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HAZUS Coastal Flooding Assessment under Current and Future Conditions for the Village of Islamorada, Florida

Report by:

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September 2019



HAZUS Coastal Flooding Assessment under Current and Future Conditions for the Village of Islamorada, Florida

Introduction

This report describes the results of an assessment of current and future flooding risks for public infrastructure and private property within the Village of Islamorada, Florida. The assessment utilized the Multi-Hazard Loss Estimation Methodology (Hazus), a standardized hazards modeling software developed by Federal Emergency Management Agency tool for the purpose of estimating potential losses from disasters including earthquakes, winds, and floods. The Hazus coastal flood model was run for several scenarios to develop multiple estimates of potential losses in the Village of Islamorada for a 100-year storm surge event. These scenarios included a “base case” storm surge under current sea level conditions and multiple scenarios simulating how losses for a similar storm surge event would be exacerbated by projected increments of future sea-level rise. Damage assessments for public infrastructure were developed using precise building footprint location data and, where available, finished floor elevation data from Elevation Certificate surveys. The results from the Hazus assessments of public infrastructure may be used to inform prioritization of hazard mitigation projects for protection of public safety, health, and welfare. In addition, parcel-level valuations and detailed building structure information were used to develop dollars-based Hazus damage estimates for public and private property. These Hazus loss models for the Village of Islamorada may provide useful insights for development and modification of post-disaster recovery plans at the local, state, and federal levels.

Hazus Model

For this project we used the Coastal Flood Model in Hazus-MH Version 3.1 (a freely downloadable add-on to ESRI’s ArcGIS 10.2.2 software) to develop water level estimates for a series of 100-year return interval flood event scenarios for all inhabited keys within Monroe County, including all of the Village of Islamorada. The Hazus Coastal Flood Hazard Model includes computations from FEMA’s erosion, Wave Height Analysis for Flood Insurance Studies (WHAFIS), and RUNUP models to develop estimates of flood height under a defined coastal flooding event for the study area (FEMA 2013). The outputs from the Coastal Flood Hazard Model are flood depth grids that describe the projected depth and extent of flood waters above ground height for the modeled flood event. These depth grids are then used to model the impacts of the projected flood event on essential facilities, property, and economic activity within the study area.

Although the Hazus-MH Coastal Flood Model utilizes coastal flood height transect information obtained from FEMA’s Flood Insurance Rate Map (FIRM) as a technical input, it is important to note that the Coastal Flood Model process for delineating a 100-year coastal flood event is generally more risk-averse as compared to those used to develop a standard FIRM. These differences are a function of divergent purposes between risk assessments in HAZUS-MH and a FIRM. The purpose of HAZUS-MH is to inform decisions about evacuation, maintenance of essential emergency services, and facilitation of efficient rescue and recovery processes in the event of a disaster event. Because such decisions inherently involve potential risks to human life and public safety, the HAZUS-MH modeling process will tend to err toward overestimation of potential flood risk out of an abundance of caution. By contrast, the fundamental purpose of a FIRM is to set premium rates for the federally-backed insurance of property

against flood risk through the National Flood Insurance Program (NFIP). There is some evidence that financial difficulties observed within NFIP over recent years are associated with FIRMs tending to underestimate flood risk for some locations (Pralle 2019), thus indicating the appropriateness of using more risk-averse tools – such as Hazus-MH – for flood vulnerability assessments that are being used for emergency planning and response purposes (Luke et al. 2018).

Flood Height Scenarios

A base case Coastal Flood Model scenario was run in Hazus-MH using current stillwater elevation¹ heights for a 100-year storm surge, as defined by coastal transects from the current Flood Insurance Study for Monroe County (FEMA 2005) and an assumed 1992 baseline for mean sea level (MSL). Three additional future conditions scenarios that account for sea-level rise projections within adjusted 100-year flood heights were also run within the Coastal Flood Model: 1) 14” of sea-level rise, which is the 2060 “Low” scenario defined by the Southeast Florida Regional Climate Change Compact; 2) 26” of sea-level rise, which is the 2060 “High” scenario defined by the Southeast Florida Regional Climate Change Compact; and 3) 4.13’ of sea-level rise, which is the NOAA Intermediate-High sea-level rise projection for 2100 as referenced to the Key West tide gauge. The NOAA Intermediate-High projection was selected for analysis at the 2100 time period because this is currently defined as the minimum sea-level rise projection assessment that may qualify for crediting through the NFIP’s Community Rating System (CRS) Coordinator’s Handbook (FEMA 2017).

Facilities Assessment

The Village of Islamorada and Monroe County supplied the project team with a GIS-based inventory containing point locations for a total of 38 essential and critical facilities. Elevation Certificates with finished floor elevations for nine of these facilities were located by the Village of Islamorada or Monroe County Floodplain Coordinator. These finished floor elevations were then digitized into the GIS inventory records for each relevant structure. The NOAA VDatum tool (Yang et al. 2012) was used to transform all Elevation Certificate data originally referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) into NAVD88.² Overlays of this infrastructure data with the flood depth grids for the base case, 2060, and 2100 100-Year Coastal Flood Model scenarios were then developed using the Hazus-MH software package.

The facility inventory and associated base scenario Hazus-MH Coastal Flood Model results are provided in Table 1 (Disaster Preparation and Response facilities), Table 2 (Utilities), Table 3 (Hazardous), and Table 4 (Essential and Municipal Services). Results of the Hazus-MH Coastal Flood Model with sea-level rise scenarios for 2060 (Low of 14” and High of 26”) and 2100 (4.13’) are provided in Table 5 (Disaster Preparation and Response facilities), Table 6 (Utilities), Table 7 (Hazardous), and Table 8 (Essential and Municipal Services).

¹ Stillwater elevation refers to the height of a coastal flood without the additional height associated with wave action. The Hazus Coastal Flood Model adds wave height onto the stillwater elevation

² A default finished floor elevation of 2 feet above adjacent ground level was assumed for all facilities without Elevation Certificate data.

The results of the Hazus-MH assessment provide a high level of flood risk concern for two facilities located on Lower Matecumbe Key that are owned by the Village of Islamorada: 1) Fire Station #19, located at 74070 Overseas Highway; and 2) a wastewater pump station located at 142 Sunshine Blvd. Although both of these facilities have Elevation Certificates that indicate finished floor elevations above the regulatory 100-year base flood elevation for the FIRM of record, the Hazus-MH Coastal Flood Model results show a substantially higher 100-year flood height for the location of these facilities as compared to the FIRM.

Communications with Village of Islamorada officials indicate that both of these facilities experienced substantial flood damage during Hurricane Irma, which passed south of Islamorada as a large Category 4 storm in September 2017. This congruence between the potential risk identified by the Hazus-MH damage assessment and actual damages that accrued during a recent storm event gives impetus for pursuit of hazard mitigation investments to relocate, elevate, or otherwise harden these two facilities to lessen the potential for future damages.

In the case of Fire Station #19, the baseline 100-Year Hazus Coastal Flood shows a flood depth of 4.58 feet above the existing finished floor elevation of 6.53 feet NAVD88 (8.00 feet NGVD29) shown by the facility's Elevation Certificate. Flood damage to a fire station poses high concern for public health, safety, and welfare due to the adverse impacts on post-disaster response and recovery for even a temporary loss of a fire station's functionality. Recent examples of new fire station construction in Monroe County – such as the Stock Island Fire Station – have incorporated substantial free board above the base flood elevation for the purpose of minimizing current and future flood risk to these first responder facilities.

For the pump station facility, the baseline 100-Year Hazus Coastal Flood shows a flood depth of 3.00 feet above the finished floor elevation of 6.46 feet NAVD88 (8.00 feet NGVD29) shown by the facility's Elevation Certificate. Flood damage to a wastewater pump facility poses high concern for public health, safety, and welfare due to the potential for spillage of untreated wastewater during pump failure events. Elevation of electronic components and other flood sensitive equipment several feet above base flood elevation and possible wave action during a large storm event is best practice for wastewater pump systems in storm surge areas.

Table 1: Inventory of Disaster Preparation and Response Facilities with Base Scenario Hazus-MH Coastal Flood Model Results³

Building	Address	Type	Elev Cer	Depth	FIRM Zone
Fire Station #19	74070 Overseas Highway	Fire	Yes	4.58	100-Year
Islamorada Fire\EMS #20	81850 Overseas Highway	Fire	No	N/A	N/A
U.S.C.G. Plantation Key	183 Palermo Drive	Military	No	7.98	100-Year
MCSO Roth Building	50 High Point Rd	Police	Yes	-1.20	100-Year
Plantation Key MCSO Sub-Station	88770 Overseas Highway	Police	Yes	N/A	N/A
Island Christian School	83400 Overseas Highway	Refuge of Last Resort	No	-0.15	100-Year
St. James Episcopal Plantation Key	87500 Overseas Highway	Refuge of Last Resort	No	0.95	500-Year
Island Christian School Field	83400 Overseas Highway	Staging	No	1.54	100-Year
Plantation Yacht Harbor	87000 Overseas Highway	Staging	No	6.04	100-Year

Table 2: Inventory of Utilities Facilities with Base Scenario Hazus-MH Coastal Flood Model Results³

Building	Address	Type	Elev Cert	Depth	FIRM Zone
FKEC Ellis Facility Islamorada	80571 Old Highway	Energy	No	N/A	100-Year
Monroe County Fleet	87831 Overseas Highway	Energy	No	N/A	N/A
Pump Station	142 Sunshine Blvd	Wastewater	Yes	3.00	100-Year

Table 3: Inventory of Hazardous Facilities with Base Scenario Hazus-MH Coastal Flood Model Results³

Building	Address	Type	Elev Cert	Depth	FIRM Zone
Fuel Island/Pumps	88000 Overseas Highway	Hazardous materials	No	N/A	500-Year
Fuel Tank (8,000 gallons)	88000 Overseas Highway	Hazardous materials	No	N/A	500-Year

³ ElevCer column indicates if facility's finished floor elevation was modeled using Elevation Certificate data from the Monroe County Floodplain Coordinator's office ("Yes") or an assumed value of 2 feet above ground level("No"). Depth is reported as feet above finished floor elevation based on the depth grid from the Hazus-MH Coastal Flood Model. FIRM Zone indicates the flood zone delineation for the facility's location within the current Flood Insurance Rate Map for Monroe County. **Bolded facilities are owned by the Village of Islamorada.**

Table 4: Inventory of Essential and Municipal Services Facilities with Base Scenario Hazus-MH Coastal Flood Model Results⁴

Building	Address	Type	Elev Cert	Depth	FIRM Zone
Island Christian School Site	83250 Overseas Highway	DMS	No	1.01	100-Year
Tavernier Airport Site	135 N. Airport Rd	DMS	No	0.47	100-Year
AARP/Senior Center	50 High Point Road	Health	No	-0.91	100-Year
Plantation Key Convalescent Center	48 Highpoint Road	Health	No	2.24	100-Year
#65 County Offices	MM 88.5 US 1	Local government	Yes	2.57	100-Year
Administrative Center & Public Safety	86800 Overseas Highway	Local government	Yes	N/A	100-Year
Founders Park Community Center	87000 Overseas Highway	Local government	Yes	N/A	100-Year
Government Center Carpenter Shop	50 High Point Road	Local government	No	1.32	100-Year
Government Center Ellis Building	50 High Point Road	Local government	No	-1.07	100-Year
Green Turtle Hammock Library	81224 Overseas Highway	Local Government	No	-0.67	500-Year
Green Turtle Hammock Russell Cottage	81224 Overseas Highway	Local Government	No	N/A	N/A
Islamorada County Library	81840 Overseas Highway	Local government	Yes	N/A	500-Year
PK Courthouse	88000 Overseas Highway	Local government	No	-0.54	100-Year
Plantation Detention Center	53 Highpoint Road	Local government	No	-0.74	100-Year
Plantation Key Govt. Center	88820 Overseas Highway	Local government	Yes	N/A	100-Year
Plantation Key Public Works Yard	186 Key Heights Dr.	Local government	No	N/A	100-Year
Public Library (lease)	81830 Overseas Highway	Local government	No	N/A	N/A
Spottswood Building-Public Works	88770 Overseas Highway	Local government	No	N/A	N/A
Coral Shores High School	89901 Old Highway	School	N/A	N/A	N/A
Pace Upper Keys School	89015 Overseas Highway	School	No	N/A	100-Year
Plantation Key School	100 Lake Rd	School	No	N/A	100-Year
Treasure Village Montessori Charter School	86731 Overseas Highway	School	No	3.36	100-Year

