University of the Philippines Cebu
Master of Science in Environmental Studies

Geographic Information Systems
(ENS 281)

Are Mangroves in Mactan Island at Risk?

Assessing the Exposure of Mangrove Forests in Mactan Island towards Environmental Hazards

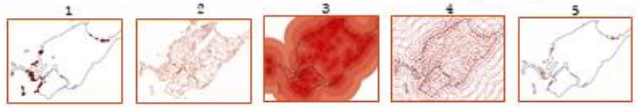
Presented by:
Mark Anthony A. Cabanlit

Introduction

Mangroves have been proven to be a very beneficial key habitat in coastal areas. It is home to various species and provides protection services along coastal communities *(Guannel et al, 2018)*. However, systematic long-term neglect of mangroves can lead to environmental degradation *(Koh et al, 2018)*. In conside-ration of the foregoing, this project aims to aid in the assessment of at-risk zones of mangrove forests by identifying areas with high exposure towards environmental hazards.

Data Analysis

In order to assess the exposure of mangroves in Mactan Island[1], seven different exposure factors *(criterion)* were collected[2] and multiple buffered distances were created for proximity analysis[3]. A union was performed on all vector layers from the factors together with the latest mangrove cover shapefile of the area of interest[4]. A calculation of percentage was then performed to estimate the at risk score of a certain mangrove patch[5].



There are two main measures for exposure: (1) severity of physical environment conditions which can be seen in the presence of anthropogenic structures, this features includes buildings, fishpond, ports, roads and traffic, and (2) long-term trends which includes (near) decadal mangrove loss detection.

The formula below shows the calculation for exposure:

$$Exposure_{(mgr)} = \frac{Factor_{1+Factor_2+\ldots+Factor_7}}{MAX(Factor_{1+\ldots Factor_n)}} * 100$$

A smoothing was then applied to the resulting shapefile for display purposes.

Citation / Attribution

Journal

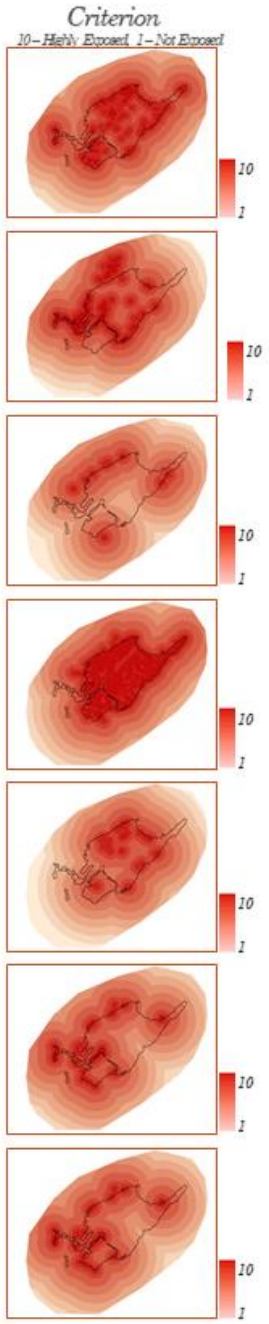
Alino, P.M, Follosco, N.M.G., Mamauag, S.S., Martinez, R.J.S., Panga, F.M., (2013). Vulnerability Assessment Tools for Coastal Ecosystems: A Guidebook. Marine Environment and Resources Foundation, Inc. Quezon C

Guannel G, Arkema K, Ruggiero P, Verutes G, (2018). The Power of Three: Protect Coastal Regions and Increase Their Resilience. PLoS ONE. 2016;11(7):1-22. doi:10.1371/journal.pone.0158094

Koh, H. L., Teh, S. Y., Kh'ng, X. Y., & Raja Barizan, R. S. (2018). Mangrove Forests: Protection against and Resilience to Coastal Disturbances. Journal of Tropical Forest Science, 30(5), 446–460.

Dataset

Mangrove Data for 1996, 2011 & 2016 ..... Global Mangrove Watch
Buildings, Fishpond, Roads, Traffic ..... Open Street Map (OSM)
Seaports ..... Visual Inspection through Google Earth
Satellite Image and Basemap Image ..... USGS LandSat 8



To aid in the assessment of at-risk areas of mangrove forests by identifying areas with high exposure towards environmental hazards.

MAIN OBJECTIVE

Related Literature

A SHORT REVIEW ON MANGROVES

Mangrove Forests

Mangrove forests live in the tropical and subtropical regions at the interface between terrestrial and marine environments (Koh et. Al, 2018). As a community, mangroves thrive in a wide range of harsh environmental conditions and they share unique adaptive traits such as salt-excreting leaves, an exposed breathing root system, and production of viviparous propagules (Duke, 1992). Mangrove habitats are ecologically important because they provide valuable ecosystem goods and services to coastal populations.

