Geophysical Research Abstracts
Vol. 19, EGU2017-9080, 2017
EGU General Assembly 2017

A global assessment of wildfire risks to human and environmental water security

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Extreme wildfire events extensively affect hydrosystem stability and generate an important threat to the reliability of the water supply for human and natural communities. While actively studied at the watershed scale, the development of a global vision of wildfire risk to water security has only been undertaken recently, pointing at potential water security concerns in an era of global changes. In order to address this concern, we propose a global-scale analysis of the wildfire risk to surface water supplies based on the Driving forces-Pressures-States-Impacts-Responses (DPSIR) framework. This framework relies on the cause-and-effect relationships existing between the five categories of the DPSIR chain. Based on the literature, we gathered an extensive set of spatial indicators relevant to fire-induced hydrological hazards and water consumption patterns by human and natural communities. Each indicator was assigned a DPSIR category. Then, we collapsed the information in each category using a principal component analysis in order to extract the most relevant pixel-based information provided by each spatial indicator. Finally, we compiled our five categories using an additive indexation process to produce a spatially-explicit index of the wildfire-water risk (WWR). For comparison purposes, we aggregated index scores by global hydrological regions, or hydrobelts, for analysis. Overall, our results show a distinct pattern of medium-to-high risk levels in areas where sizeable wildfire activity, water resources, and water consumption are concomitant, which mainly encompasses temperate and sub-tropical zones. A closer look at hydrobelts reveals differences in the factors driving the risk, with fire activity being the primary factor of risk in the circumboreal forest, and freshwater resource density being prevalent in tropical areas. We also identified major urban areas across the world whose source waters should be protected from extreme fire events, particularly when they are dependent on mountainous headwaters. This study offers new insights towards a better understanding of global water security issues that can inform and help guide international water governance.