⁴ ElevCer column indicates if facility's finished floor elevation was modeled using Elevation Certificate data from the Monroe County Floodplain Coordinator's office ("Yes") or an assumed value of 2 feet above ground level ("No"). Depth is reported as feet above finished floor elevation based on the depth grid from the Hazus-MH Coastal Flood Model. FIRM Zone indicates the flood zone delineation for the facility's location within the current Flood Insurance Rate Map for Monroe County. **Bolded facilities are owned by the Village of Islamorada.**

Table 5: Flood Exposure of Disaster Preparation and Response Facilities with Hazus-MH Coastal Flood Model and Potential Future Conditions⁵

Building	Type	2060 Low	2060 High	2100 Int-High
Fire Station #19	Fire	5.99	7.67	9.80
Islamorada Fire\EMS #20	Fire	N/A	N/A	N/A
MCSO Roth Building	Police	1.09	2.78	4.91
Plantation Key MCSO Sub-Station	Police	-0.69	0.85	3.16
Island Christian School	Refuge of Last Resort	1.08	2.62	4.75
St. James Episcopal Plantation Key	Refuge of Last Resort	2.36	3.32	5.45
Island Christian School Field	Staging	2.89	4.52	6.65
Plantation Yacht Harbor	Staging	7.42	7.93	10.06

Table 6: Flood Exposure of Utilities Facilities with Hazus-MH Coastal Flood Model and Potential Future Conditions⁵

Building	Type	2060 Low	2060 High	2100 Int-High
FKEC Ellis Facility Islamorada	Energy	N/A	0.78	3.09
Monroe County Fleet	Energy	N/A	0.98	3.29
Pump Station	Wastewater	4.41	6.09	8.22

Table 7: Flood Exposure of Hazardous Facilities with Hazus-MH Coastal Flood Model and Potential Future Conditions⁵

Building	Type	2060 Low	2060 High	2100 Int-High
Fuel Island/Pumps	Hazardous materials	-0.12	1.42	3.73
Fuel Tank (8,000 gallons)	Hazardous materials	-0.29	1.25	3.56

⁵ Future conditions Hazus-MH Coastal Flood Models included sea-level rise of 14” for 2060 Low, 26” for 2060 High; and 4.13’ for 2100 Intermediate High. Addresses and method for determining finished floor elevation for each facility are described in Table 6. All numeric values are in flood depth feet above finished floor elevation. **Bolded facilities are owned by the Village of Islamorada.**

Table 8: Flood Exposure of Essential and Municipal Services Facilities with Hazus-MH Coastal Flood Model and Potential Future Conditions⁶

Building	Type	2060 Low	2060 High	2100 Int-High
Island Christian School Site	DMS	2.20	3.83	5.96
Tavernier Airport Site	DMS	1.88	1.54	3.67
Plantation Key Convalescent Center	Health	3.32	5.00	7.13
Senior Center/AARP	Health	2.17	6.14	8.27
#65 County Offices	Local government	3.59	5.24	7.37
Administrative Center & Public Safety	Local government	N/A	1.83	4.14
Founders Park Community Center	Local government	N/A	N/A	N/A
Government Center Carpenter Shop	Local government	2.25	3.94	6.07
Government Center Ellis Building	Local government	0.09	1.58	3.71
Green Turtle Hammock Library	Local government	0.63	1.79	3.91
Green Turtle Hammock Russell Cottage	Local government	0.00	1.17	3.48
PK Courthouse	Local government	0.47	2.05	4.18
Plantation Detention Center	Local government	0.39	2.00	4.13
Plantation Key Govt. Center	Local government	N/A	-1.49	0.64
Plantation Key Public Works Yard	Local government	-0.18	1.38	3.69
Public Library (lease)	Local government	N/A	N/A	N/A
Spottswood Building-Public Works	Local government	-0.54	0.97	3.28
Coral Shores High School	School	N/A	N/A	N/A
Pace Upper Keys School	School	-0.53	1.16	3.47
Plantation Key School	School	N/A	N/A	N/A
Treasure Village Montessori Charter School	School	4.44	5.74	7.87

⁶ Future conditions Hazus-MH Coastal Flood Models included sea-level rise of 14” for 2060 Low, 26” for 2060 High; and 4.13’ for 2100 Intermediate High. Addresses and method for determining finished floor elevation for each facility are described in Table 7. All numeric values are in flood depth feet above finished floor elevation. **Bolded facilities are owned by the Village of Islamorada.**

Comprehensive Property Damage Assessment

The Hazus-MH Coastal Flood Model was used to develop damage assessments for the 100-Year coastal flood for all property parcels located within the Village of Islamorada. Characteristics used in the damage assessment included 2014 assessed valuations from the Monroe County Property Appraiser, land use and occupancy types, building construction materials, finished floor substructure type, and year of construction for each parcel. Assumption for finished floor elevations were based on floor substructure type and year of construction, as summarized in Table 9. The break point of 1975 for assuming higher finished floor elevation types by floor type is based on Monroe County code requiring structures built after December 31, 1974 to meet or exceed the adopted base flood elevation (<https://www.monroecounty-fl.gov/692/Building-Requirements>).

Table 9: Finished floor elevation assumptions for Village of Islamorada structures

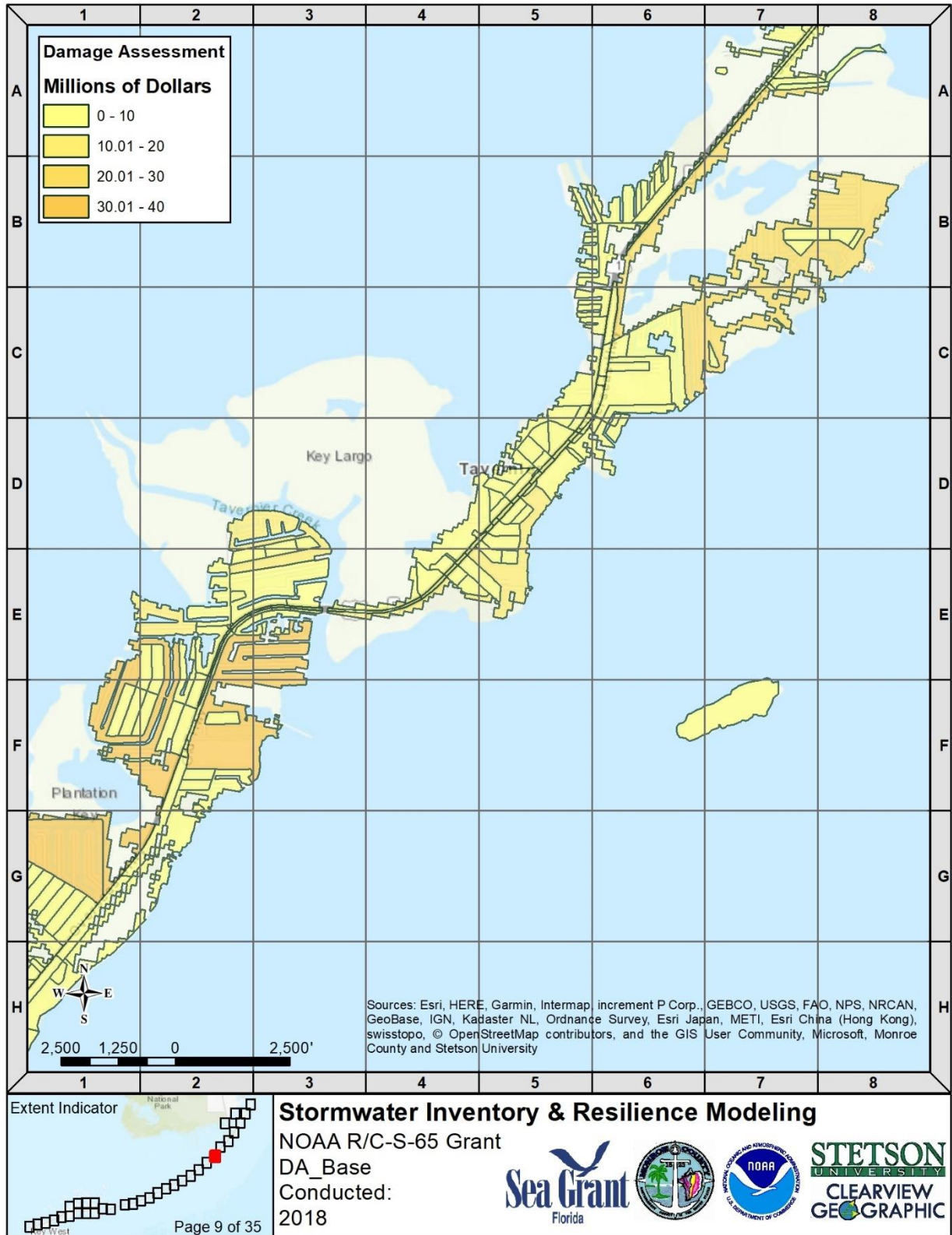
Floor Type	Year Built	Finished Floor Elevation (Feet Above Ground)
Slab or Unknown	Pre-1975	1
Slab or Unknown	Post-1975	2
Pier	Pre-1975	3
Pier	Post-1975	4

Damage assessments using flood depth-damage curves were then performed for the base 100-Year flood within the Hazus-MH Coastal Flood Model, as well as the 2060 Low, 2060 High, and 2100 Intermediate-High sea-level rise scenarios. A summary of the dollar values-based property damage assessments for all considered flood scenarios across the Village of Islamorada is provided as Table 10. Map visualizations for Hazus-MH damage assessments the Village of Islamorada as summed to Census Block Group geographies and as excerpted from the full damage assessments performed across the inhabited portions of Monroe County, are provided as Map Series 1 (Baseline), Map Series 2 (2060 Low Sea-Level Rise), Map Series 3 (2060 High Sea-Level Rise), and Map Series 4 (2100 Intermediate-High Sea-Level Rise