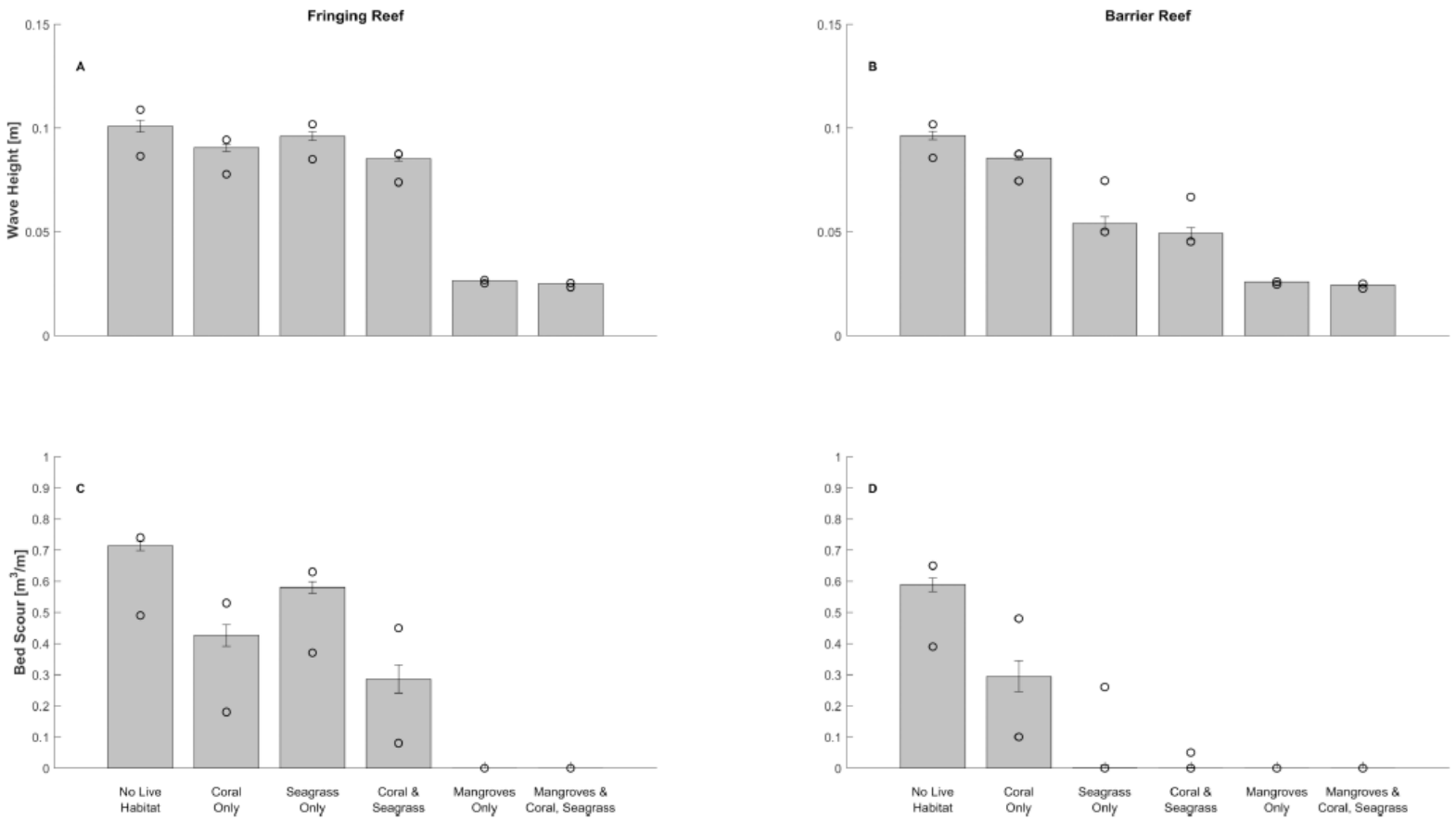
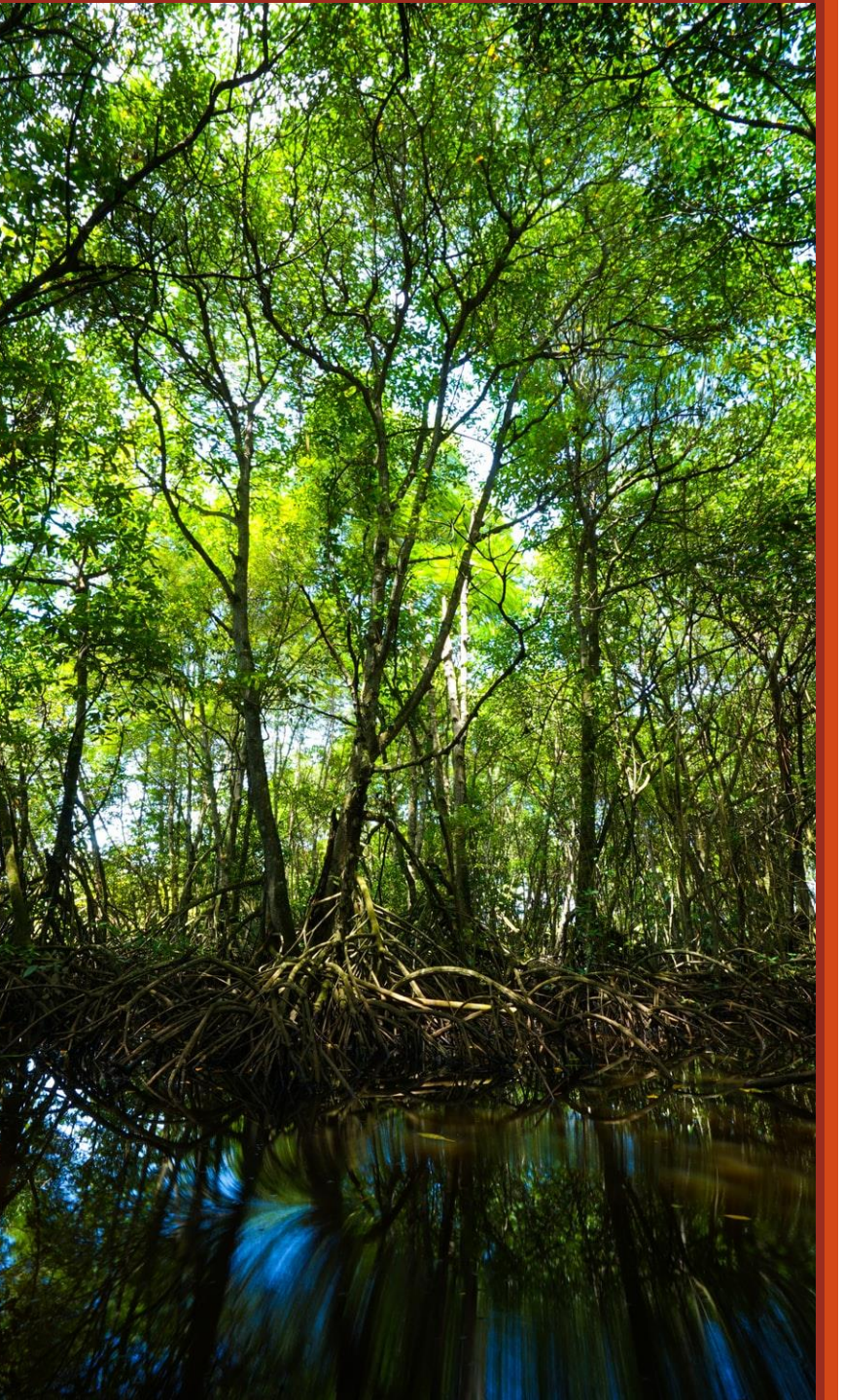
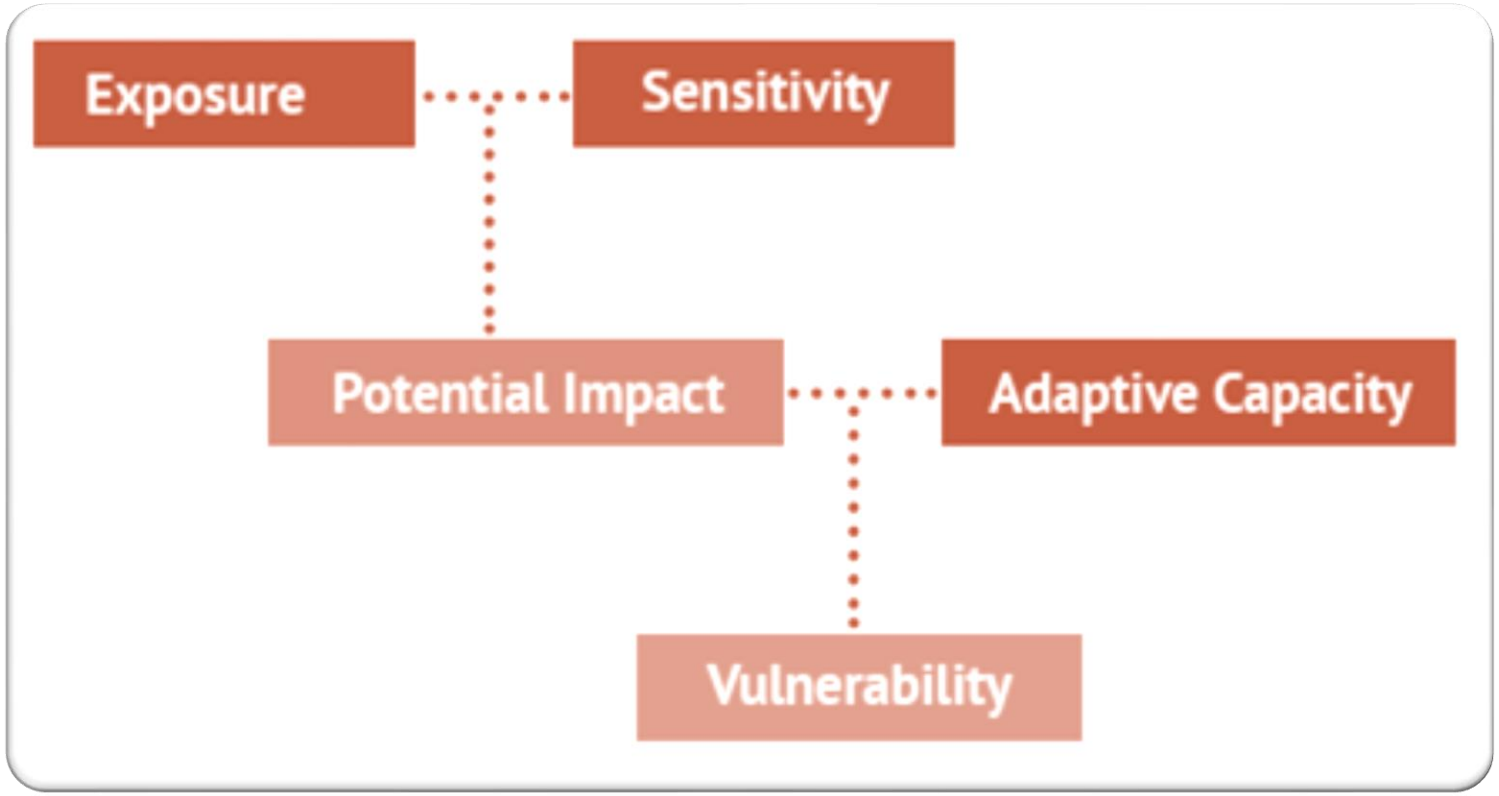


Fig 7. Protective role of corals, seagrasses and mangroves during non-storm conditions under present sea-level conditions. Bar plot of average wave height at the shoreward edge of the submerged mangrove forest (top subplots) and bed scour volume over the submerged mangrove forest (bottom subplots) computed for different combinations of live reef, seagrass meadows and mangroves presence, under present sea-level conditions. Vertical tick marks indicate 1 standard deviation value around the mean. Circles represent minimum and maximum values. See S5 Fig for box plot version of this figure for a future sea-level rise scenario.

