Floodwater Depth Estimation Tool - Coastal Version (FwDET-C)

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Background

- Information on flood inundation extent is important for understanding societal exposure, water storage volumes, flood wave attenuation, future flood hazard, and other variables.
- Satellite Remote Sensing analysis is useful for providing large-scale maps if flood inundation but cannot be readily used to map floodwater depth over large areas.
- Hydraulic models are commonly used to simulate water dynamics but these are data and computationally expensive.
- The Floodwater Depth Estimation Tool (FwDET; Cohen et al., 2017) generate floodwater depth maps based solely on inundation extent layer and a DEM.
- FwDET low data need and high computational efficiency are desirable for near-real-time and large-scale applications.
- A coastal flooding version of the FwDET (FwDET-C) is presented here which deals with the open-boundary condition of the waterbody and the need for hyper-resolution DEMs.

FwDET

- Water depth at each location within the flooded domain is calculated based on its elevation (amsl) relative to its nearest flood-boundary elevation, as demonstrated in this cross section:

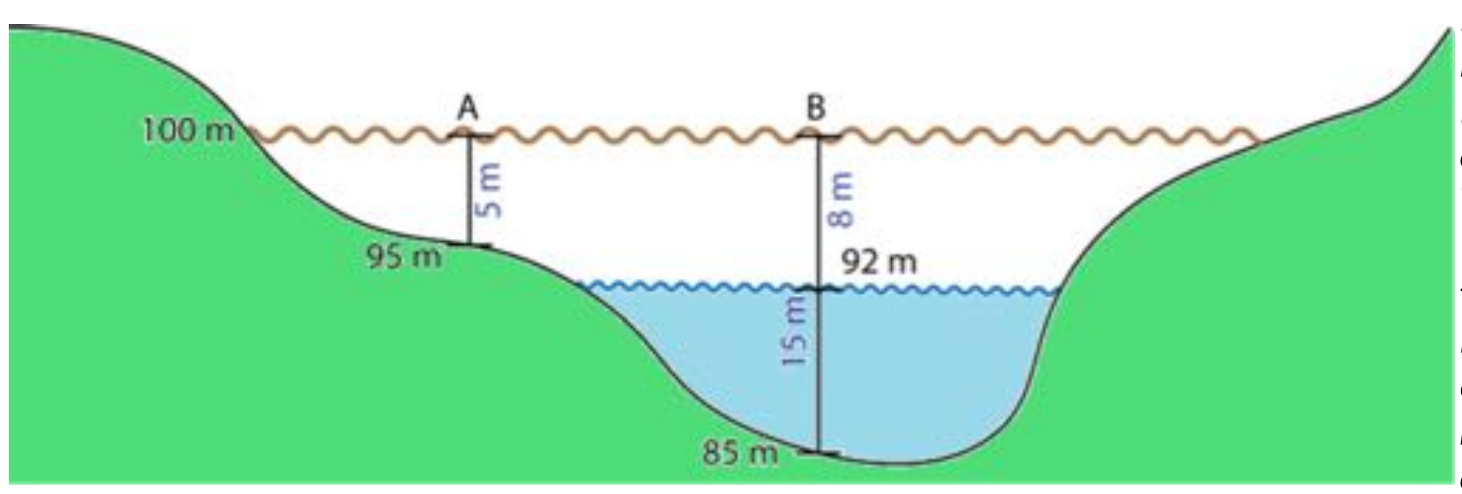
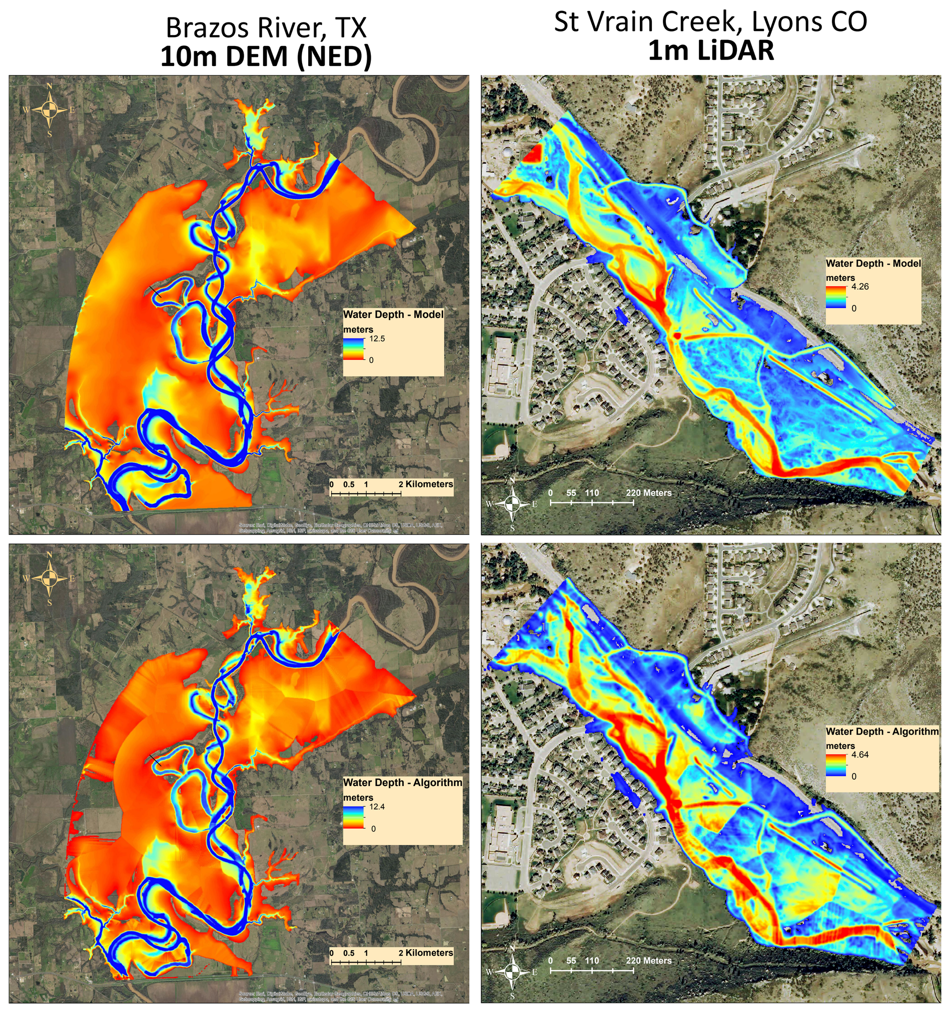


