DEVELOPING A NEW ARCGIS TOOL TO QUANTIFY BUILDING-CONTENT VULNERABILITY FROM STORM-SURGE INUNDATION

CHANDI WITHARANA[1]
THOMAS MEYER[2], DANIEL CIVCO[2], and JEFFREY OSLEEB[3]

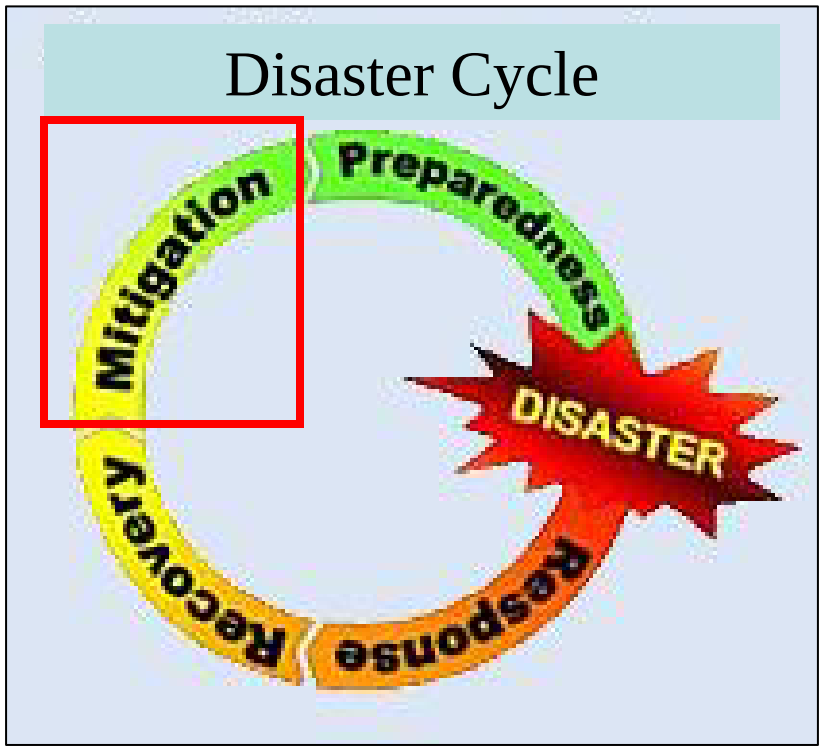
Center for Integrative Geosciences[1], Dept. of Natural Resources and the Environmnet[2],
Dept. of Geography[3]
University of Connecticut

Motivation

Natural hazards occur and recur, impacting humans and infrastructure.

Motivation

It is critical to assess potential damage on the human environment prior to a natural hazard



Problem Statement

The greatest potential for loss of life related to a hurricane is from the storm surge

Source(s): www.katrinadestruction.com

Objective

develop a new method of quantifying flood-damage risk to vulnerable-building contents

Background

Storm Surge: *Damage*

Source(s): www.katrinadestruction.com

Background

Storm Surge: *Modeling*

SLOSH Model

Sea, **L**ake and **O**verland **S**urges from **H**urricanes is a computerized model to estimate storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes

