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Range and Pasture Technical Note No. 4

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Non Point Surface Runoff From Cattle Pasture – Hydrology and Nutrients[1]

Three articles that document the effects that range management techniques have on water quality and quantity within a watershed.

RUNOFF AND DRAINAGE FROM GRASSLAND CATCHMENTS[2]

Grazing Management Practices

Over-grazing of grassland can cause soil erosion; several factors contribute to this. Heavy grazing reduces vegetation cover and so reduces infiltration; soil compaction by treading also results in lower infiltration rates. Soil properties are affected more by the number of grazing animals than by the animal species. The resulting increase in runoff increases soil erosion, which is accelerated by the depleted cover and increased availability of material, due to trampling. Surface crusting then occurs and reduces still further the capacity of the soil to retain and transmit water.

A physical interpretation of the hydrological consequences of grazing has proved difficult, but the deleterious consequences of over-grazing can often be halted, and measures taken to restore infiltration characteristics. Cover standards have been defined to specify tolerable limits of grazing in fragile systems to avoid irreversible deterioration. These standards are derived empirically, and vary depending on the type of plant cover and soil fertility conditions. The heavy reliance on empirical methods in combating erosion due to grazing is exemplified in the "universal soil loss equation," which forms the major basis for specifying conservative grazing practice in U.S.A.

Fire and Drought

Deliberate burning of grassland is widely practiced in an attempt to increase pasture growth, or make new season's growth more accessible to grazing animals, and is prescribed in the western United States to maintain the grazing resource. Burning has been justified on the basis that it does not affect soil and water loss; if this is correct, it suggests that evapotranspiration is not affected by burning. However, repeated burning is likely to accelerate erosion, increase nutrient losses, and reduce vigor of the grassland. In addition, fire may make soils water-repellent, and thus reduce infiltration.

Extensive flooding commonly follows drought, as in eastern Australia during the autumn of 1983; this suggests that infiltration is reduced after drought. Furthermore, drought-stricken grassland is commonly overgrazed, which may lead to increased runoff, though other studies indicate that runoff after drought may be little different than from predicted values.

Water Quality

Recent concern for the environment had led to increasing interest in the quality, as well as the quantity, of water collected from grassland. Flow rate and availability of erodible material are the major factors controlling the amount of material transported; grassland management can affect both these factors. Loss of plant cover affects flow rate first, but when more cover is lost, sediment transport increases rapidly, and the quality of runoff water deteriorates. Water quality is also affected by leaching. Irrigation, changed land-use, and fertilizer use can all increase the solute concentration of drainage water.

Although grassland management at the local level may not have large effects on river flow, it can greatly affect water quality. Simple linear relations between quality and quantity offer little understanding of contamination in river systems, and more attention needs to be focussed on the few discrete events which affect the export of suspended and dissolved material. Fire and grazing normally affect water quality more than they affect flow rate.

Transport of soluble and insoluble material tends to occur together, because of the plant nutrients adsorbed on the particulate material. These losses of plant nutrients in suspension can be of similar magnitude to losses by leaching from the root zone. The vertical flow of water through the soil is very slow; this poses major problems in identifying potential pollution, and thus making it difficult to plan management so as to protect groundwater systems. One of the most serious problems of groundwater contamination is salinization, though a wider range of pollutants are increasingly found in groundwater as a result of human activity.

Secondary salinization is becoming a serious problem in mediterranean climates, especially in southern Australia; early agrarian settlement in the Middle East produced similar problems. In southern Australia, the affected area exceeds 500,000 ha; it includes some of the more productive land and endangers regional water supply. In western Australia, the phenomenon is associated with replacement of deep-rooted native woodland by shallow-rooted pasture. Drainage has increased from near zero to about 50 mm yr^{-1}, with the result that high concentrations of solutes in the deep lateritic profiles have been mobilized and appear in streamflow. Rising water-tables have also led to secondary salinization in outflow areas within five years of the forest replacement.

It seems, therefore, that changes in the management of grassland which increase the quantity of water outflow may have a disproportionately large effect on the quality of the outflow. This is true of both surface and groundwater flows. Although there has been considerable success in improving the quality of surface runoff, the problems of polluted groundwater flow generally still await resolution.

[2]Summary of Chapter 5 in Ecosystems of the World. 1987. Pages 205-213.

SECO CREEK WATER QUALITY DEMONSTRATION PROJECT - RANGE IMPROVEMENT THROUGH COOPERATION[3]

The Seco Creek Water Quality Demonstration Project was initiated in April 1990, through a joint effort of the USDA-SCS, Texas Agricultural Extension Service, USDA-ASCS, and Texas State Soil and Water Conservation Board.

This project is part of the national USDA Water Quality Initiative. The project is distinct from other national projects because the primary focus is on rangeland. About 88 percent of the project area is rangeland, 10 percent is cropland, and 2 percent is pastureland. It covers 267 square miles in the Edwards Plateau and Rio Grande Plains Major Land Resource Areas. It is located 50 miles west of San Antonio. The project area consists of the Seco Creek watershed that lies in portions of Bandera, Medina, Uvalde and Frio counties.

The primary goal of the Seco Creek Project is to demonstrate and transfer technology to local landowners and operators. This new knowledge will lead to a voluntary increase in practices that maintain or improve water quality and result in water augmentation.

The project calls for application of best management practices on the various land uses within the 171,000 acre privately owned watershed. Landowners are applying conservation practices through the Great Plains Conservation Program and the Annual Conservation Program, however, many landowners receive only technical assistance.

Numerous practices are being utilized by landowners within the project area. Prescribed burning and mechanical brush management have been completed on 4,500 and 6,000 acres, respectively, resulting in improvement of range condition, higher forage quality, and increased water infiltration. Alternative methods of chemical brush management on species such as mesquite, twisted acacia, and persimmon have been completed on more than 2,000 acres, reducing the threat of water quality degradation. Range seeding and pasture planting have been completed on 4,000 acres. These practices increase infiltration, improve forage quality, and decrease soil erosion. Cross fencing, livestock pipelines, and water facilities have helped landowners achieve better livestock grazing distribution and improved wildlife habitat. Sediment and water control structures and vegetative filter strips in and around riparian areas have reduced erosion and increased recharge potential. Management practices such as proper grazing, grazing systems, and pasture management have been applied to more than 65% of the watershed.

Demonstration and monitoring sites have been established within the watershed to evaluate best management practices. Nine small watersheds are monitored to evaluate two broadcast chemical applications for water quality and quantity. Two additional small watersheds are being monitored to determine water use by ashe juniper, one of the major non-economic water using species in this area. Five spring enhancement sites are monitored for spring flow following ashe juniper management. One site is yielding a 25% increase in spring flow when compared to pre-treatment baseline data.

A cooperative agreement with United States Geological Survey (USGS) has allowed for establishing six gauging stations within the watershed where water quality parameters are constantly monitored through a complete chemical scan according to Environmental Protection Agency standards. The project will also evaluate and utilize data from the watershed in computer models designed to predict water yield and non-point source pollution.

Interest in the project has been outstanding. More than 50% of the landowners within the watershed are involved in the project, applying practices to more than 60% of the land area. More than 150 tours, field days, and presentations have reached more than 11,000 people. Efforts of the Seco Creek Demonstration Project and application of the best management practices will have significant effects on the water quality and quantity in this area of Texas. The project has also demonstrated that landowners will voluntarily apply practices to maintain or improve water quality and quantity.

[3] Summary of article from Rangelands 15 (4), Aug. 1993, Pages 174-176.