A New Look at Erosion Control[1]

NORMAN H. FRENCH

State Range Conservationist, Bureau of Land Management, U. S. Department of the Interior, Phoenix, Arizona

Ranchers, conservationists and a host of organizations and individuals have been active in erosion control for years. Much has been accomplished; much more remains to be done. The new look at erosion control in Arizona is the realization that flash floods must be controlled and regulated before erosion control can be obtained on flood plain bottoms, and that this type of erosion must often be controlled from the bottom up. That is, the control work starts on the main drainage and works back up stream. This is not in conflict with the firmly established policy of soil conservation principles of erosion control, but rather an adaptation of these principles to a particular situation which occurs in areas where alluvial flood plains are being destroyed by head cut erosion.

Accelerated erosion is a cancerous thing which rapidly destroys the productive asset of a farm, a ranch, or a country. Man is affected by erosion. He may cause erosion or he may work toward controlling it. Erosion control is so broad and all inclusive that it is necessary for us to limit this discussion to a specific situation. Our boundaries will be the active and accelerated erosion of alluvial valleys, where there is a practical and feasible chance of reducing this type of erosion and improving the forage. This work applies primarily to range areas.

Destruction of Grassed Valleys

Geological erosion, in ages past, laid down in Arizona many broad flat valleys which were grass covered and were, what we term, stabilized. The torrential and widely scattered storms which occurred in this area flowed rapidly off the steep side slopes but slowed down and spread out when they reached these heavily grassed valley bottoms. The silt laden water dropped much of its silt load on the grass. Since these floods moved slowly through the heavy grass, moisture was stored in the soil. Valley bottoms continued to become more gradual, and the grass became heavy and stayed that way. These grasses, headed by three major species, tobosa (*Hilaria mutica*), vine mesquite (*Panicum obtusum*), and sacaton (*Sporobolus wrightii*), became the major stabilizers of soil and moisture in much of the southwest. Surely there were years when there were no floods, perhaps many years in sequence; but the grass roots were there and alive. When the rains came, the grass again grew rapidly and provided erosion control.

These heavily grassed bottoms close to water were ideal for large herds of cattle and horses. The early Spanish and American ranchers staked out claims and built their headquarters in these grass valleys. These smooth valley bottoms were also the best routes for trailing cattle, the best wagon routes, and the best and easiest grades to run the tracks for the "iron horses."

What happened? The combined effects of heavy grazing, wagon roads, stock trails, and railroads started cuts in the valley bottoms. As an example, sharp edged wagon wheels left deep depressions in the fine silt loam soils, and water concentrated in these depressions. Since the grass had also been destroyed by the wheels, there was nothing to retard the flow, and as it moved faster, less soaked into the soil. Less moisture, therefore, less grass! More significant is the fact that as water moves faster it has much more digging power, and it can carry more soil with it. If it moves only twice as fast, it has

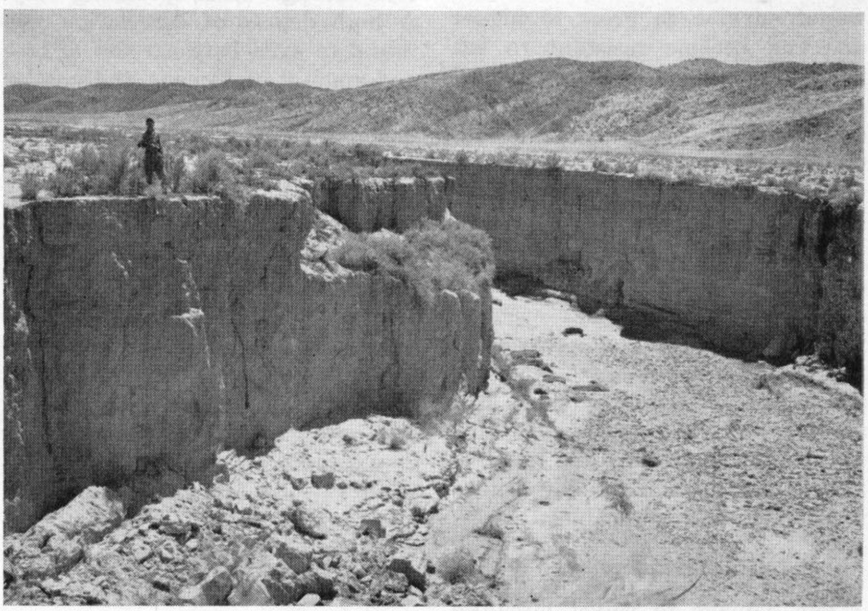


FIGURE 1. Flash floods must be controlled and regulated before erosion control can be obtained on flood plain bottoms. Head cutting and gullying of alluvial valley bottoms has destroyed over a half-million acres of Arizona's best range land. This shows the serious erosion on Hurricane Wash, District 1, Arizona.