Source(s): www.nhc.noaa.gov, Jelesnianski et al. 1992

Background

Storm Surge: *Damage Assessment*

Damage to Building's

Structure

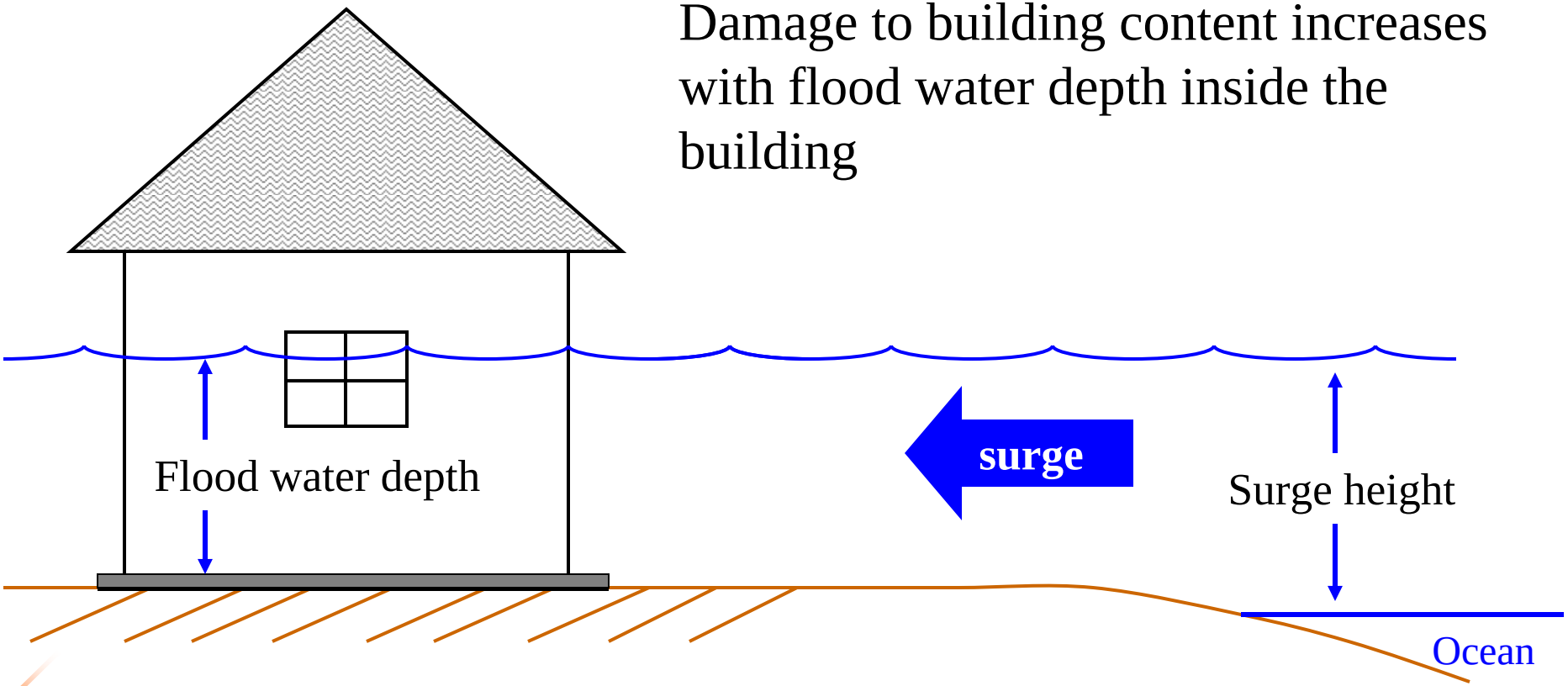
Contents

Source(s): www.katrinadestruction.com

Background

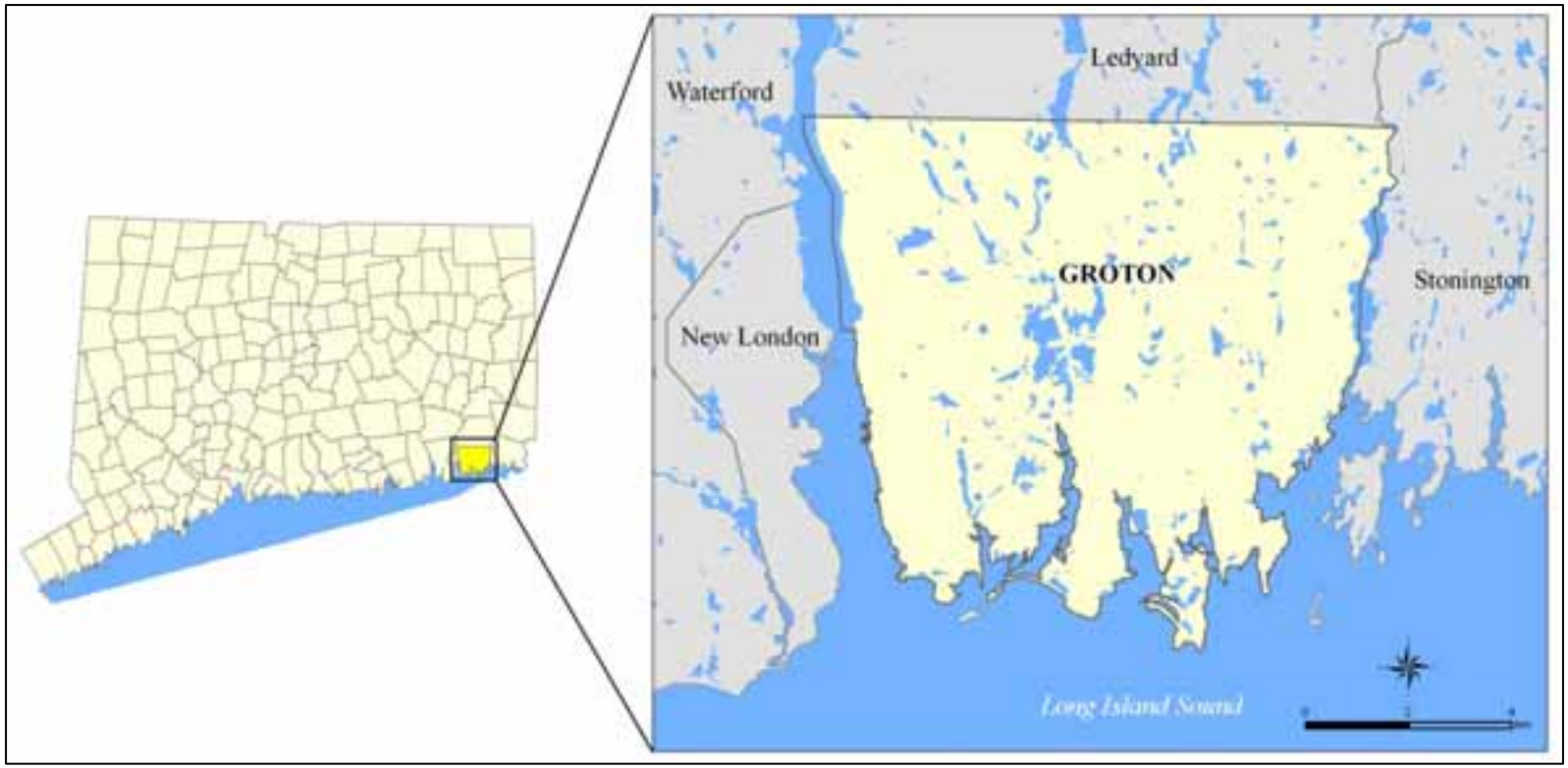
Storm Surge: Damage to Building Contents