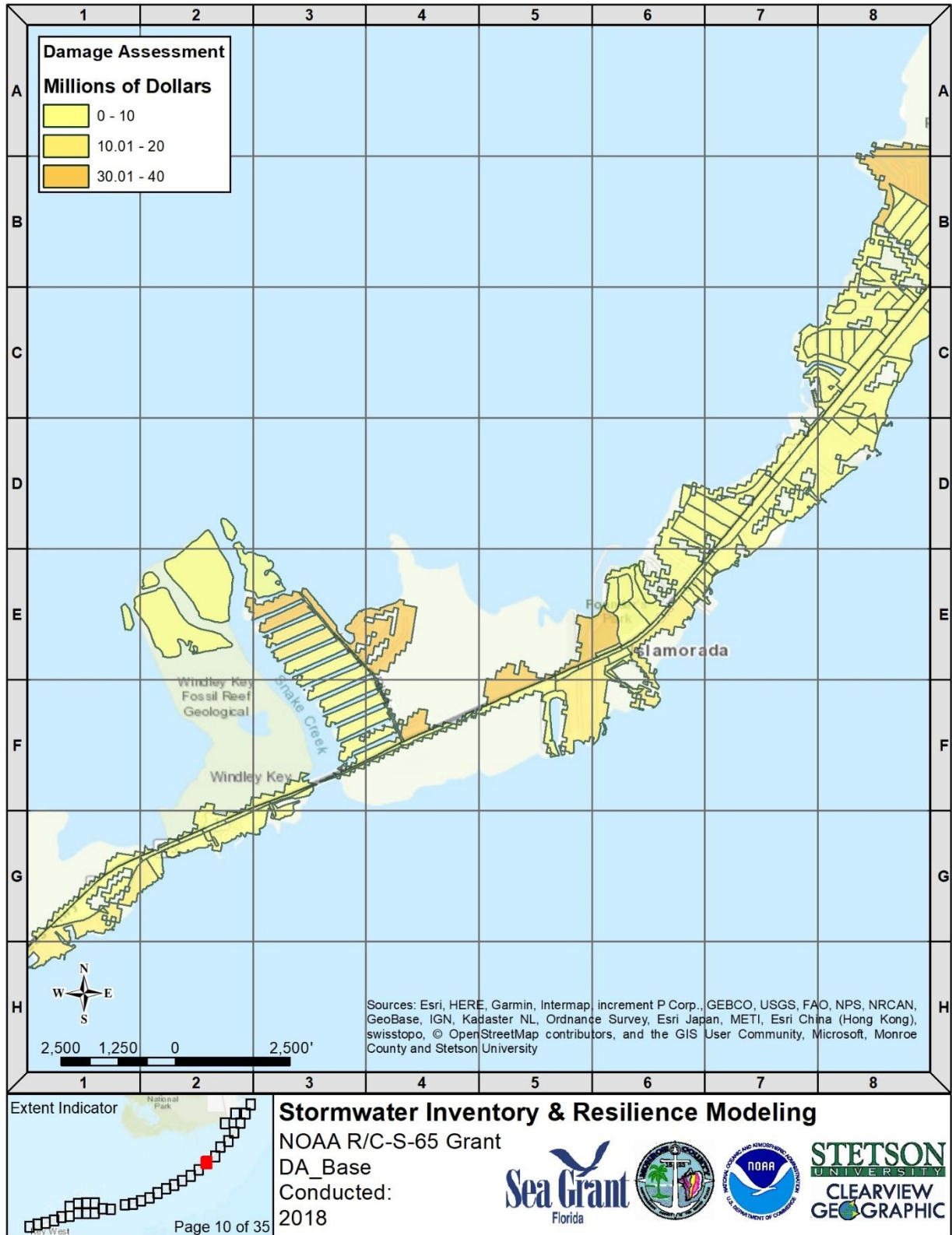
Table 10: Hazus-MH Property Damage Assessment for 100-Year Coastal Flood under Current and Future Conditions in Village of Islamorada

Hazus-MH 100-Year Coastal Flood Scenario	% Structures Damaged	Losses (2014 \$)
Base (Current sea level)	72.4%	\$696,470,000
2060 Low (14" sea-level rise)	78.1%	\$939,444,000
2060 High (26" sea-level rise)	85.8%	\$1,190,087,000
2100 Int-High (4.13' sea-level rise)	91.7%	\$1,411,540,000

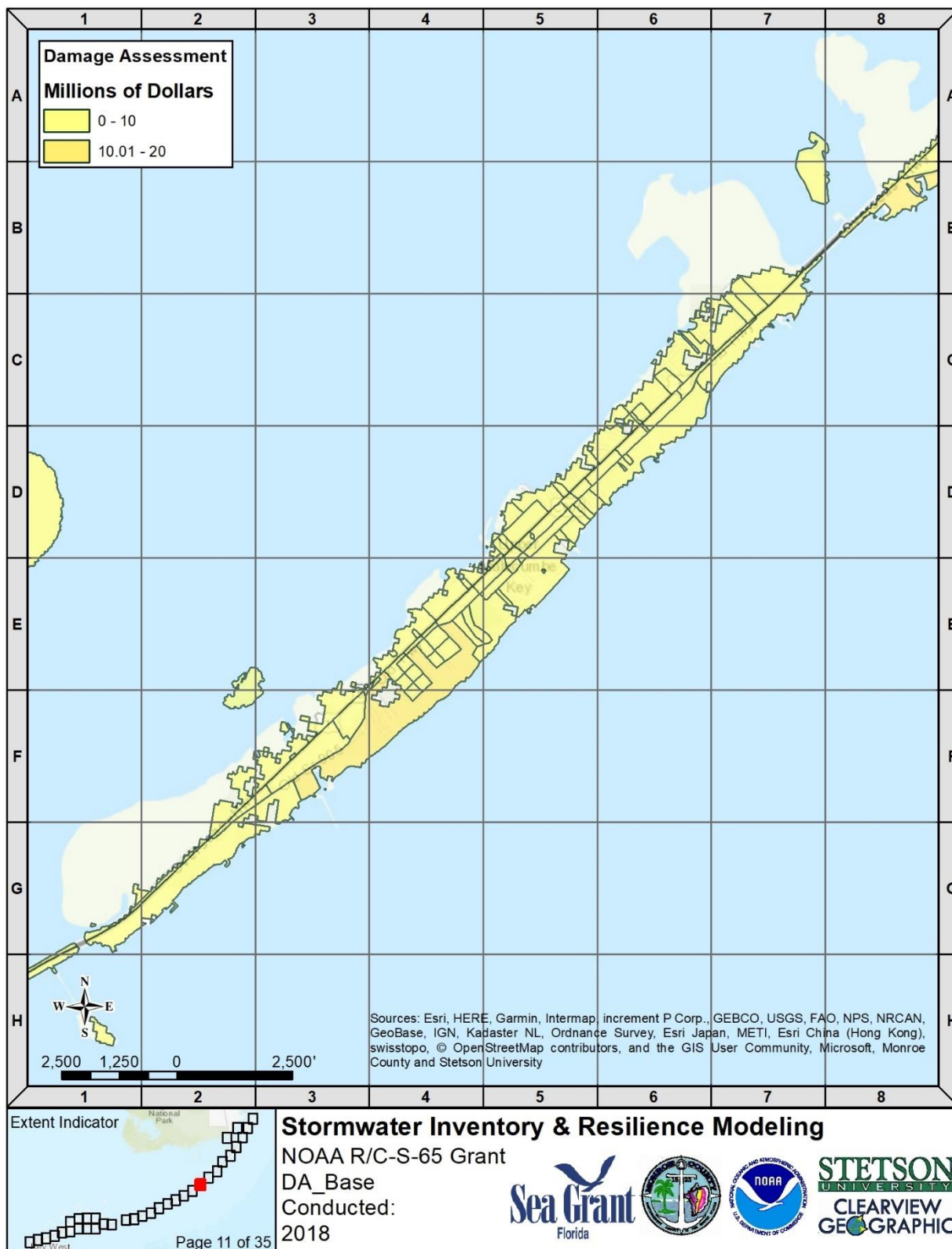
Map Series 1: Hazus-MH 100-Year Coastal Flood Model Damage Assessment
Baseline Scenario (1992 Sea Level) & 2014 Assessed Valuations



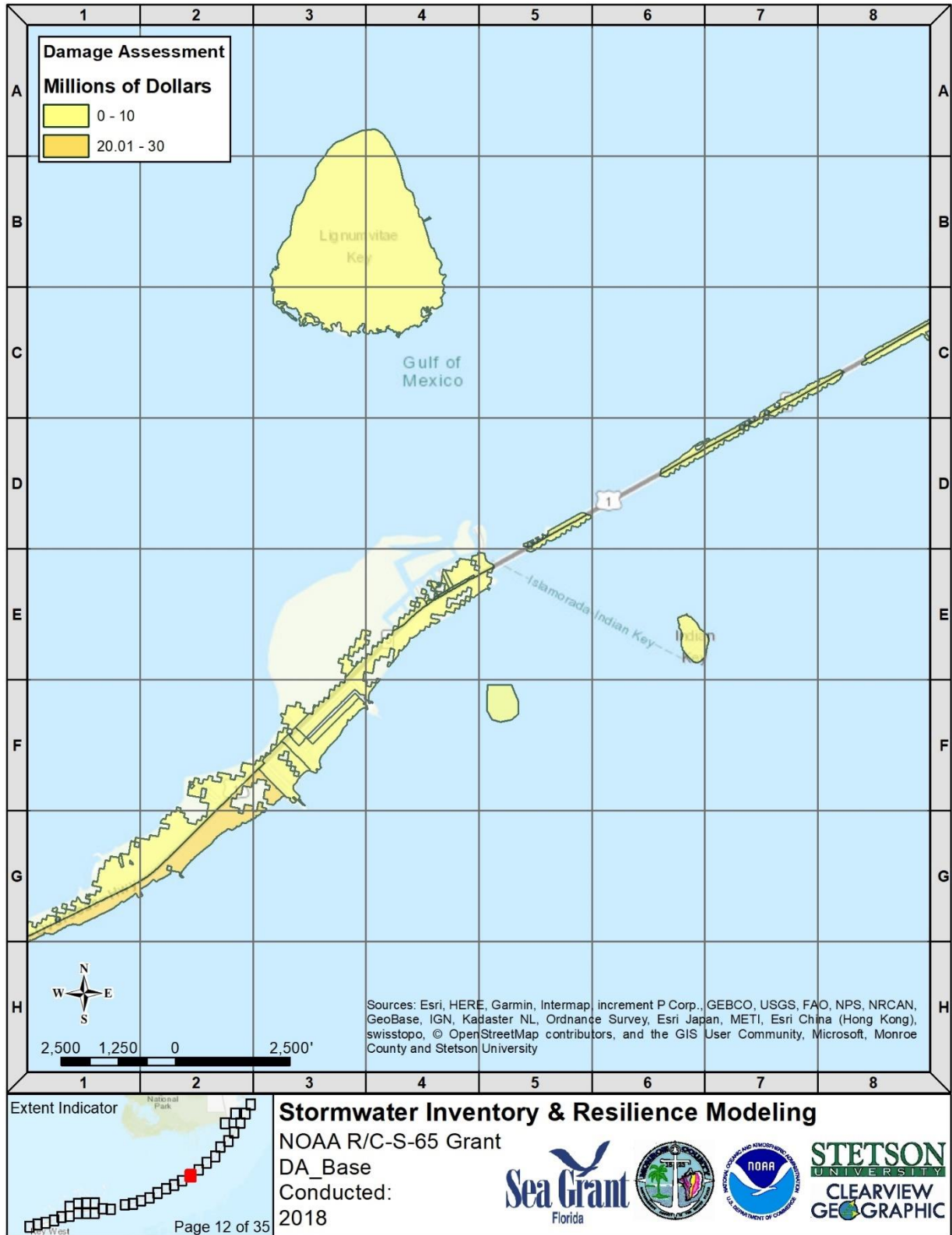
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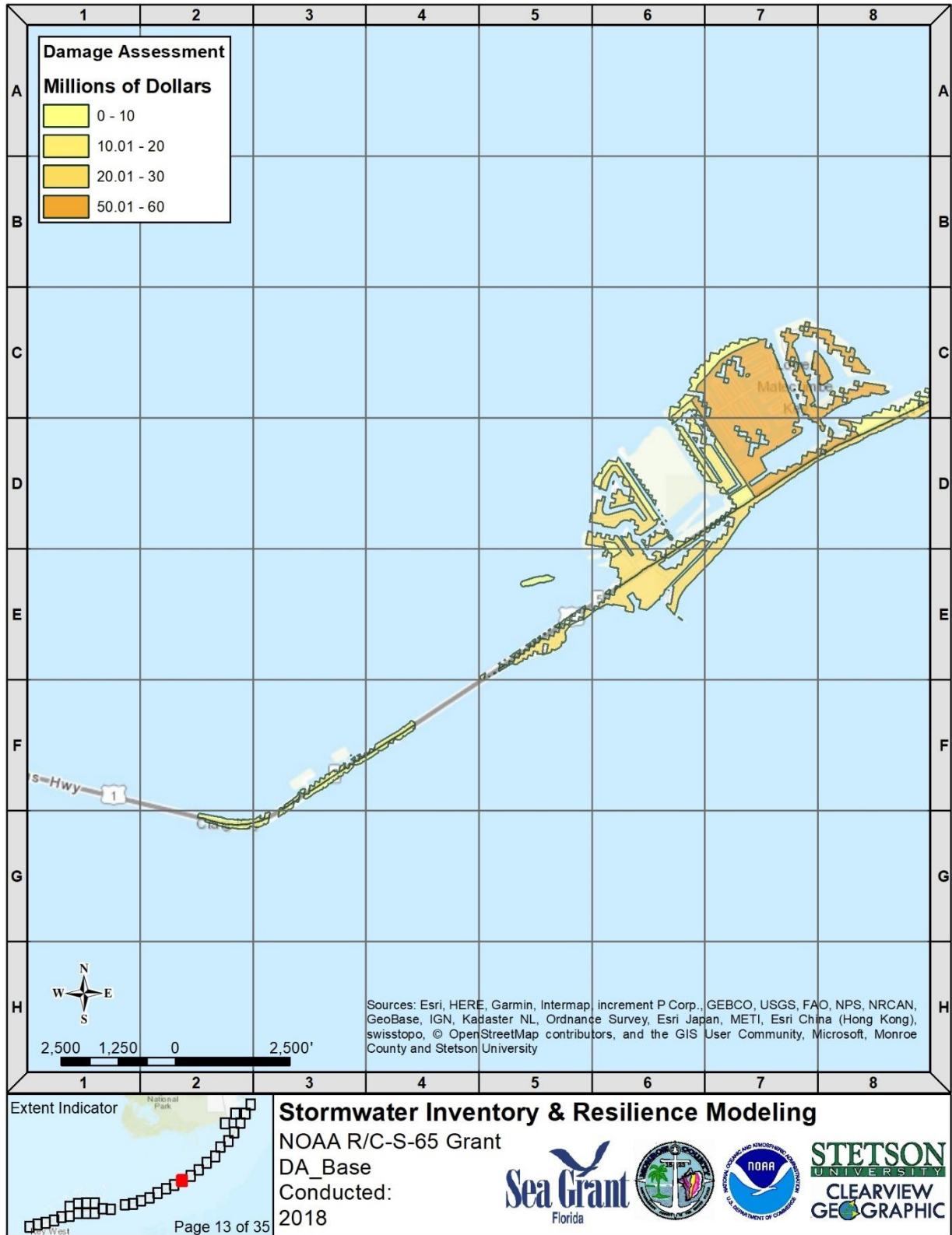
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Baseline Scenario (1992 Sea Level) & 2014 Assessed Valuations



