CERA: GIS-BASED ASSESSMENT ON COASTAL EROSION RISK

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INTRODUCTION

- 2/3 of worldwide population lives in coastal zones;
- Increased exposure leads to higher risk in these areas;
- Several coastal hazard assessment methods were developed along the years, but:
  - There is a big focus on extreme events, disregarding other coastal hazards;
  - Heavy reliance on modelling, which increases complexity (and costs);
  - Limited accessibility to the general user.
- CERA was created to answer to these shortcomings.

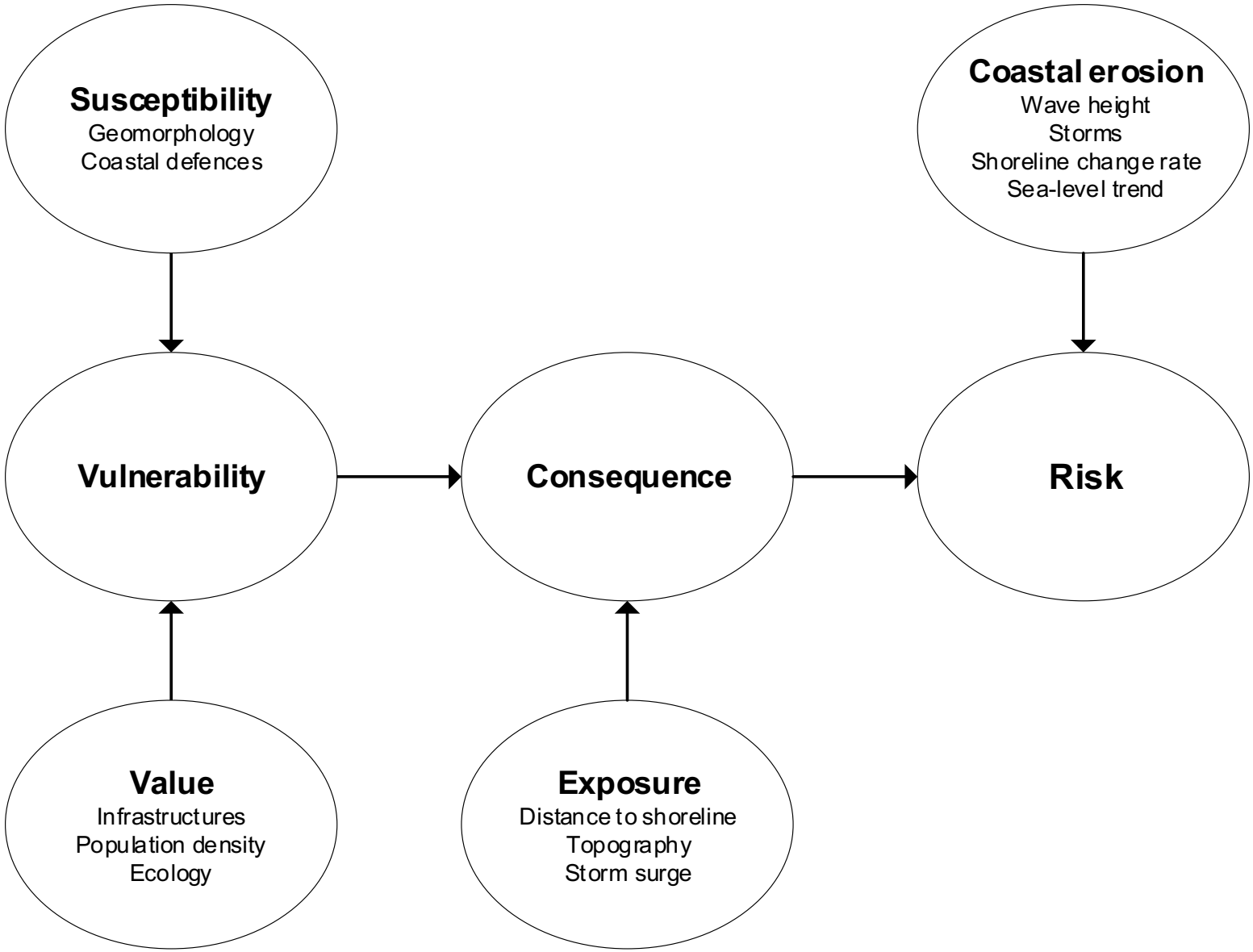
PRESENTATION STRUCTURE

- **Introduction to CERA**
- **Presentation structure**
- **CERA2.0 framework**
  - Susceptibility module
  - Value module
  - Exposure module
  - Coastal erosion module
  - Combination and final outputs
  - Sensitivity analysis
- **CERA2.0 application**
  - QGIS integration and workflow
  - Results
- **Conclusions**
- **Future development**

