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Assessing stream water quality in watersheds with contrasting land use in Navarre (Spain)

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Four experimental watersheds in Navarre (Spain), maintained by the local government and with different land uses, have been monitored and studied since 1996 (La Tejería and Latxaga) and 2001 (Oskotz "principal", Op and Oskotz "woodland", Ow). In previous publications, a detailed description was given of their hydrological and erosion behaviour, as well as their production of nitrates, phosphates and potassium, all these chemicals being directly related to agricultural activity (fertilization). However, the dynamics of an equally large series of other important solutes –bicarbonates, carbonates, sulphates, chlorine, calcium, magnesium and sodium– also conditionants of water quality– had not been analyzed up to now. Thus, the objective proposed in this work was the exhaustive analysis of chemical erosion in experimental watersheds with contrasting land use.

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 watershed (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, with a mean annual rainfall of 1,200 mm and a mean annual temperature of 12ºC.

The average annual production of solutes as a whole was considerably higher in Op/Ow ($1{,}653 \pm 245$ kg ha^{-1}) than in the grain growing watersheds; it was precisely the lower record which corresponded to the Latxaga watershed (715 ± 292 kg ha^{-1}).

However, only two solutes (bicarbonate and calcium) account for approximately 90% of the total in Op/Ow, this predominance being even greater in the grain-cultivated watersheds due to their alkaline soils, rich in carbonates. Even so, only one minority solute, nitrate, exceeded the tolerance limit (50 mg l^{-1}), although exclusively in La Tejería watershed with an annual mean value of 87 ± 15 mg NO_3 l^{-1} and occasional maxima of 100 mg l^{-1}. In Latxaga, the annual mean concentration (24 ± 12 mg NO_3 l^{-1}) was normally under the thresholds permitted but with occasional peaks exceeding it. Also, in the grain-cultivated watersheds –not so in Op/Ow– the high nitrate concentrations together with values –not very high but important ones– of phosphates (0.20 ± 0.15 mg PO_4 l^{-1}) could cause alarming eutrophication problems. It should be noted that the phosphate production in grain-growing watersheds –and in spite of the intensive fertilization carried out in both watersheds– was lower than that recorded in Op/Ow. This was due to the important fixation of phosphate produced in the calcareous soils predominating in the grain cultivated watersheds. The rest of the solutes analyzed exhibited marked differences in their records depending on the land use, although in no case did they exceed tolerance thresholds for drinking water. Finally, we mention that chemical erosion in Op/Ow is more important –around 70%– than that of sediment (soil erosion). By contrast, soil erosion is slightly higher than chemical one in the grain-growing watersheds.