**COMUNIICA, Año 4, N°15, 2001, p. 6-9**

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# NTENSIVE SOIL EROSION[1][1]: Applications in the Dominican Republic

## The impact of erosion

Soil conservation is the practice of using the land properly to prevent soil degradation. The process of soil loss entails numerous types of direct loss: lessened soil fertility, thinning of useful topsoil (one centimeter of soil, which may have taken 1000 years to form, can be lost in a week or even a day when rainfall is intense and the soil is exposed), risk of desertification and loss of land areas where plants could grow.

The impact of soil erosion is wide-ranging. Offsite effects include increased accumulation of sediment in the stream bed, where silting can damage structures and properties and shorten the useful life of reservoirs. One of the most significant effects is alteration of the hydrological regime in the watershed. Although the amount of water circulating through the water cycle does not change significantly, its pattern of distribution during the year is greatly disturbed. As erosion thins the topsoil, peak flows or flash floods become more frequent. The thinner soil cover has low water-holding capacity. Soils quickly become saturated during storms, and runoff occurs more quickly. As a result, less rain water seeps into the soil to supply the aquifer with enough moisture to discharge into low-lying sections of the river and thus sustain streamflow during the dry season. Not only do dry-season water shortages become more acute, but the ground surface of the entire watershed becomes vulnerable to the effects of extreme events.

Natural disasters due to heavy rain or high winds are merely one indication of how vulnerable the land has become as erosion disturbs its ability to withstand. There can be little doubt about the concept of time of concentration in the watersheds.[1][2] Maximum discharge occurs when rainfall intensity, averaged for the entire watershed, remains at a maximum level for a lapse equal to the time of concentration of the watershed. For lengthier periods, maximum intensity levels are generally lower, and the corresponding discharge is therefore less (see Figure 1). A watershed that is well protected with dense coverage allows for greater soil infiltration and surface storage. Runoff is slowed, lessening the risk of dangerous maximum discharge. Storm characteristics are only one factor in discharge, as inappropriate use of the land, expansion of areas rendered impermeable by urban growth, and the resulting erosion, reduce the soil's water-holding capacity. This feeds high-speed runoff, reducing the watershed's time of concentration. The inevitable result is peak flows or flash floods in the streams, that in the presence of extreme events cause flooding and damage to infrastructure, property and persons (see Figure 2).

The illustration in Figure 1 shows a two-year recurrence interval (time of return), with an average maximum intensity (1) of 0.3 cm/h over the period that corresponds to the time of concentration (Tc=50 minutes) in the unprotected watershed; by contrast, the maximum intensity is 0.9 cm/h during the time of concentration for the same watershed when it is protected (Tc=250 minutes). The coefficient of runoff (C) for the first case was given as 0.65, and 0.453 for the second. If the area of the watershed (A) is 400 ha, the maximum runoff is 21.7 $m^3/s$ under the first set of conditions and 4.53 $m^3/s$ under the second (Q=CIA/36, see reference 4 for details). In the first case, water shortages during the dry season will be

more acute.

Land use, whether for farms, cities, roadways or any other activity, is the causal factor in all these circumstances. If the impact is important for society, policies need to be developed and enforced to halt processes of erosion and minimize all those uses that wreak negative changes in the hydrological system of the watershed. Soil conservation practices are essential for this.

## Institutional considerations

The Dominican Republic created a soil conservation service in the 1980s under the Secretariat of Agriculture, as part of what is now known as the Department of Lands and Waters (DTA) of the Under Secretariat of Natural Resources (SURENA). This Department is responsible for the main soil conservation projects in Jánica, Ocoa, Padre las Casas and the Northeastern Line, and initiated an AID-funded project for natural resources management (the MARENA Project), later taken up by FIRENA I and II through the Development Department of the Municipality of San José de Ocoa (ADESJO). The work of the Service is to draft land-use plans with farmer organizations and provide technical assistance for carrying out these plans. It also applies the principles of rural engineering for building small water storage projects, stream-bank and gully protection structures, and more. The DTA has trained many technicians who now work in other public agencies or private companies. For reasons that bear careful scrutiny, the Department is currently being phased out.

Shortly after the DTA came into existence, the Department of the Natural Resources Inventory (DIRENA) was also created in the Under Secretariat of Natural Resources of the SEA. Its purpose was to compile the information needed for land-use plans to be implemented, and to provide users with valid information so their plans could be managed properly. At present, the Department's work has turned toward analysis and presentation of information using Geo-referenced Information Systems (GIS). No detailed territorial inventory of soil information is currently being done; thus, no data base on resources is yet available to enrich these systems of analysis, and the information needed for developing land-use plans and providing effective technical assistance is impossible to obtain.

The Hydrology Office of the INDRHI continues to employ very valuable personnel; but it has suffered major losses of both staff and equipment and lacks the necessary resources for operating its information systems normally. Under current circumstances, the efforts made by remaining technical staff to discharge their responsibilities are truly admirable. With the exception of the Program to Develop a Culture of Water, which requires considerable support, this agency has no clear directives that would permit it to distribute and monitor the amount and quality of water effectively.

## Recommendations

(1) Strengthen the Soil Conservation Service to pursue achievements made to date and extend its work to all land uses.

(2) Investigate the usefulness and possibility of establishing a cooperative system to develop detailed survey information on soils and natural resources related to land cover for the entire country, using systematic, priority-based methods. Continue to support the development of technologies for the analysis of geo-referenced information on natural resources, cross-referenced with information on the economy, population and more.