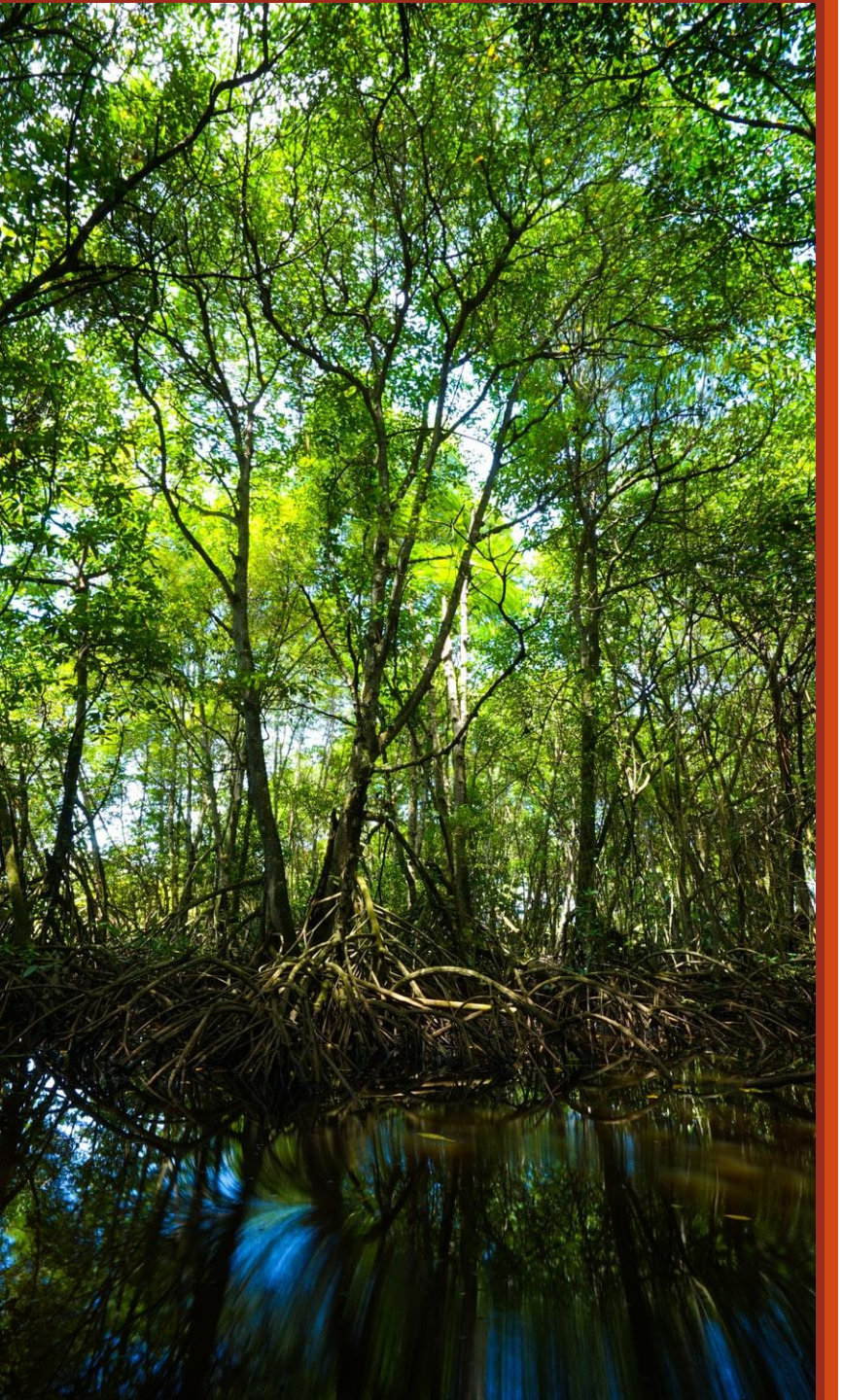
Guannel at al (2018)



Exposure



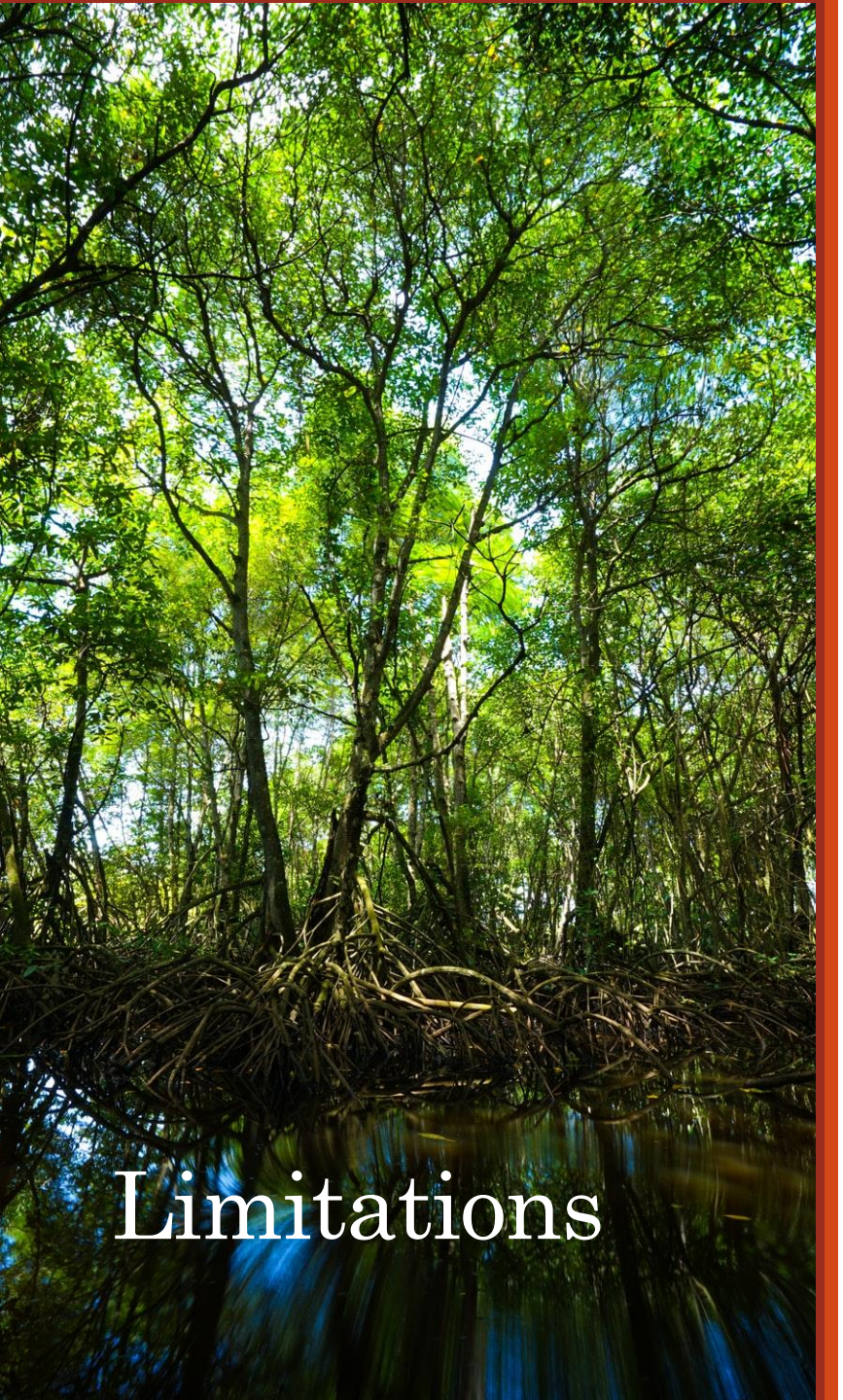
Alino et al (2013)



Exposure

Table 3: Operational definitions of each Vulnerability component as they are applied in the Coastal VA Tools*

COMPONENT	OPERATIONAL DEFINITION
Exposure	▶ Measures that quantify the intensity or severity of physical environment conditions that drive changes in the state of the biophysical system ▶ Like Adaptive Capacity, projections of future state may be derived from the analyses of historical, long-term trends. ▶ Unlike Adaptive Capacity, Exposure measures may be projections of possible future conditions on which scenarios may be evaluated.
Sensitivity	▶ Measures that describe the system's present state for specific properties that respond to Exposure factors arising from changes in climate ▶ "Here and now" characteristics ▶ Although the present state is clearly the result of past processes and events, the descriptors must be easily quantifiable, preferably by visual inspection by non-specialists. Those that require inferences about trends or involve detailed quantitative techniques are avoided (e.g. transects and quadrats). ▶ Some descriptors are better quantified using specific instruments (e.g. maps) and methods (e.g. beach profiling).
Adaptive capacity	▶ Measures that characterize the ability of the system to cope with impacts associated with changes in climate ▶ Essentially, proxies quantifying processes that renew, replenish, or replace conditions described by Sensitivity variables ▶ Intrinsic characteristics or properties inherent to the biophysical realm, with particular focus on natural processes ▶ May be projections of future state inferred from trends seen in past states (e.g. changes in the position of the shoreline) ▶ In contrast to Sensitivity variables which describe state, Adaptive Capacity factors measure processes (e.g. recruitment potential through availability of reproductively mature individuals; long-term shoreline trends).



Limitations

- This project is focused on the mangrove forests located in Mactan Island and a few islets in Cordova.
- The proposed indicators/criterions might be limited due to financial and time constraints of the project, however the replicability of the presented method should still accommodate if in case a new variable/criterion is introduced.

