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Evaluating drought risk in data scarce tropical catchments

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Droughts are causing severe damages to water abundant tropical countries worldwide. Their resilience to water shortages tends to be low, which often can be attributed to a lack of water related infrastructure. What is more, drought characteristics and the spatial distribution of drought risk in tropical catchments are poorly understood, which makes it difficult to select adequate adaptation measures. Thus, reliable methodologies to evaluate spatial and seasonal drought risk in data scarce tropical catchments are urgently needed.

We combined drought hazard and vulnerability related information to assess drought risk in three rural tropical test catchments, the Muriaé in southeast Brazil, the Tempisque in Costa Rica and a headwater catchment of the Magdalena basin, Colombia. Meteorological drought hazard was assessed by applying a threshold of 5 days <= 0.3 mm rainfall to Chirps v2.0 data (best performing satellite based rainfall product in all test catchments). The spatial distribution of drought susceptibility of vegetation was evaluated by applying a Vegetation Condition Index (VCI) to 16 days composite NDVI images (MODIS data MOD13Q13) and looking at the driest month in records (July 2015, SPI12). To assess hydrological drought hazard, we applied a threshold of 5 days <= daily variable Q95 to observed discharge data if available and the ISIMIP 2a dataset downscaled by Hydrostreamer (https://github.com/mkkallio/hydrostreamer). For the Muriae, we used 93 simulated subcatchment discharges (SWAT2012) to obtain an adequate spatial distribution. Combining the three Hazard values, we defined the cumulative frequency of drought occurrence for each grid cell (0.1°).

To assess vulnerability, we reclassified and weighted globally and regionally available gridded socioeconomic data (crop and livestock density, population, GDP, proximity to infrastructure) to represent the potential of a drought to cause damages in selected socioeconomic sectors.

For the Muriae, the drought risk map clearly identified the downstream area as being exposed to a stronger drought risk compared to the upstream areas. This can be attributed to a high vulnerability as well as a higher hydrological and vegetation based hazard. For the Tempisque basin, also the downstream and coastal part turned out to be most at risk due to higher population rates, intensive agriculture and a strong meteorological and hydrological hazard.

Results were partly validated by evaluating local socioeconomic data, media reports and stakeholder communication. However, further independent information is needed to validate the final risk maps and test them against stakeholder perception. The presented risk assessment methodology for data scarce and rural tropical areas offers a holistic, science based and innovative solution to provide relevant drought related information. Once validated, it will make a valuable contribution to regional planning by water management institutions dealing with the control of future drought disasters in tropical rural areas.