Damage to building content increases with flood water depth inside the building



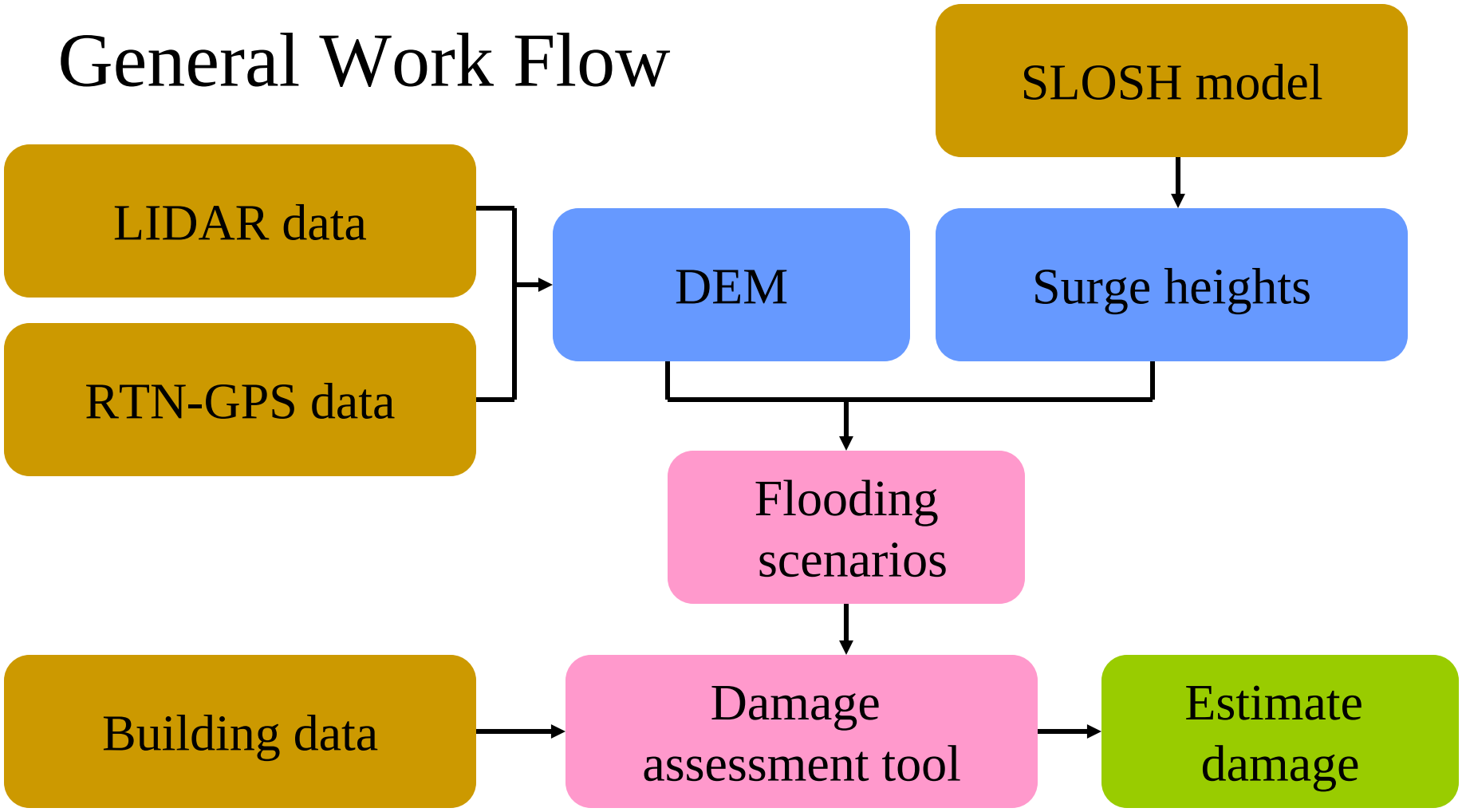
Methodology

Study Area: *Town of Groton*



Population ~ 40,000, Population density ~ 490 people/km^2

Methodology



Methodology: Damage Assessment Tool

Hypothetical-damage function

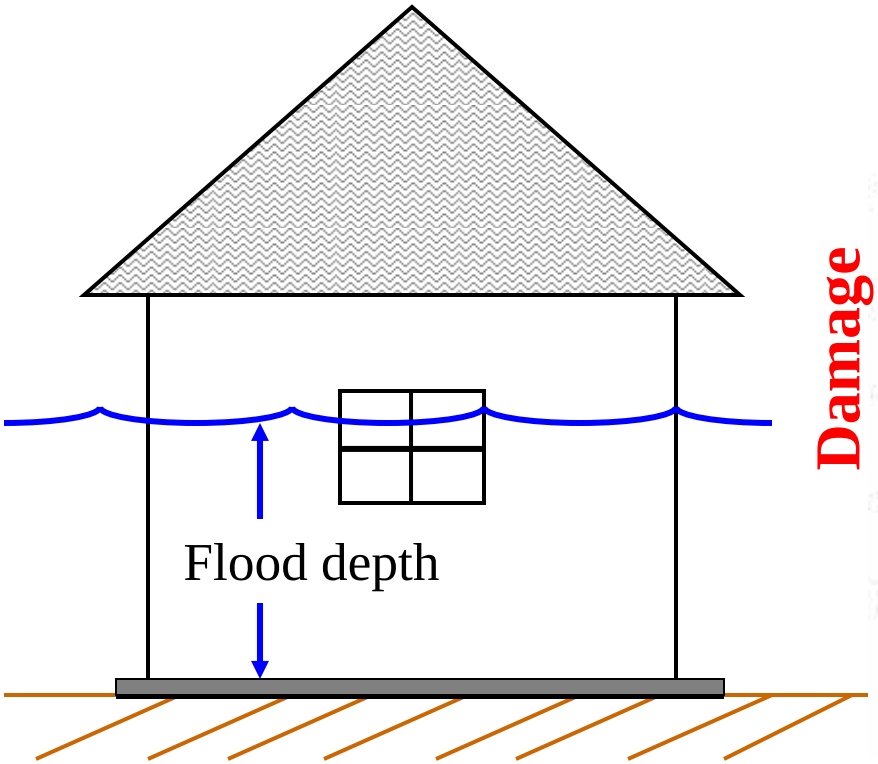
$$D = \lfloor S_n(d) \rfloor + 1 - e^{-5Mod[S_n(d),1]}$$