Figure 1: Theoretical ***Floodplain*** *cross section Illustrating the floodwater depth estimation approach. The blue line represents "within banks" water level, and the brown line represents flood level. Horizontal numbers are elevation (amsl) and vertical numbers are calculated water depths.*

- FwDET expend this concept in 2D by:
  1. Identifying boundary grid-cells
  2. Extract their elevation from a DEM
  3. Assign the Boundary Cells Elevation (BCE) to their nearest grid-cells within the flood domain
  4. Calculate water depth by subtracting the nearest BCE by the DEM
- FwDET automate this using Python script utilizing the **ArcGIS ArcPy** library of tools (available on the CSDMS Model Repository).

- Water depth estimations by FwDET were compared to simulated depth with a hydraulic model (iRIC; USGS) for two flood events:



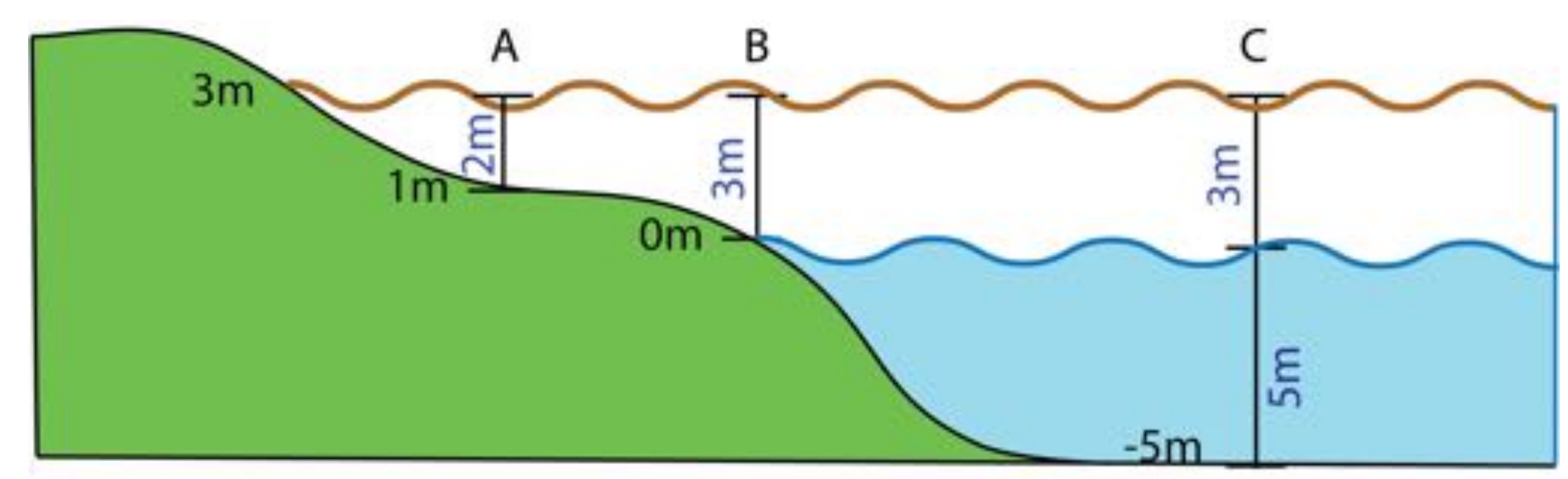
Correspondence between FwDET and simulated water depths was strong with nearly identical max value and a Root Mean Square Difference (RMSD; the average absolute difference between all cells) of 0.38 and 0.37 m for the Lyons and *St Vrain* respectively.

Figure 2: Comparison between FwDET (bottom) and hydraulic model (top) water depth maps for two flood events: Brazos River TX, using 10m DEM and St Vrain Creek CO, using 1m DEM. The flood inundation extent used in FwDET are based on the model's output, not remote sensing (to isolate water depth calculation in the comparison).

FwDET-C

- Coastal flood maps include boundary cells at the coastline or seaward (elevation = 0m amsl; points B and C). These cells cannot be used for depth calculation as they do not represent the flood elevation:

Figure 3: Theoretical ***Coastal*** *cross section Illustrating the floodwater depth estimation approach.*



- FwDET-C include an automated procedure for removing boundary cells at the coastline.
- Low topographic gradient in coastal region mandate the use of hyper-resolution DEMs.
- FwDET-C was programed using **Open-Source QGIS Python** tools which allowed for considerable improvement in its computational efficiency.

- FwDET-C is currently compared to simulated depth with a hydraulic model for flood events in Mid-Atlantic coast:

