CIFDP-C
Hispaniola Demonstration Project Overview
Hispaniola Storm Surge Inundation

The SLOSH model uses a numerical model based on the work of NOAA to compute storm surge. Storm surge is defined as the abnormal rise of water generated by a storm, overlaid on the predicted astronomical tides. Flooding from storm surge depends on many factors, such as the wave, wind, and forward speed of the hurricane and the characteristics of the coastline where it comes ashore or passes nearby. For planning purposes, the National Hurricane Center uses a representative sample of hypothetical storms to estimate the near worst-case scenario of flooding for each hurricane category.

The SLOSH model uses a computational approach to simulate the storm surge hazard. The spatial coverage for each SLOSH grid extends from the coast to a few kilometers onshore. The resolution of individual grid cells within each basin ranges from tens to hundreds of meters to a few kilometers. Sub-grid scale water features and topographic obstructions, such as channels, rivers, and cuts and levees, barriers and roads, are parameterized to improve the modeled water levels.

The model provides products based on hypothetical hurricanes. MOWs and MORMs are created by computing the maximum storm surge resulting from up to 100,000 hypothetical storms simulated through each SLOSH grid of varying forward speeds, radii of maximum wind, intensity (Category 1-5), landfall location, tide level, and storm direction. MOWs are created for each combination of category, forward speed, storm direction, and tide level, while MORMs are created for Category 3 storms north of the NHC's Spray. MOWs are created for each storm category by retaining the maximum storm surge value in each grid cell for all the hypothetical storms, regardless of the forward speed, storm trajectory, or landfall location. SLOSH products are available for mean tide and high tide scenarios and represent the near worst-case scenario of flooding under ideal storm conditions. A high tide initial water level was used for the storm surge hazard maps.
<table>
<thead>
<tr>
<th>Initial Stakeholders Workshop – Dominican Republic</th>
<th>November 15-19, 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definitive National Agreement (DNA); National Coordination Team (NCT) Terms of Reference</strong></td>
<td>Signed August 2012: ONAMET, INDRHI, Disaster Management Agency (DMA)</td>
</tr>
<tr>
<td><strong>Phase 1 Review and Phase 2 kick-off - Hispaniola</strong></td>
<td>23-29 April 2015</td>
</tr>
<tr>
<td><strong>Phase 2 Review and Phase 3 kick-off Hispaniola</strong></td>
<td>27-30 April 2016</td>
</tr>
</tbody>
</table>
| **COMET© training modules translated into Spanish and French** | 1. Introduction to Tropical Cyclone Storm Surge (October, 2016)  
2. Storm Surge and Datums (October, 2016)  
3. Forecasting Tropical Storm Surge (October, 2016)  
6. Tropical Cyclone Forecast Uncertainty (October, 2016) |
<p>| Training workshop on storm surge, SLOSH Display, GEONETCAST, led by NHC | 17-21 July 2017 |
| <strong>Final Training Workshop led by NHC</strong> | December 3-7, 2018 |
| <strong>Funding</strong> | USAID WMO Voluntary Cooperation Programme Fund (VCP-F) (US) |
| <strong>System Developer (SD)</strong> | U.S. National Hurricane Center (Jamie Rhome) Florida International University (Keqi Zhang) |</p>
<table>
<thead>
<tr>
<th>SS Model</th>
<th>SLOSH (NHC)</th>
</tr>
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<tbody>
<tr>
<td>- Wave Input</td>
<td>Parametric model coupled</td>
</tr>
<tr>
<td>- Wind Input</td>
<td>Implicit in SLOSH</td>
</tr>
<tr>
<td>- Ensembles</td>
<td>Implicit in SLOSH</td>
</tr>
<tr>
<td>Wave Model</td>
<td>N/A</td>
</tr>
<tr>
<td>River Discharge</td>
<td>Parameterized from upstream forecast (INDRHI) in first implementation; river discharge model later discharge model later HEC-RAS (INDRHI)</td>
</tr>
<tr>
<td>Tides</td>
<td>Implicit in SLOSH</td>
</tr>
<tr>
<td>SSHA</td>
<td>N/A</td>
</tr>
<tr>
<td>Integrating System</td>
<td>SLOSH</td>
</tr>
<tr>
<td>Bathymetry</td>
<td>Best Available – various NCT members integrated into SLOSH grid</td>
</tr>
<tr>
<td>DEM</td>
<td>Best Available – various NCT members integrated into SLOSH grid</td>
</tr>
<tr>
<td></td>
<td>TANDEM-X satellite-derived</td>
</tr>
<tr>
<td></td>
<td>DEM FIU anchor points</td>
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</tbody>
</table>
Coastal Inundation Forecasting Demonstration Project

- Fully funded by USAID (1.2 Million U.S.)
- Implement a coupled storm surge and wave modeling system
  - SLOSH hydrodynamic model
  - Wave model recommended by IOOS modeling testbed (parametric)
- Develop products for planning, preparedness, and forecasting
  - SLOSH MOMs and MEOWs
  - Same display system as employed by RSMC-Miami (SLOSH Display Program)
- Provide specialized training programs on how to use the storm surge products for planning and preparedness.

hurricanes.gov/surge  @NHC_Surge
WMO CIFDP-C Participants

RSMC Miami
Jamie Rhome CIFDP-C System Developer/Project Manager
Ethan Gibney CIFDP-C Grid Builder

NWS Environmental Modeling Center
Andre Van der Westhuysen and Dongming Yang CIFDP-C Modelers

Florida International University
Keqi Zhang CIFDP-C DEM and Grid Builder
CIFDP-C Demonstration Project Plan

Phase 0
2013-2014

Project Scoping and Preparation:
Definitive National Agreement (DNA), training, and initial data inventory