$$S_n(d) = Min(d/m, n)$$

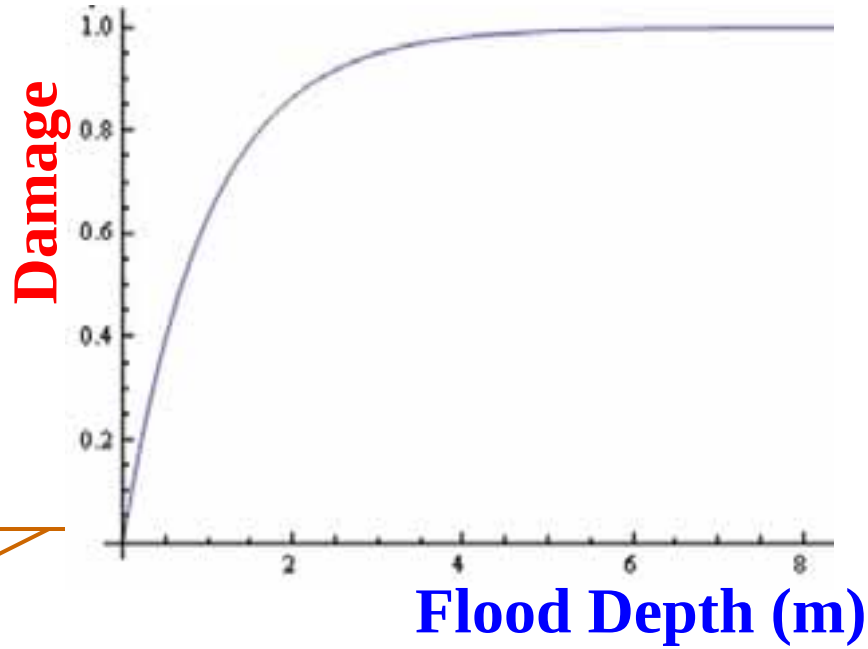
D	normalized damage (unitless, $0 < D < 1$)
d	flood-water depth inside the building (meters)
m	meters per story
n	number of floors in the building (stories)
$\lfloor . \rfloor$	floor operator

