Phosphorus transfer across boundaries: From basin soils to river bed sediments

Luz Iglesias, Rosa Devesa-Rey, Francisco Díaz-Fierros, María Teresa Barral

Departamento de Edafología y Química Agrícola. Facultad de Farmacia, Universidade de Santiago de Compostela, Spain
luz.iglesias@usc.es

Phosphorus transfer from soils to water bodies has attracted increasing interest, as P is a driver for biological activity in waters and needs to be managed to avoid eutrophication. Several studies have highlighted the importance of soil erosion and physical transfer of P with soil particles from land to water. Moreover, in some rivers the particulate fraction can dominate the total P flux. In this work, the variation of particulate P concentrations and forms in the Anllóns River basin (NW Spain) was studied, comparing their status in the soils of the basin with that of the suspended sediments and the deposited bed sediments. Eighty nine complex soil surface samples (<2 cm) were taken from forest, cultivation and pasture land, in two sub-basins in the upper part of the river (Upper Anllóns and Grande River). Thirty three samples from river bank and road talus were also taken, as they can contribute to suspended material in the river channel. Twenty samples of suspended sediments were taken at each of the sub-basins closure. Bed sediments (<5 cm) were sampled at 14 sites along the main course of the Anllóns River, downstream from the confluence of the Grande River and the Upper Anllóns. Liofilized samples < 63 µm were analyzed for C, N, total P and available P (Pa).
The soils with the highest total P concentration were those from pasture or cultivation land, related to amendment and fertilizer inputs. Total P increased from soils (mean value 653 mg $kg^{-1)}$ to bed sediments (mean value 1598 mg kg^{-1}) and suspended sediments (mean value 1961 mg kg^{-1}). For Pa the differences were even stronger, ranging from 98 mg kg^{-1} for the soils, to 849 mg kg^{-1} for bed sediments, and 1314 mg kg^{-1} for suspended sediments. The high surface area and organic matter contents of the fine suspended particulates may be responsible for the P enrichment due to sorption reactions with soluble reactive P during transport and on entering the water column. The percentage contribution of Pa to total P is relatively low in the soils (15 %) but increases in the bed sediments (53%), and even more in the suspended materials (67%).
The C:N:P molar ratios varied from 243:16:1 in the soils to 125:11:1 in the suspended sediments collected in the Upper Anllóns sub-basin, and from 398:26:1 in the soils to 254:19:1 in the suspended sediments of the Grande River, which clearly contrast with the lower 44:3:1 C:N:P ratios observed from the bed sediments. Even though biofilms develop over the bed sediments of the Anllóns River, their ratio is well below the Redfield ratio (106:16:1) or average rate for phytoplankton, and only the suspended material of the Upper Anllóns was close to this ratio. When C, N and total P concentrations were plotted in a ternary diagram, the biggest separation was observed between all the forest soils, on the one side, and the bed sediments, on the other side, due to their marked differences in organic matter contents. In the central part of the plot, the non-forest soils and suspended sediments from the Upper Anllóns are grouped together and separated from those of the Grande River, pointing to an influence of the lithology (schist and gabbro, respectively) on total P concentrations. Nevertheless, when Pa was plotted instead of total P, all the soil types lie close together at the organic rich base of the ternary diagram, and far from both the suspended and bed sediments, which are enriched in Pa. A discriminant analysis showed that, together with C and N concentrations, it was the available P and not the total P, which allows to clearly differentiate between the soils and the suspended sediments, with bed sediments lying between these two groups.