Hotels.com, 2019

Methodology

Dataset

TEMPORAL PATTERN

- Mangroves (1996)
- Mangroves (2007)
- Mangroves (2016)

PHYSICAL ENVIRONEMNT

- Buildings
- Aquaculture
- Traffic
- Roads
- Seaports

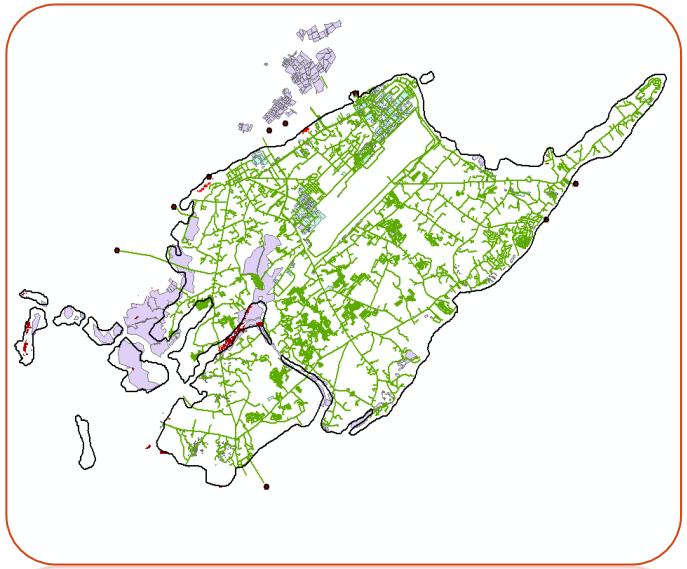
OTHERS (BASEMAPS)

