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Hydroclimatic extremes regulation by mangroves in a highly vulnerable small Caribbean Island

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The archipelago of San Andrés, Providencia and Santa Catalina (SAI), southwestern Caribbean islands (Colombia), declared as a Biosphere Reserve by the UNESCO, is highly vulnerable to tropical storms, meteorological tides, coastal flooding and the effects of sea level rise, which are substantially increasing in a context of climate change. In 2020, for the first time in the Colombian history, a hurricane reached category 5 on its territory, destroying the island of Providencia and damaging San Andrés Island. However, historical and future hydroclimatic events trends along with potential mitigation effects of nature-based solutions with mangroves are still very little known and studied in this part of the Caribbean Sea.

Our study analyzes historical (1960s-2020) and future (2050, across low and high mitigation IPCC scenarios) trends in duration, frequency and intensity of extreme rainfall, wind, floods, hurricanes and tropical storms, and discusses their relationship with the regulation ecosystem services in terms of regulation of erosion, flood control and protection against storms, provided by the SAI mangrove forest ecosystems. Using the InVEST Coastal Vulnerability model with new in-situ data for this specific region, we estimate the vulnerability of the Archipelago (in terms of affected inhabitants, damaged houses, loss of property value) to extreme climate without, with current and with maximal mangrove area.

Our work highlights the urgent need to restore and expand the mangrove forest areas in the Archipelago as a measure of both mitigation and adaptation to climate change and extreme weather events. Investments in reducing the vulnerability of the island's inhabitants to the harmful effects of climate change must combine several strategies (climate mitigation, nature-based solutions, waste management, territorial planning, etc.) to reduce environmental damage, economic and social aspects of one of the largest marine protected areas on Earth.