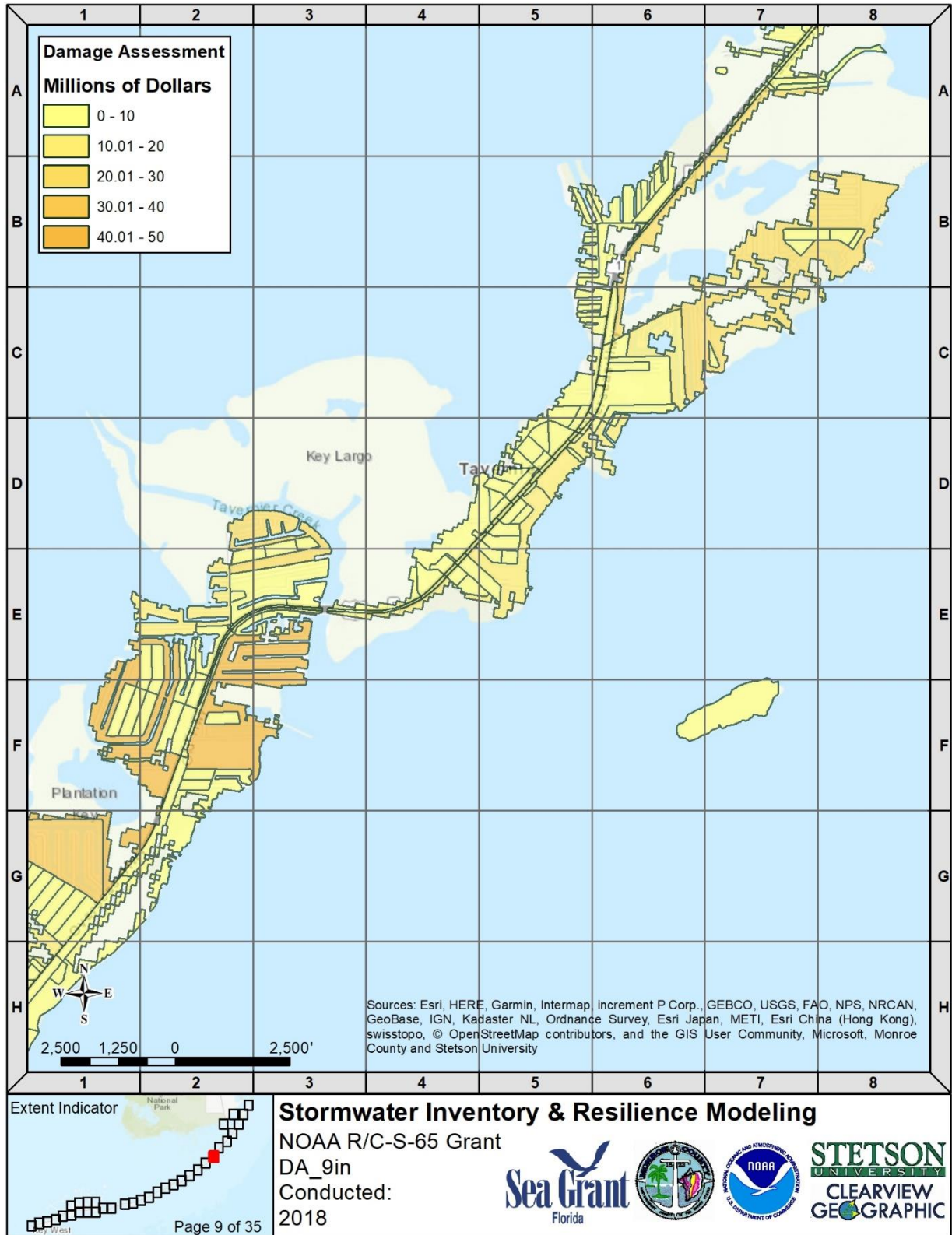
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 Baseline Scenario (1992 Sea Level) & 2014 Assessed Valuations



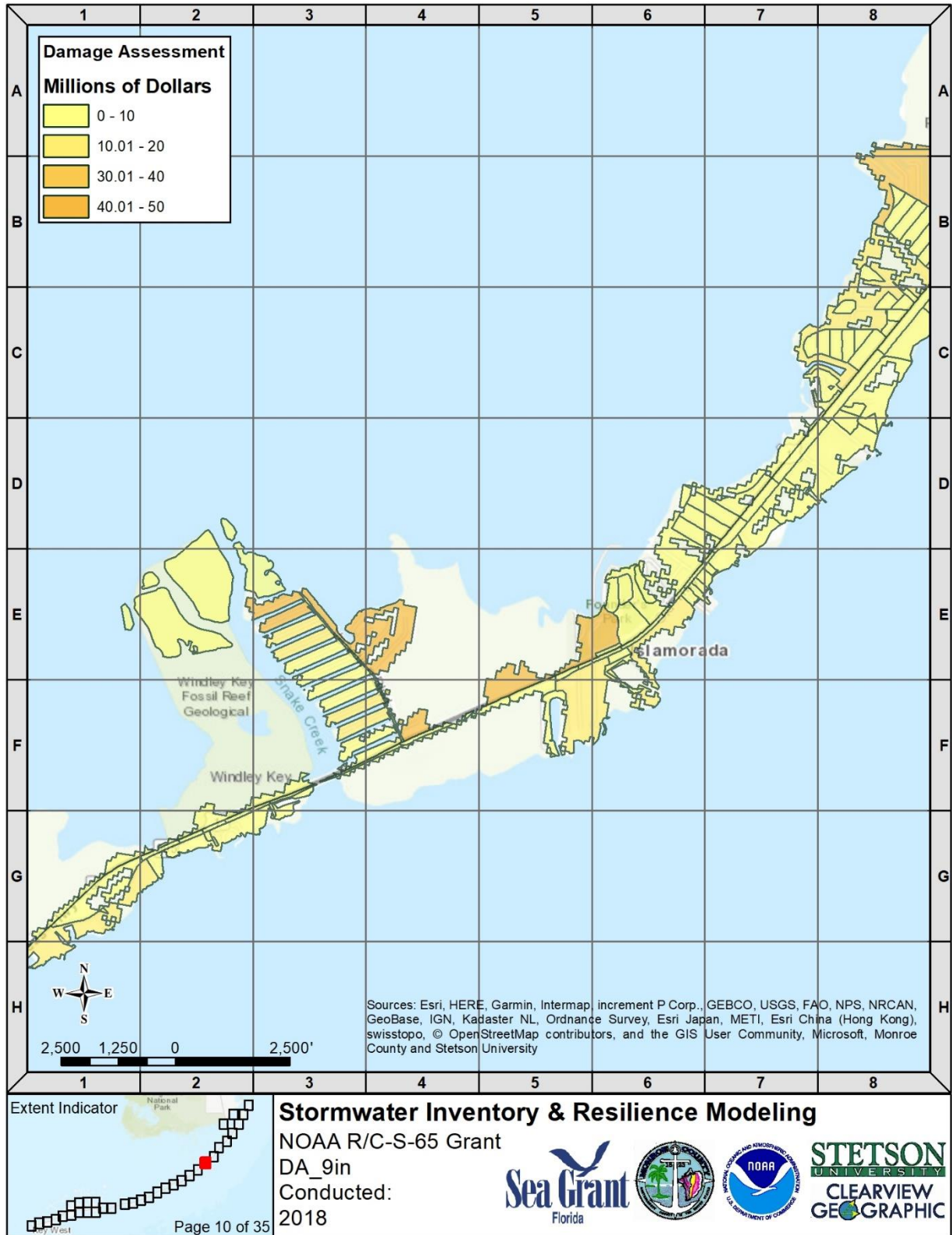
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 Baseline Scenario (1992 Sea Level) & 2014 Assessed Valuations



