Risk MAP CDS

Hurricane Analysis Structure Tool (HAST)

Prototype

September 30, 2019

Document Management History

Revision History

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| **Version Number** | **Version Date** | **Summary of Changes** | **Team/Author** |
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Approvals

This document requires the approval of the following person(s):

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Role** | **Review Date** | **Approved Date** |
| Casey Zuzak | FEMA | 10/1/19 | 10/11/19 |

Table of Contents

[1. Introduction 1](#_Toc20861986)

[2. Stakeholders 1](#_Toc20861987)

[3. Description of change request scope 1](#_Toc20861988)

[4. Requirements 1](#_Toc20861989)

[5. Future Considerations 3](#_Toc20861990)

[5.1. Add additional characteristics 3](#_Toc20861991)

[5.2. Accurate damage state probability values 3](#_Toc20861992)

[6. Assumptions & Dependencies 3](#_Toc20861993)

[6.1. Damage Results 3](#_Toc20861994)

[6.2. Wind Building ID (wbID) 4](#_Toc20861995)

[6.3. System/Security Requirements 4](#_Toc20861996)

# Introduction

The purpose of this document is to describe the requirements (and some design components) for creating an open source tool for hurricane loss estimation at structure level.

# Stakeholders

Table 2-1 Change Request Identification

|  |
| --- |
| Project Name: Hurricane Structure Analysis Tool (HAST) Prototype |
| FEMA Project Owner: Jesse Rozelle |
| CDS Project Manager: Andrew Ditmore |
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| Hazus Project Manager: Doug Bausch |
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# Description of change request scope

1. Create an open source tool for loss estimation from hurricane winds at the structure level. (HAST)

2. Create an open source pre-processing tool that will help the user assign required terrain and wind building type IDs to the input data (structures) that are required to calculate losses.

# Requirements

Detailed Requirements

1. HAST – Input data collection: The following are the inventory input data that are required from the user:

|  |  |
| --- | --- |
| **Field Name** | **Data Type** |
| Longitude | Decimal |
| Latitude | Decimal |
| Specific Occupancy (SOCType) | Varchar (5) |
| Building Area (Sq.ft.) | Decimal |
| Building Value (USD) | Decimal |
| Content Value (USD) | Decimal |
| HUSBT | Varchar (10) |

2. The following are inventory input data that can be provided by the user or assigned by the pre-processing tool – (note that if the user provides TerrainID and Wind Building (wbID), this pre-processing step is not required.

Terrain ID & Damage function assignment –

1. The Longitude & Latitude of the structure will be joined spatially to the respective state database’s hzCensusBlock\_TIGER table to fetch the CensusBlock ID (note this step will be skipped if the user provides CensusBlock or TerrainID).
2. The surface roughness value will be fetched from the huTerrainB table in the respective state database with a join using the CensusBlock
3. Based on the surface roughness value obtained in step b. a TerrainID will be assigned using the huTerrain table under the syHazus database currently in Hazus
4. The HUSBT will be used to assign the Wind Building Id (wbID) (if not provided by the user). The HUSBT will be matched to a selected default wbID provided by a table
5. We will use the wbID, and TerrainID to select the damage function.
6. For the prototype version of the tool, we will fetch the tract based windspeeds for each structure, for each of the 7 probabilistic return periods in the respective state databases (huHazardMapWindSpeed table) lookup unless the peak gust values are provided by the user on the input dataset (at structure level) and apply the 9 damage types based on DamLossDescID. In the future, the tool will be configured to extract the 3 second peak gust windspeed from any shapefile/raster identified by the user in the respective hazard data folder.
7. Other optional fields that will be included as placeholders for future enhancements include:
   1. Year Built
   2. Mapping Scheme
   3. TopoFactor
   4. Comments

4. HAST – Loss calculation – The damage values that were fetched in step 2.f will be interpolated and will be used to calculate losses in 9 new columns for each wind hazard input appended to the input tables including damage state probabilities, building losses, content losses, loss of use and debris. An output table will be provided for each wind field input selected by the user.

