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Mercury mobilisation from soils and ashes after a wildfire and rainfall events: effects of vegetation type and fire severity

Isabel Campos (1,2), Nelson Abrantes (1), Jan Jacob Keizer (1), Carlos Vale (2,3), Dalila Serpa (1), Patrícia Pereira (2,4)

(1) CESAM (Centre for Environmental and Marine Studies), Department of Environment, University of Aveiro, Aveiro, Portugal (isabel.ncampos@gmail.com), (2) IPMA (Portuguese Institute for the Sea and Atmosphere), Lisbon, Portugal., (3) CIIMAR (Interdisciplinary Centre of Marine and Environmental Research), University of Oporto, Oporto, Portugal., (4) CESAM (Centre for Environmental and Marine Studies), Department of Biology, University of Aveiro, Aveiro, Portugal

Wildfire is a major disturbance of forests worldwide, with huge environmental impacts. The number of catastrophic wildfires is increasing over the past few decades mainly due to a combined effect of climate change and poor land-use management. Interestingly, wildfires have an important role in contaminants production and mobilization and, thus, on their biogeochemical cycles. For instance, trace elements could be mobilized during a wildfire from burnt vegetation and ashes and may eventually achieve the aquatic systems upon a rainfall period. In this regard, wildfires represent a relevant diffuse source of trace elements to aquatic systems that has, so far, been poorly investigated. The current study aims to mitigate such lack of knowledge for mercury, a well-recognized persistent toxicant with potential harmful impacts on the environment and on human health. Thus, a field study was conducted in two Portuguese forests (Ermida and S. Pedro do Sul, North-centre of Portugal) with distinct fire severity. Fire was classified as moderate in Ermida and moderate to high severity in S. Pedro do Sul. In Ermida, soil samples and ashes were collected in the seven hillslopes (three burnt eucalypt, three burnt pine and one unburnt eucalypt) immediately and 4 months after the fire, the latter following an episode of intense rainfall. In S. Pedro do Sul, sampling took place immediately after the fire in four hillslopes (one burnt eucalypt and three burnt pine). Mercury analysis was performed in an Hg analyser in which samples were thermally decomposed by controlled heating. The final decomposition products were passed through an Hg amalgamator heated to 700 ºC and Hg(0) was released and detected by absorption spectrometry at 254 nm. Burnt soil samples showed significantly lower levels of mercury than non-burnt soil, confirming the potential of a forest fire to release accumulated mercury in soil prior to the burning. Such process could be particularly relevant for this element due to its low volatilization temperatures. Both burnt eucalypt slopes and the respective ashes showed significantly higher levels of mercury than burnt soils and ashes collected in the burnt areas covered by pine. This result suggest that eucalypt accumulate higher levels of Hg and that its burning could contribute in a higher extent to mercury mobilization than pine. Moreover, burnt soils and ashes produced during a fire with moderate severity had higher levels of mercury than similar samples collected upon a high severity wildfire, pointing out the relevance of the fire severity on mercury mobilization. The first rainfall after the wildfires caused an accentuated reduction of mercury levels in ashes (30-60%) related with a washing out process. Consequently, the produced runoff after these rainfall events can probably introduce mercury in the adjacent terrestrial areas or eventually in the water systems located in the vicinity of a wildfire area. Our results highlight that wildfires and subsequent rainfall play a key role in the mobilisation of mercury in the environment and point out the importance of further studies to assess the impact of Hg in aquatic systems downstream to burnt areas.