Methodology: Damage Assessment Tool

Hypothetical damage function

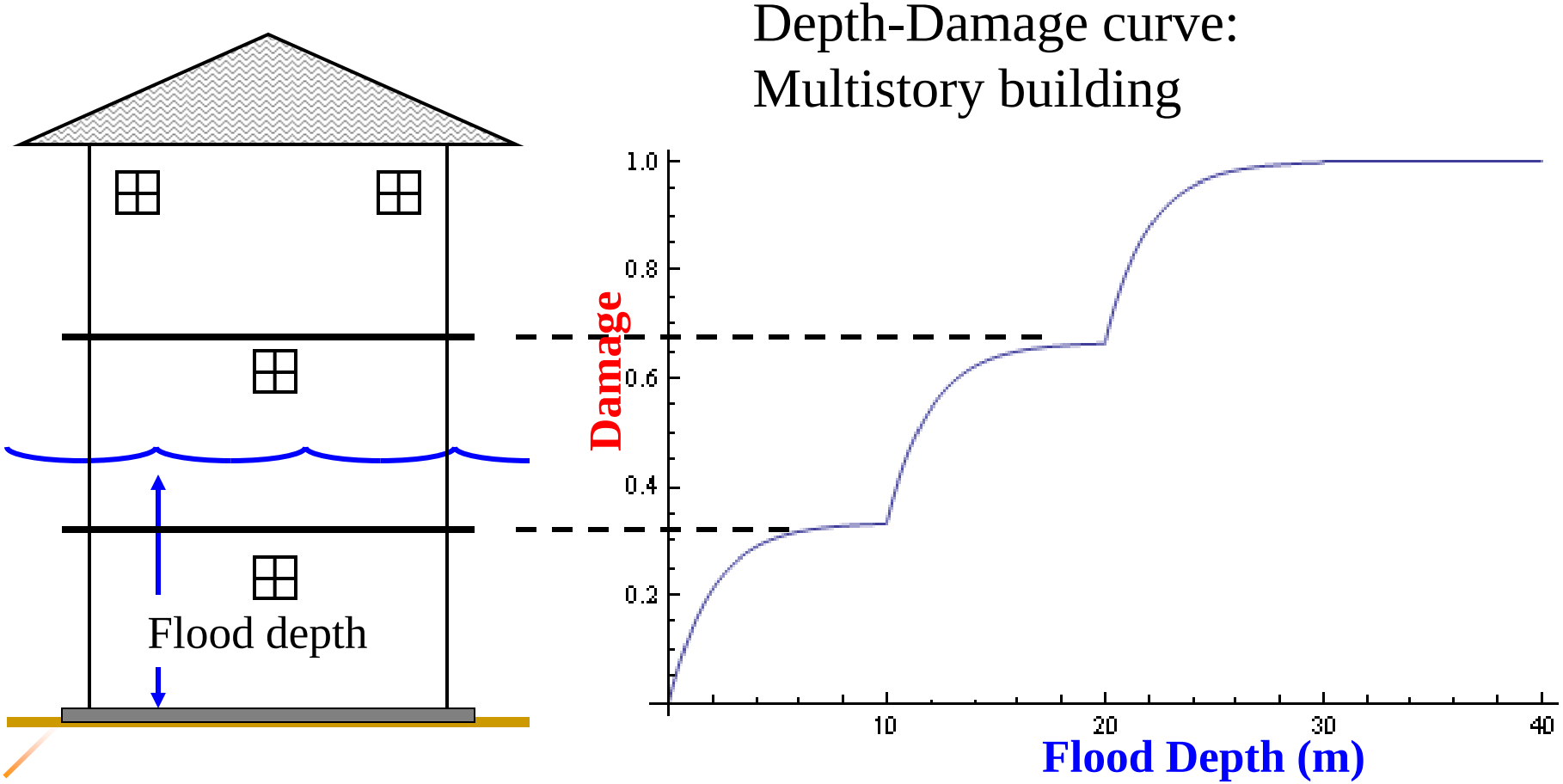


Depth-Damage Curve:
Single story



Methodology: Damage Assessment Tool

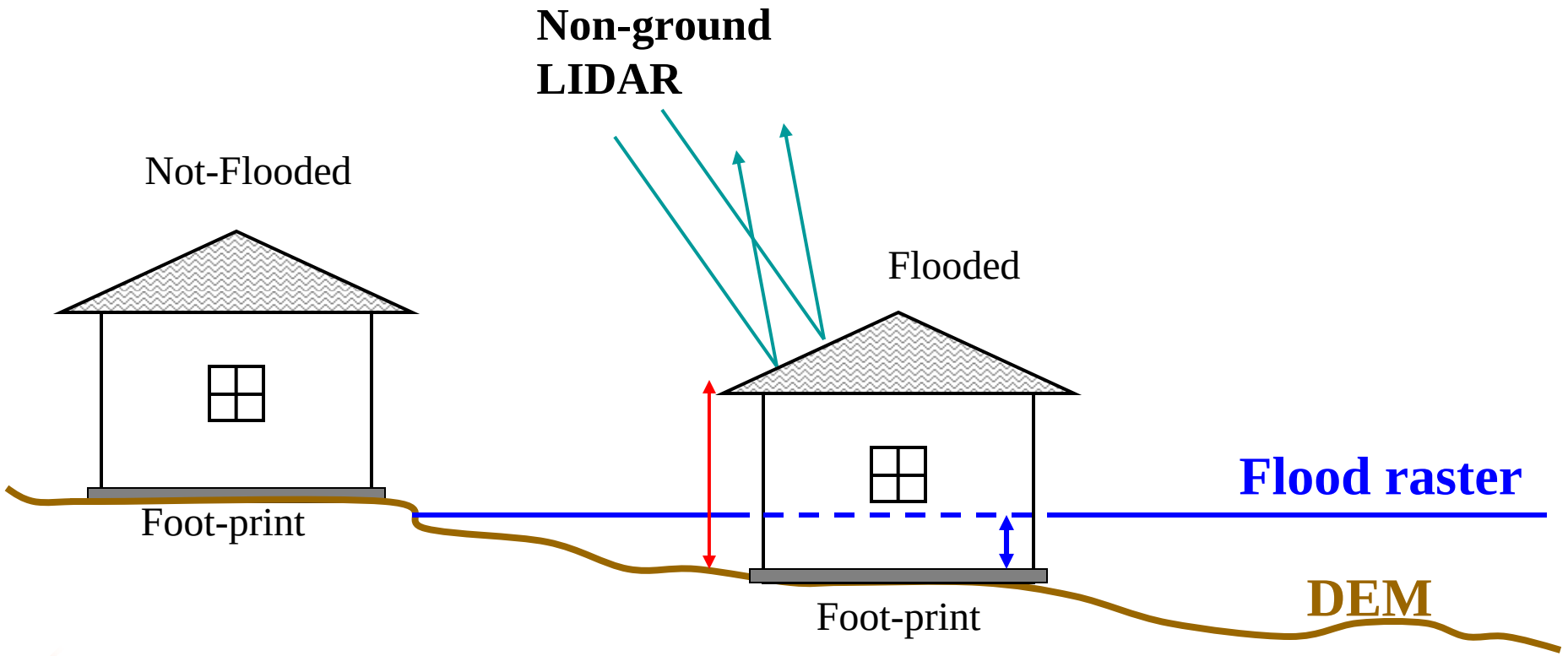
Hypothetical damage function



Methodology: Damage Assessment Tool

Damage assessment algorithm:

simplified version



Methodology: Damage Assessment Tool

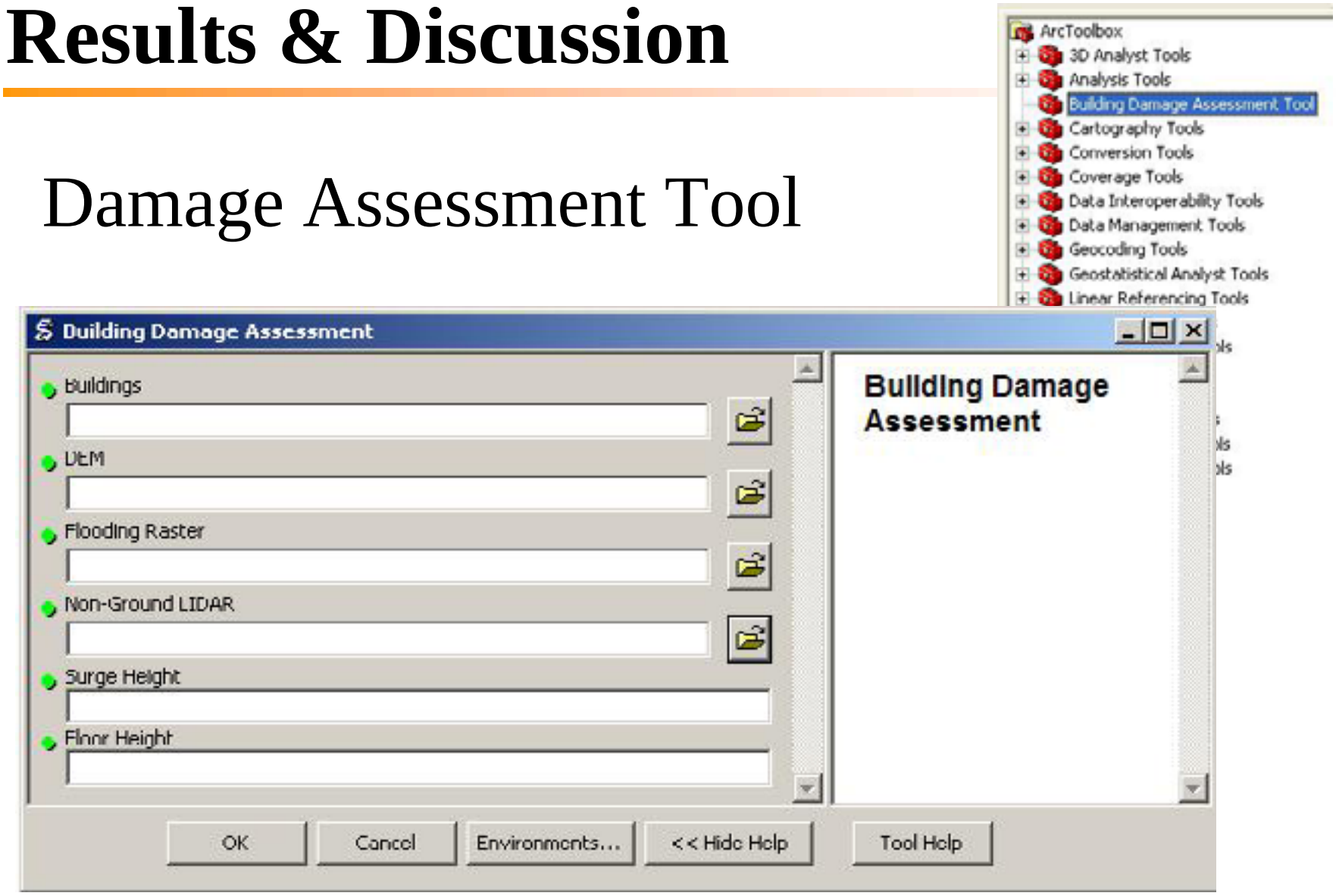
Programming with Python

Python IDLE 2.5.1 was used to code the damage assessment-algorithm script

A new ArcGIS 9.3 tool was developed to automate the entire process

Results & Discussion

Damage Assessment Tool



User interface of the damage assessment tool

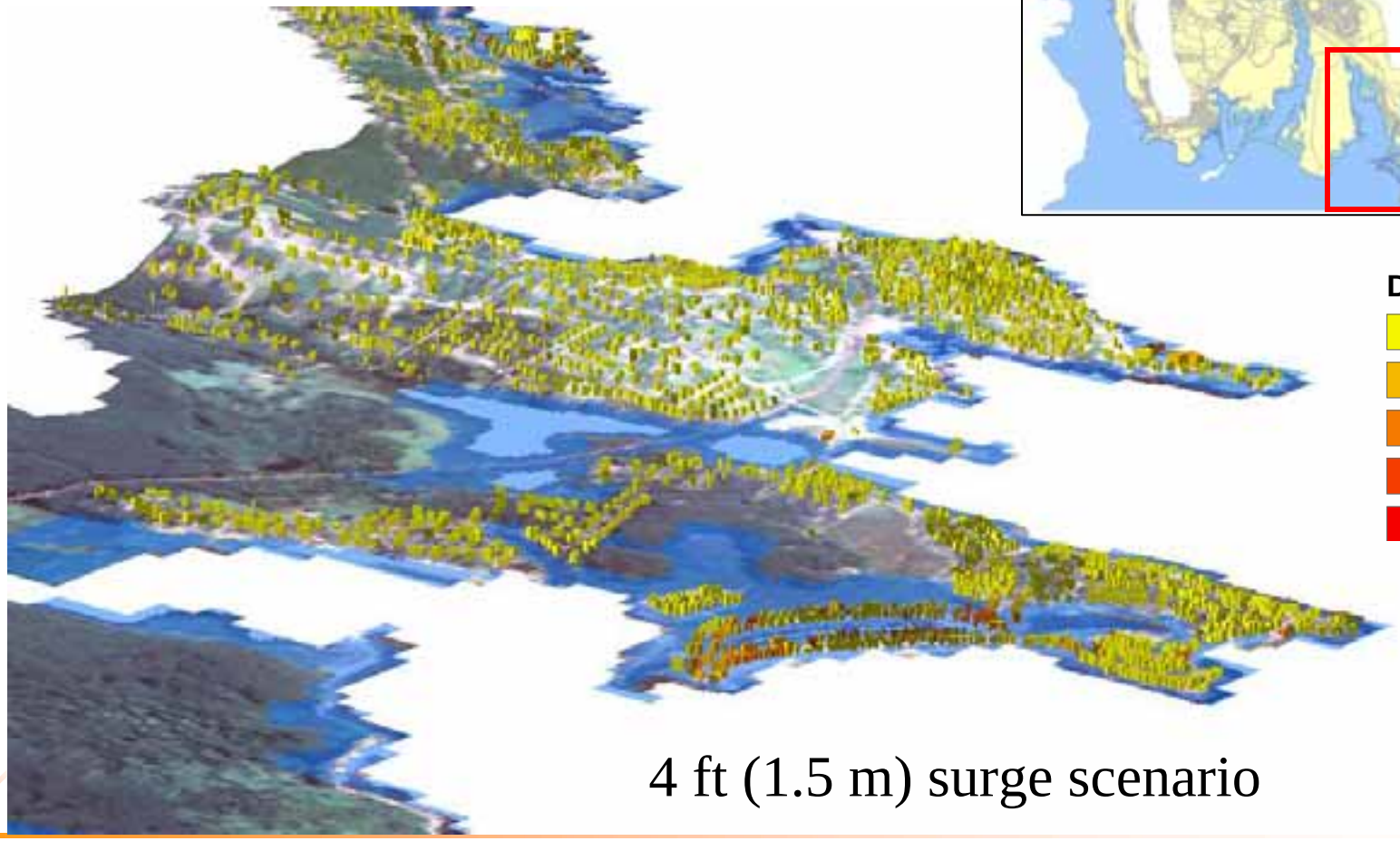
Results & Discussion

Estimated damage: 27 flooding scenarios *in detail*

Flooding scenario	Estimated Damage (Nominal Damage - ND)																	
	Total no. of damaged buildings		Residential				Commercial				Industrial				Unclassified			