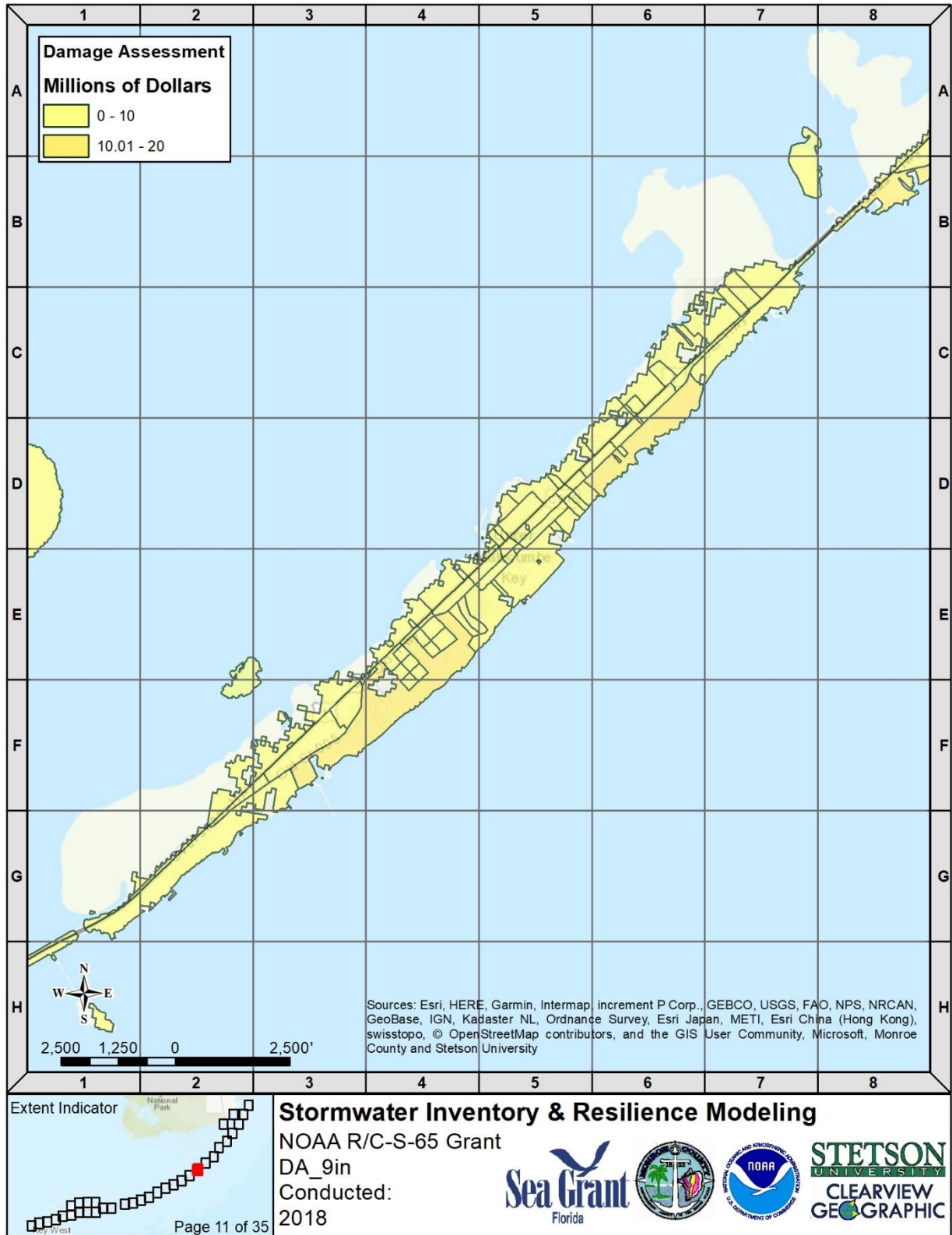
**Map Series 2: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 Low Sea-Level Rise & 2014 Assessed Valuations**



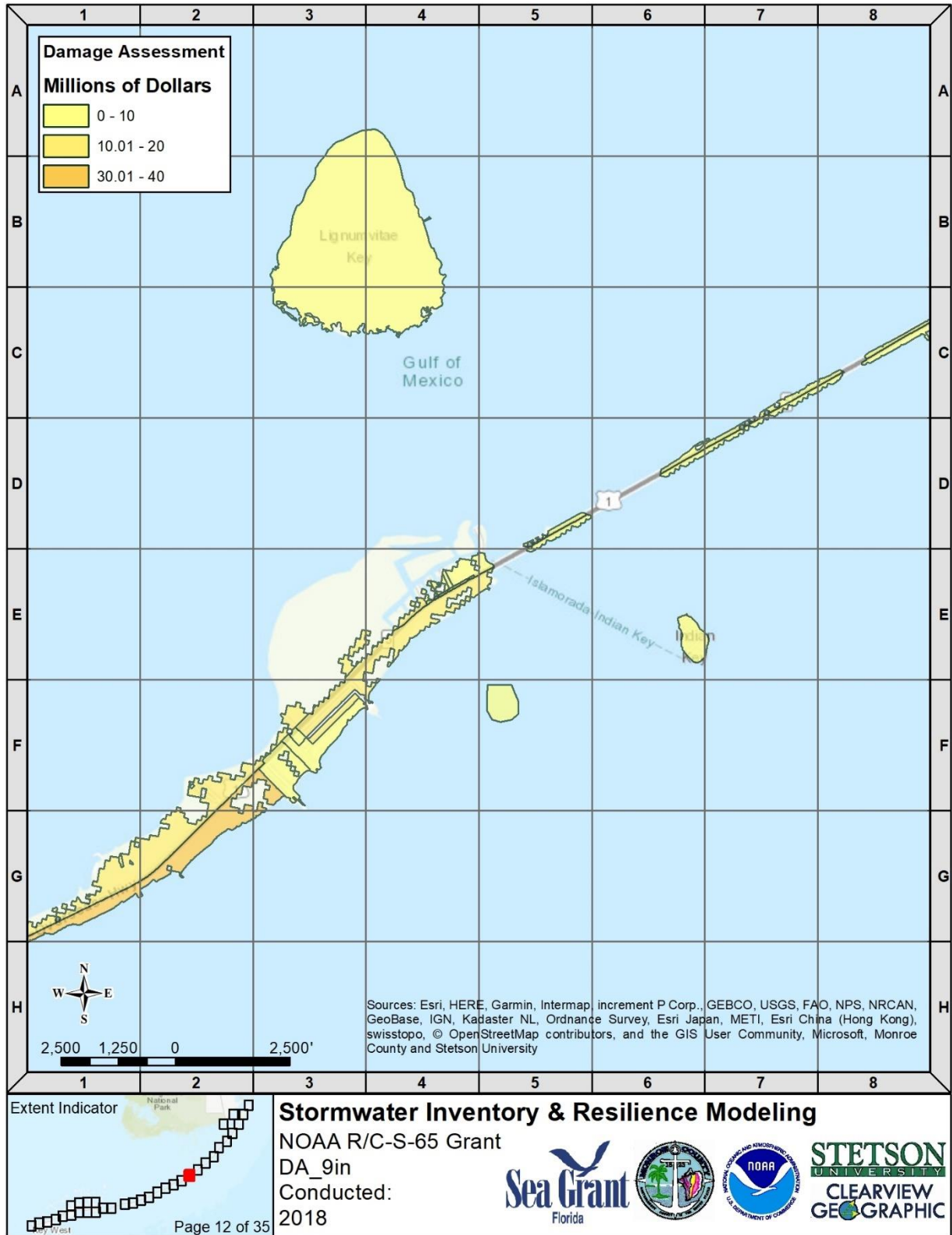
**Map Series 2: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 Low Sea-Level Rise & 2014 Assessed Valuations**



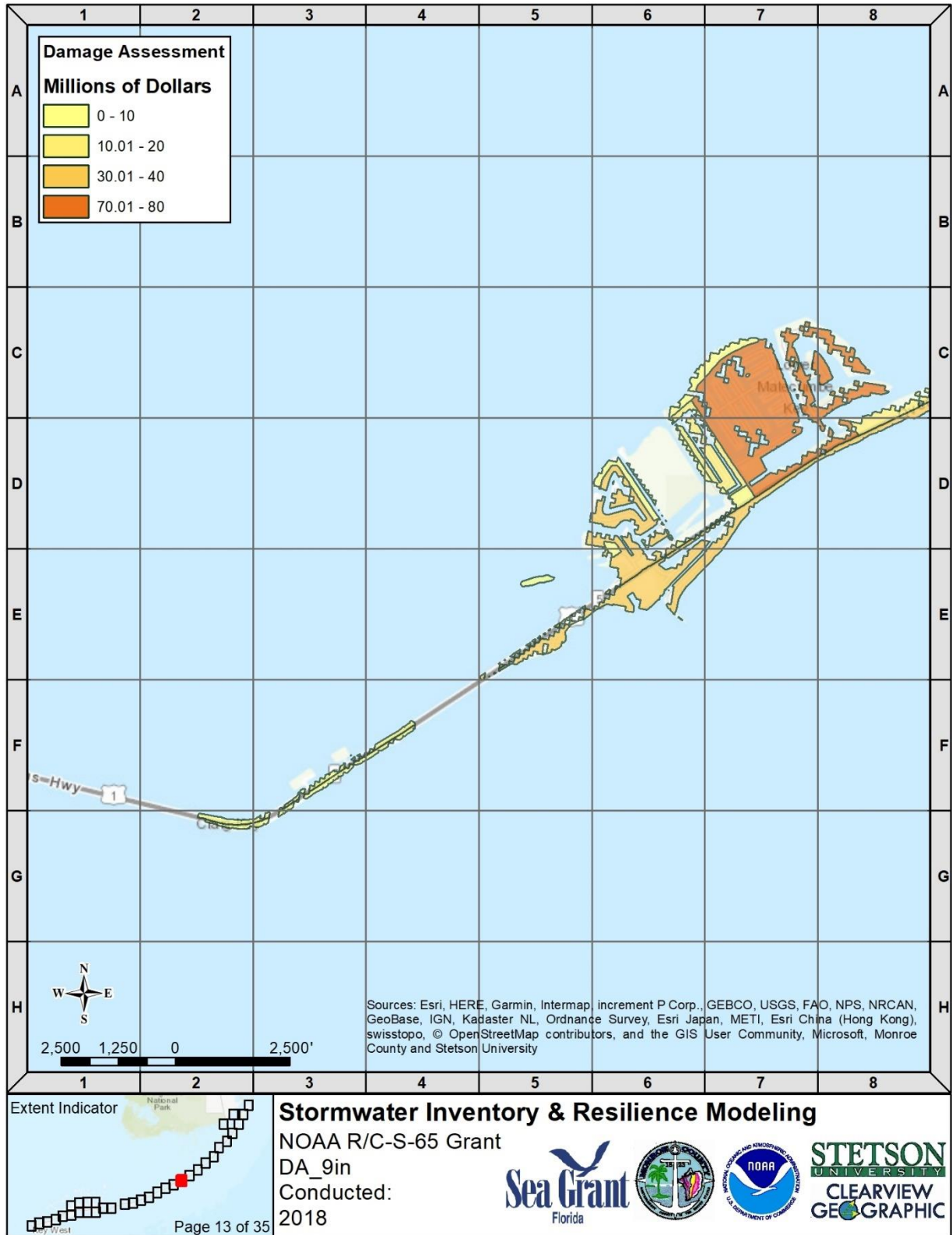
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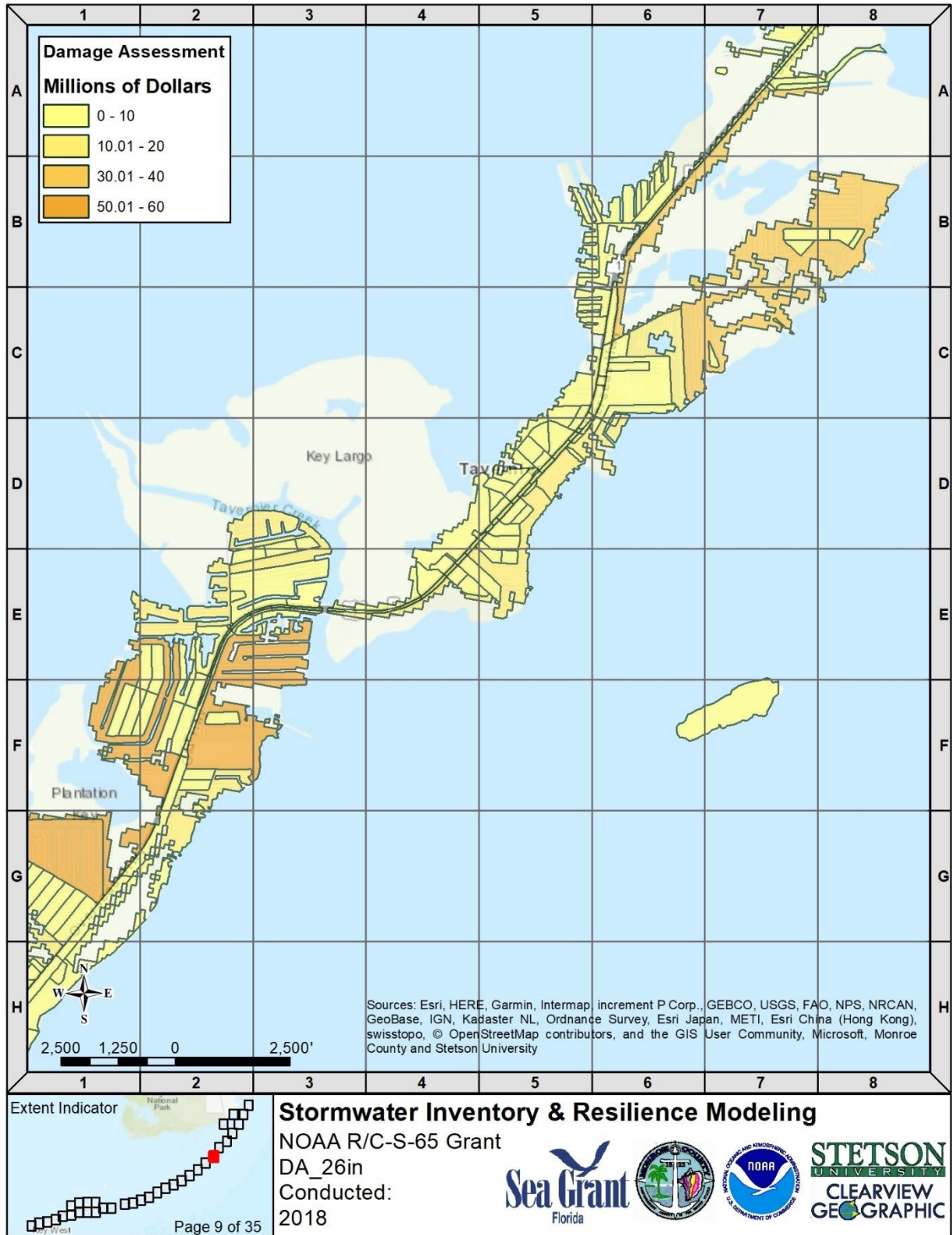
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2060 Low Sea-Level Rise & 2014 Assessed Valuations**



