AquaFire – Study of the impact of heat waves and forest fires on groundwater recharge and quality

Summary

The AquaFire project aims to investigate the impacts of the wildfire that occurred in October 2017 in the Leiria Pine Forest on the hydrological cycle and groundwater quality. Despite the catastrophic nature of the event, which affected approximately 86% of the forest, its impacts have never been evaluated. Given the magnitude and scale of the fire, the geological background, and the cultural and historical importance of the forest, this study has the potential to enhance groundwater management, improve climate resilience, and ensure water supply for the population.

This project is designed to accomplish the following tasks: 1) Determine the role of vegetation and soil characteristics on the infiltration patterns and unsaturated zone; 2) Evaluate the combined effect of the heatwaves and wildfires on soil erosion and groundwater recharge, and 3) Investigate the effect of groundwater recharge variability from before and after the wildfire and potential issues related to groundwater quality, as well as the risk for the population.

Tests were conducted to determine soil and hydraulic parameters, including particle density, permeability, and specific yield, in soil samples affected and unaffected by the wildfire. This analysis aims to understand how the presence of ashes influences infiltration patterns in the unsaturated zone (Figure 2a). Monthly field campaigns were conducted to collect groundwater level and physico-chemical parameters data. Groundwater samples, including major ions, minor ions, and isotopes, were collected and analysed to assess the chemical status of the aquifer (Figure 2b).

The groundwater chemistry data were processed and analysed to explore relationships between different ions, classify water samples accordingly, and understand the main processes affecting the water chemistry (Figure 3).

Three groundwater recharge estimation methods, including the soil-water balance, water level fluctuation method, and chloride mass balance, were employed to assess the impact of the wildfire on infiltration and, consequently, groundwater recharge (Figure 4).

Results indicate that groundwater recharge is significantly affected by wildfires in the initial years following the event. It increases by approximately 50% in the first year, 30% in the second, and 17% in the third year within the burnt area.

Predicting the hydrological impacts of wildfires is a complex process due to the challenges in isolating the effects of changes in land cover, soil properties, and climate variability. Despite the extensive study of wildfires' impacts on soil and surface water, there is limited knowledge regarding their consequences on groundwater.

Considering the growing concern about the impact of climate change on the frequency and intensity of wildfires and heatwaves in the Mediterranean region, coupled with the presented findings, this project aims to emphasize the importance of comprehending the effects of these events on groundwater to propose effective management and adaptation measures and guarantee future supply.

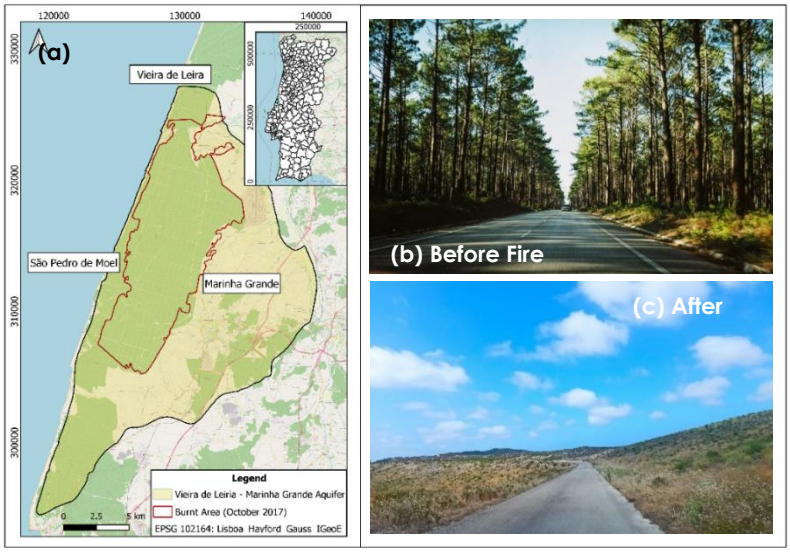

Figure 1. Leiria Pine Forest location map with the area burnt in 2017 limited in red; and pictures of the forest (b) before and (c) after the wildfire.

Project Reference

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Leading Institution

CERIS – Civil Engineering Research and Innovation for Sustainability (Portugal)

Partners

UPC – Universitat Politècnica da Catalunya (Spain), IDAEA – Institute of Environmental Assessment and Water Research (Spain), CSIC (Spain), Wageningen University & Research (the Netherlands)

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Funding

CERIS – Civil Engineering Research and Innovation for Sustainability

Period

2022

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7 000.00€

CERIS

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Project Website

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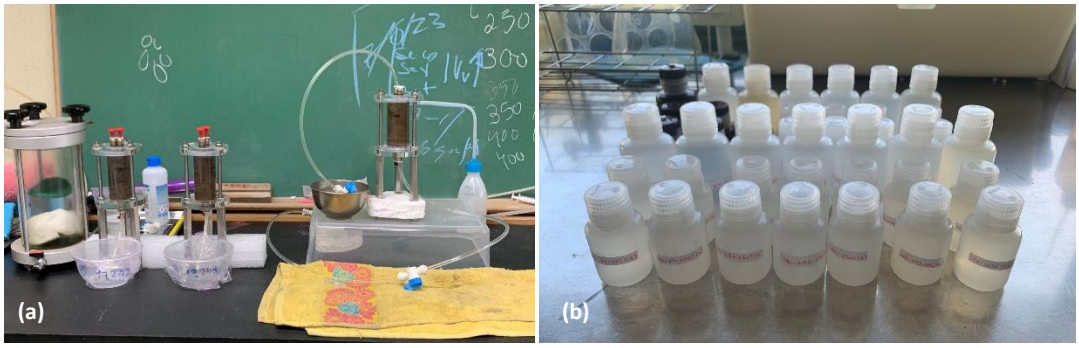

Figure 2 – (a) Permeability test set up; (b) Groundwater samples.

