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A decision support system for water supply in watersheds with recurrent wildfires

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The Beça River basin (North of Portugal) is barely affected by anthropogenic pressures, namely by the harmful effects of industrialization, urbanization or intensive agriculture. However, this basin is subject to recurrent wildfires, which plays a major role on soil erosion and water quality deterioration. Wildfires are responsible for increasing the concentration of soil nitrogen (N) and phosphorous (P) that ultimately arise in the rivers and water reservoirs as a result of transport by rainfall. In this sense, the main aims of this study are threefold: (i) to assess the relationship between fire occurrence and P concentration in river water, (ii) to model the P and N concentrations in stream water at the basin and sub-basin scales, and (iii) to propose management guidelines for the protection of drinking water resources taking into account the local history on forest fires.
This study includes morphological, hydrological and climatological characterization of the study area as well as the spatial-temporal distribution of the fire incidence in the basin. The rainfall-runoff and nutrient transport processes were performed respectively with Mike Hydro Basin and the ECO Lab. The data requirements for these analysis/tools includes: a digital elevation model, Corine Land Cover maps (for 1990, 2000 and 2006), cartography of burned areas (covering the period 1990 – 2013) and wildfire risk (assessed in 2011), daily records of temperature, precipitation and stream flow, measured at monitoring stations (during the 1990 – 2006 period).
Obtained results reveals a maximum fire recurrence of 5 times during the study period (1990 – 2013) and robust exponential regression observed between burned area and wildfire risk ($R2 > 0.9$). The biophysical parameters contributes to 86% of the fire risk which suggest that burnt area in the Beça River basin is essentially triggered by natural causes. A total of 16,396 ha was burned between 1990 and 2013, corresponding to 47% of the basin area which was covered by scrubs (69%), forests (22%) and heterogeneous agricultural areas (9%). A close relationship was found between the concentration of phosphorus in river water and the occurrence of forest fires. The annual and monthly phosphorus concentrations are influenced by the burned area and the river flow discharge. However, the hydrologic conditions prevail in the sense that, for similar values of burnt area, the maximum phosphorous concentration is higher in dry than in wet years. In addition, the phosphorus concentrations in the water bodies exceeded the limits imposed by the National and European legislation for good ecological status, human consumption and multiple uses mostly in last years of the study period.
The fire frequency is a key variable in the planning and management of water bodies within a fire-prone watershed. The impacts of wildfires on water quality may become periodical instead of occasional as a consequence of the reduced precipitation and increased fire frequency and intensity projected for the near future climate.

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