Project POCI/AGR/59180/2004 – Forest Fires

"How do wild forest fires influence groundwater quality and quantity in Portugal?"

Financial support: Fundação para a Ciência e a Tecnologia; LNEC.

Duration: 2005 - 2008

Institutions: Laboratório Nacional de Engenharia Civil, Escola Superior Agrária de Castelo Branco, Instituto Nacional de Engenharia, Tecnologia e Inovação, I.P., e Câmara Municipal de Mação (logistic support)

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Justification

Every year, Portuguese forests are assaulted by wildfires that destroy them and their associated ecosystems. The 2003 summer was an especially dramatic period with more than 4000 km^2, i.e. equivalent to 4/5 of the Algarve, had been burn. Solely between June and September 2003 more than 280 000ha of cork oak, oak, pines and eucalyptus (areas predominantly with forest management) as well as 170 000ha of wild bush did burn (PNDFCI, 2007).

Forest fire (Photo: 2006 Report - gabineteflorestal@cmm.pt)

The subsequent change in vegetal cover and in the topsoil layer due to the wildfires has impacts on the amounts of water involved in the several sectors of the hydrogeological cycle. Evapotranspiration is reduced due to the lowering of the vegetation cover activity, and the water surplus available for surface flow increases.

Ashes produced by wildfires are composed of polluting substances, such as heavy metals, nitrites and other less known products.

These pollutants contaminate the environment (air, soil, water) and have an impact not totally clarified on the health of living beings and in the food chain. Ashes are transported as overland flow pollutants or are leached by infiltrating waters into the soil until eventually reaching groundwater (aquifers).

Objectives

- ✓ Assess the impact of wildfires on water quantity in the different components of the hydrological cycle.
- ✓ Assess the impact of polluting substances in ashes on soil, groundwater and surface water quality.

Main activities

- Selection of the case study areas: Caratão, Penhascoso, Carvoeiro, Quebrada, Ponte de Panasco, Couto de Andreiros, Manteigas (Figure 1 and Figure 2);
- Assessment of the initial situation and the situation after a wildfire (vegetation cover, its density, combustible biomass volume);
- Soils, piezometry, groundwater quality (Figure 3), surface water quality and direct runoff monitoring (Figure 4);
- Characterisation of the pollutant substances (ash composition through combustion laboratory tests; Figure 5) and its quantities as a function of the vegetation cover;
- Agro-forestry assessment (Figure 6);
- Study of the amount of water that recharges the groundwater medium (aquifer recharge). The surface flow existing prior to the wildfires will be compared with the surface flow existing after those fires;
- Study of the amount of polluting substances in groundwater.

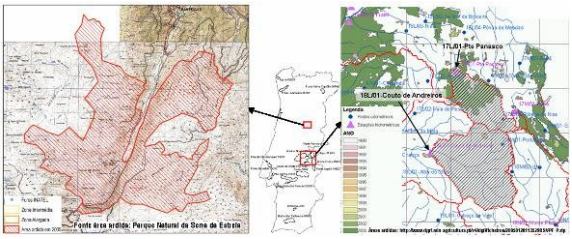

Figure 1 – Location of the case study areas: Ponte Panasco and Couto de Andreiros (right) and Vale do Zêzere (left)

Figure 2 - Location of the four case study areas from Mação county

Figure 3 – Soil and groundwater sampling (Penhascoso – Mação, 7 August 2006)

Figure 4 – Direct runoff sampling (test site) e superficial on a burned area (Ribeira da Barba Pouca – Penhascoso, 15 March 2007)

Figure 5 – Shrub biomass combustion tests in (LNEC/LERF). Volatile combustion and final combustion phase (Char combustion).

