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A lysimeter study of nutrient mobilization from wildfire and factory ashes by overland flow and soil leaching

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Wildfires are documented to affect physical, chemical and biological properties of topsoil. Besides through the direct heating-induced impacts, wildfires can also affect topsoil properties indirectly through the ash layer deposited on the soil surface immediately after fire. These indirect ash effects are less well understood, because of the marked dynamics in ash loads with time-since-fire due to mobilization by wind and water erosion. Therefore, we took advantage of a lysimeter study - a controlled experiment under field conditions - into the mobilization of ashes by overland flow, to address the ash impacts on topsoil nutrient contents. The lysimeter study involved a total of 15 lysimeters with a surface area of 50 cm by 120 cm and at a slope angle of approximately 10°. The lysimeters were equally and randomly distributed over five treatments. Four treatments involved the application of two types of ash at a rate of 500 g.m⁻² on a 2-3cm-thick layer of soil (in fact, sediments from the Mondego river), while the fifth, control treatment did not. One ash type consisted of black ashes collected in a 2020 burnt mature pine plantation in north-central Portugal, while the white ashes were obtained from a paper mill factory. In turn, two treatments per ash type involved the presence vs. absence of a 10cm-wide strip of 1cm-diameter PVC bars with a density of 1000 bars per m², mimicking a riparian vegetation zone and, assess its effectiveness to retain eroded ashes preventing them from entering streams. The lysimeter experiment ran for 7 weeks, starting on September 6 (ash application) and ending on 22 October 2021, covering the period that typically corresponds to the initial phase of the post-fire window-of-disturbance in the study region. At the end of the experiment, the upper 2cm of the soil were sampled at 3 locations within each lysimeter, in its middle and halfway its upper and lower halves. This was done after removing the remaining ashes on the soil surface. All soil samples were analysed for their contents of available Phosphorus (P_{av}) and total Nitrogen (TN) but, at this moment, only the P_{av} analyses have been concluded. The preliminary P_{av} results revealed a much smaller enrichment by the black than white ashes. The median P_{av} contents were 4.6 microgram per gram of soil for the control lysimeters as opposed to 5.6 and 9.2 microgram per gram of soil for the lysimeters with black and white ashes, respectively. This difference in enrichment could be linked to the differences in P_{av} content of the two ash types, being 1.9 and 1.0 microgram per gram of the white and black ash, respectively. Furthermore, the P_{av} enrichment was not affected by the presence/absence of the simulated riparian zone at the bottom of the lysimeters, as the

differences in Pav contents of the lysimeters with and without these zones amounted to 0.1 microgram Pav per gram of soil in the case of both the black and the white ashes.