Geophysical Research Abstracts,
Vol. 11, EGU2009-7977, 2009
EGU General Assembly 2009

Hydrological and erosion behaviour in two experimental agricultural watersheds in the centre of Navarra (Spain)

J. Casalí (1), R. Gastesi (1), J. Álvarez-Mozos (1), J. Del Valle de Lersundi (2), R. Giménez (1), J. Díez (1), M. Goñi (1), U. Agirre (1), M.A. Campo (1), and J.J. López (1)

(1) Department of Projects and Rural Engineering, Public University of Navarre, Pamplona, Spain (jcs@unavarra.es), (2) Department of Agriculture, Livestock and Food, Government of Navarre, Pamplona, Spain

Two experimental watersheds, La Tejería and Latxaga, located in the central area of Navarra and maintained by the regional government, were monitored for 12 years (1996-2008) with the aim of assessing their hydrological and erosion behaviour, as well as the quality of their water. In this work, an extensive and detailed analysis has been made of these aspects on different time scales, from annual to per ten minutes, or per rain event.

Both watersheds have a similar surface coverage (approx. 200 ha), geology, soils, climate (a Mediterranean one with a mean annual temperature and precipitation of around 13º and 750 mm, respectively), and land use (cereal growing). However, their sediment production records are very different. For instance, the total sediment evacuated in La Tejería ranged between 390 Kg ha^{-1} (2000/01) and 5,609 Kg ha^{-1} (1996/97), whereas in Latxaga it only varied between 48 Kg ha^{-1} (2002/03) and 1,386 Kg ha^{-1} (2006/07). Simulations made with the EUROSEM model led to the assumption that this notable contrast in sediment production was mainly due to the different general shape of the watersheds, along with the unequal relief predominant in each of them. In another direction, the largest amount of sediment was recorded during the winter, as, in that season, the soil is usually bare and contains a high degree of moisture. The mean annual sediment discharge in La Tejería was of 1,342.27±2,390.39 Kg ha^{-1}, with 84% of the total annual sediment being accumulated in wintertime. This figure was, again, much more modest in Latxaga: 444.94±436.15 Kg ha^{-1} and 61% of the total annual sediment.

With regard to water quality, the nitrate concentration values were also disparate in both watersheds. In Latxaga, the nitrate concentration was of 31.22 ± 26.98 mg NO_3 l^{-1}, namely, below human consumption tolerance and environmental values (50 mg NO_3 l^{-1}). Conversely, in La Tejería, this concentration was notably higher, 93.89 ± 26.98 mg NO_3 l^{-1}, thus, continuously throughout the year, exceeding the tolerance values cited. However, the phosphate concentrations were similar in Latxaga and La Tejería: 0.236 ± 0.622 mg l^{-1} and 0.150 ± 0.495 mg l^{-1}, respectively. These values are not so high but, together with the presence of nitrogen, they could cause eutrophication problems.

A more detailed analysis of the variations in the sediment-discharge in the time shows a more complex dynamics, specific to each watershed, which is manifested through the "hysteresis" phenomenon. The most frequent rain events normally presented a single peak sediment discharge, which did not necessarily coincide with the hydrograph peak ("clockwise" or "counter clockwise"); although double peak events ("figure of eight shape") have also been observed. No clear relationship between the time of year at which the event occurred and the type of hysteresis was noted in La Tejería, but it was found in Latxaga, where the clockwise hysteresis was predominant during the winter. On the other hand, only in La Tejería and during the wintertime was a close relationship observed between hydrological variables like: the present rainfall, the rainfall previous to the event accumulated for 21 days, and the maximum flow value of the event with the total sediment discharge.

The cross-correlation analysis showed a close correspondence between the runoff and the previous day's precipitation, but only during autumn and winter (r close to 0.6); this was not so during spring and summer ($r<0.2$). The rapid hydrological response of La Tejería was thus evidenced since the 'memory' of this watershed was the same or under 1 day during the winter months.

Finally, by means of principal component analyses, we were able to infer which maximum and minimum values

of precipitation and runoff intensity were the principal factors controlling the erosion power in both watersheds. To be specific, 40% of the sediment production can be explained with the two variables cited.

This investigation, unprecedented in the region, constitutes a valuable database of a fundamental importance in hydrological, erosion and water quality studies.