[1]*This paper was given at the Tenth Annual Meeting of the American Society of Range Management, at Great Falls, Montana, January 30, 1957.*

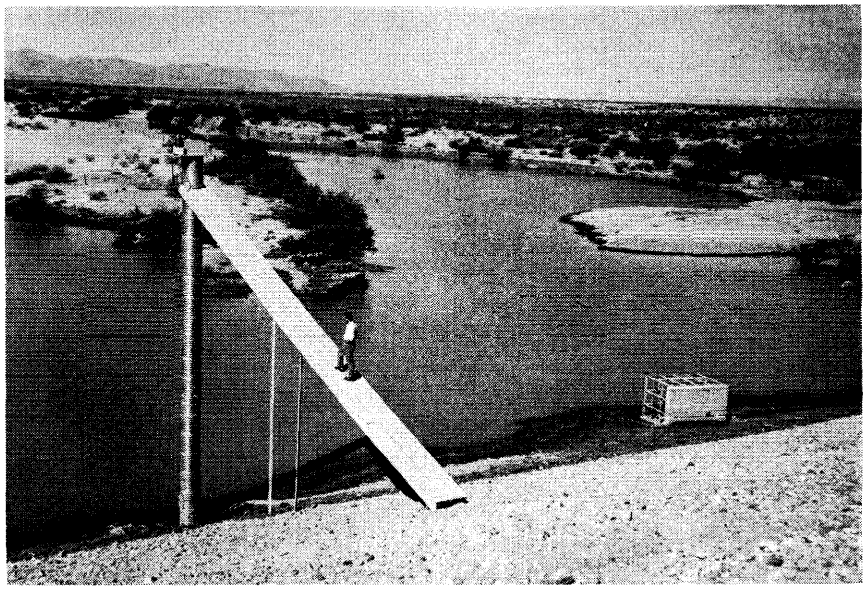
eight times the cutting power and eight times the silt carrying power. Thus erosion builds up rapidly, and much more soil is carried away.

The wagon track is cut down and a new cut is formed. As this becomes a sharp, straight sided cut, the forces of destruction team up to destroy what grass remains. Heavy floods no longer spread out over the valley floor to soak in and grow more grass. They concentrate rapidly in the ever growing cut, and rush madly down stream carrying ever increasing loads of good soil and grass. Not only that, but now millions of finger side cuts start cutting back into the grass bottom. Soon the whole grass bottom is cut by gullies. They get so thick they eat into each other, and the entire bottom is rough, bare ground. Even where gullies cannot reach out because of lack of runoff water, and where the remaining grass is vainly trying to store moisture in the soil, the deep cuts drain off the moisture from below. Each cut becomes a drain ditch. When any moisture is stored in grass roots, it is pulled away by the ever falling moisture zone caused by the gullies. As the grass dies, some shrubs or trees come in to try and cover the soil, but they, too, are robbed of moisture by the gullies and die. The grass is gone, the shrubs and trees are dead or dying—a valley has been destroyed. It is estimated that 500,000 acres of the best grassland in Arizona have been destroyed in this manner.

Man made erosion has taken only 50 to 60 years time. Over these desolate badlands the few remaining ranchers tell of running bands of horses and wild burros in the nineteen-twenties, only 35 years ago, when they were broad grass flood bottoms.

