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Field Data Collection to Support the Numerical Modelling of Mangrove Contributions to Compound Flood Mitigation

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Small Island Developing States (SIDS) experience disproportionate vulnerability to natural and climate related hazards driven by geographic constraints, demographic trends, limited economic diversification and growing development pressures. In the Caribbean, flooding is one of the region's most devastating and recurrent hazards, contributing to substantial socio-economic losses. Despite frequent events, many SIDS lack the long-term datasets needed to characterize flood behavior, particularly for coastal compound flooding, involving the interaction of multiple drivers such as storm surge, waves, tides, precipitation, runoff and river discharge. Climate change, including sea level rise, is expected to alter these processes and increase uncertainty in both magnitude and frequency.

Coastal ecosystems such as mangrove forests are increasingly recognized for their potential as Nature-based Coastal Solutions (NBCS), offering coastal protection alongside social, environmental and economic co-benefits. However, key gaps remain, including limited understanding of their flood mitigative properties across varying hydrodynamic conditions and stages of ecosystem maturity and health. Although numerical models are widely used to assess flood hazards, their ability to represent multiple interacting drivers and incorporate NBCS remains limited, a challenge that is particularly pronounced in data-sparse regions. Addressing these limitations requires field data to develop numerical models.

The relevance of these challenges becomes particularly clear in Trinidad's South Oropouche River Basin (SORB), a low lying and highly flood prone watershed on the southwest coast that includes mangrove areas within the Godineau Swamp. This study therefore centers on collecting the necessary datasets and integrating them into the numerical modelling needed to characterize compound flooding in this basin. Field monitoring in SORB includes weather stations, water level loggers, short-term ADCP deployments, and a paired camera and water level logger system designed to capture flood depth and extent at a high resolution. Additional measurements including water quality parameters and vegetation characteristics from field surveys and satellite imagery, will support the mangrove related parameterization.

The modelling will be forced primarily using open-source datasets, with field observations used to assess their performance and suitability. Comparison of radar rainfall with in-situ measurements will enable the development of a bias-corrected relationship, allowing long-term radar datasets to

be translated into site-specific rainfall inputs for compound flood modelling. These observations will be supplemented by historical datasets, including river discharge, Intensity–Duration–Frequency (IDF) curves, bathymetry and land cover. Thus, the numerical model will simulate the key hydrodynamic processes driving compound flooding while mangrove influences will be represented using vegetation-drag formulations to capture momentum dissipation and associated reductions in inundation. Field observations will be used to calibrate and validate the model, enabling spatial estimates of flood depth and extent under different forcing scenarios.

Field monitoring in SORB is expected to provide new insights into how flood drivers interact to generate inundation, as well as emerging trends and patterns, while deterministic modelling will quantify the degree to which mangroves mitigate flooding. Together, the data-collection and modelling approaches offer a practical means of improving compound flood assessment in regions with limited long-term observations and support a more holistic evaluation of NBCS for SIDS.