Hydrological impacts of wildfires at a global scale

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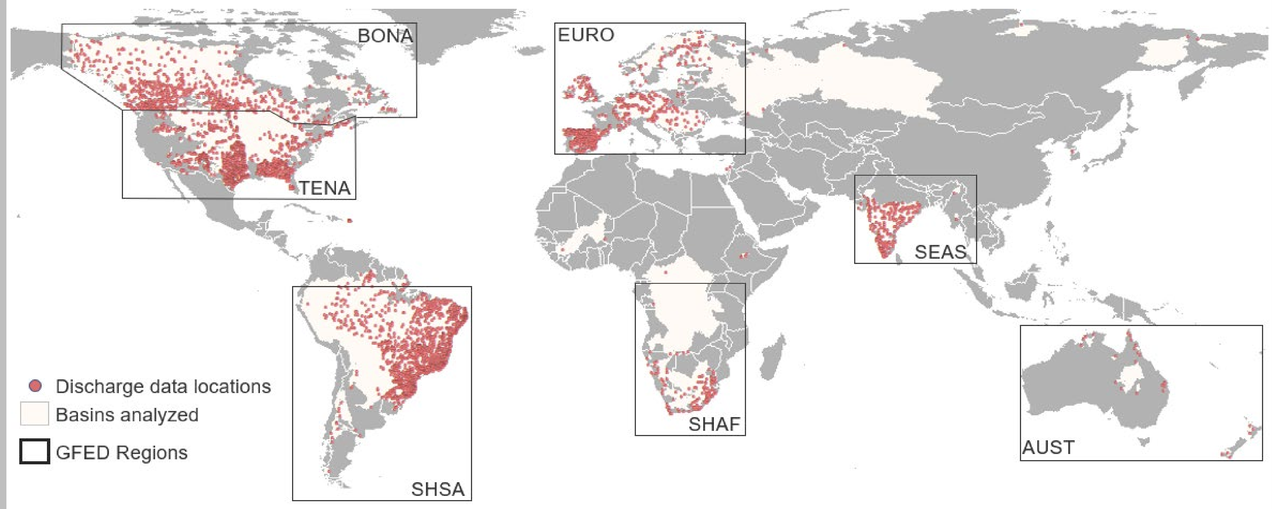
Abstract

Wildfires can affect the hydrological regime of a watershed by increasing soil imperviousness, increase in the surface runoff speeds and the probability of debris flows. Such wildfires effects the amount of river flow can be quantified as changes in runoff coefficient. Here we attempt an analysis at a global scale.



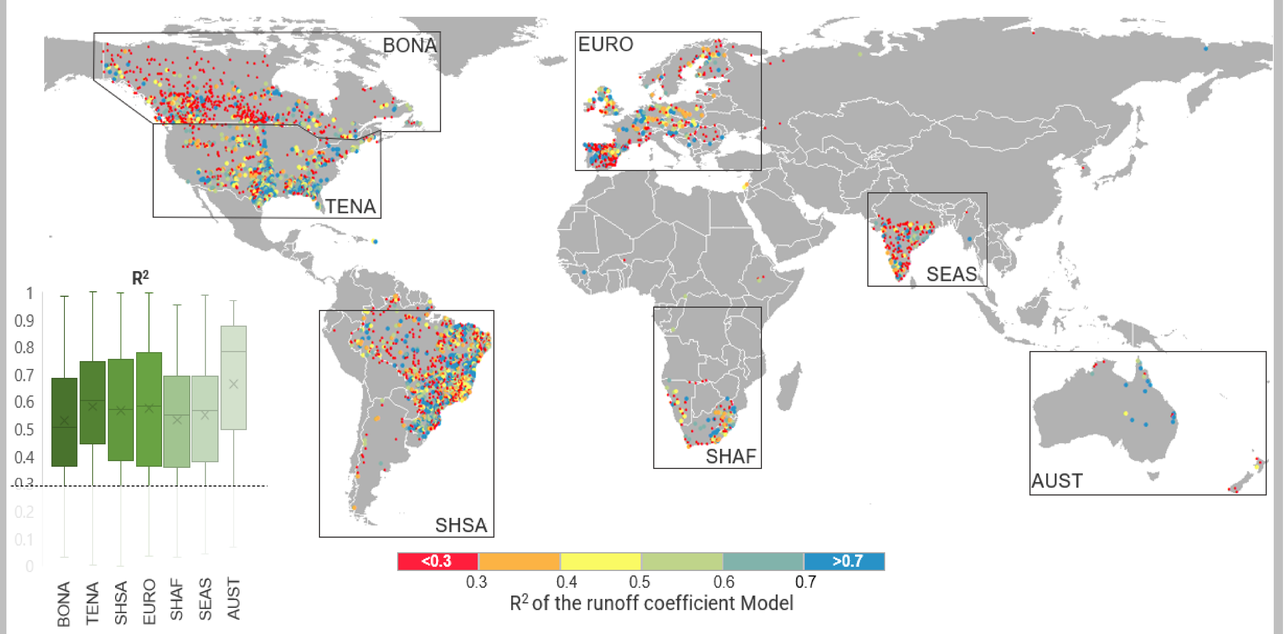
River discharge locations with at least 10 years of available data between 2001 – 2018 and non-zero MODIS forest burned area.

Methodology applied for each watershed: Make a regression model to predict the runoff coefficient for years before a wildfire.

$$\text{Runoff Coefficient} = \frac{\text{Runoff volume (m}^3\text{ per water year*)}}{\text{Precipitation volume (m}^3\text{ per water year)}}$$

We set a multiple linear regression model to predict the runoff coefficient for years **before a wildfire**.