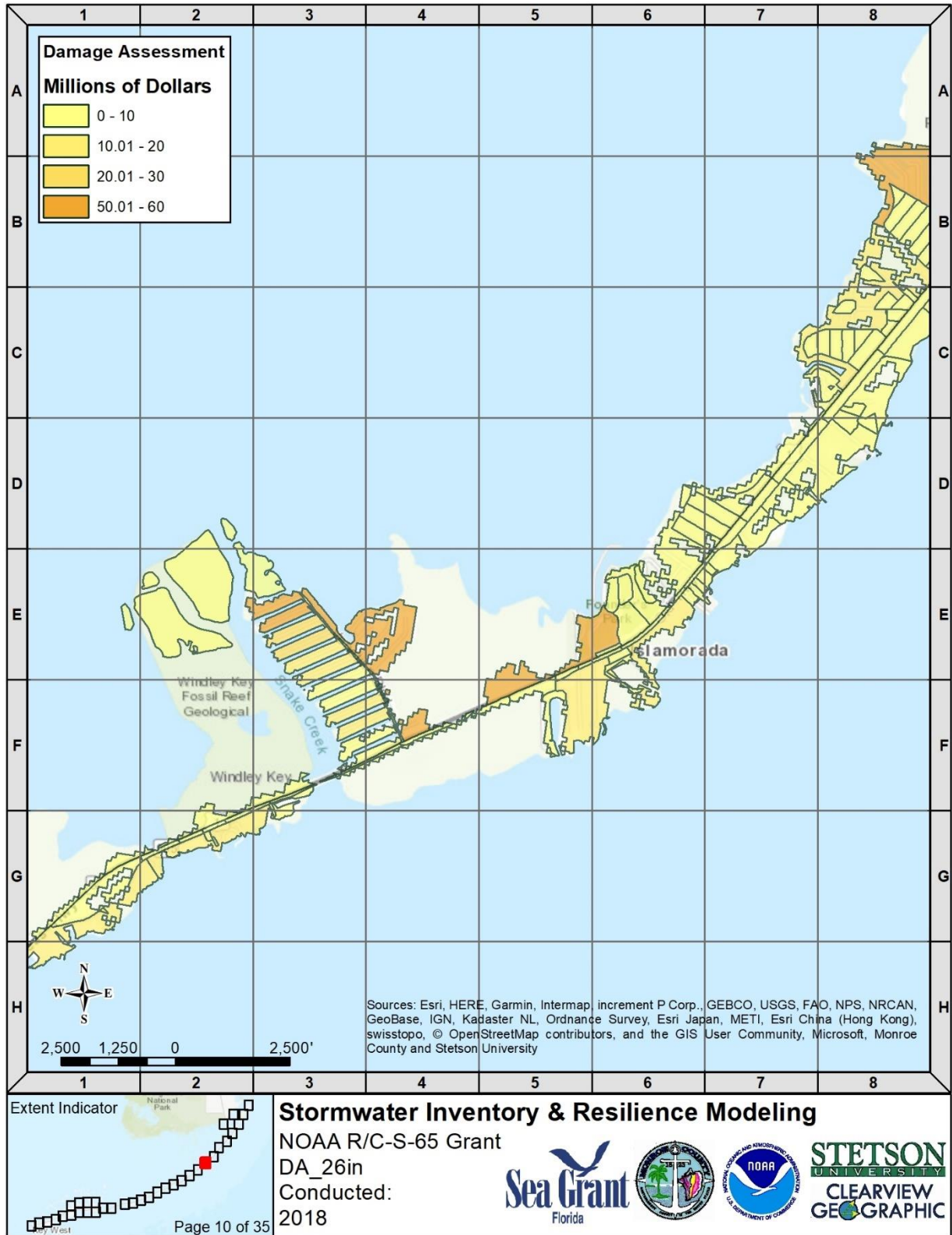
**Map Series 2: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 Low Sea-Level Rise & 2014 Assessed Valuations**



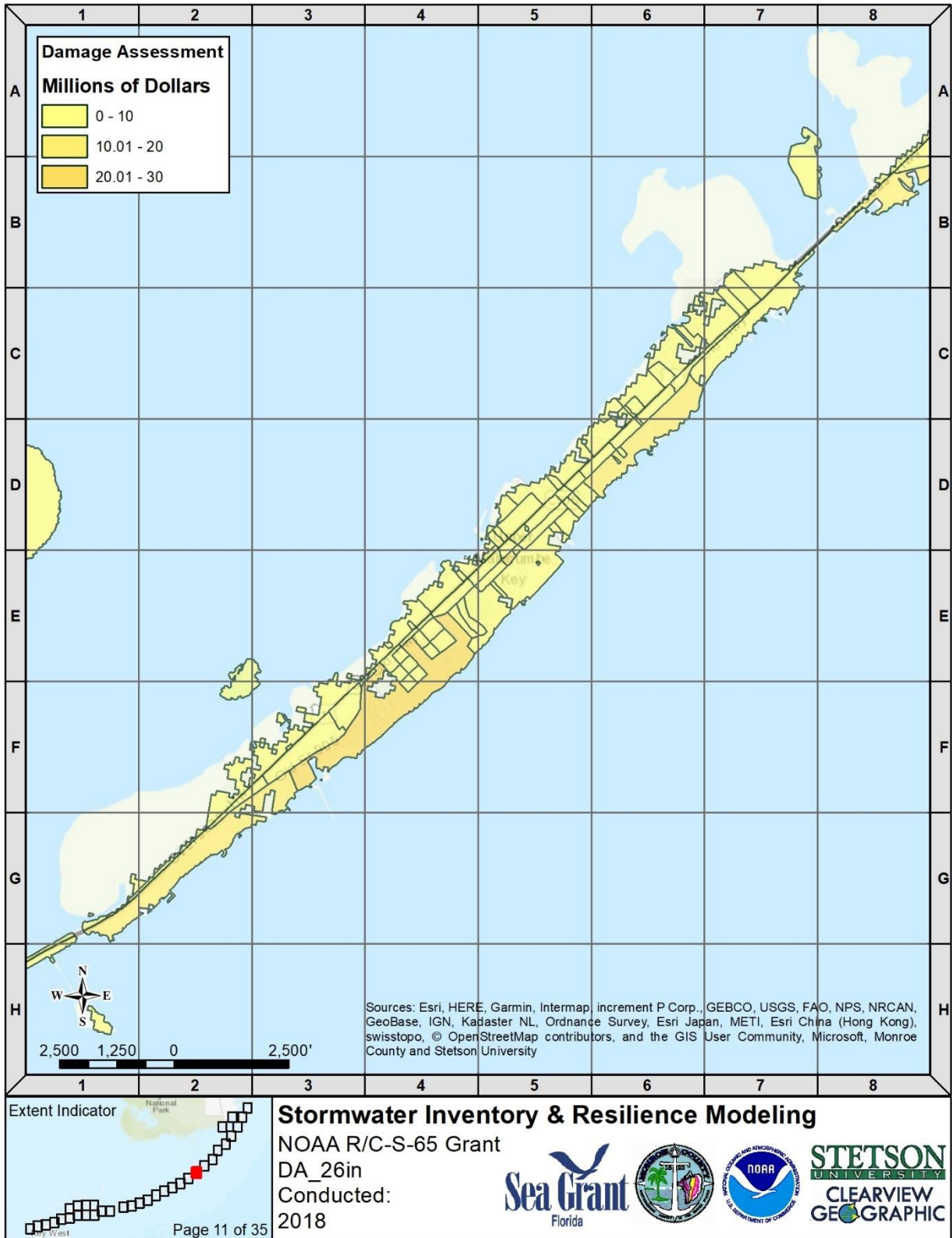
**Map Series 3: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 High Sea-Level Rise & 2014 Assessed Valuations**



**Map Series 3: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 High Sea-Level Rise & 2014 Assessed Valuations**



**Map Series 3: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 High Sea-Level Rise & 2014 Assessed Valuations**



Damage Assessment
Millions of Dollars

- 0 - 10
- 10.01 - 20
- 20.01 - 30
- 30.01 - 40

Gulf of Mexico

Lignumvitae Key

Islamorada Indian Key

Indian Key

Stetson University

2,500 1,250 0 2,500'

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community, Microsoft, Monroe County and Stetson University

Stormwater Inventory & Resilience Modeling
NOAA R/C-S-65 Grant
DA_26in
Conducted:
2018

