Geophysical Research Abstracts
Vol. 12, EGU2010-4372, 2010
EGU General Assembly 2010

Assessment of the hydrological behaviour of watersheds of contrasting land use using suspended sediment-discharge hysteresis patterns

Rafael Giménez, Javier Casalí, Javier Díez, Mikel Goñi, and Miguel A. Campo
Public University of Navarre, Project and Rural Engineering, Pamplona, Spain (rafael.gimenez@unavarra.es)

Four experimental watersheds in Navarre (Spain), maintained by the local government, have been monitored and studied since 1996 (La Tejería and Latxaga) and 2001 (Oskotz "principal", Op, and Oskotz "woodland", Ow). La Tejería and Latxaga watersheds, located in the central western part of Navarre, are roughly similar to each other regarding size (approximately 200 ha), geology (marls and sandstones), soils (alkaline, fine texture topsoil), climate (humid sub Mediterranean) and land use (80-90% cultivated with winter grain crops). On the other hand, Op (ca.1,700 ha) is covered with forest and pasture (cattle-breeding); while Ow (ca. 500 ha), a sub-watershed of the Op, is almost completely covered with forest. The predominant climate in Op/Ow is sub-Atlantic. As a result, a detailed description and a general characterization of the hydrological and erosion behaviour of these watersheds were published recently by the same authors of this current research. However, this information, although extensive and valuable, is still insufficient for finding out the internal and complex hydrological functioning of these watersheds reflected in the frequent occurrence of the hysteresis phenomenon.

"Hysteresis" is when the amount of sediment concentration associated with a certain flow is different depending on the direction in which the analysis is performed –towards the increase or towards the diminution of the flow. This phenomenon to some extent reflects the way in which the runoff generation processes are conjugated with those of the production and transport of sediments, hence the usefulness of hysteresis as a diagnostic hydrological parameter. However, the complexity of the phenomena and factors which determine hysteresis make its interpretation uncertain or, at the very least, problematic. 5 types of hysteresis have been recognized but, however, only three types are usually reported: "clockwise", "anticlockwise" and "eight-shape".
This article aims to investigate the hydrological-erosion behaviour of 4 watersheds with contrasting land uses by means of the analysis and interpretation of the sediment-flow relationship throughout a long period of time. The first results of this work are presented here.

The sediment-flow relationship of 375 events occurring between 1996 and 2009 in the La Tejería, Latxaga, Ow and Op watersheds was analyzed seeking to identify events presenting hysteresis. To make the comparison between events easier a normalized hysteresis index was calculated –although it was only applicable for clockwise and anticlockwise hysteresis– based on the determination of the area comprised between the top and bottom limbs of the sediment-flow graph. Only 25-60% of the events taking place in the grain-cultivated watersheds exhibited a clear hysteresis. Conversely, in Op/Ow this figure rose to 95%. In the watersheds cultivated with grain, the factors controlling erosion –protection due to cultivation, tillage, etc.– can change drastically throughout the year and even inside one same watershed, so that it is not surprising that the sediment-flow relationship did not show a clear hysteresis, unlike what happened in the watersheds under woodland/pasture. In general, 3 types of hysteresis were observed: clockwise, anticlockwise and eight-shape, although the first of these was predominant. It was, thus, in Op/Ow that 90% of the events which displayed hysteresis did so with the clockwise type, whereas in La Tejería this rate was only 50%. Also, the hysteresis in Op/Ow and Laxtaga was more clearly defined (a higher index) than that in La Tejería. This predominance of curves with clockwise hysteresis suggest that the main areas of sediment discharge were to be found in the banks and areas near to the bed and to the record station.