Risk MAP CDS

Hurricane Structure Analysis Tool (HUSAT)

Prototype

September 26, 2019

Document Management History

Revision History

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Approvals

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Role** | **Review Date** | **Approved Date** |
|  |  |  |  |

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# 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.

# Project Change Request and Impact Assessment Summary

Table 2-1 Change Request Identification

|  |
| --- |
| **Project Name: Hurricane Structure Analysis Tool (HUSAT) Prototype** |
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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. (HUSAT)

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. HUSAT – 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(5) |

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).
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 ii. a terrain ID 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 Terrain Id to select the damage function
6. The tool will eventually be configured to extract the 3 second peak gust windspeed from any shapefiile or table containing tractIDs identified by the user in the hazard data folder. For this prototype we will incorporate the tract based windspeed for each of the 7 probabilistic return periods from huHazardMapWindSpeed (in the respective state database) lookup and apply the 9 damage types based on DamLossDescID.
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. HUSAT – Loss calculation – The damage values that were fetched in step 2.vi 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
* EF building types and damage functions
* Incorporate Tree blowdown in losses

## Accurate damage state probability values

* We can interpolate the value for the damage state probability by using the two values depending on the windspeed values (upper and lower bounds) (e.g. wind speed of 103 will interpolate the damage state between 100 and 105, rather than choose the closest value (105))
* 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. (note we plan in the future may work on a way toto interpolate between the two values to apply more accurate damages)

|  |  |
| --- | --- |
| **Column** | **Calculations** |
| PeakGust | 3 second peak gust obtained from user input hazard data, extracted at point from shapefile or TractID table. |
| 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/HUSAT/>
* 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 and sample data will be provided
* The tool will be supported on Windows 10 (Pro & Enterprise) and will use the following python libraries:
  + pandas
  + geopandas
  + shapely
  + pymssql

Authorization

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