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Tackling post-fire impacts and their mitigation by modelling hydrological processes at different scales in Portugal

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As in any other Mediterranean region, wildfires highly affect Portuguese forests leading to substantial economic and ecological losses. Wildfires are also an important cause for the degradation of forest ecosystem services, which are responsible for the maintenance of water quality, flooding and soil erosion control. Considering that wildfire frequency is expected to increase in the future due to changes in climate and socio-economic drivers, future land degradation caused by wildfires is considered with great concern.

To tackle the impacts of wildfires on the affected ecosystems such as soil erosion is highly recommendable the use of adequate post-fire management practices for its mitigation. However, the dimension of the area affected by the 2017 wildfires in Portugal (500 thousand ha) showed the impossibility to effectively treat a nation-wide burned area for erosion control. Given this context, hydrological modelling arises as a key-tool for post-fire land management decision making, by identifying potential on-and-off-site post-fire impacts, and by allowing the selection of target areas with a higher soil erosion risk for the implementation of mitigation treatments.

To address this problem, the ESP team - under the FEMME project - defined the strategy of using soil erosion models at hillslope scale to address on-site impacts at the national level and catchment scale models to address off-site impacts. A national soil erosion risk map in case of a wildfire will help land managers to choose the priority areas for the implementation of emergency stabilization measures. While continuous and event-based hydrological models, will allow assessing the risks of water quality degradation and the occurrence of extreme hydrological events, which can impact downstream values-at-risk.

To understand if the chosen model approach is adequate to the problem in hand since it resulted in outputs with distinct spatial and temporal scales, we have decided to perform an evaluation focused on scales and model adaptations to burned areas. We were able to conclude that simple empirical models such as the Morgan-Morgan-Finney [1], which can provide predictions at hillslope and seasonal-to-annual scale, are well adapted to post-fire conditions and are useful to identify high risk areas for the implementation of mitigation treatments. On the other side, their simplicity does not allow to determine the risk of flooding or water bodies contamination, outside the burned area, and under specific rainfall events which implies a daily or sub-daily time-steps. For that purpose, spatially-explicit process-based such as SWAT [2] or LISEM [3] can provide a

more detailed feedback, although there have been few model adaptations to burned conditions at this scale, especially considering the implementation of post-fire mitigation measures.

[1] Morgan, R., 2001. A simple approach to soil loss prediction: a revised Morgan–Morgan–Finney model. *Catena* 44 (4): 305–322. [https://doi.org/10.1016/S0341-8162\(00\)00171-5](https://doi.org/10.1016/S0341-8162(00)00171-5)

[2] Arnold, J.G., Fohrer, N., 2005. SWAT2000: Current capabilities and research opportunities in applied watershed modelling. *Hydrol. Process.* 19, 563–572. <https://doi.org/10.1002/hyp.5611>

[3] De Roo APJ, Wesseling CG, Ritsema CJ (1996) LISEM: a single-event physically based hydrological and soil erosion model for drainage basins. I: theory, input and output. *Hydrological processes* 10, 1107–1117.