Surge height (ft)	number	%	total	ND = 1	1>ND >0.5	0.5> ND> 0	total	ND = 1	1>ND> 0.5	0.5>ND> 0	total	ND = 1	1>ND> 0.5	0.5>ND> 0	total	ND = 1	1>ND> 0.5	0.5>ND> 0
2.0	27	0.4	19	0	1	18	3	0	0	3	0	0	0	0	5	0	1	4
3.0	82	1.1	63	0	6	57	10	0	0	10	0	0	0	0	9	0	2	7
3.5	179	2.3	152	0	13	139	18	0	2	16	0	0	0	0	9	0	3	6
4.0	268	3.5	228	0	26	202	29	0	2	27	0	0	0	0	10	0	2	8
4.5	395	5.1	344	0	49	315	40	0	3	37	0	0	0	0	10	0	4	6
5.0	513	6.7	444	0	67	377	56	0	6	50	0	0	0	0	14	0	4	10
5.5	647	8.4	554	0	94	450	69	0	9	60	10	0	1	9	14	0	4	10
6.0	750	9.8	637	0	112	525	87	0	14	73	12	0	1	11	14	0	4	10
6.5	850	11.1	721	0	126	595	98	0	17	81	17	0	2	15	14	0	4	10
7.0	948	12.3	800	0	145	655	111	0	21	90	21	0	2	15	16	0	4	12

