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Climatology and the Problems of Western Grasslands

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Sixty years after Coronado, Don Juan de Oñate wrote the first reasonably good description of the High Plains. He was near the present site of Wichita, Kansas, in 1601, when he arrived at a large rancheria, or temporary Indian camp, containing more than 5000 souls. Oñate's account expressed wonderment at the great extent of the level land, at the numerous small streams bordered with luxuriant groves of trees, and, of course, at the large number of buffalo.

We shall never see the wonderland of the blossoming prairie which he described as follows: Grazing for the horses "had been lacking for several days, as there had been none for many leagues, for the fields there were covered with flowers of a thousand different kinds, so thick that they choked the pasture" (1, p. 256).

We who fly from Chicago to Denver in a few hours cannot get the same view of the western grasslands as those who, with rifle or sword in hand, moved at the rate of 10 to 15 miles a day.

The tall- and short-grass prairies of the West comprise more than 700,000 square miles in the United States alone, not to mention the great prong extending northward into Canada. Such an area represents nearly a quarter of the United States. There are areas other than prairie where grass is an important natural resource. Among these should be mentioned the grass openings in woodland and along the borders of desert shrub associations in the plateau and basin-and-range provinces. So considered, the western grassed areas constitute even a larger proportion of our country.

This vast domain has problems commensurate in complexity with its geographic scope, and these are in part related to the changes which have occurred since settlement. I shall attempt to state the most important current problems as I see them, and then will discuss briefly the role of the climatologist in their solution.

The first major problem is the need for increasing water supplies. It is a climatologic axiom that variability is one of the principal attributes of semi-arid lands. In the financial losses and hardships caused by the drought of the past decade, we see an example of what this variability implies. The climatologist, more than others perhaps, recognizes that these long periods of deficient moisture are indeed an intrinsic part of the pattern. However temporary this lack of water may be in the broad climatic picture, to him who experiences drought, the problem is immediate and serious. The sufferers are contemplating or are even now resorting to extreme methods for drought alleviation, such as broad-scale changes in types of vegetation with a view to reducing transpiration losses.

The second major problem, correlative with the variability and immediate shortage of water, is erosion. Gully erosion, particularly, is serious in large areas of the western grasslands. West of the true prairie with its deep and fertile soil, the problem lies not so much with the loss of topsoil but in the loss of valuable alluvial land and associated silting of reservoirs.

Gullies pose problems more far reaching than the disruption of easy travel and the elimination of areas which once grew good grass. The gullying process is a symptom of changing relations of rainfall to runoff, and results in a net change in the relation of runoff to erosion. Thus the second major problem is the control of erosion and the reestablishment of a quasi-equilibrium between the degradational forces of erosion and the protective influence of vegetation.

The third major problem is the need for maintenance or increase of total forage production. Large areas of the grassland are in cultivation, but the bulk is still principally a grazing country. Drought and grazing have taken a toll of the native vegetation, and forage production is far below optimum sustained yield. In forage production is found an apt illustration of the lack of compatibility of the economic climate and the atmospheric climate as they affect management. A rancher tends to stock his range for the forage in an average year. He may attempt to stock at a level not exceeding carrying capacity of the range, but when a dry year occurs, economic considerations do not allow an immediate reduction of stocking to compensate for decreased forage yield. And of course the human heart is always full of hope, particularly when it comes to next year's rainfall. Thus a feedback mechanism goes into operation—overgrazing leads to further scarcity of forage, which in turn intensifies the grazing pressure on the remaining forage.

Here are stated three general problems of the grasslands of western United States, and in fact, the same problems are encountered in some of the other grassland areas of the world: the need for increased water supply, extensive erosion, and the need for increased forage. These problems are only indirectly related to climate, but the climatologist may contribute importantly.

The techniques of climatology would perhaps not be specifically applied to the solution of these practical problems but would be interwoven through many different kinds of peripheral studies, a few of which will now be mentioned.

Already built or in the planning stage are projects for reservoir storage on western rivers which bring into sight the ultimate development of much of the water in the semi-arid lands. Reservoir storage is one of the practical ways man combats the variability of water supply mentioned earlier. This development of storage capacity does not necessarily imply the optimum utilization of the available water. In fact, overdevelopment is a real possibility, and in certain basins, reservoir storage already planned may exceed the optimum development in the following respect. Storage is used to iron out the streamflow variations carrying over excess flows of a good year to provide water in a drought year. Owing to the fact that in addition to short-term fluctuations in runoff there are secular or long-term variations, building increased storage capacity will approach only asymptotically the complete control of all the runoff. However, increased storage capacity exposes more water surface to evaporation, and there is a limiting value of storage beyond which losses by evaporation exceed gains in usable water resulting from reservoir control.

Studies of optimum storage require knowledge of evaporation losses. Estimating evaporation losses from future reservoirs involves the use of climatologic reasoning in a complex hydrologic framework.

In increasing the amount of water available for man's use, much remains to be done in reducing consumptive losses of various kinds, particularly water used by phreatophytes. The normal riparian vegetation along drainage courses contributes to transpiration losses. Control of such indigenous vegetation is complicated by the ability of many plants to sprout from roots or suckers even when the crown has been destroyed. Exotic species such as Tamarisk are particularly virulent for they have spread into an ecologic niche which previously was not filled by any indigenous species. Economically feasible reduction in water losses through the control of phreatophytes involves reliable estimates of the total water transpired under different conditions. Climatologic techniques now appear to offer great promise for computing transpiration.