- Landsat (Basemap)
- Municipal Boundary

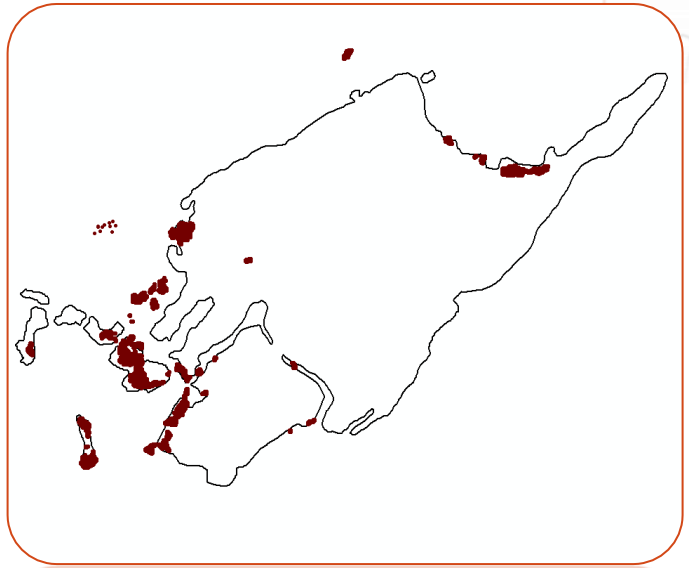
Methods

Data Analysis

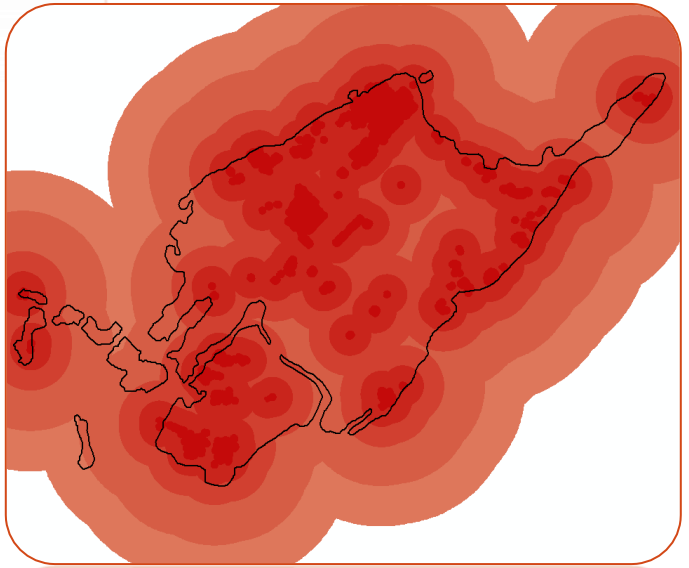
Get Mangrove Data



Buffer Data

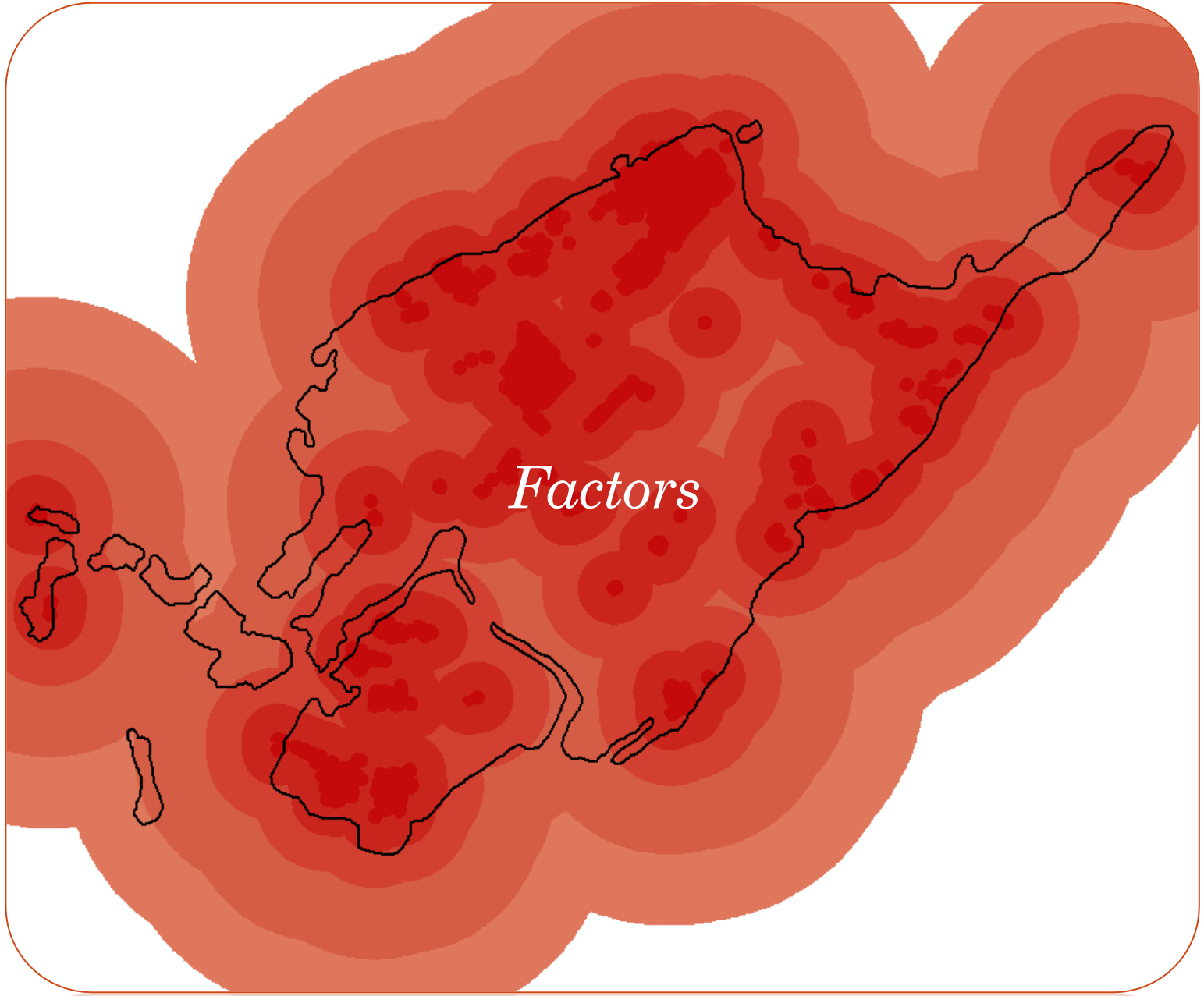


Get Factors



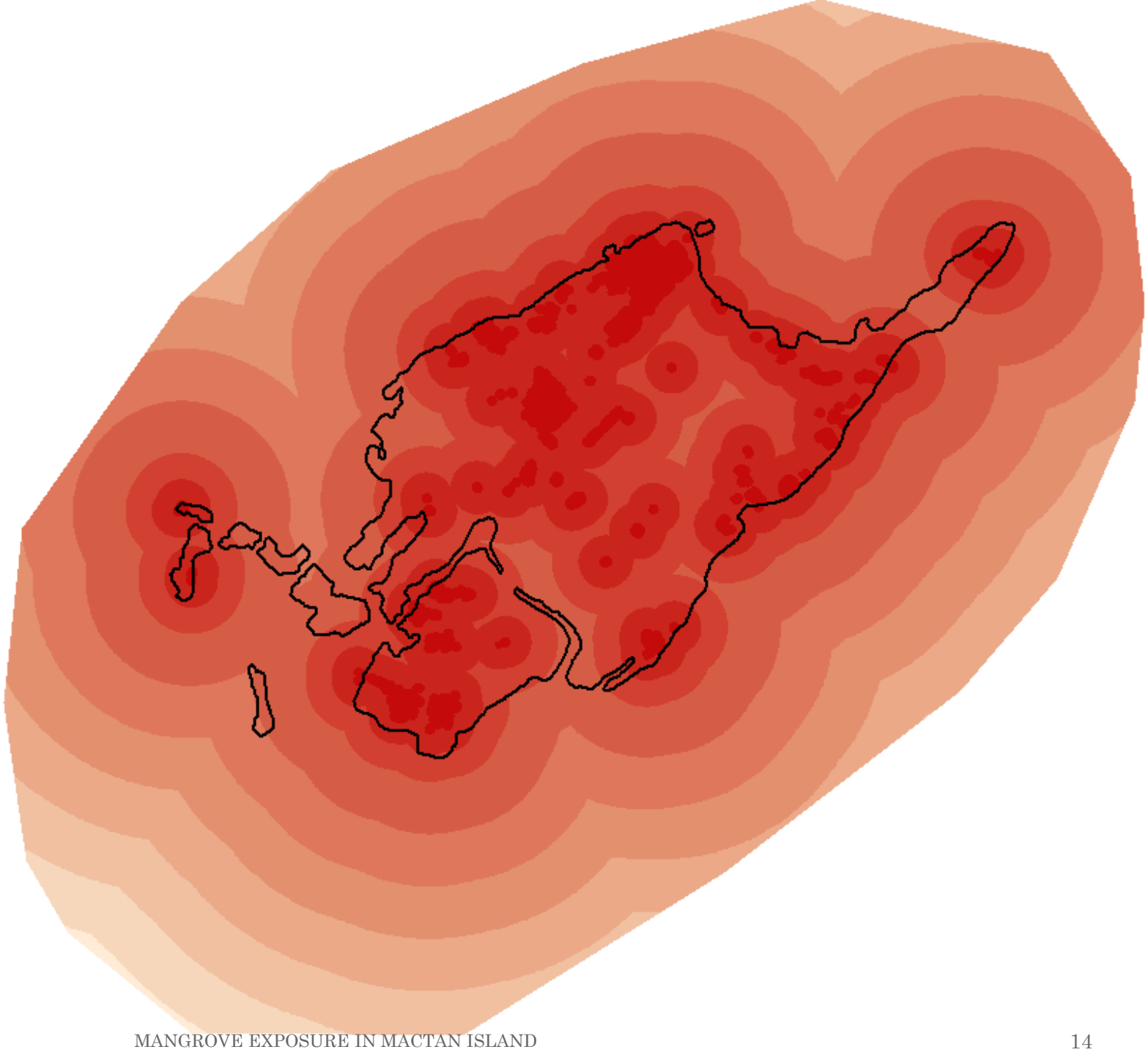
Methods

Data Analysis



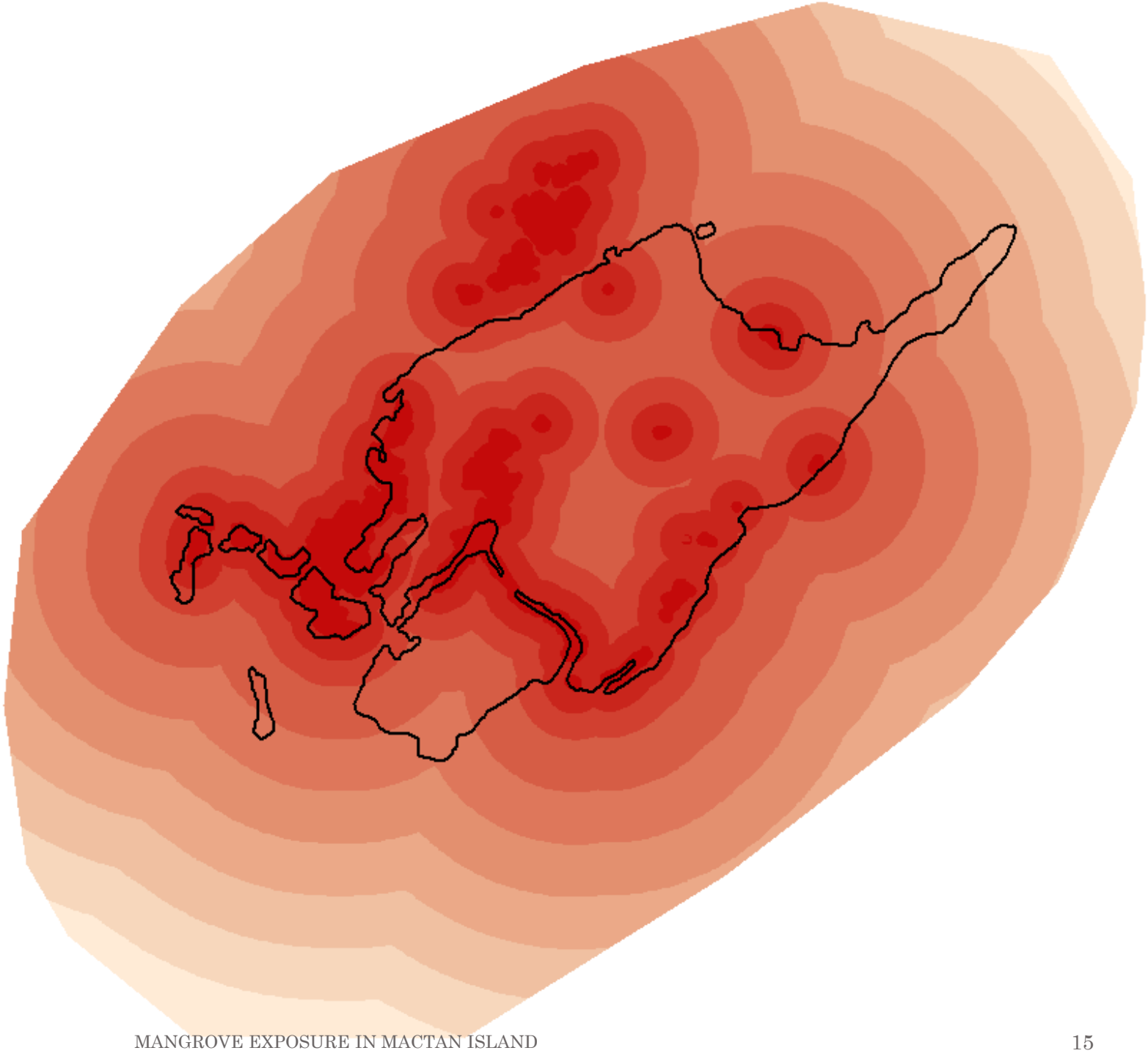
Buildings

Factors



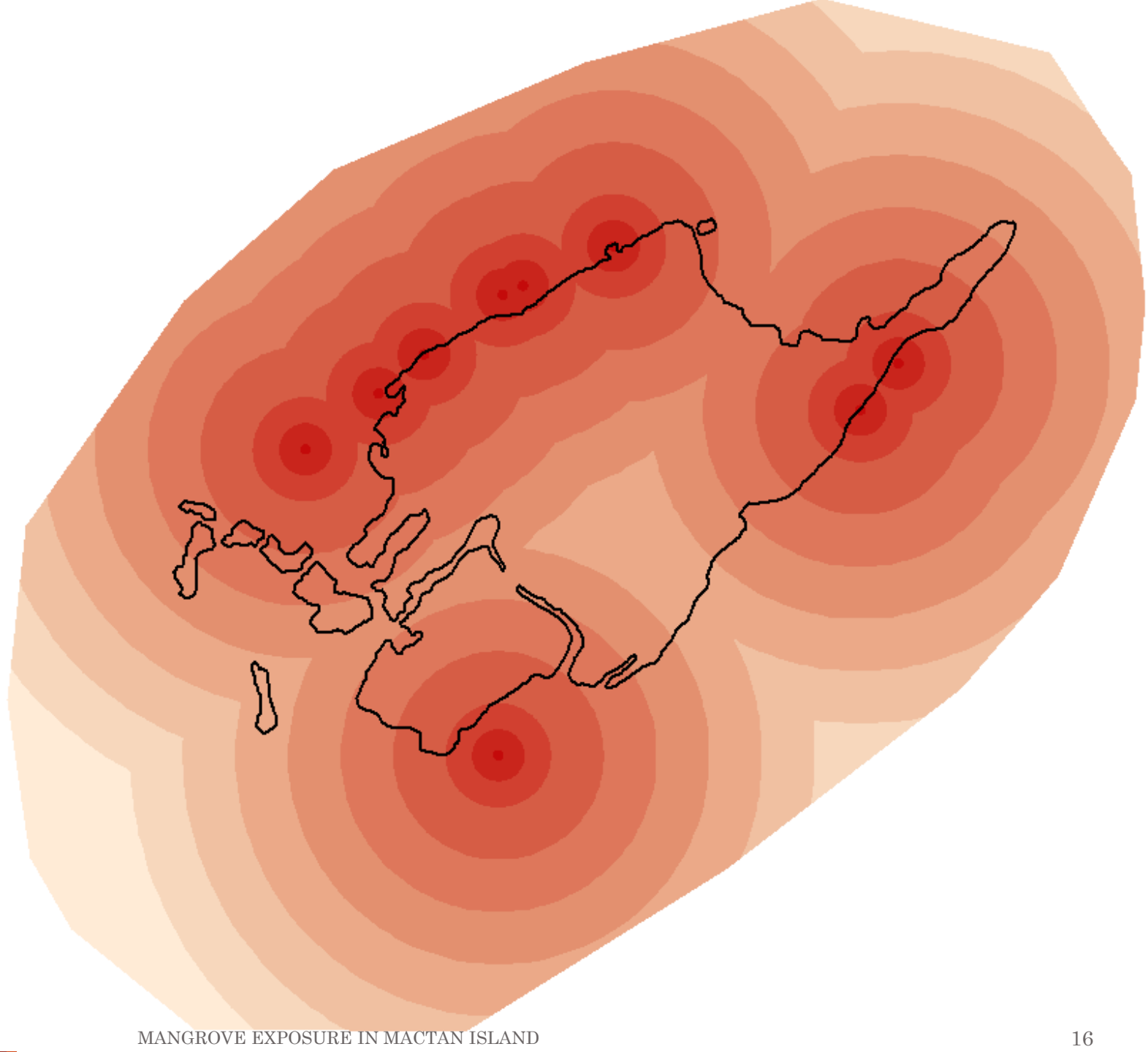
Fishpond

Factors



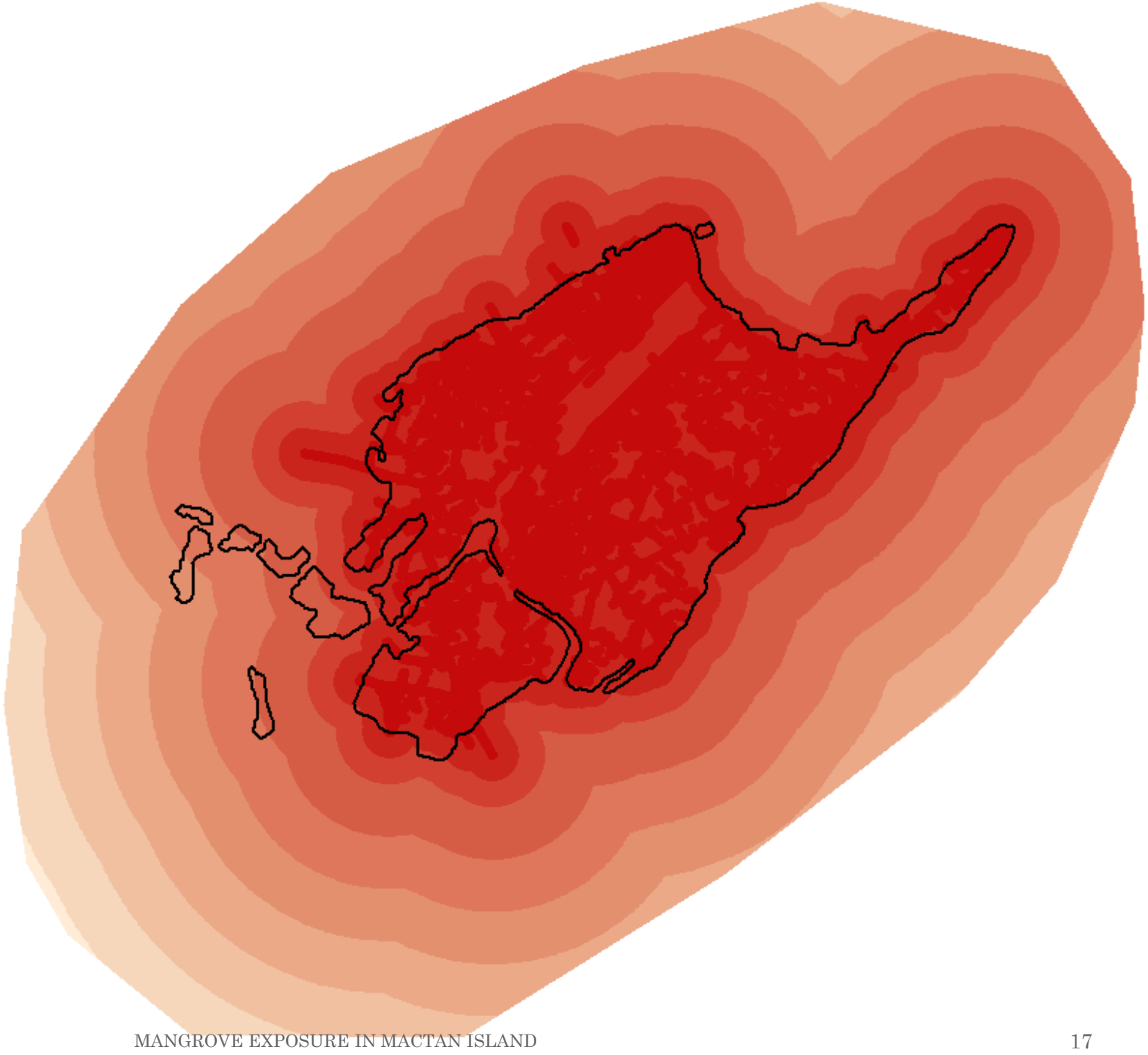
Seaports

Factors



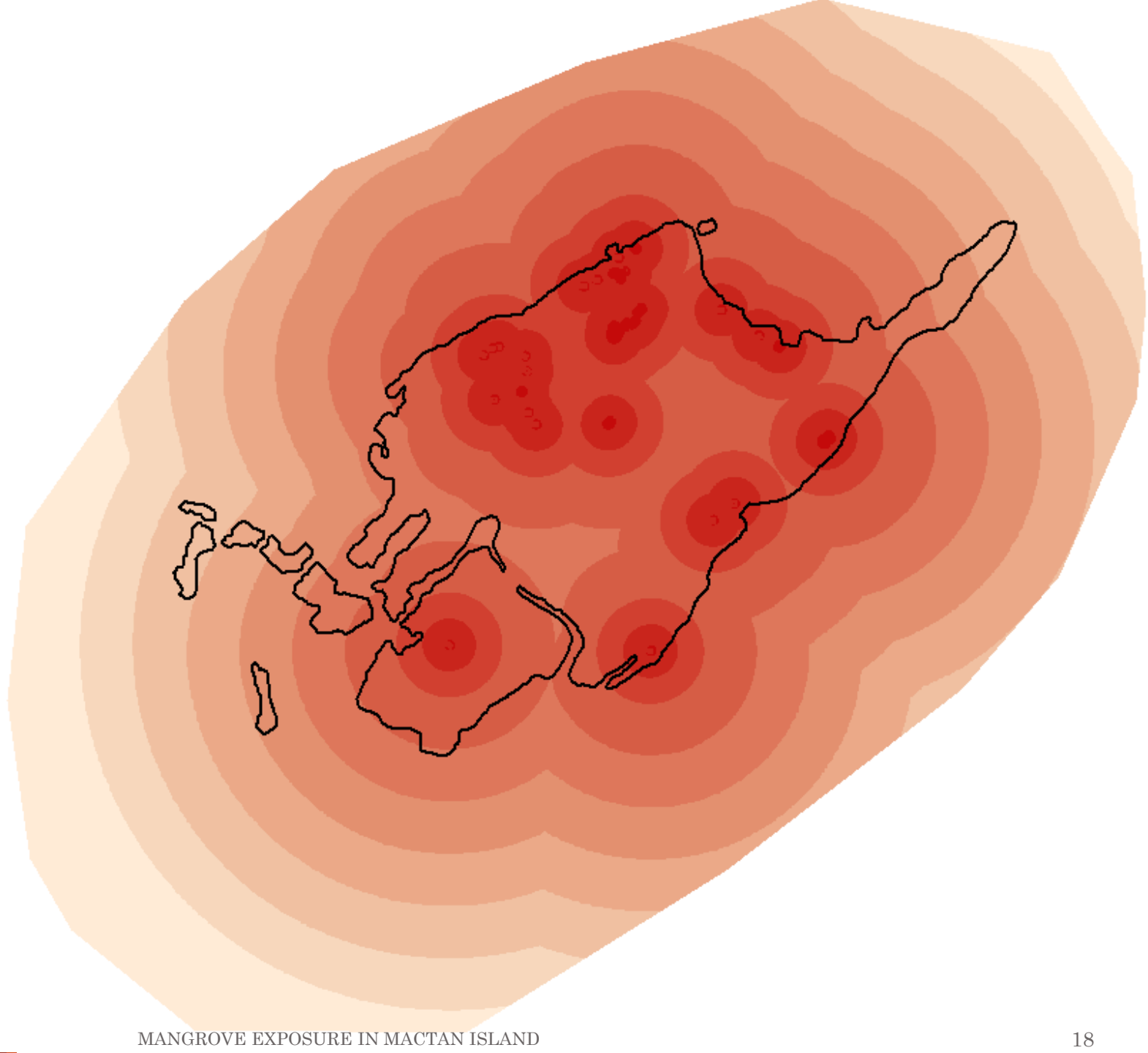
Roads

