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Erosion in the Valleys of the Southwest

By KIRK BRYAN

THE PROBLEMS of Southwestern United States have been of late much in the public eye. The depression began in this area with the fall in price of livestock in 1920-21 and was gradually accentuated with the collapse of the banks in 1926 and the general crisis of 1929. Dry years added their toll, since in general high prices for livestock and good, that is, rainy, years seldom occur together.

The continually changing fortunes of the stock business, its booms and depressions, its good years and droughts, have led to much governmental activity reflected as far as Boston, the great marketing center for wool. This major Southwestern industry is also charged with the onus of soil erosion, and in the name of soil conservation, vast sums out of the public treasury have been and are being spent in the Southwest. The collapse of the war-time wheat prices and the long-continued drought which culminated in 1934 also contributed to distress in this area. The general depression, still continuing, affected also the transportation business, and many a county government is supported largely by railroad taxes. The Southwest is thus one of the problem children of our fatherly Uncle Sam whose apparently bottomless purse has been generously opened at the request of his highly vocal dry-land citizens.

Research on the physical geography and geology of the area has been carried on for many years. The pioneers in the work gave such attention as they could spare to the problem of the valley floodplains, and we owe much to the studies of Gregory and others. In the past fifteen years, a more or less systematic campaign has been in progress which is just beginning to show general results.

Most of the minor streams of the Southwest are mere wet weather water courses. Muddy floods accompany and follow rain, but throughout the remainder of the year, the
stream beds are dry. These ephemeral streams flow in valleys floored with alluvium from twenty to one hundred feet thick. The alluvium has been accumulated by the building up of the grade of the streams which, before the year 1880, ran in discontinuous shallow channels and during floods spread widely over the valley floors. After 1880 and continuing to the present, stream after stream has cut a deep channel, or arroyo, twenty to fifty feet deep into its valley floor or floodplain. The mud excavated from these channels or arroyos is carried into the main rivers, and as the arroyos are widened by each successive flood, more mud is carried down. Because on the main streams, the Colorado, the Gila, and the Rio Grande, great reservoirs have been built, the increased load of mud will, within a few generations of men, fill the reservoirs and render them valueless for storage. This is the great "arroyo problem." How and at whose expense are these reservoirs to be protected?

The western migration of cattle and cattle men began in the late seventies, and at the same time bands of sheep migrated from New Mexico. Both the cattle and sheep businesses were well developed by 1880. As the cutting of arroyos was begun at this time, some hold that the stock business is the malefactor. The claim is made that the reduction of the native vegetation, by the use or misuse of the grazing, has increased the flood run-off, and thus caused the cutting of arroyos. There is no question that our hesitant land policy, or lack of policy, has encouraged the misuse of grazing land and that overgrazing has resulted in many localities. Nor can one question the general coincidence in time between the cutting of arroyos and the development of the stock business. However, geologic studies of the valleys of the Southwest have demonstrated that the present arroyos had predecessors cut and filled up again before the coming of white men and the introduction of his domestic animals. Investigations of many stream valleys have been made, and the results are brought together in the accompanying table.
EROSION AND SEDIMENTATION IN THE FLOODPLAINS OF SOUTHWESTERN VALLEYS

<table>
<thead>
<tr>
<th>Alternate processes</th>
<th>Evidence on the ground</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion</td>
<td>The existing arroyo</td>
<td>Cut from floodplains since 1880 A.D. and still being eroded.</td>
</tr>
<tr>
<td>Sedimentation</td>
<td>Late channel fill</td>
<td>Contains in places potsherds and other human relics; began to be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>deposited about 1300 to 1400 A.D.</td>
</tr>
<tr>
<td>Erosion</td>
<td>Ancient arroyo</td>
<td>Similar in size to existing arroyo; in places known to have been cut</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in period 1100-1400.</td>
</tr>
<tr>
<td>Sedimentation</td>
<td>Intermediate fill</td>
<td>Of Pueblo or earlier date; may be two-fold.</td>
</tr>
<tr>
<td>Erosion</td>
<td>Earliest arroyo</td>
<td>Much larger than later arroyos; associated with strong wind action.</td>
</tr>
<tr>
<td>Sedimentation</td>
<td>Early fill</td>
<td>Cemented and/or weathered; contains in some localities extinct animals;</td>
</tr>
<tr>
<td></td>
<td>(Neville, Jeddito,</td>
<td>absent in some valleys.</td>
</tr>
<tr>
<td></td>
<td>and other formations)</td>
<td></td>
</tr>
</tbody>
</table>