# Future Considerations

## Add additional characteristics

* Wind Building Characteristics: allow, yes (1), no (0), or NA (not applicable), for each characteristic - full incorporation of wind building characteristics (details in the related documents section) in data prep – The wind building Id (wbID) will be assigned based on the wind building characteristics chosen via the UI based on an algorithm for choosing the correct combination.
* Topo speedup values for HI, PR, USVI – will recalculate the windspeeds before calculating losses
* Essential Facility building types and damage functions
* Incorporate tree blowdown in losses using the tree data (at block level) from respective state and assign the tree damage functions based on HUSBTs.
* Use General Building type based on HUSBT to classify debris as Brick/Wood or Concrete/Steel.

## Accurate damage state probability values

* Loss estimation for other wind-field formats (raster)

# Assumptions & Dependencies

## Damage Results

* The wind speed fetched from the user provided wind-field folder (defaults from huHazardMapWindSpeed will be provided) may or may not match exactly to the 5 mph increment wind speed categories in the damage function library. Therefore, we will use the damage state probability by using the windspeed category closest based on the 5 mph increments to the fetched windspeed value.

|  |  |
| --- | --- |
| **Column** | **Calculations** |
| PeakGust | 3 second peak gust obtained from user input hazard data, extracted at point from shapefile/raster |
| Affected | Probability of Affected damage for the fetched windspeed depending on wbId, terrainId, DamLossDescID=1 from huDamLossFun |
| Minor | Probability of Minor damage for the fetched windspeed depending on wbId, terrainid, DamLossDescID=2 from huDamLossFun |
| Major | Probability of Major Damage for the fetched windspeed depending on wbId,terrainid, DamLossDescID=3 from huDamLossFun |
| Destroyed | Probability of Destroyed damage for the fetched windspeed depending on wbId, terrainid, DamLossDescID=4 from huDamLossFun |
| Building | (% Building loss value for the fetched windspeed depending on wbId, terrainid, DamLossDescID = 5 from huDamLossFun) \* Building Value (USD) = Building Loss (USD) |
| Content | (% Content loss value for the fetched windspeed depending on wbId, terrainid, DamLossDescID = 6 from huDamLossFun) \* Content Value (USD) = Content Loss (USD) |
| LossOfUse | Loss of Use in days for the fetched windspeed depending on wbId, terrainid, DamLossDescID = 7 from huDamLossFun) |
| BrickWood | Brick and Wood debris lbs/sqft for the fetched windspeed depending on wbId, terrainid, DamLossDescID=8 from huDamLossFun) \*Building Area (SQFT) = Brick and Wood Debris (lbs) |
| ConcreteSteel | Concrete and Steel debris (lbs/sqft) for the fetched windspeed depending on wbId, terrainid, DamLossDescID=9 from huDamLossFun) \*Building Area (SQFT) = Concrete and Steel Debris (lbs) |

## Wind Building ID (wbID)

The wind building ID (wbID) assigned for each structure will be the default for each HUSBT if not provided by the user

Results

* The input data file will be modified by the tool to add additional columns for parameters and damage calculations
* The results will be saved to a new table/file depending on the technical design with a new table created for each wind-field input selected by the user

## System/Security Requirements

Description

* The download of the prototype tool will be provided to FEMA using FEMA’s NHRAP-Dev Github site - <https://github.com/nhrap-dev/HAST>
* We encourage the user to make modifications to the code to fit their need
* A basic file zip/unzip program will be required to download and use the tool
* Documentation (requirement specs, readme) and data (Lookup tables, sample data) will be provided
* The tool will be supported on Windows 10 64 bit (Pro & Enterprise) and will use the following Python 3 libraries:
  + pandas
  + geopandas
  + shapely
  + pymssql
  + numpy
  + scipy

Authorization

* There is no authorization required to download and run the tool.