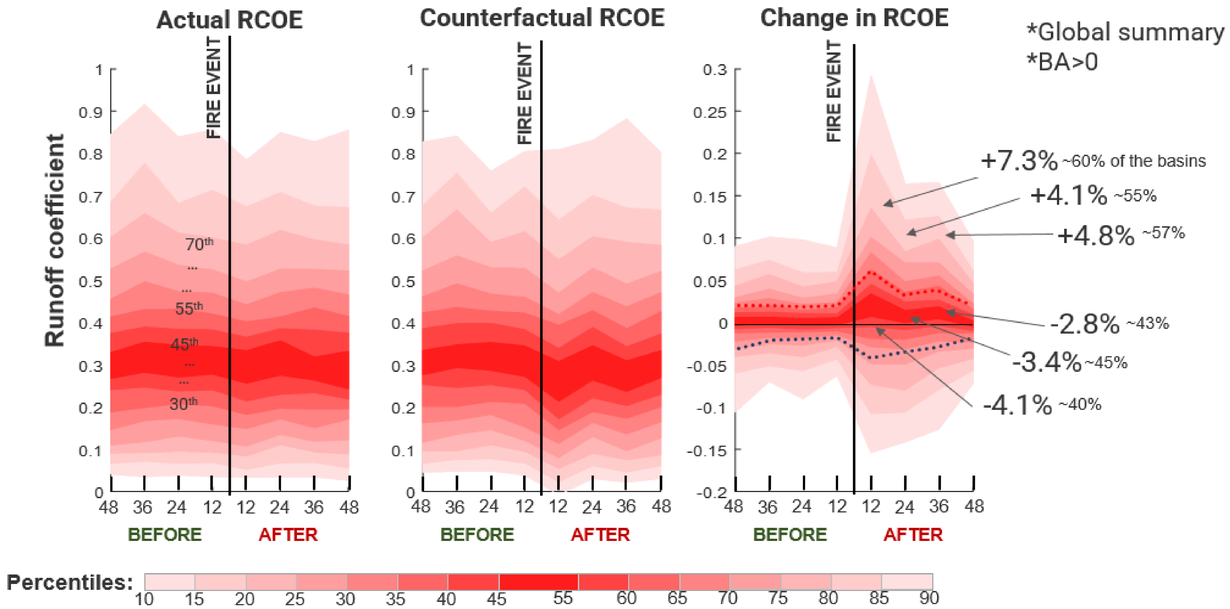
$$\textit{Runoff Coeff} = f(PRECIPITATION, TEMPERATURE, PET)$$



Then, we use the regression model to estimate the runoff coefficient for burn years, as Counterfactual Runoff coefficient.

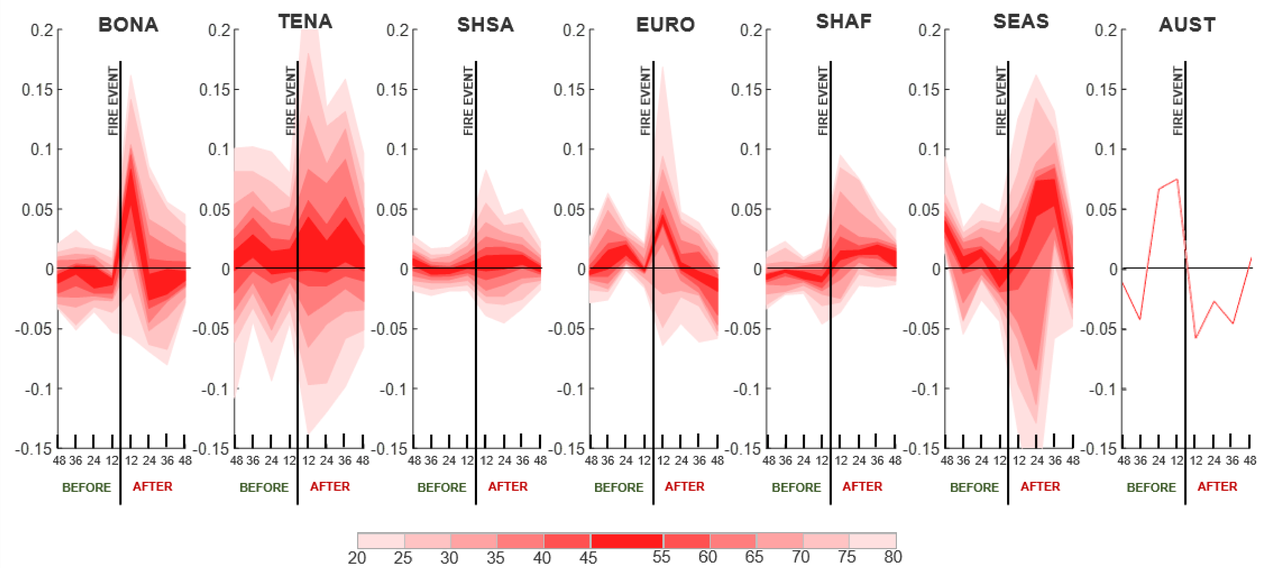
$$f(PR, TEMP, PET) \rightarrow \textit{Runoff Coeff}$$

Finally, we compare the Counterfactual runoff coefficient to the Factual runoff coefficient.



Runoff coefficient estimated from (a) the actual data, (b) the model and (c) the difference of a and b

We observe that approximately 60% of the watersheds at a global scale, exhibit a +7.3% of increase in the runoff coefficient for the hydrological year that follows the wildfire.



Furthermore, regional results show a different response for different pyro-regions. Indicatively, the Boreal North America and Europe show increased runoff coefficient for the year after the wildfire, while the Temperate North America a milder but more persistent increase for more years beyond. South Hemisphere south America and Africa regions show a milder increase but less variability among the results of different watersheds. Finally, Southeast Asia show increase the second year after the event which needs more analysis.

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