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Influence of land use on hyporheos in catchment of the Jarama River (central Spain)

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The Water Framework Directive (2000) requires integrated assessment of water bodies based on water resources but also the evaluation of land-use catchment effect on chemical and ecological conditions of aquatic ecosystems. The hyporheic zone (HZ) supporting obligate subterranean species are particularly vulnerable in river ecosystems when environmental stress occurs at surface and require management strategies to protect both the stream catchment and the aquifer that feed the stream channel. The influence of catchment land-use in the Jarama basin (central Spain) on river geomorphology and hyporheic zone granulometry, chemical and biological variables inferred from crustacean community biodiversity (species richness, taxonomic distinctness) and ecology was assessed. The study was conducted in four streams from the Madrid metropolitan area under distinct local land-use and water resource protection: i) a preserved forested natural sites where critical river ecosystem processes were unaltered or less altered by human activities, and ii) different degree of anthropogenic impact sites from agriculture, urban industrial and mining activities.

The river bed permeability reduction and the increase of low sediment size input associated with changes in geomorphology of the stream channels are greatly affected by land-use changes in the Jarama watershed. Water chemical parameters linked to land-use increase from the natural stream to the urban industrial and agricultural dominated catchment. Principal coordinate analysis (PCO) and multidimensional scaling (MDS) clearly discriminate the pristine sites from forested areas by those under anthropogenic stressors. In streams draining forested areas, groundwater discharge and regular exchange between groundwater and surface water occur due to relatively high permeability of the sediments. Consequently, forested land-use produce sites of high water quality and crustacean richness (both groundwater dwellers and surface-benthos species), as indicate the expected diversity pattern after the simulation procedure for taxonomic distinctness. Crustacean diversity (Shannon index) was greatest in less extensive agricultural land-use sites where riparian zone is slightly developed, while intensive agricultural activities cause a decline of water quality and therefore of crustacean richness. Intensively urban industrial land-use yield highly contaminated hyporheic water with heavy metals and VOC (i.e. toluene, benzene). Complementarily, the streams geomorphology and low rates of water flow favour the deposition of fine sediments that clog the interstices, generate a reverse dynamic of river channel and induce a reduction of groundwater discharge. In results, the hyporheic is unsuitable for hyporheos that are missing or harbour reduced populations of exclusively surface-water taxa. There are sites of intermediate biodiversity including hypogeans, located in natural regional parks thriving well-established riparian zone and relatively good water quality.

The differences among sites in the Jarama basin indicate the impact that changes in land-use have upon the hyporheic ecology as shown the pattern of crustacean community distribution, diversity and ecological structure. We suggest that in rehabilitation processes of streams sectors require the understanding and recognition of the potential roles of the hyporheic zone and its biota in the whole stream ecosystem.