CERA2.0 FRAMEWORK

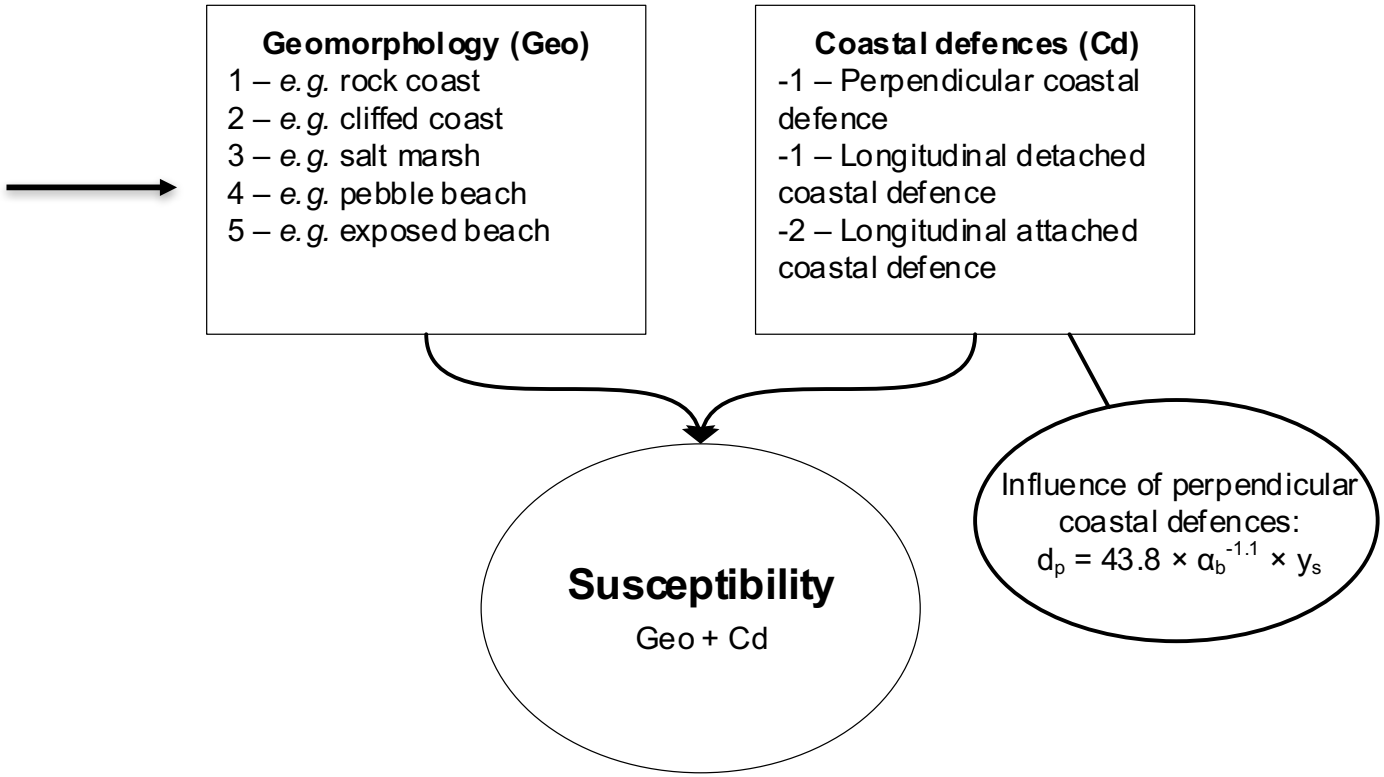
- CERA2.0 is the second version of the Coastal Erosion Risk Assessment;
- CERA2.0 is based on the Source-Pathway-Receptor-Consequence (SPRC) conceptual model;
- A total of 12 indicators is considered in CERA2.0 assessment;
- The framework is divided into 4 modules: susceptibility, value, exposure and coastal erosion.