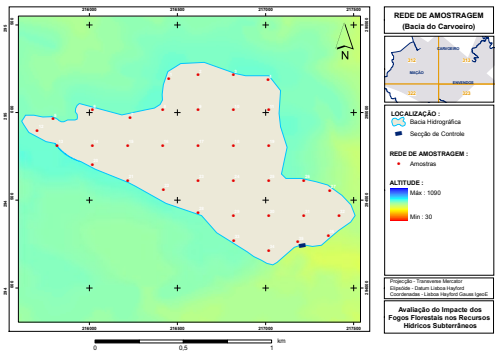

Figure 6 – Spatial distribution of the samples from the fitosociological inventory in Carvoeiro basin.

Preliminary results

The overlapping-study of data from the surface runoff and precipitation monitoring allowed the identification of disturbances in the surface runoff caused by fire, on Ponte Panasco basin, and their components (direct runoff

and basal runoff). However, it was not possible to assess the range and magnitude of these disturbances, due to changes in the pluviometric regime and the short monitoring period.

The soils and waters from the case study area of Penhascoso have been analysed for Polycyclic Aromatic Hydrocarbons (PAH), due to the fact they can be generated during the combustion process of the forest's biomass. At least 9 from the 16 PAH considered prioritary by US EPA - pirene, fenantrene, naphtalene, indene(1,2,3-cd) pirene, fluorene, fluorantene, crisene, benzo(a) antracene e acenaphtilene – have been identified in samples from burned soils, 4 days after the fire (Figure 7), which implies that there is a need for a control of these contaminants in the areas that had been subjected to forest fires, in order to minimize the risks of environmental contamination and, as a consequence, the human exposure to these contaminants.

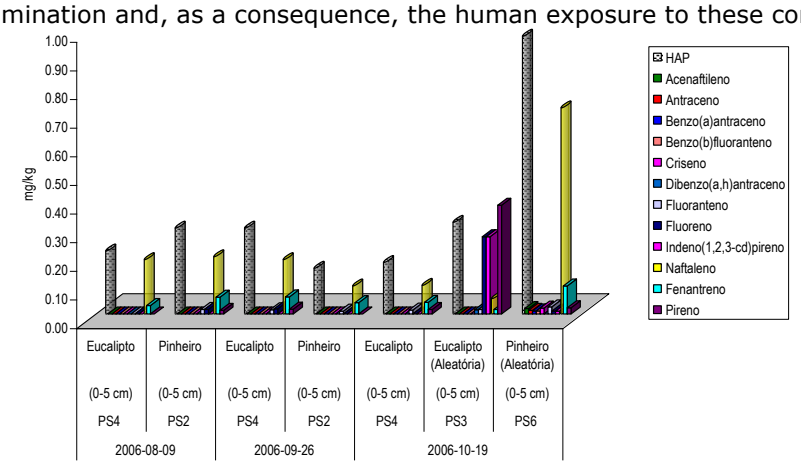

Figure 7 – Hydrocarbons concentrations in soils on the Penhascoso area, burned on 2006

As far as PAH concentrations on surface and groundwater samples are concerned, their values are below the detection thresholds (<0,37 ng/l), with the exception of water samples collected in the runoff test site (Figure 4), where the presence of acenaphtene (0,019 μg/l) and naphtalene (0,16μg/l) was found, in 19-10-2006, one month after the fire.

The occurrence of high levels of Mn were also confirmed in one water sample from direct runoff, collected in the de Zêzere river (Manteigas valley) basin, after the first strong rains following a fire in the summer of 2005. The causes for these high levels of Mn can be assigned to the burned vegetation, especially the leaves of the coniferous trees. Water collected in the Zêzere river 5 days later, has shown a lower concentration and, 7 days later, no Mn was found. The same water samples collected in Manteigas valley (Zêzere river) were also analysed for Dissolved Organic Carbon. For the same periods as for Mn, Dissolved Organic Carbon showed concentrations of 25,7 mg/l, 1,6 mg/l e <1 mg/l, respectively. The set of results shows that Carbon can be an important tracer, as far as water pollution related to forest fires is concerned.

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