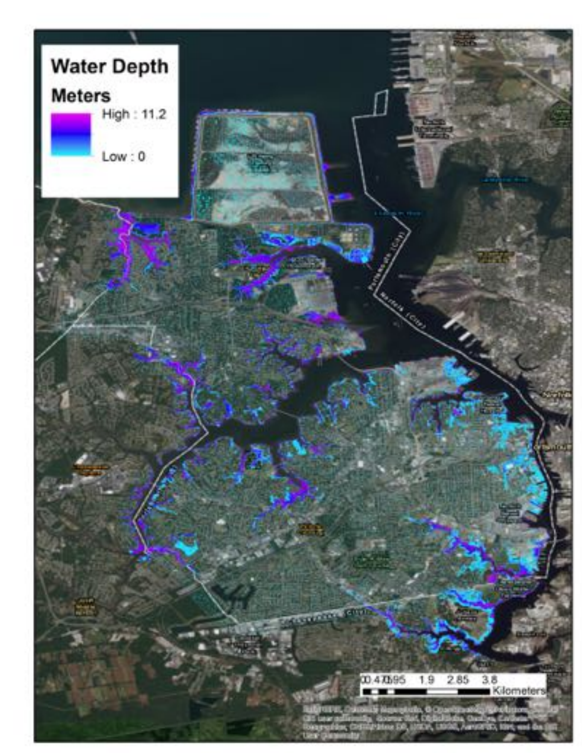


Figure 4: FwDET-C floodwater depth calculation for Portsmouth VA during Hurricane Irene in 2011.

Use during the 2017 Hurricane Season

- FwDET was used to estimate floodwater depth for Texas, Florida and Puerto Rico in near-real-time as part of the *Global Flood Partnership.*

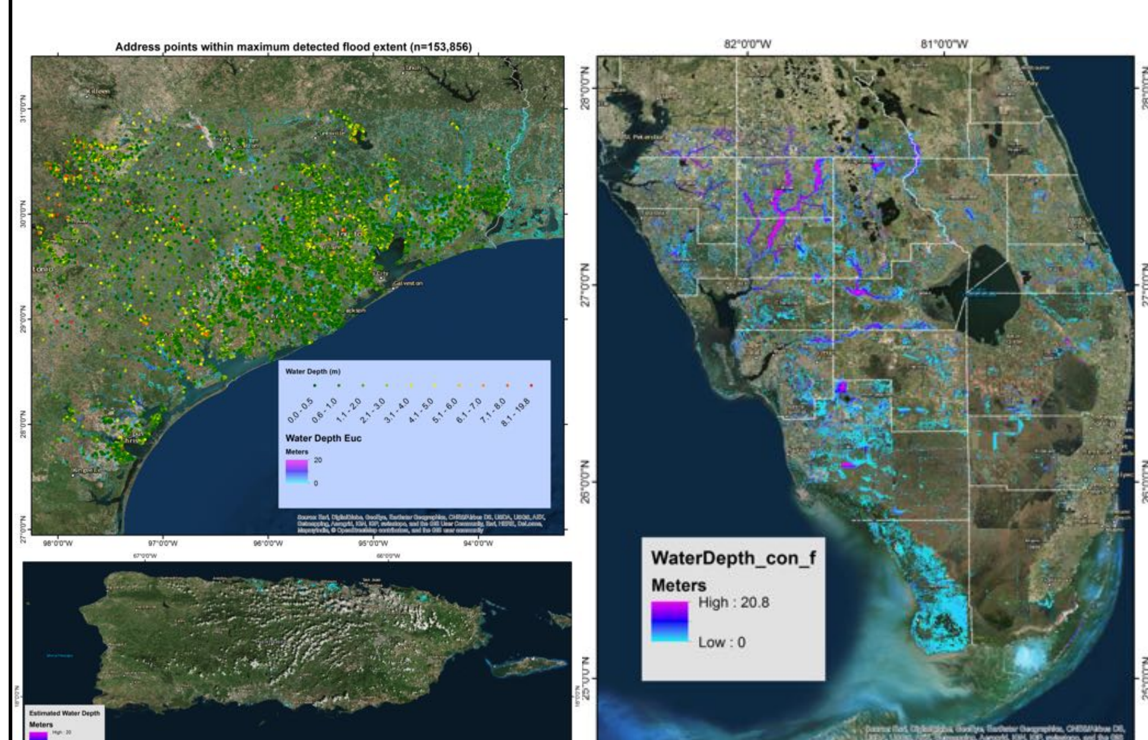


Figure 5: Top left: ***building impact assessment*** *in Texas during* ***Hurricane Harvey*** *based on FwDET estimations; Bottom left: floodwater depth estimation in Puerto Rico during* ***Hurricane Maria****; Left: floodwater estimation in Florida during* ***Hurricane Irma****.*

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