

## Off-site hydrological impacts of kaolin mines on the Upper Tagus river Natural Park (Spain)

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The Upper Tagus (Alto Tajo) Natural Park is one of the largest and most valuable protected natural areas in Spain (Guadalajara Province), and it includes Natura 2000 habitats and species. At the edge of the Natural Park, a series of kaolin mines, operating before of the area protection in 2000, have affected in the past to the wildlife aquatic habitats of the area, and constitute nowadays a very high risk of siltation of the nearby fluvial network (within the Park), being this the main environmental issue of the protected area, as it is stated by its managers.

The erosion of the abandoned mines produces severe on and off-site hydrological impacts. Indeed, the destruction of wildlife aquatic habitats is, and has been, significant due to non reclaimed kaolin mines, by both direct and indirect effects. Suspended silt and clay particles difficult the fish and insects breathing, because the siltation affects directly to their respiratory tissues. Indirectly, because the sedimentation of sand and the decanting of silt and clay drapes spoil the gravel beds which are spawning grounds for fishes and insects. The decrease on these populations affects to the rest of the food chain, such as other fishes, birds and mammals.

Active mines control the runoff and sediment emissions with decanting pools, but need to assure the long-term hydrological stability of the mined reclaimed areas.

In this work, a characterization and quantification of sediment sources is made for the *Peñalen* watershed (in which most of the abandoned mines are included). That has been carried out by both indirect (RUSLE 1.06) and direct (volumetric assessment of sedimentation in existing check-dams) methods. The results make clear that the reclamation of the degraded sites which constitute the abandoned mines should be a priority for the involved administrations (Mine and Environment authorities).

In parallel with this evaluation, geomorphic criteria for the hydrological reclamation of both abandoned and active kaolin mines are suggested. The proposed landform designs point out that runoff and soil erosion can be reduced to the minimum by building composed concave slopes, whereas the highwalls' geomorphic activity has to be controlled with retention trenches, tending to blending them into the landscape. It is proposed that the layout of the reconstructed terrain (waste dumps, surficial deposits, and topsoil) resembles the original surficial geomorphology. Finally, the runoff control envisages the construction of systems of flow control and sediment storage (decanting pools, as small ecologically functional wetlands), at the basis of the concave slopes. For the gauging of these decanting pools, the methodology of the IECA (International Erosion Control Association) is proposed.

Since other factors seem to have played a role in the decrease and degradation of wildlife species and habitats, our research intends to make a holistic and historical approach to the problem, trying to assess any other influences by managing and land uses practises in the last decades. All that is made in a collaborative framework between Universities (UCM-UAH), the managers of the Natural Park and one mining company (CAOBAR S.A.).