Sea Grant
Florida

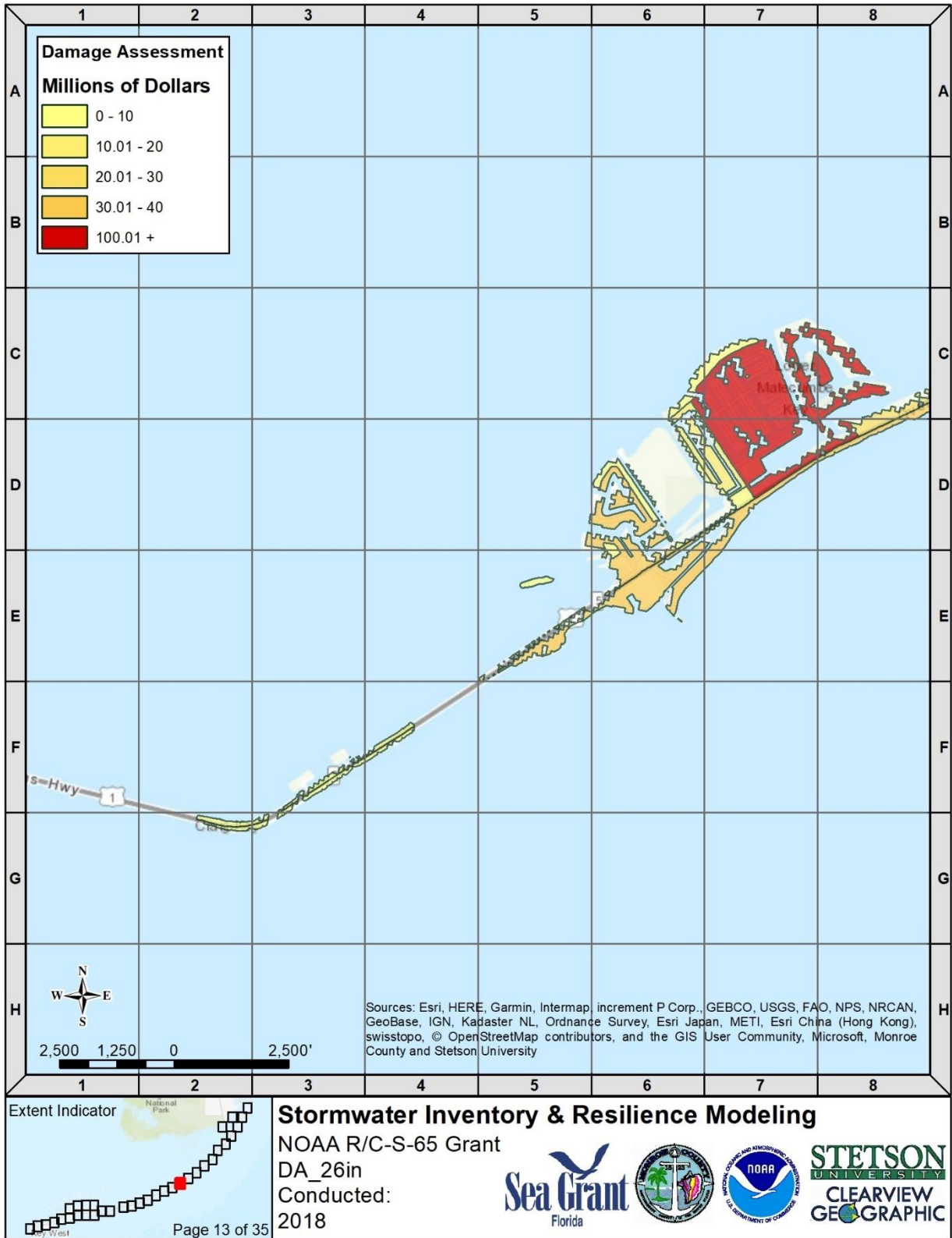
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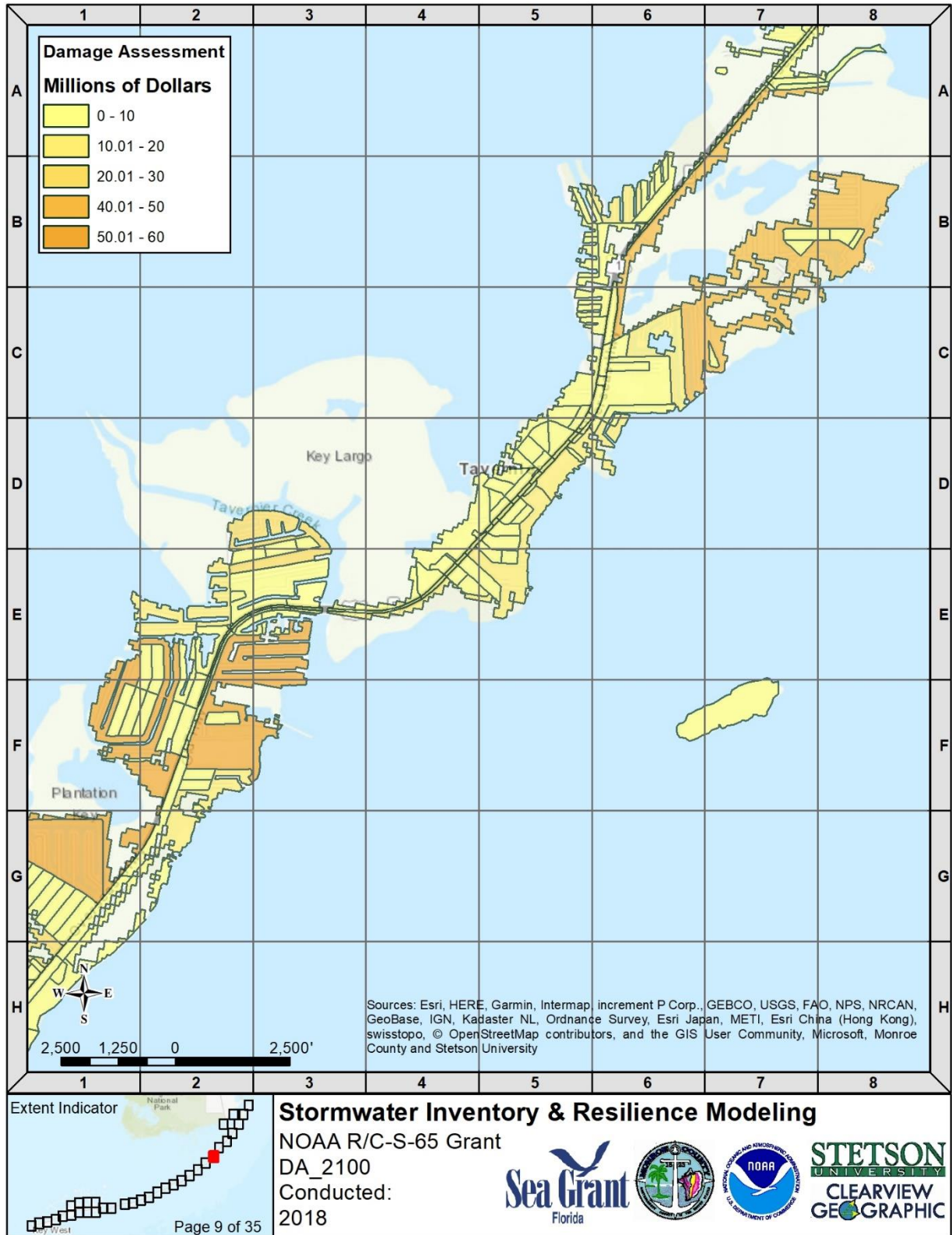
Extent Indicator

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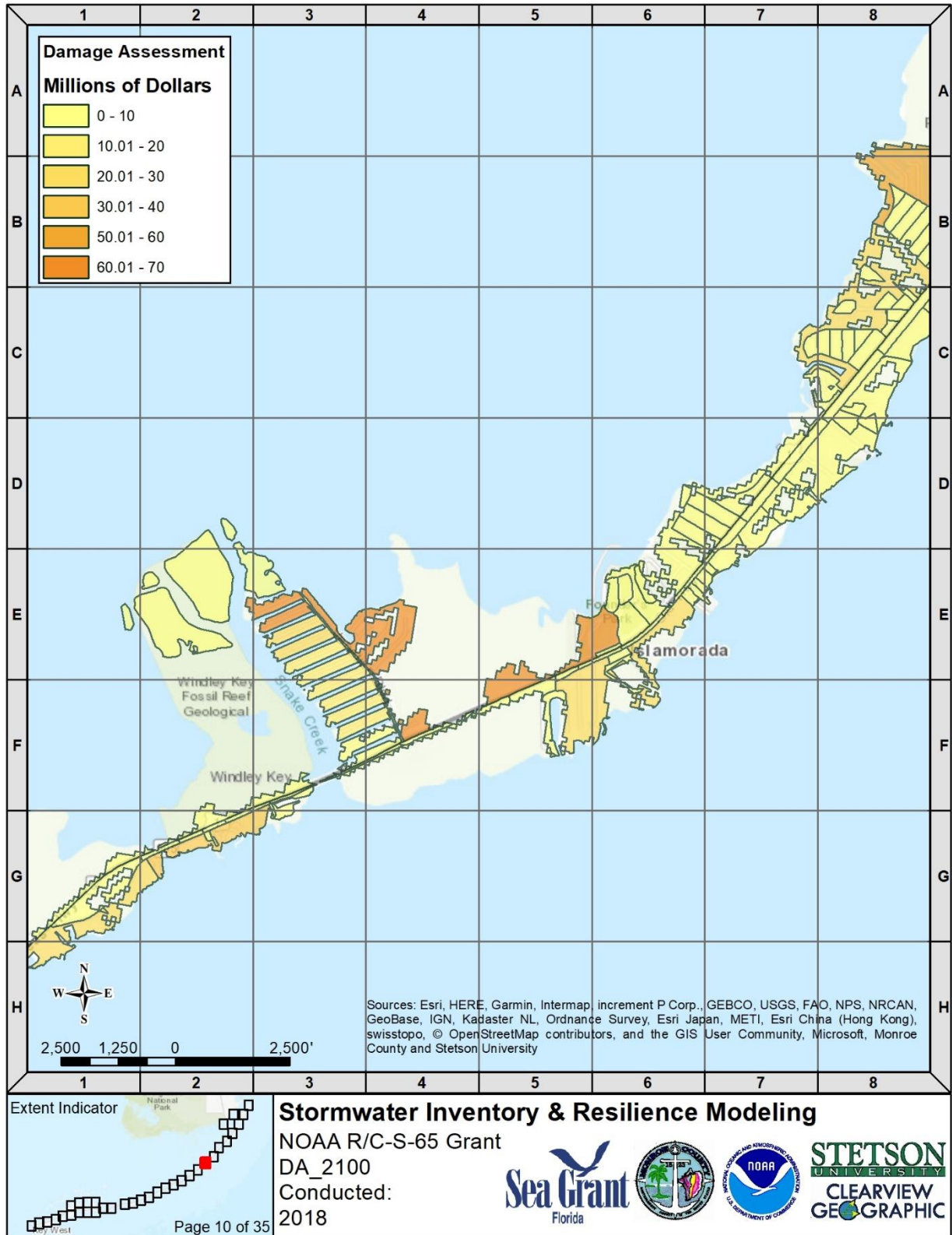
**Map Series 3: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2060 High Sea-Level Rise & 2014 Assessed Valuations**



