H31Q-1711: Hydrologic and Hydraulic Modeling of Coastal Watersheds at an Island-Scale

UNIVERSITY OF GEORGIA
Compound Inundation Team for Resilient Applications

Orlando M. Viloria-Marimón and Félix L. Santiago-Collazo
School of Environmental, Civil, Agricultural and Mechanical Engineering
University of Georgia, Athens, GA
AGU 2023: December 13th, 2023; Contact: Orlando.Viloria@uga.edu

CARICOOS
Latin American and Caribbean Studies Institute
Franklin College of Arts and Sciences
UNIVERSITY OF GEORGIA

Introduction

- The Caribbean Islands are one of the main paths for tropical cyclones (TC) within the Atlantic Ocean basin.
- There is a need to enhance flood forecasting by employing modeling techniques that support risk-mitigation solutions to TC.
- Current modeling techniques require extensive data and computational resources to simulate several storm events, especially at an island scale.

Fig. 1. Destruction over Puerto Rico (PR) during Hurricane Maria (Credit: National Weather Service- San Juan)

Study Area

- Catchment Area = 8,690 km^2
- Average annual precipitation = 1,690 mm
  700 mm in the southwest & 4,600 mm in the northeast
- Simulated area = 68% of Puerto Rico's total area

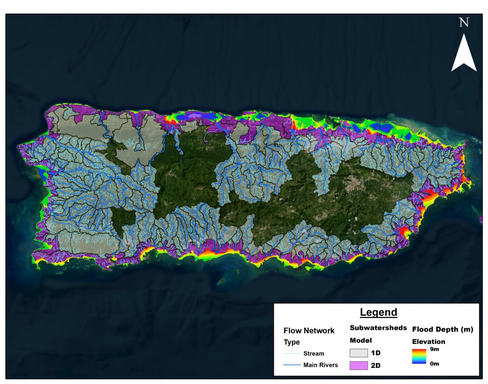

Fig. 2 . Storm Surge map for hurricane category V and Watersheds throughout PR (Source: caricoos.org and PR Planning Board)

Methods

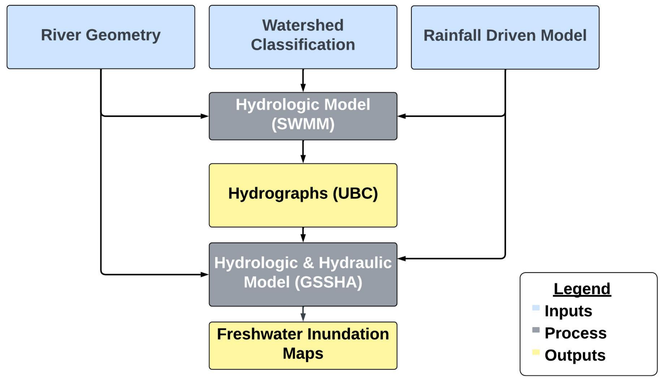

Fig. 3. Research methodology flowchart

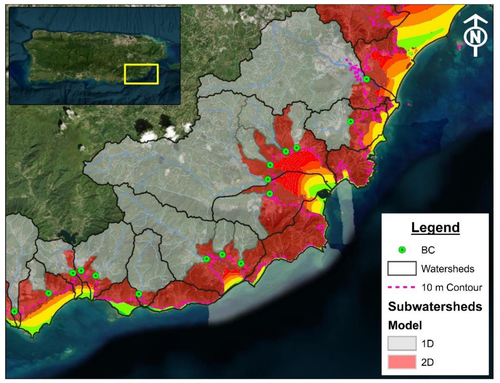

Fig. 4. Watershed classification

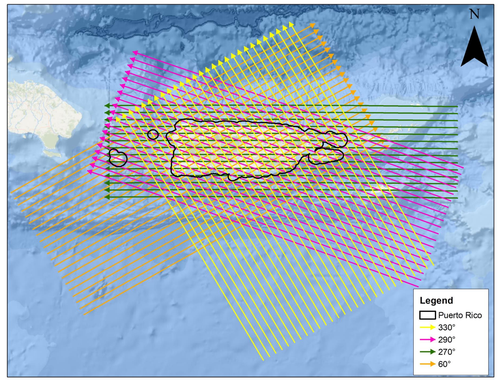

Fig. 5. Collection of tracks

By Homogeneous Regions

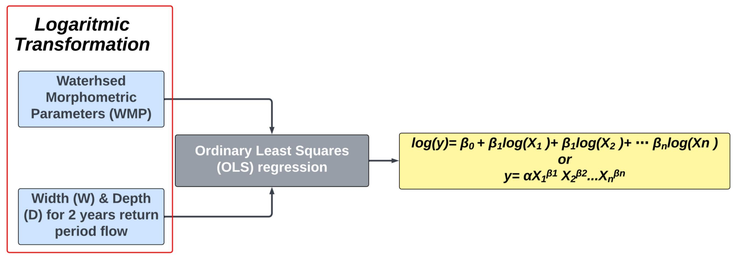

Fig. 6. River geometry definition

Where:

- y is the W or D
- X_{i-n} is the WMPs
- β_0 is the intercept
- β_{i-n} is the slope of the relationship between X_{i-n} and y
- $\alpha = \log(\beta_0)$.

