Climatic Data Monitoring for Soil Moisture and Runoff Modeling 1987-1990

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Wyoming Water Research Center
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CLIMATIC DATA MONITORING FOR SOIL MOISTURE AND RUNOFF MODELING 1987-1990

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By

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Introduction

This report summarizes Wyoming's activities as a member of the High Plains Regional Climate Center. The University of Wyoming cooperated with the University of Nebraska Center for Agricultural Meteorology and Climatology during 1987-90 in the High Plains Regional Climate Center Agreement. The overall objective of Wyoming's participation was to cooperate in the regional efforts of the High Plains Regional Climate Center. Specific objectives were the monitoring of climatic data through maintenance of two automated weather stations and measurement and modeling of soil moisture. Wyoming (a) operated two weather stations, located at Pine Bluffs and Wheatland, as part of the regional Automated Weather Data Network (AWDN), (b) acquired soil moisture measurements in winter wheat and grass, at Archer and Chugwater during the summers of 1987, 1988, and 1989, and (c) monitored mountain snow pack temperatures during the winters of 1987-88 and 1988-89.

Locations

Field sites were located in southeastern Wyoming. The AWDN stations were near the towns of Pine Bluffs and Wheatland. Soil moisture was monitored at Archer on the University of Wyoming Research and Extension Center and at Chugwater on John Baker's farm. Snow pack temperatures were taken on National Forest land near the town of Centennial.

Climatic Data Monitoring

The AWDN stations were automated by use of Campbell Scientific CR21 data loggers which continuously monitored sensors. The

stations recorded air temperature, soil temperature at 18 inches depth, relative humidity, wind speed and direction, solar radiation, and precipitation. The data were retrieved daily via phone by the University of Nebraska Center for Agricultural Meteorology and Climatology at Lincoln. The maintenance and service of the stations were conducted by the University of Wyoming.

Soil Moisture Monitoring

The Archer soil moisture site was on a slight plateau that is fairly flat. Most of the surrounding area is rangeland with a few nearby trees. The Chugwater soil moisture site is a flat plateau located in a region of rolling hills. Most of the area is cropped, with the major crop being dryland winter wheat. The surrounding area includes a small amount of grassland used for hay production.

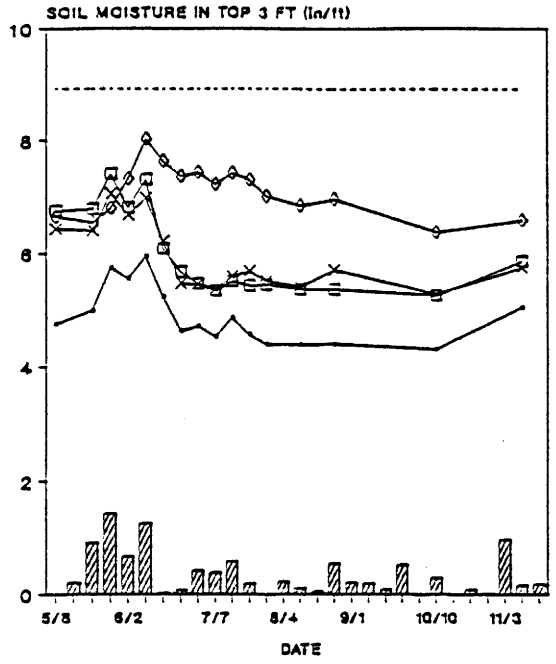
Soil moisture measurements at the Archer and Chugwater sites were taken weekly through the growing season and monthly during the spring and fall. Four aluminum access tubes were placed in each of the fields monitored. The tubes were inserted a maximum of six feet into the ground, depending on location of a gravel layer. The tubes at Chugwater were all six feet deep while the tubes at Archer tended to be closer to four feet because of the gravel layer. Soil moisture measurements were taken at one foot intervals using a neutron probe. The readings were manually recorded in the field and then transferred to a computer. Soil moisture values were calculated in percent and then reduced to inches of water in the soil The total inches of water in each foot were calculated by date and crop.

At Archer, soil moisture was monitored for two winter wheat cropping practices and grass. One wheat field was continuous no-till wheat, which was replanted to wheat the same year it was harvested. The other wheat fields were in a summer fallow-wheat cropping rotation. All fields were strip-farmed with strips of about 110 feet in width.

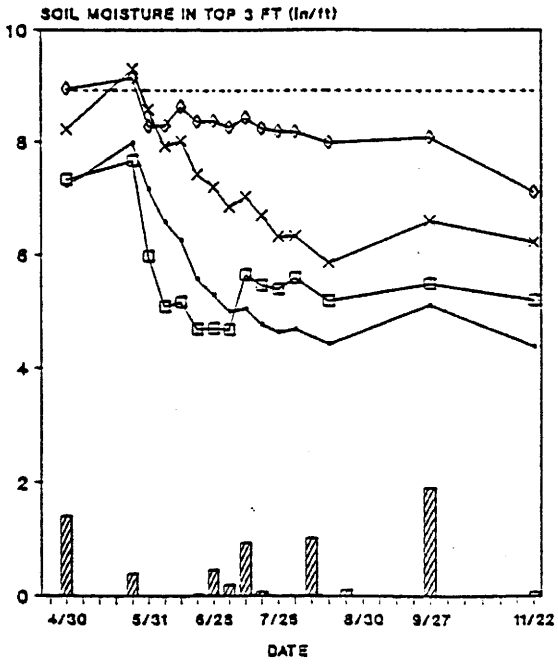
At Chugwater, soil moisture was monitored for winter wheat having a summer fallow-wheat rotation and for grass. The wheat fields were strip-farmed, the dominate farming practice of the region, with alternating 120 foot wide strips of wheat and summer fallow.