Lost Grazing Values

Just what happened to the grazing? Most ranchers were doing their level best to keep their herds together and to maintain them on the ever shrinking forage supply. The grass bottoms were the key and foundation of the whole grazing pattern. The grass bottoms comprised some 10 to 15 percent of the total grazing area but they provided 50 to 70 percent of the livestock feed. The major grasses in the bottoms were tobosa, vine mesquite and giant sacaton. These are summer growing grasses which usually start in July and continue through August, with green grass up to October 15, and abundant but dry feed from there on. In other words, the bottoms should provide the bulk of the feed from July 1 to December and should also provide a reserve of dry cured grass on the ground. During periods of good runoff, such as 1955, the grass bottoms would have produced a heavy volume of feed. Much of this feed would have remained unused that season. After it became dry, cattle would range on the slopes and ridges. Here are found the annual grama grasses:



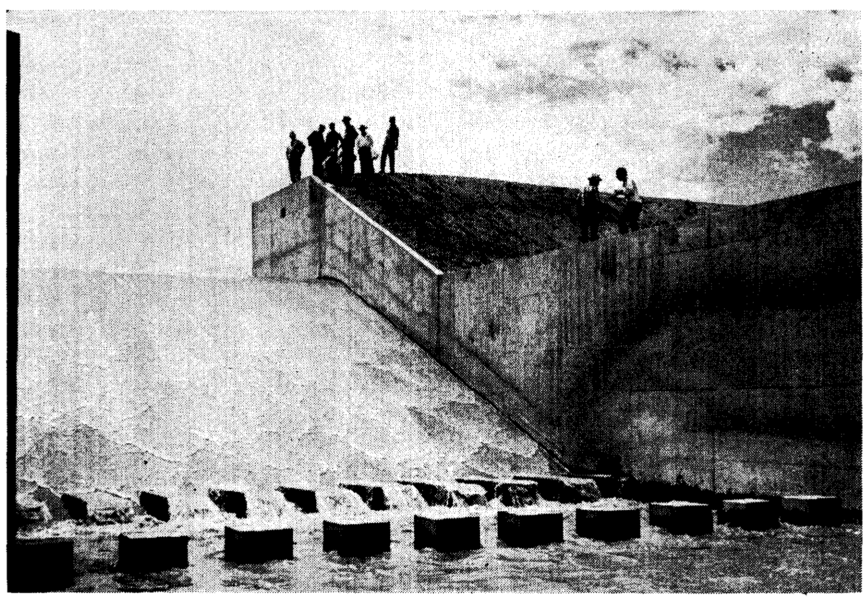


FIGURE 2. Flood control structures must be large enough to control the flash flows of water and start silt accumulations in the main channel to check head cutting. Above is the Creighton water control dam, showing the water stage recorder and the trash rack over the 4-foot pipe outlet. Below is the San Simon drop structure, which controls flood flows and drops water 20 feet to the channel below.

Bouteloua aristidoides, Bouteloua barbata, Bouteloua parryi, and desirable perennials such as black grama (*Bouteloua eriopoda*), blue grama (*Bouteloua gracilis*), and side-oats grama (*Bouteloua curtipendula*). In general, these, too, are summer growing grasses, but they had a very definite advantage since they were rested or deferred while grass in the flood bottoms was being utilized. Since palatability of these grasses was higher than the coarser flood plain grasses, they served to draw stock away from the bottoms after the forage there had matured.

Let's review what happens when an alluvial flood plain bottom is cut out. A head cut moves up through the grass bottom, side fingers develop and destroy the whole bottom area. Grass production is reduced by 50 percent or more and the condition that provided for a natural system of deferred grazing no longer exists. Livestock must be reduced, and the pattern of grazing changed. If not, the concentration of stock on the side slopes will destroy that cover, too, and excessive erosion will develop. In most instances the rancher has lost one half or more of his productive grazing base through erosion. In some cases the loss is almost 75 percent. What happened to the ranchers? Many of them went out of the stock business a long time ago.

Floods Must Be Controlled

Can this destruction and loss be stopped? Yes, but not easily nor cheaply. We can't just fence the area off, and keep stock out for 20 years. This will not bring the bottoms back. We must first get control of the flood waters. Some kind of detention structures are necessary. Careful hydrology is basic to developing any type of flood water control. Calculations of peak volume runoffs as well as the maximum peak cubic-foot-per-second flow is necessary. Control structures must adequately handle peak volume flood flows, or they will be washed out, and very serious damage many occur. What do we mean by control? It is the reduction of peak flood flows to an intensity which can be spread out over the natural flood plain without damage. Where headcuts occur, water must be stepped down through pipe outlets or concrete overpour spillways. The control must start at the bottom and work upstream, and the main drainage must be the starting point. This is the key to re-establishing the natural stream grade line and maintaining soil moisture throughout the flood bottom areas. These basic principles of control must be accomplished before headcuts can be stopped, and grass re-established on the flood bottoms.