Some of the WMPs considered were:

- Stream length (Lu)
- Basin slope (Bslp)
- Form Factor (Ff)
- Elongation Ration (Re)
- Circularity Ration (Rc)

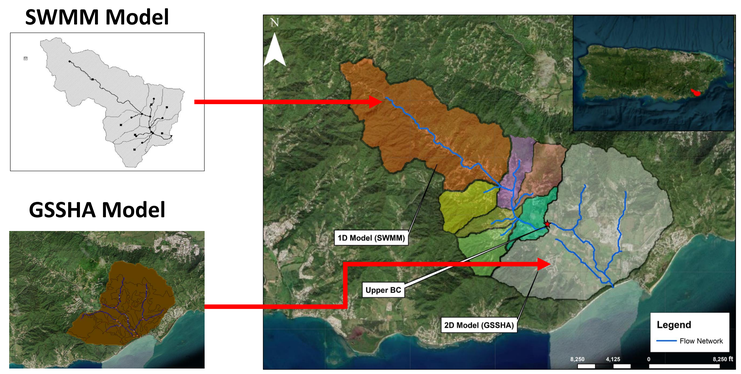

Fig. 7. Proposed approach for the H&H model

Preliminary Results

Equations for the southwest region

$$D = \frac{{L_u}^{0.65} {R_e}^{33.12}}{10^{1.11} Bslp^{0.63} {F_f}^{14.66}}$$

$$W = \frac{1}{10^{1.79} P^{10.7} {R_c}^{4.23} {R_e}^{42} {F_f}^{23.15}}$$

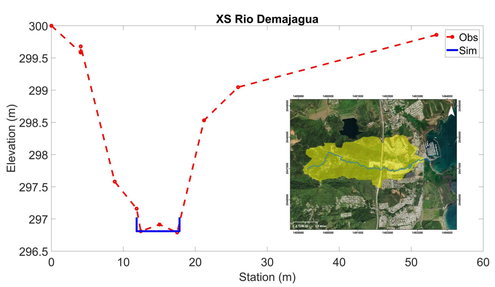

Fig. 8. Demajagua River results from regression equations

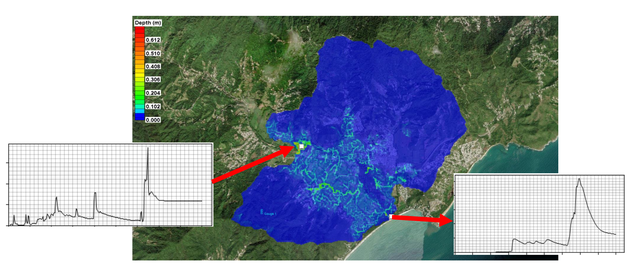

Fig. 9. Pilot watershed: Maunabo River

Future Works

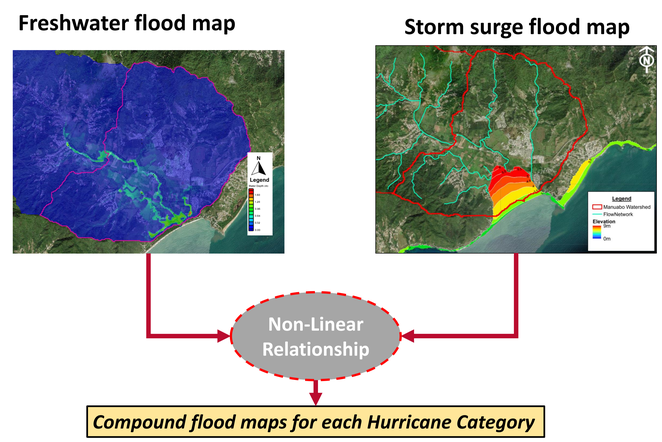

Fig. 10. Proposed approach for compound flood map generation

Conclusions

- Partitioning the analysis area into watersheds with homogeneous characteristics facilitates the derivation of equations that more accurately capture the geometric features of the stream.
- Constructing a hybrid model that combines elements of both semi-distributed and fully distributed architectures enables saving computational resources while concurrently fostering the development of more efficient models.