtaining continuous records of temperature in soils.

Both designed by S. P. Fergusson.

a ~~Snow~~ Evaporation Pan for determining the evaporation from snow caught by the crowns of trees.

By Arthur L. Smith.

Cooperation

The year has been one of large and practical cooperation. Data on the precipitation and evaporation of snow was placed at the service of the Geological Survey in making a report on the feasibility of establishing a federal reclamation project on the Walker River.

The Reclamation Service in return for the seasonal snow-survey of the Tahoe Basin has given the Department the use of land and adequate buildings for headquarters at the outlet of the lake and is sharing in the maintenance of the snow observers.

Close cooperation is being planned with by the Nevada Section of the U.S. Weather Bureau with a view to extending and completing the snow studies inaugurated by the Department and ultimately adopting the snow surveying in all of the watersheds of the State.

major expenses were the purchase of instruments and shelters,

Officials of the Forest Service also have consulted with the Department in formulating plans for the study and charting of air currents in the National Forests with the view to improving present methods of fire protection.

Finally, the U.S. Experiment Farm at Fallon has extended its cooperation by taking charge of four additional temperature stations, placed at Pyramid Lake, Salduro, The Island, and Stillwater, which with the Mount Rose base station at Fallon and a temperature station at Tuscarora should furnish an accurate record of the climate of the Truckee-Carson Project.

Plans

During the present year, accumulated data in the snow studies will be prepared for publication, and the study of the evaporation of snow and the forecasting of water resources continued. The temperature survey will be concluded in the Truckee-Carson basins before publication of the data on this unit is made. The general plan is to map the basins into zones according to the intensity of frost and the hours of heating required. To study the progress of temperature changes with a view to local forecasting, and compare the thermal intensity of the growing season on slopes and in valley bottoms.

Y E ( ) Stupell E

The Value of a Department of Meteorology

1. To perfect methods of determining the amount of water available on the various watersheds for irrigation each season.

The water for irrigation falls mostly in the form of snow on the high mountains and its amount varies with elevation and situation. Only 5 per cent of the water is stored in reservoirs. Experiments already made by the Station ~~have demonstrated that the amount of water available can be readily~~ close forecasts can be made sufficiently early to permit the adjustment of crops to available water.

The department's ~~preliminary~~ methods are now being adopted by the U. S. Weather Bureau in Nevada. Cooperation is being arranged ~~, and~~ with the purpose of ultimately applying the present service to all parts of the State.

2. To study Nevada climate with reference to Agriculture.

~~a mountain state like~~ Nevada has a complex climate as compared with the states of the plains. This is ~~especially~~ true in the case of temperature. ~~In the plains states a few well placed stations will be sufficient, to determine the~~

~~The past season~~

The present year, the orchards of Fallon and Glenbrook, sixty miles apart and ~~250~~ having a difference of 2500 feet in elevation, bloomed full two months apart. The fruit at Fallon was

injured by an untimely freeze; that at Glenbrook ~~enjoyed a normal season~~. because of its lateness escaped.

The study of the climate of Nevada should be directed along the following lines:

(1) The climatic survey of basins and slopes to determine the relative intensity of the growing season of each both day and night; the frequency, intensity, and length of frosts with a view to the economical protection of gardens and orchards; the relative humidity and the effect of wind with reference to the winter killing of fruit and alfalfa; the progress of temperature changes ~~in various~~ on bottom land and slopes to facilitate the forecasting of frost; and finally the comparison of the climatic elements found here with those found in other states to facilitate the introduction of plants congenial. ~~to them~~

The most pressing need is the development of the home orchard, ~~promising~~ by selecting frost-resistant and late blooming plants and trees, and learning how to protect them easily and economically. The survey being conducted in the Truckee-Carson basins indicates that not more than two heatings will be required each season to save ~~the~~ a full crop and that no heating above 28°F. except when the fruit is setting will be required to save a crop sufficiently large for home and local consumption. So valuable is this latter observation, if true,

injured by an untimely freeze, that at Glenbrook escaped.

The study of Nevada climate should take the following

that its accuracy should be thoroly verified.

Experiments of this nature are too detailed to be conducted by the U. S. Weather Bureau locally and the instruments employed by their voluntary observers are not adapted to the work.

(2) In cooperation with the Departments of Biology and Agronomy, attention should be given to the relation of climatic factors to plant growth, not only the climate of the air but the temperature of the soil, especially as affected by irrigation.

Such cooperation would be valuable in the experiments now being conducted on the Experiment Station Farm.

(3) In similar cooperation with the Department of Animal Husbandry, studies could be made of the effect of out-door wintering on the milk production of dairy herds, particularly the effect of rain, snow, mud, winds, etc.

(4) Increase the present limited knowledge of the climate of the stock ranges, particularly the temperature, precipitation both of rain and snow, and relative humidity, for their possible bearing on its improvement.

Not only is the department well equipped to conduct the studies outlined but the associate meteorologist, who, as an experiment designer and inventor of meteorological instruments, has

Then the efforts of Professor Ferguson, Associate Meteorologist, who is an experiment designer and

makers of meteorological instruments, the department is well equipped to conduct the studies outlined and can furnish further apparatus at a nominal cost. This advantage is of utmost importance, for instruments adapted to the work are both difficult to obtain and are expensive. Furthermore, Professor Ferguson is a trained meteorologist, having resigned as first assistant at Blue Hill Observatory, Harvard University, to have a share in the pioneer work here.

~~3. The third point in which the department should be of value is~~,

3. To teach agricultural students and others the value of instruments and the meaning of climate.

4. To advance the general science of meteorology.

(1) along agricultural lines of more remote interest than the preceding, as (a) the nature of frost phenomena and (b) the study of mountain winds in their relation to the spread of forest and brush fires.

(2) along pure lines, as the climate of the Great Basin, upper air phenomena, assisting in preserving data for world meteorology.

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5. To design and repair instruments for other departments of the University.

There are the reasons for urging the establishing of the department of meteorology as a permanent footing in the Experiment Stations and University. Dean Knight strongly favors giving instruction in meteorology in the College of Agriculture. The College of Engineering has made use of the Department in designing and testing instruments.

For the immediate future, the continuance of the Department is imperative, for the data ~~has~~ on the relations of mountains and forests to the conservation of snow are yet to be ~~prepared~~ ~~up~~ for final conclusions and publication, and the records being obtained in the temperature survey of the Tucson-Oracle Basins must be tabulated and analyzed.

When the larger projects now under way are concluded, as they should be by the summer of 1917, the department can probably be maintained for $2500 per annum, providing $500 can be apportioned from the ~~the~~ College of Agriculture for instruction in meteorology and $300 by the University for designing and repairing instruments in the colleges of the University. If necessary, Professor Ferguson ~~if given a part~~ can devote one-fourth to one-third of his salary by devoting a proportionate amount of time to outside work. However,

the work that should normally fall to the Department will occupy his entire time.

Respectfully submitted,

J. E. Church Jr. [Meteorologist]