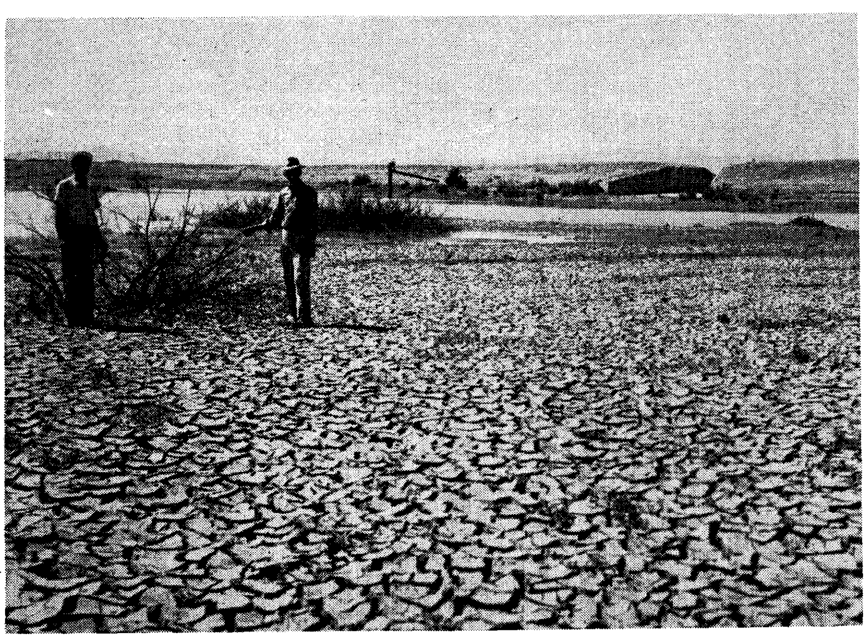


FIGURE 3. Water control must often start at the bottom and work upstream. The controlled water will move slowly over the flood bottom depositing silt and storing moisture for grass production. Twenty feet of silt have accumulated here above the San Simon silt dam.

Basic Facts Needed

To solve these difficult problems certain basic facts are necessary. These facts must be harmonized with our basic objectives, which in turn must be in line with a practical program of economical control. By economical control we mean, that over the long period of years the benefits will be greater than the costs. This brings up a basic initial decision. Are we justified in controlling the very severe storm which might occur once in 1000 years, once in 500 years, or should we be concerned with the 100 year frequency storm or even the 50 year storm?

Frequency of peak storm occurrence is a generalized term applied to storm runoff. A 100 year peak storm is the greatest storm which will occur once in an average 100 year period. A 500 year peak storm is one which can be expected to occur once in an average 500 year period of time. The longer the period of time which is considered, the greater the expected peak runoff. Basic economics dictates that we must try to keep expenditures for erosion control structures to a minimum. Yet these structures must control a reasonable sized peak flow of water to be effective. A good general rule is that a structure should be built to adequately control the storm which may occur within a period calculated to be twice the expected life of the structure. For example most earth fill structures, such as small dams, dikes and diversions, have a life of or will require maintenance or almost complete reconstruction every 20 to 25 years. Thus we should calculate to control the