There have been at least three periods of deposition of alluvium, and three periods of arroyo cutting of which the present arroyo is one. The dates at which these events took place have been determined mostly by interpretation of the relics of man found in the alluvium through the generous cooperation of many archaeologists. In this field the two sciences merge and the broken pieces of Pueblo pottery and other relics of man become fossils recording geologic events. The chronology of Southwestern Pueblo cultures is now in a highly developed state, so that types of pottery are correlated with the tree ring chronology invented by Douglass, and dates on the absolute time scale are possible. The third period of deposition which was brought to a close by the present arroyo cutting is quite well established as to date in these widely scattered areas and apparently occurred between 1200 and 1400 A.D. The period of arroyo cutting next pre-
vious is also fairly well established and occurred between 1100 and 1300 A.D. The next earlier period of deposition is not so well known, and it may easily be that two or more periods of deposition are represented, and that mere lack of data enables the placing of these deposits in the same category. Similarly, the earliest fills recorded, such as the Neville of Texas, are made equivalent to each other, either because of a common content of extinct animals or because there is no information as to date. As elephants and horses undoubtedly lived over a long period, the presence of their bones merely implies antiquity without defining it, and these several bodies of alluvium may have been deposited at more than one ancient date.

The erosion period which followed the deposition of the Neville formation of Texas and the Jeddito of the Hopi country was accompanied by extensive wind action. This similarity, although not established for other areas, tends to show that this erosion interval was coincident in these two localities.

So far as the cause of the arroyo cutting which began after the year 1880 is concerned, the dates set forth in the table are conclusive that arroyos similar to and even larger than the recent arroyos were cut in past time. As these ancient episodes of erosion antedate the introduction of grazing animals, they must be independent of that cause. Each interval of erosion apparently occurred synchronously over the Southwest. Nor can successive episodes of arroyo cutting be attributed to local uplift or to local change in stream regimes. They must be due to a general cause, such as successive fluctuations in climate by which the streams cut down and formed arroyos in dry periods and built up their channels and filled their valleys in wet ones. Such an interpretation is supported by the evidence of wind action coincident with the great arroyo that followed in time the Neville formation in Trans-Pecos, Texas, and also the Jeddito in the Hopi country of Arizona. Furthermore, as recently emphasized by Colton, there is in the Rio de Flag near Flagstaff an
older alluvium, deposited under conditions moister than the present, as proved by great stumps of pine trees that had broad growth rings, "complacent rings," which indicate that the trees grew under conditions moister than the present. Also Douglass has shown by tree ring studies that a great drought occurred from 1276 to 1299 A.D., or about the time that the second episode of arroyo cutting occurred over the whole Southwest.

If, therefore, previous to 1880 A.D., alluvium was deposited under moister climates than the present and arroyos were cut under drier conditions, it seems reasonable to believe that the present arroyo is essentially climatic in origin. The introduction of grazing animals handled by optimistic owners may have reduced the already impoverished vegetation, and precipitated the event. Overgrazing thus becomes merely the trigger pull which timed the arroyo cutting in the thirty years following 1880.

From the standpoint of land use and governmental policy, such a theory of arroyos checks optimism as to a complete cure of arroyos by control of grazing, or even by supplemental works, the so-called "upstream engineering." At best such measures are palliatives. It becomes, therefore, necessary to consider with discriminative care, free from the present hysteria, just what damage has been done, and how much it amounts to in the common denominator of the dollar. Such a viewpoint may not be easily reached by the poor man whose corn field has been gutted by an ever-increasing channel or by the rancher whose hay meadow now stands high above a deep arroyo which carries away the flood waters that once irrigated the grass; but the governmental administrator can be more coolheaded. Obviously the average annual value of grazing can be approximated and the destructive effects of arroyo cutting can be estimated. The present policies are inspired by enthusiasm and bolstered by sentiment, but the spending of ten dollars an acre on land that the government has purchased at from fifty-eight cents to two dollars and fifty cents an acre cannot long be justified,
even if these lands are restored to their pristine and native loveliness, unless in that state they will make a return on the whole capital invested. If a reservoir is filling with mud and thus deteriorating, a decision must be reached as to how much of this deterioration is due to accelerated and controllable erosion. The control of erosion, however commendable on aesthetic or sentimental grounds, should not cost more than the value of the stored water that would otherwise be lost. Furthermore, in equity the users of stored water should pay for its protection rather than the general taxpayer, who has already shouldered rather more of the cost of these reservoirs than appears to be his share.

In the formation of these policies, the fundamental data brought forward by these investigations lead to general conclusions. The Southwest has in the past and will presumably in the future pass through alternating periods of slightly moister and slightly drier climate. The present appears to be one of the periods of dryness with concomitant evils of erosion. The future, which would look dark indeed, if present conditions are to continue, may, however, see a return to the relatively moist conditions of the past. The predictions of the gloomy that the sins of our civilization and particularly the evils induced by our land policy, will rob future generations of a livelihood, may be overcome by a generous Nature, returning good for evil.

Intrusion

By STANTON A. COBLENTZ

There are some dark dead suns that bolt through space
And pull green orbs from their established course,
Marking, as tribute to their mindless force,
Storm-pits and deserts on a planet’s face.

So alien lives that come without an aim
May scorch where love and harmony had shone,
Then, fading bat-like in the night alone,
Leave not one heart they lashed at quite the same.