Phase 1
2015

Project Planning and Design:
Stakeholder workshop, establish National Coordination Team (NCT), regional buy-in, initial project design/setup (Mexico demo)

Phase 2
2016

System Development:
Digital elevation model (DEM), SLOSH/wave grid creation and quality control, and model development
Develop Training modules

Phase 3
2017

System Validation:
MOMs/MEOW creation, QA/QC, and model validation
Deploy online training modules

System Integration and Training:
System implementation, project evaluation, specialized training workshop
Project evaluation and recommended application to region (RA-IV)
Scatter plot of TDX DEM vs GPS measurements at Pedernales, Samana, and Sanchez in The Republic of Dominica (Zhang et al. 2018 – under review)

WMO Coastal Inundation Forecasting Demonstration Project (CIFDP) – for the Caribbean (C)
Funded by USAID

TanDEM-X Project

- TDX global DEM developed by German Aerospace Center
  - Relative vertical accuracy (2m slope < 20 %); (4m > 20%)
  - Absolute vertical accuracy (10 m)
  - 0.4 arc second resolution in latitudinal direction (12m)
  - Resolution varies in longitudinal direction (0.4-4 arc seconds)
- Vertical datum – EGM2008 (Pavlis et al. 2012)
- Filtered DEM using the Morph Method

hurricanes.gov/surge @NHC_Surge
Bathymetric Data

- NOAA single and multi-beam sounding surveys
- NOAA Tsunami program
- CIFDP-C NCT data collection
- IOC bathymetry

- Already incorporated into model grids
SLOSH Model MOMs and MEOWs

- **MOMs** — are an ensemble product of maximum storm surge heights and are created by compositing all the MEOWs, separated by category and initial water level anomaly, and retaining maximum value in each grid cell.

- **MEOWs** — represent the maximum storm surge resulting from hypothetical storms of varying forward speed, radius of maximum wind (RMW), intensity (categories 1–5), landfall location, initial water level, and storm direction.
**END USER PERSPECTIVES**

- All participants expressed appreciation for CIFDP-C and a strong desire to continue partnerships and engagements with the system developer. The latter feedback speaks to the value of utilizing the RSMC as the system developer.

- INDRHI expressed a strong desire for the inclusion of and coupling with riverine modelling.

- Not all forecasters were involved throughout CIFDP-C, which complicated their understanding of the overall project scope. This was especially evident with Haiti, which did not have consistent nor dedicated representation.

- Forecasters requested more time for hands on exercises and practice.

- The 1-1.5 year pause while funds were obtained and the scope expansion to include all of Hispaniola may have resulted in a decline in awareness and participation.

- ONAMET was very pleased with the inclusion of training for Civil Defense and the addition of civil defense experts from the USA. Civil Defense regretted not participating from the beginning of CIFDP and wished for more training.

- Users requested a short 1-2 page user guide and additional documentation of the project.

- All participants expressed a strong desired for follow up, or maintenance training.

- ONAMET requested forecasting support from RSMC Miami (NHC) during hurricane season.
FUTURE ENHANCEMENTS AND EXTENSION

- Include river flooding contributions to the overall coastal inundation forecast; work is already progressing at present on a method to include rivers. Both ONAMET and INDRHI expressed a commitment to work jointly to integrate enhanced river flood components into the CIF.

- Incorporation of real-time rainfall forecasts was also considered as another possible long-term enhancement.

- Extend the operational implementation and training to Haiti. This could be achieved by incorporating Haiti within NHC-planned activities to develop similar capabilities in Belize and Mexico in 2019 and 2020.

- To ensure sustainability of the new CIF system, ONAMET needs to continue modelling and development activities.

- The strong consensus of the users was that the current CIF operational system is an excellent platform, upon which to base improved forecast and warning systems in the Dominican Republic, and had contributed greatly to increased communication and cooperation, and strengthened partnerships between local stakeholders.
<table>
<thead>
<tr>
<th>Type of Communication</th>
<th>Intended Audience</th>
<th>Story Aspects</th>
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<tbody>
<tr>
<td><strong>WMO News Release (December 2018) on the WMO Website</strong></td>
<td>International meteorological community</td>
<td>Conclusion of the second CIFDP, in the Dominican Republic (Dec 2018) and the success of the overall story.</td>
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<tr>
<td></td>
<td>International and relevant donors</td>
<td></td>
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<tr>
<td><strong>WMO Bulletin (2019)</strong></td>
<td>International meteorological community</td>
<td>Success of the overall story of CIFDP, incorporating the CIFDP-C and other completed sub-projects.</td>
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<td><strong>WMO Annual Report 2018</strong></td>
<td>WMO Members, and International meteorological community and relevant donors</td>
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<tr>
<td>A relevant journal for science projects with social impacts</td>
<td>DRR community, researchers in practical application of science influence on social systems</td>
<td>Describing the social activities and aspects in the CIFDP-C</td>
</tr>
<tr>
<td><strong>Dominican Republic National, Regional and Local News</strong></td>
<td>Dominican Republic public</td>
<td>Emphasizing the value of early warning for coastal communities</td>
</tr>
<tr>
<td>Media, Newsletters and Web releases by Local Stakeholders (eg Red Cross)</td>
<td>Targeted vulnerable local communities in Dominican Republic coastal areas</td>
<td>Explanation and raising awareness of early warnings for coastal inundation</td>
</tr>
<tr>
<td><strong>Summary for the CIFDP-C page on the JCOMM website and in WMO Meteoworld March 2018 edition.</strong></td>
<td>For distribution by web-link, to Donors (eg USAID), WMO and JCOMM communities and anyone else relevant</td>
<td>Summary article of the overall CIFDP-C story</td>
</tr>
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</table>