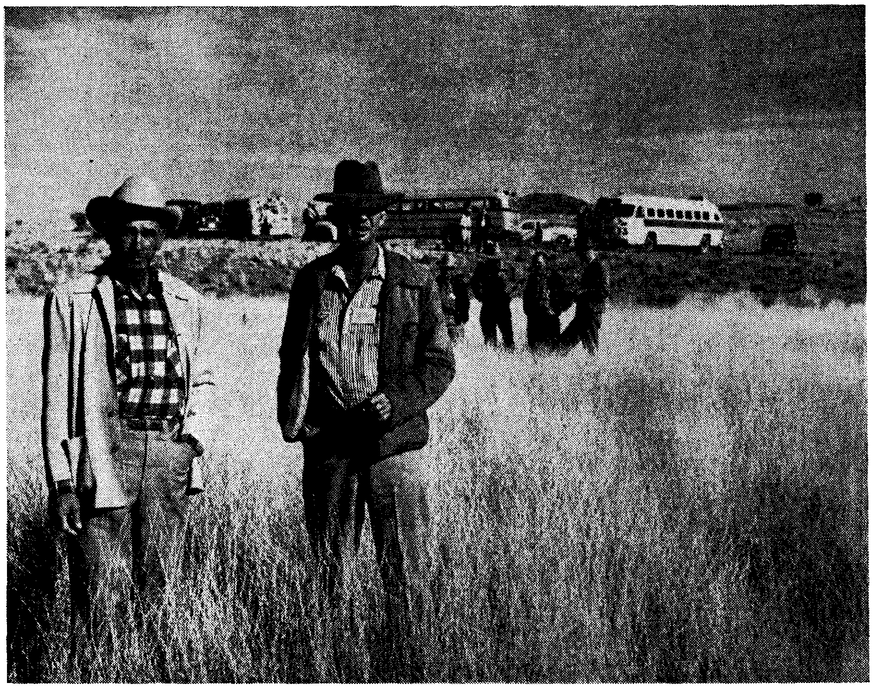


FIGURE 4. Once silt has accumulated in the flood bottom area, grass can move in and produce abundant livestock feed, as shown here in Railroad Wash.

maximum peak runoff from the storm calculated to be of a 50 year frequency. Further, all major structures should be so designed that they will safely operate with only moderate damage to spillways even if the maximum calculated peak storm runoff occurs. Local conditions may alter this requirement, but it must be considered.

Types of Structures

First of all, detention dam sites must be available so that peak flood flows can be reduced. Sites may be good, fair, or poor; but detention storage must be secured to reduce peak flood flows. This may be accomplished by a single dam in a good detention site or it may also require a number of supplemental smaller dams in the side drainage. A combination of good small sites is sometimes better than one large site.

In order to determine the adequacy of the detention dam program we must know what peak floods are to be controlled. Good flood records are essential in order to make an accurate determination of peak volume flow which must be tempoaarily detained. In the Southwest such records are not complete, but the U. S. Geological Survey has developed some very good guides from actual flood flow records over a period of years.

If we should take a particular drainage having serious head cutting, where much of the flood bottom has been destroyed, our first step would be to determine the peak flood volume to be controlled. With this as a guide, detention sites would be picked to secure this control. Generally this would be a series of small dams with pipe outlets placed just below points of serious head cutting. These may be located on side drainages as well as on the main channel. Once control has been established, smaller diversions such as plugs or dikes, are used to distribute the flood water over the natural flood bottom areas. The type and frequency of such minor structures are determined by local conditions. In most instances, these will be a combination of plugs and long, low dikes.

This controlled water will move slowly over the flood bottoms, depositing silt and storing moisture for grass production. It is not always practical to combine detention storage and water control at the point of head cutting and accomplish both with one structure. Where this is not practical, a supplemental structure must be placed immediately below the headcut in the valley bottom. Here, water is dropped down by means of a pipe or over-pour structure from the natural level of the flood plain, which existed before the head cutting occurred, to the present channel level. Only in this way can the head cut be stopped and soil moisture be re-established. Once such conditions are developed the native grass comes in, and the whole grazing pattern changes back to that existing before the destruction of the natural grass flood bottoms. Good range management is of course an essential part of this recovery.

Benefits of Control

This control of erosion and development of grass bottoms is not easy, nor is it cheap, but the benefits far outweigh the costs. What would ranchers pay for a ranch 50 percent larger than their present holdings? Much better, what would they pay for a ranch which would produce 50 percent more feed with no additional fence costs, building costs, or water developments?

This capitalized value is what can be expended to develop the grass bottoms, plus the value of increased wildlife habitat, plus the savings resulting in reduction of flood damage to high value irrigation and populated areas downstream, with their roads, bridges, railroads, townsites, irrigation canals, and high value crops.

The whole community benefits when erosion is controlled and grazing is improved. Irrigation districts benefit through less silt in major reservoirs with more stable water flow of usable water. Highly productive grassland bottoms have been developed from eroding waste areas.

Control of erosion and rebuilding grass bottoms is not easy or cheap, but it is possible and practical. It must be done if the present livestock production is to be maintained in Arizona.