Factors



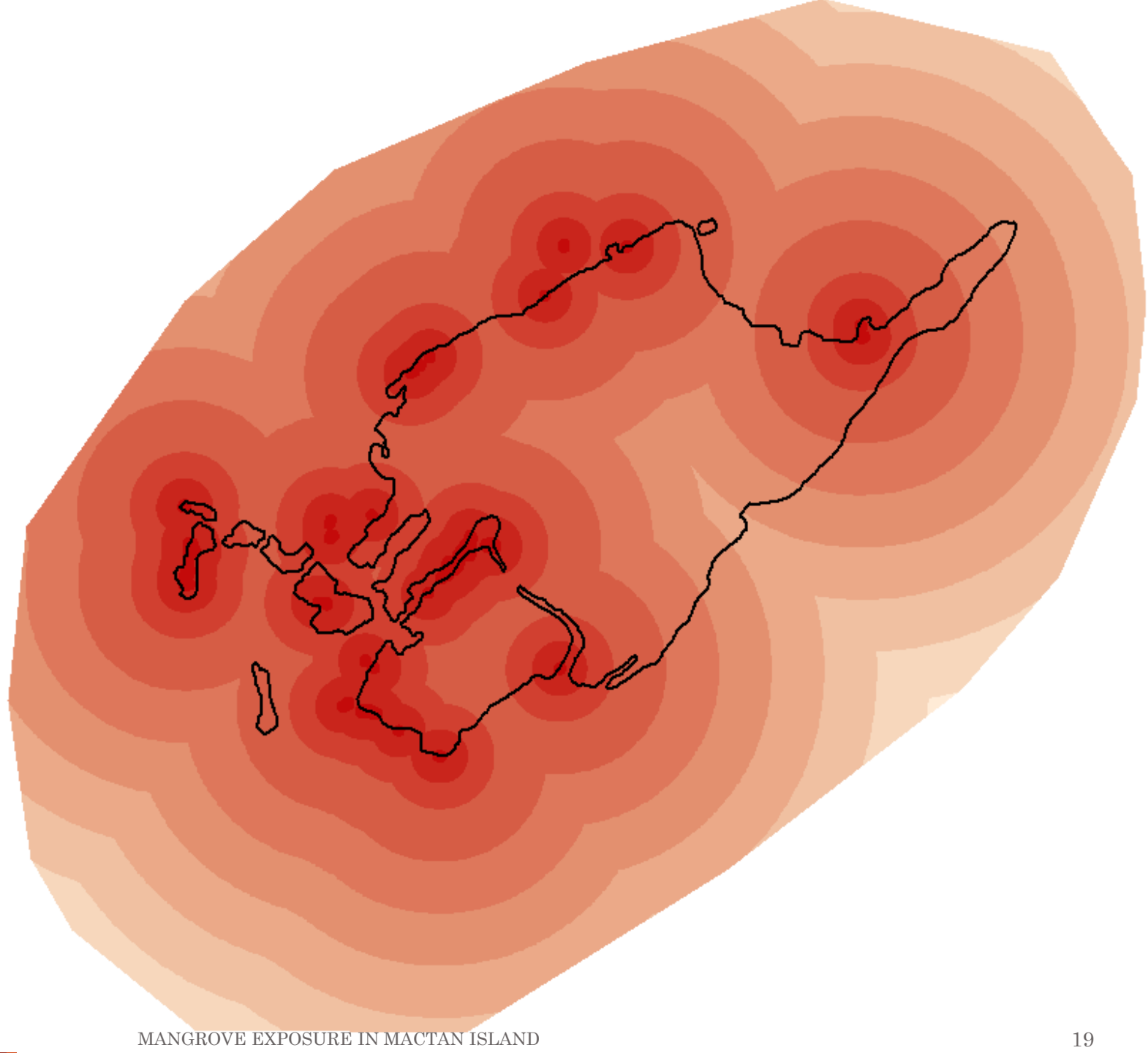
Traffic

Factors



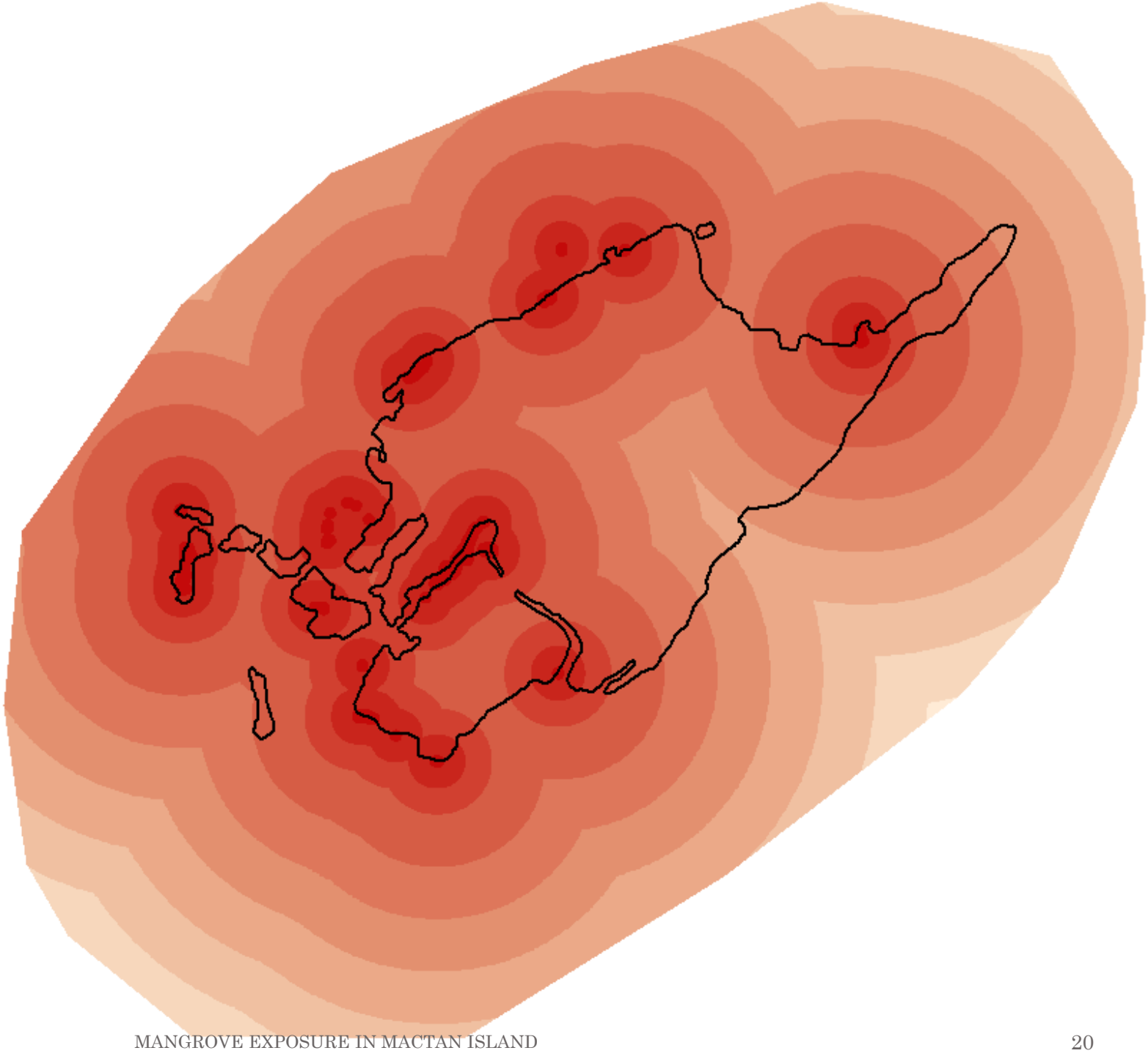
11 Year Loss

Factors



20 Year Loss

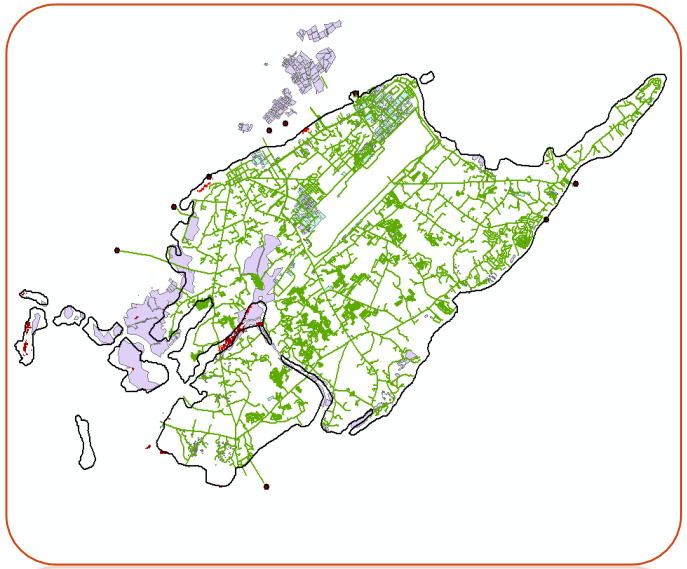
Factors



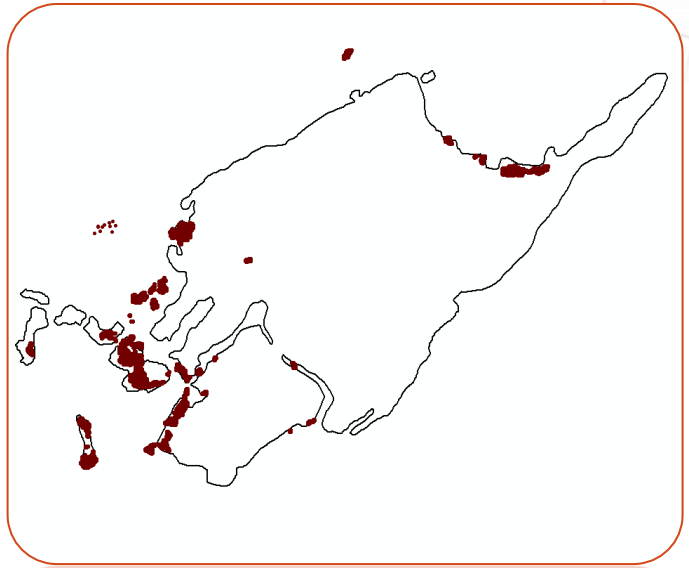
Methods

Data Analysis

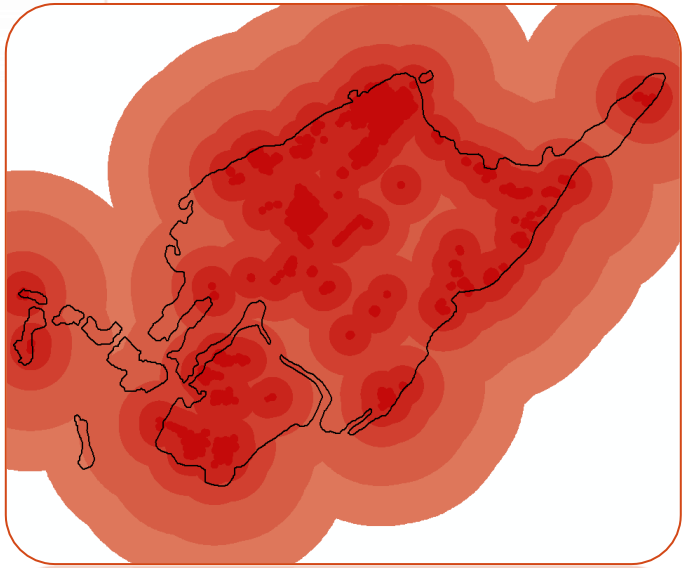
Get Mangrove Data



Buffer Data

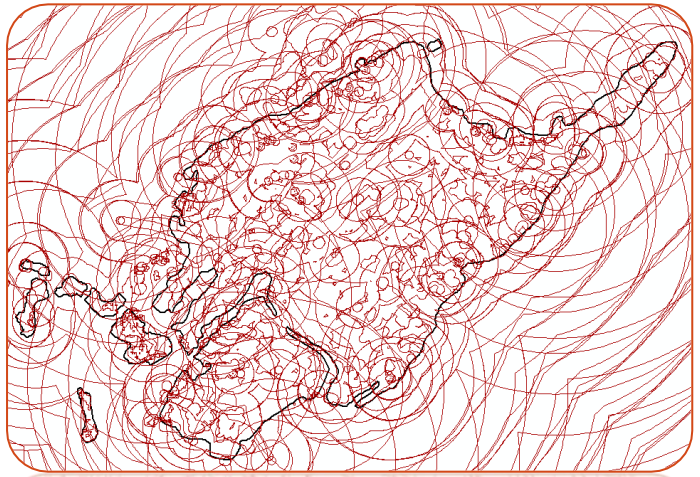


Get Factors

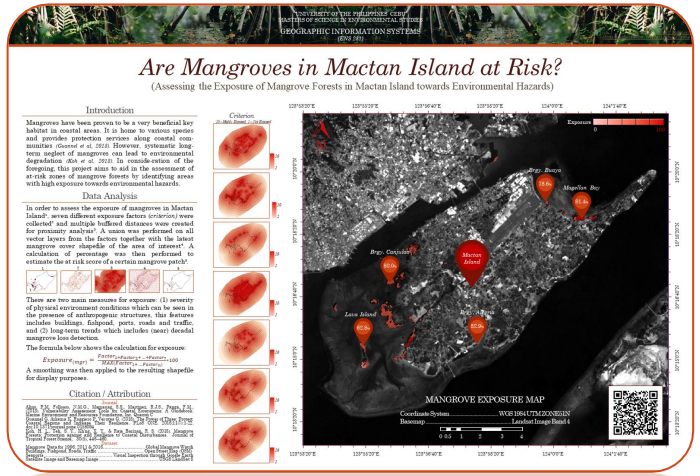


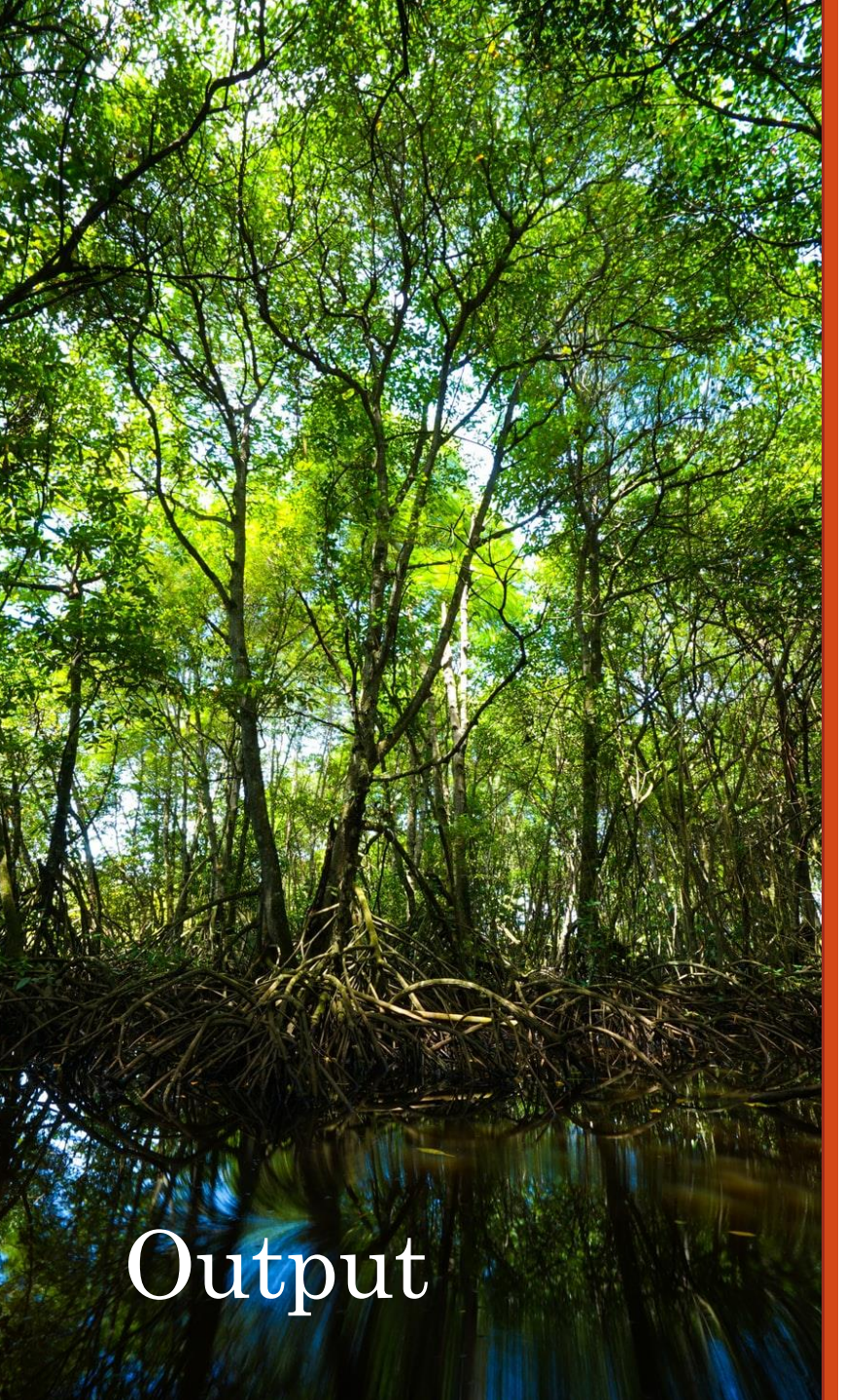
Perform **Union**

Create **Map**



Caculate **Exposure**