In addition to the encroachment of exotic phreatophytes on flood plains and drainageways, there has been a remarkable spread of certain indigenous species beyond their original geographic range. Piñon-juniper woodlands have encroached on previously grassy or park areas at middle elevations in the southwestern states. There has been a notable spread of mesquite into certain grassland areas of Texas. Locally, physical eradication of these brush types has been initiated for the purpose of improving forage production. In eastern Arizona serious consideration is being given to a large-scale program of woodland eradication for the purpose of reducing consumptive use of water by piñon and juniper. The efficacy of such measures is quite unproven, and action programs are even now being planned on estimates of water savings unsupported by quantitative studies. Water-budget studies are necessary to provide quantitative data. Such studies require climatologic instruments and methods.

Land use practices aimed at the control of erosion and of flood runoff pose perplexing problems, social and legal as well as physical. Evaluations of the effect of such conservation measures on water supply require studies of changes which might be wrought in the interrelation of surface and ground water, changes in channel or conveyance losses due to alteration of stream regimen, and changes in evaporation when storage reservoirs of different sizes are built. In a study of stock ponds built by ranchers in eastern Wyoming, Culler and Peterson (2) showed that evapotranspiration losses induced by these ponds reduced the total annual runoff in the main channel downstream about one third. Similar studies are needed elsewhere.

In searching for a solution to the gully problem we are plagued by an inability to discern the differential effects of changing climatic factors and land use by man. For example, in Kansas near where Oñate spoke of numerous small streams (1), McLaughlin (6) showed that within the last half century channels have widened tremendously. In New Mexico, on the other hand, alluvial channels generally have deepened rather than widened during the same period. Mechanisms within some parts of the hydrologic cycle are only imperfectly understood.

In attempts to determine the relative role of climatic variation and overgrazing in the western erosion problem, archeologic and geologic methods have been used. One line of inquiry involves working out the sequence of erosion and deposition in alluvial valleys during the postglacial period. Though many excellent studies of this kind have been made, their results are difficult to interpret until more is known about how different types of climatic variation affect the water budget on land surfaces. Particularly important is a delineation of those climatic factors which are most important in influencing rainfall-runoff relations. For example, rainfall-runoff relations are greatly influenced by vegetation. But the response of vegetation to changes of different climatic factors is not well known. There is still much to be learned concerning what kinds of rains, occurring at what seasons of the year, are the most important in determining the growth and vitality of vegetative species. The recent work of Glock (4) which combined climatological and botanical work is an important contribution to this field of study.

Another kind of climatologic investigation which can add importantly to our understanding of the determinants of rainfall-runoff relationship is the continued study of statistics on rainfall frequency and magnitude (5).

Climatology could contribute to many management problems. Techniques need to be developed for computing budgets of soil-moisture adapted for specific use in range management. Thornthwaite's work in this field is well recognized. He and his students are applying the concept of soil-moisture budget to agricultural operations, and similar techniques are needed to suit rangeland conditions.

Another aspect of forage management is reseeding. Range seeding has been attempted in scores of different circumstances and on thousands of acres. Methods have included drilling, broadcast, and use of fertilized pellets. At least on open range lands, success has been discouragingly spotty. Here is indeed a practical problem for the applied climatologist.

In a recent paper, W. C. Palmer (7), speaking as a rancher as well as meteorologist, stressed the need for climatological expectancies in lieu of long-range forecasts, as a guide for operational decisions of western ranch managers. Such expressions from users of climatic and weather information reinforce my own view that the climatologist generally does not know enough about related disciplines, nor about management problems to which he could contribute.

How well is climatology contributing to our ability to live in and with our heritage of grass? For the most part, students who have made important contributions to climatology of the western environment have, interestingly enough, not been climatologists. They have been scientists in other fields who have spread their activities into adjoining disciplines. One of the best papers on the climatology of the American grassland is a contribution of a geographer, Borchert (2). Important reasoning in the field of climatology has been developed by plant ecologists, for example, Weaver and Albertson (8). The work of Glock has been mentioned in relation to discernment of climatic parameters governing vegetative growth.

I would summarize by pointing out that ecological studies in the plant field involve the interrelation of soils, water, microorganisms, temperature, and other weather factors. The climatic data used in such studies are obtained either from the national network or by instruments set up to gather data during the investigation. Thus in great part, climatic data are analyzed by the ecologist. The modern ecologist has a good understanding of meteorological concepts and he is quite competent to make interpretations of relevant data. We climatologists, however, might well ask ourselves whether we are similarly knowledgable in the field of plant ecology, and whether the meteorological profession is fulfilling its responsibility to related fields which must perforce deal with at least some aspects of our discipline. We must admit that the present emphasis of dynamic meteorology and on airway forecasting has tended to relegate climatology to a secondary role in the meteorological profession.

When we who are interested in climatology begin to think again of our field as a part of the field of natural history, or of physical geography, and when we become more conversant with fields closely allied to our own, then I think climatology will be able to play a more important role in enlarging our understanding of the environment in which we live. This will also permit climatology to assume its proper place in the field of science. Perhaps that time is not yet. But the achievement of such an objective is up to us.

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