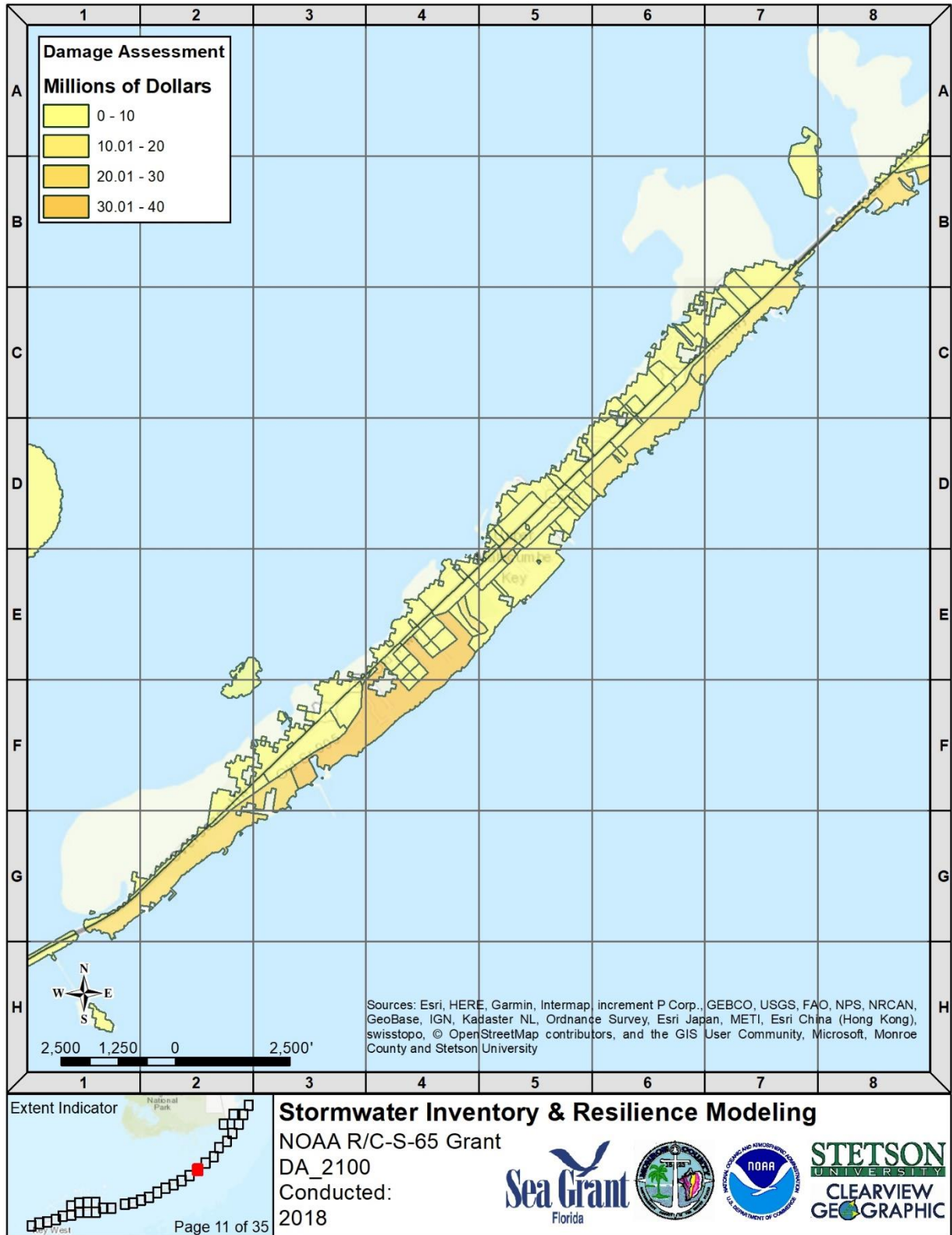
**Map Series 4: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2100 Intermediate High Sea-Level Rise & 2014 Assessed Valuations**



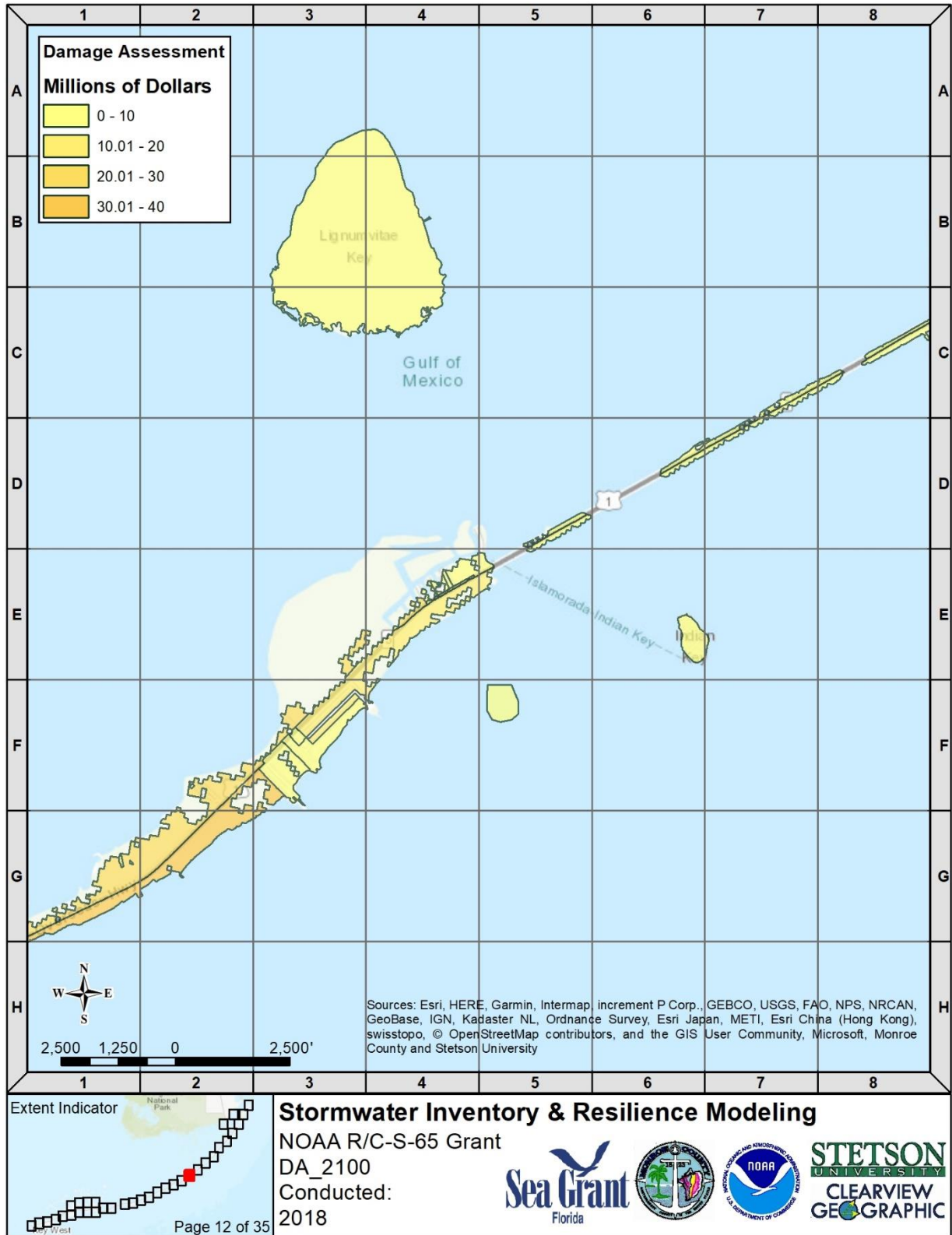
Map Series 4: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with 2100 Intermediate High Sea-Level Rise & 2014 Assessed Valuations



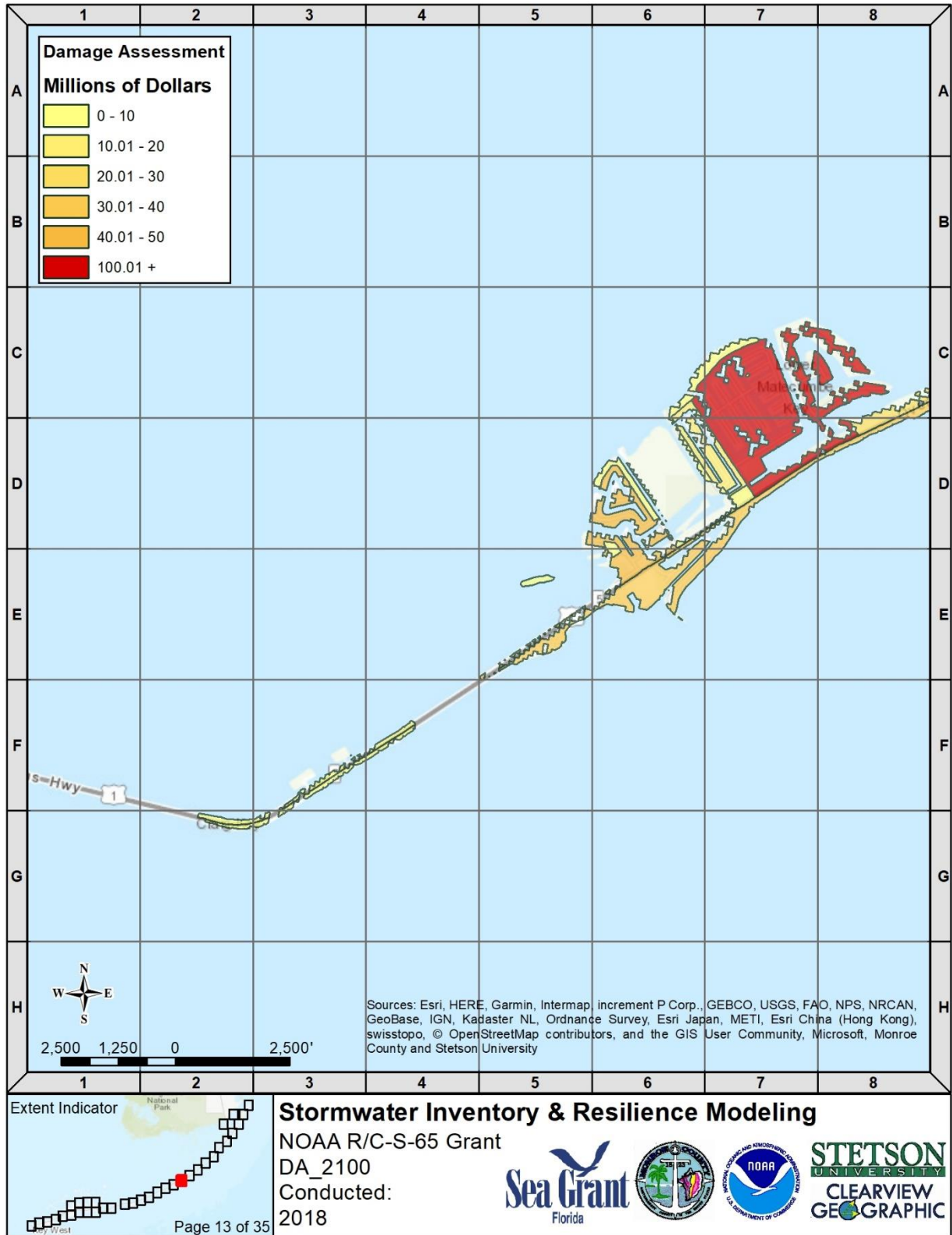
**Map Series 4: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2100 Intermediate High Sea-Level Rise & 2014 Assessed Valuations**



**Map Series 4: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2100 Intermediate High Sea-Level Rise & 2014 Assessed Valuations**



**Map Series 4: Hazus-MH 100-Year Coastal Flood Model Damage Assessment with
2100 Intermediate High Sea-Level Rise & 2014 Assessed Valuations**



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