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## Compensation for Ecosystem Services in the Watersheds of Rumiyacu, Mishquiyacu and Almendra, Peru

FERNANDO LOPEZ

*Universidad Nacional de San Martín, Peru*

### Abstract

In the San Martin Region, Northern Peru, the increasing deforestation of the mountain rainforest and inadequate land use practices generate different kinds of environmental impacts and externalities for downstream communities. The soil erosion has negative effects on the water quality and the regulation of the river dynamics. To evaluate the generation of water and sediment in the watershed sub and micro basins studied, hydrological models were developed using SWAT (Soil and Water Assessment Tool). These models allowed the identification of high risk areas for soil erosion.

The hydrological models provided necessary information to develop the mechanism of payment or compensation for ecological services, which is being developed in the Alto Mayo river basin, and pretends to establish incentives to reduce the externalities. The models enabled us to predict the effects of land use changes on the generation of externalities and determinate the effectiveness of conservation practices. Furthermore, the upper areas are established as local protected areas.

The SWAT model delimited the sub and micro basins using the digital elevation model of the area. This information was combined with land use, soil type and weather data, in order to determine the Hydrological Response Units (HRU). The HRU with the highest quantities of sediments, were given priority for establishing incentives for land use changes or for applying conservation practices.

The HRU on bare land, grassland or shrubland generally contributed more sediment to the water body, compared with primary forest or secondary vegetation with the same combination of soil type and slope. Nevertheless, there were some exceptions of primary forests that contributed more sediment to the water body, due to the influence of steep slopes and soil type.

The average contributions of sediments to the water body were lower in the watershed sub basins Avisado, Yuracyacu, and in the micro basin Urcuyacu, with values between 9.28 and 20.46 t ha<sup>-1</sup> per year. Higher values presented the watershed micro basins Mishquiyacu, Rumiyacu and especially Almendra with 84.39 t ha<sup>-1</sup> per year. The probability that these sediments arrive at the water body varies between 4.2 % in the case of sub basin Avisado and 44 % in the case of the micro basin Mishquiyacu.

In the sub basin Yuracyacu, contrary to our expectations, the HRU that contributed more sediment to the water body were located in the lower part of the watershed. This can be explained because of the temporally unprotected soils in the rice cultivation, which are very susceptible to erosion. The upper parts of the watershed contributed only few sediments to the water body in spite of having high slopes in some cases. This might be

due to the lack of information because of clouds and to the assumption that the higher parts are covered completely with primary forest, as well as the poor information on soil types.

**Keywords:** Peru, soil erosion, SWAT model