(3) Investigate the possibility of strengthening the country's hydrological and meteorological information system; this includes updating information and analysis of rainfall intensity patterns so as to design infrastructure and for planning land use.

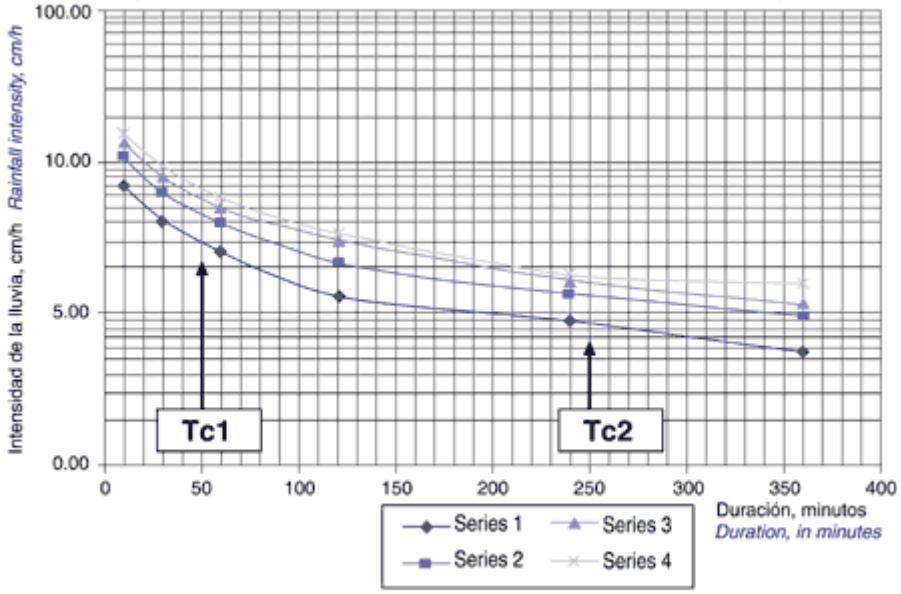
(4) Investigate the role of the Culture of Water program as a way to elicit community involvement in government-mandated activities. Strengthen the Culture of Water Program.

(5) Develop equitable financing mechanisms originating in society as a whole, as ultimate beneficiary of these projects; only this will make such services truly sustainable over the long term and allow society to know and decide how its resources are to be used.

## Project for Institution Building - IICA-USDA/NRCS Cooperation

IICA and the Natural Resources Conservation Service of the US Department of Agriculture (formerly known as the Soil Conservation Service) have been working in partnership under a cooperation agreement for several years. The reference document on evaluation of the impact of Hurricane Georges contains a proposal to design a project of institution building in the field of natural resource conservation.

**Figura 1. Relación Intensidad vs. Duración - Estación 4903 San Juan de Maguana**
***Figure 1. Ratio of intensity to duration - Station 4903, San Juan de la Maguana***




Nota: Series 1, Tr=2 años; Series 2, Tr=10 años; Series 3, Tr=50 años; Series 4, Tr=100 años (Tr, período de retorno).
*Note: Series 1, Tr=2 years; Series 2, Tr=10 years; Series 3, Tr=50 years; Series 4, Tr=100 years (Tr, Time of return).*

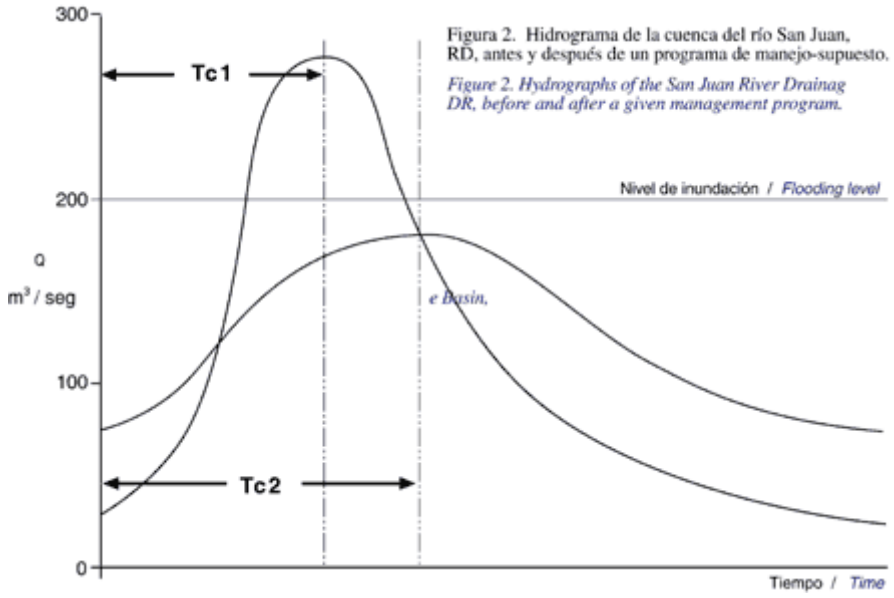



Figura 2. Hidrograma de la cuenca del río San Juan, RD, antes y después de un programa de manejo-supuesto.

*Figure 2. Hydrographs of the San Juan River Drainag DR, before and after a given management program.*

## References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1[2]In the case of a storm of average intensity that produces runoff for the entire watershed, time of concentration is the amount of time required for water from all parts of the drainage basin to flow into outlet at a given point of the stream.