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The role of droughts for electricity security in the Magdalena Basin, Colombia

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The role of hydropower in addressing energy security is increasingly relevant, especially regarding its potential for reducing greenhouse gases in the energy sector. However, the increasing drought risk worldwide has become a serious threat for countries like Colombia, where 70% of the electricity supply depends on hydropower. Such cases are leading to an urgent research demand for approaches to assess drought hazard and the relationships between droughts and electricity generation. We used a water-energy nexus (WEN) framework to evaluate linkages between electricity security and drought occurrence and applied it to the Magdalena Basin, Colombia (275,000 km2), and the departments of Tolima and Antioquia within this basin.

Based on the publicly available hydro-climatic record and hydropower data, aggregated indices were developed to assess electricity security and drought anomalies for the period from 2006 to 2016. Standardized drought indices to evaluate anomalies related to water level, discharge and precipitation, consecutive days without rain were combined to assess drought risk in the three regions. Electricity security was evaluated by looking at factors related to availability, accessibility, acceptability and affordability.

Index results, their relationships and the individual components of drought and electricity security were evaluated. The indices were able to display major and smaller drought events as well as energy security in the study regions. We found that droughts play a major role for energy security and a more diverse energy mix including wind and solar technologies would be required to enhance energy security. Our results also suggest that smaller hydropower projects are more efficient in improving energy security compared to larger ones. Furthermore, we found that new hydropower projects had negative effects on affordability due to increasing electricity prices. We think that the methodology developed in this study is a valuable tool to evaluate the interlinkages between droughts and energy security accounting for temporal and spatial dynamics.