Results & Discussion

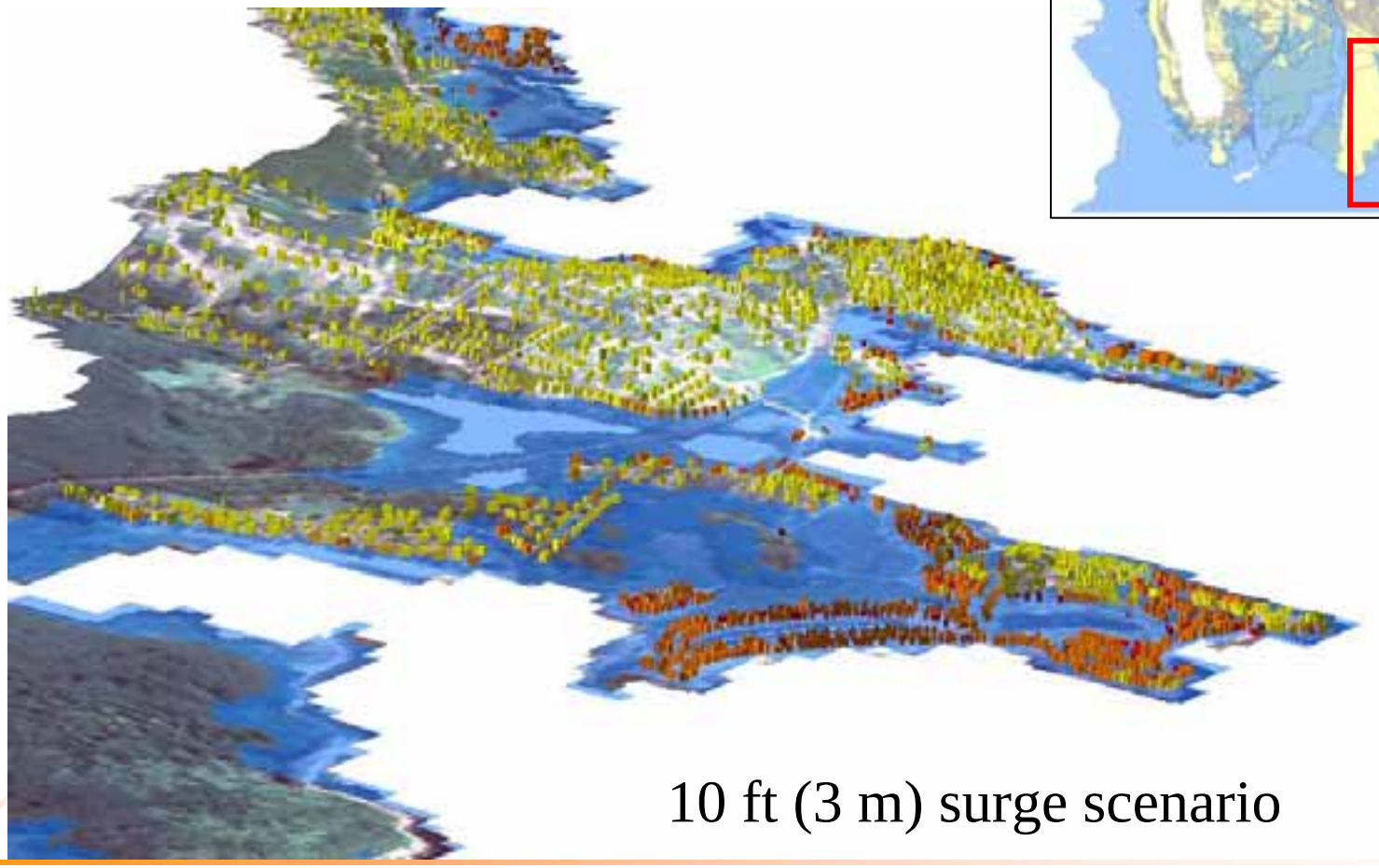
3-D Damage visualization



4 ft (1.5 m) surge scenario

Results & Discussion

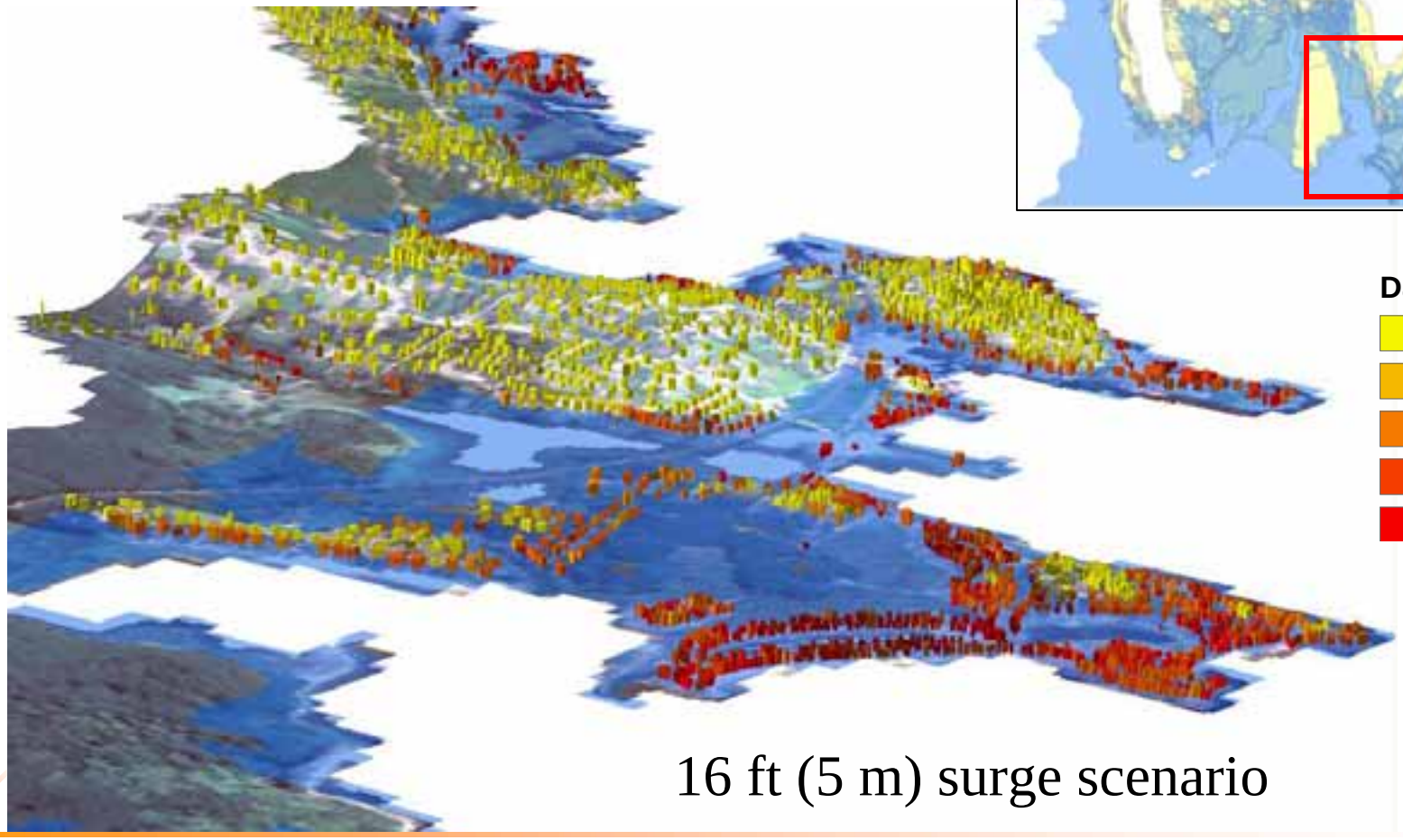
3-D Damage visualization



10 ft (3 m) surge scenario

Results & Discussion

3-D Damage visualization



16 ft (5 m) surge scenario

Results & Discussion

Estimated damage

Estimated damages were expressed as nominal damage (0 - 1)

Damage would be more meaningful if expressed in US dollars

building layer did not contain any attributes indicating either structure values or property values

Results & Discussion

Damage Assessment Tool

The ArcGIS tool is not limited to assessing flood damages posed by storm surges

Therefore, this tool can be used in other flood damage assessments as well by assuming a still water model

Results & Discussion

Damage function

It would have been desirable to validate the damage function using actual damage data

Following variables should have been included into the damage function

- Flood-water velocity (we assumed a still-water model for flooding)
- construction material of buildings