Attachment G

Soil Drying Analysis

REPORT--MATILIJA DAM SEDIMENT DRYING STUDY

J.R. Williams
Research Scientist
Blackland Research and Extension Center
Temple, TX

Summary of the EPIC model

The Erosion-Productivity Impact Calculator (EPIC) model was developed to assess the effect of soil erosion on soil productivity. It was used for that purpose as part of the 1985 RCA (1977 Soil and Water Resources Conservation Act) analysis. Since the RCA application, the model has been expanded and refined to allow simulation of many processes important in agricultural management.

EPIC is a continuous simulation model that can be used to determine the effect of management strategies on agricultural production and soil and water resources. The drainage area considered by EPIC is generally a field-sized area, up to 100 ha (weather, soils, and management systems are assumed to be homogeneous). The major components in EPIC are weather simulation, hydrology, erosion-sedimentation, nutrient cycling, pesticide fate, plant growth, soil temperature, tillage, economics, and plant environment control.

Example applications include: (1) 1985 RCA analysis; (2) 1988 drought assessment; (3) soil loss tolerance tool; (4) Australian sugarcane model (AUSCANE); (5) pine tree growth simulator; (6) global climate change analysis (effect of CO_2, temperature, and precipitation change on runoff and crop yield); (7) farm level planning; (8) five nation EEC assessment of environmental/agricultural policy alternatives; (9) Argentine assessment of erosion/productivity; (10) USDA Water Quality Demonstration Project Evaluation; (11) N leaching index national analysis; (12) Landfill cover analysis.

Hydrology and tillage were the most important EPIC components used in this study. The most important hydrology components were potential evapotranspiration (PET), actual soil evaporation, and percolation. We used Hargreaves PET method and actual soil evaporation was calculated using a function of soil moisture and depth from the surface. Percolation from a soil layer occurs when the layers soil water storage exceeds field capacity and the flow rate is a function of the layers saturated conductivity. The tillage component was used to mix the soil to speed drying.

Summary of Analyses Performed

The problem was to estimate the time required to dry saturated sediment removed from the Matilija Reservoir. There are about 1.7 million cubic yards of sediment in the reservoir. About 2500 cubic yards per day of the sediment would be placed on a 25 acre drying area and allowed to drain until it is dry enough to till. The soil of the drying area is sand and gravel with high saturated conductivity values so that drainage from the sediment layer will not be a problem. The sediment layer will be tilled until it is dried to a moisture content satisfactory for loading and hauling. The number of drying cycles will depend on the thickness of the sediment layer placed on the drying area. The sediment texture is estimated to be 67 percent silt, 18 percent clay, and 15 percent sand. The EPIC model was used to estimate the average annual number of drying cycles considering a 20 year simulation period. We assembled 20 years (1976-1995) of daily weather records (solar radiation, maximum and minimum temperature, and precipitation) from a near by weather station--Ojai, CA. To assure that tillage occured daily when the soil was dry enough to permit, we developed a special auto till function. Auto till checks the moisture in the top 6 inches of the sediment layer daily to determine if tillage is permitted. If the ratio PDSW/PDAW<0.75 tillage occurs. PDSW is the soil water content minus the soil water content at 1500 kPa, and PDAW is the soil water content at 33 kPa minus the soil water content at 1500 kPa. We simulated three sediment layer thicknesses 6, 10, and 15 inches. The drying time per cycle is longer for 15 inches but more material is dried during each cycle. Thus, there was little difference in the total time required to dry all of the sediment in the reservoir regardless of thickness. We selected 10 inches because it will be more convenient in handling. The reason we simulated little drying time difference is probably because we assumed that tillage would be just as effective in mixing 15 inches as 6 inches. For simulation purposes we divided the 10 inch sediment layer into six layers. The depths from the surface to the bottom of the layers were 0.01, 0.04, 0.07, 0.10, 0.13, and 0.254 m. Tillage mixes the layer contents according to the mixing efficiency of the tillage implement. We assumed that the tillage depth would be 10 inches and that the mixing efficiency would be 0.80. Thus, 80 percent of the soil water content of each of the sediment layers was mixed uniformly and 20 percent maintained its pre-till value. The material was considered dry enough for hauling when SW/AW<0.75 for all six layers of sediment. SW is the soil water content minus the soil water content at 1500 kPa, and AW is the soil water content at 33 kPa minus the soil water content at 1500 kPa.

Simulation results showed that during the best drying weather (June - September) the saturated soil drained and evaporated to the point where tillage could occur in 3-4 days. Usually after three days of tillage the material was satisfactory for loading. Thus the drying cycle under best conditions was 6 to 7 days. Overall the model results indicated that the average annual number of drying cycles was 41.4. The average number of drying cycles per month were Jan=1.4, Feb=2.1, Mar=3.0, Apr=3.8, May=4.3, Jun=4.6, Jul=5.1, Aug=4.8, Sep=4.3, Oct=3.7, Nov=2.5, Dec=1.8. The 25 acre drying area with a 10 inch thickness of sediment provides for drying 33,600 cubic yards per cycle. Thus, it would require 51 cycles to dry the 1.7 million cubic yards in the reservoir. Considering the model results the material could be dried in 1.25 years.

Crucial Assumptions

1. The assumption that tillage can occur if the top 6 inches of sediment is dryer than 0.75 of field capacity. To test the sensitivity of the assumption we lowered the threshold tillage value to 0.65 and still got 34.9 drying cycles per year.
2. The assumption that the material will be dry enough to haul if all sediment layers are dryer than 0.75 of field capacity. This is actually a conservative assumption because we require all

layers to be dryer than the threshold value. For example this assumption is more restrictive than assuming a threshold for the average water content in the entire sediment layer.

3. The assumption that tillage depth is 10 inches and that the mixing efficiency is 0.80. To test the sensitivity of the depth we reduced it to 8 inches and still got 38.0 drying cycles per year. Similarly we reduced the mixing efficiency to 0.60 and got 37.0 drying cycles per year. By reducing both the depth to 8 inches and the mixing efficiency to 0.60 we got 33.9 drying cycles per year.