Output


123°53'20"E
123°55'20"E
123°56'40"E
123°58'20"E
124°0'0"E
124°1'40"E
10°20'0"N
10°18'20"N
10°16'40"N
10°15'0"N
10°13'20"N
Exposure
0
100
Brgy. Buaya
78.6%
Magellan Bay
81.4%
Brgy. Canjulao
80.0%
Mactan Island
Lava Island
62.8%
Brgy. Alegria
82.9%
MANGROVE EXPOSURE MAP
Coordinate System ..... WGS 1984 UTM ZONE 51N
Basemap ..... Landsat Image Band 4
0 0.5 1 2 3 4

Significance

- Helps the Local Government Units in Prioritization
- Opens up further research on Mangrove Vulnerability
- Helps Coastal Communities
- Policy Making
- Aids in the fight against Climate Change
- Mangrove Ecosystem Protection

References

Journals

Alino, P.M, Follosco, N.M.G., Mamauag, S.S., Martinez, R.J.S., Panga, F.M., (2013). Vulnerability Assessment Tools for Coastal Ecosystems: A Guidebook. Marine Environment and Resources Foundation, Inc. Quezon City, Philippines

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Datasets

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Seaports ..... Visual Inspection through Google Earth

Satellite Image and Basemap Image ..... USGS LandSat 8