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Assessing SWAT and CE-QUAL-W2 feasibility to simulate post-fire watershed processes and reservoir water quality

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In recent decades forest fires have taken on a new form, becoming increasingly destructive. The latest catastrophic fires occurred on Portuguese territory in 2017 have forced governmental institutions to take rapid decisions to minimize the impact of those events on the environment. The use of models to support those decisions is a way to improve management solutions and to reduce the damage caused by fires.

This study focuses on the effects of 2017 forest fires, on the water quality of Rio Zêzere watershed and the downstream reservoir of Castelo de Bode. The Zêzere watershed has a draining area of approximately 3489.86 km2, with an elevation ranging from 105 to 1970 m. The Castelo de Bode reservoir, with a total capacity of 1095 hm3, supplies Lisbon and the surrounding areas (approximately 2,000,000 inhabitants). During 2017, more than one hundred thousand hectares of land (50% of its area) in the watershed burned, making it one of the most affected areas in Portugal.

The Soil Water Assessment Tool (SWAT) was first calibrated/validated for simulating streamflow and sediment and nutrient transport in the watershed during 1986-2000. Afterwards, SWAT model outputs were used as boundary conditions for the application of CE-QUAL-W2 model, capable of simulating the movements of the water quality components (nutrients, chlorophyll, and dissolved oxygen, within the reservoir. The calibration and validation of the models confirmed the validity of their complementary use, and the possibility to simulate the effects of fires in the watershed and its impacts on the water quality of the reservoir. Changes in the land use (curve number, crop vegetation management factor) and soil properties (soil erodibility) were considered by taking into account the different scale of the fire events (low, medium, and high severity).

Simulations showed a significant increase in runoff and sediment concentration at the sub-basin level in the year following the 2017 fire events, with high concentrations of nutrients characterizing the reservoir inlet, leading to the increase of both nutrients and chlorophyll concentrations. Nonetheless, these concentrations never overcome the thresholds limits foreseen in legislation for drinking water, likely due to the large volume of the reservoir which diluted the inflow concentrations.