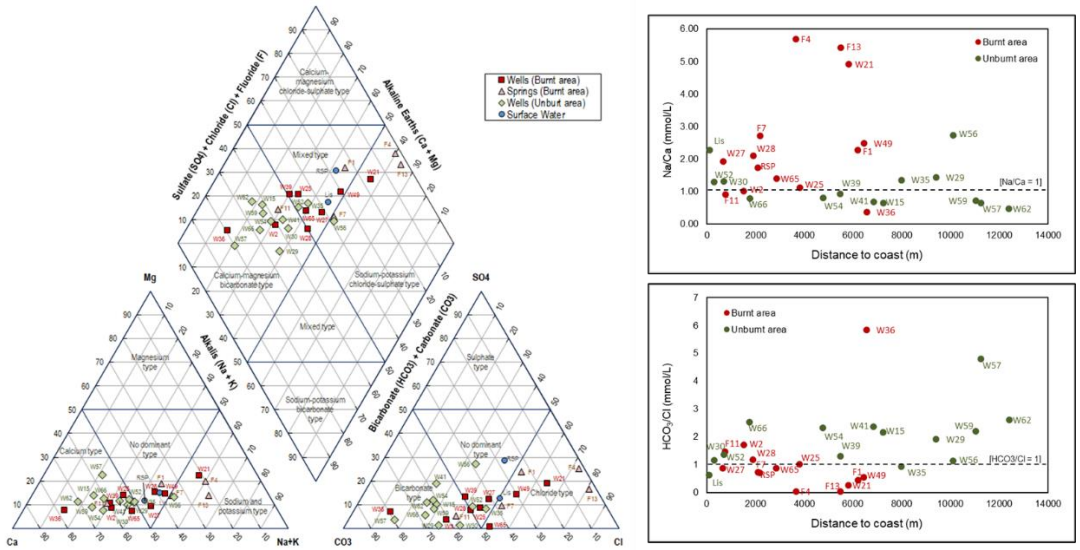

Figure 3 - Piper diagram with the composition of groundwater in the aquifer.

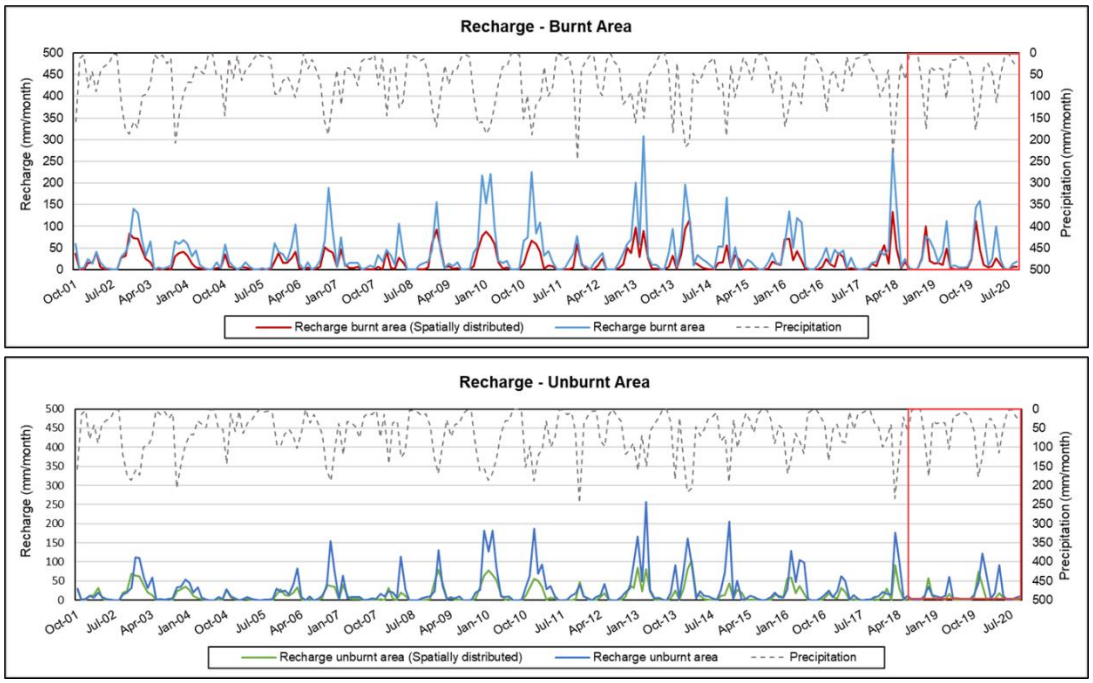

Figure 4 - Comparison between groundwater recharge estimation results in the burnt and unburnt areas of the Leiria Pine Forest using point and spatially distributed data.