All soil moisture data were submitted to the University of Nebraska Center for Meteorology and Climatology at Lincoln. Modeling and model testing of the soil moisture data were also undertaken at the University of Wyoming. The soil moisture data for Archer are summarized in Figure 1.

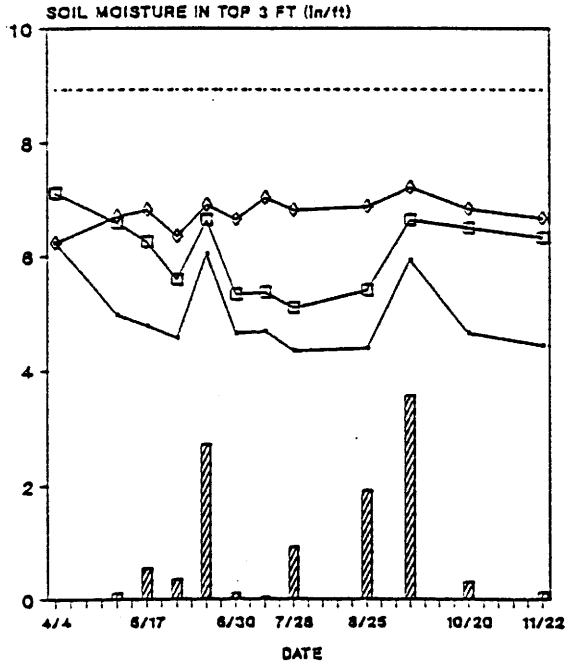
1987



1988



1989



LEGEND

Figure 1. Archer soil moisture.

Soil Characteristics

Since a primary objective of this effort was to monitor soil moisture, the magnitude of the available soil moisture at each soil moisture measuring site was determined. This required measuring the field capacity and wilting point at each site.

Field capacity tests were conducted at both Archer and Chugwater. The soil around each tube was saturated for 24 hours using a ring to contain the water and a reservoir to maintain a constant head. The ring was then covered with plastic to avoid evaporation. Neutron probe readings were then taken at approximately one half day, one day, and two days after saturation. Since the soil water content stabilized after 24 hours, the one day reading was used to define field capacity.

Since both soil moisture sites involved only dryland farming, the wilting point was defined as the lowest soil moisture value obtained.

Neutron Probe Readings vs Gravimetric Readings

Because of the question of the accuracy of the neutron probe for obtaining soil moisture measurements in the top foot of soil, gravimetric soil samples for the top foot were also taken throughout the first summer of this project. Statisitcal comparisons of the neutron probe readings versus the gravimetric measurements indicate little difference between the two methods.

Yields

Wheat yields for each year were taken as close to the access tubes as possible in each field. A 325 square foot area was harvested at each tube location.

Monitoring of Snow Pack Temperatures

Snow pack temperatues were monitored for two winters on National Forest land near the town of Centennial, Wyoming. Sensors for monitoring of temperature in the snow pack were required. Sensors were developed for the 1987-88 season and were redesigned for the 1988-89 season. In each case, PVC pipe, which has a low thermal conductivity was used for the probe. Thermocouples were then placed in various intervals and protruding one half inch out of the PVC pipe. The pipe was then filled with foam insulation to eliminate the effect of air movement within the

pipe. The placement of the thermocouples and layout of the probes differed somewhat between the two years. During the second year, nine sensors were placed in a one foot by one foot grid system. Measurements were taken at six inch intervals starting six inches below the ground and ending at 42 inches above the ground. Three such grids were used.

The temperatures were monitored by the use of a Campbell Scientific CR21X data logger. The data logger was installed with a 32 channel multiplexer in order to monitor the large number of sensors. Sensors were monitored on an hourly basis. Data collected by the CR21X were dumped onto a solid state storage module in the field.

The overall effort in monitoring snow pack temperatures was very successful in developing methodologies for obtaining snow pack temperatures under harsh winter conditions.

Project Personnel

The following individuals were associated with the Wyoming portion of this project.

NAME	STATUS
Greg Kerr	Principal Investigator
Larry Pochop	Principal Investigator
James Fornstrom	Principal Investigator
James Krall	Principal Investigator
Steve Miller	Principal Investigator
Dale Brown	Student Assistant
Fred Kadwa	Student
John Baker	Cooperator
Francis Hruby	Superintendent, Archer Res. and Ext. Center