CERA2.0 FRAMEWORK

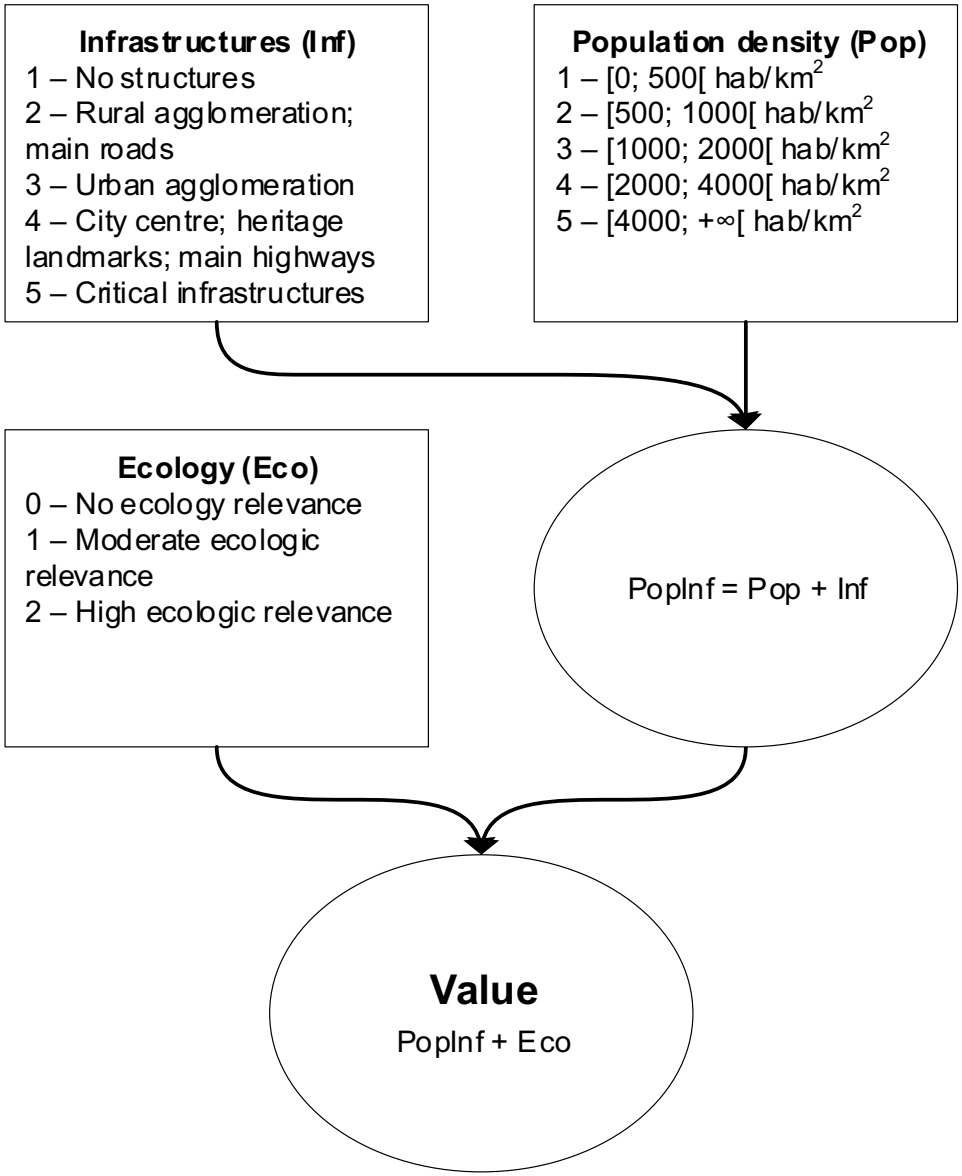


CERA2.0 FRAMEWORK – SUSCEPTIBILITY MODULE

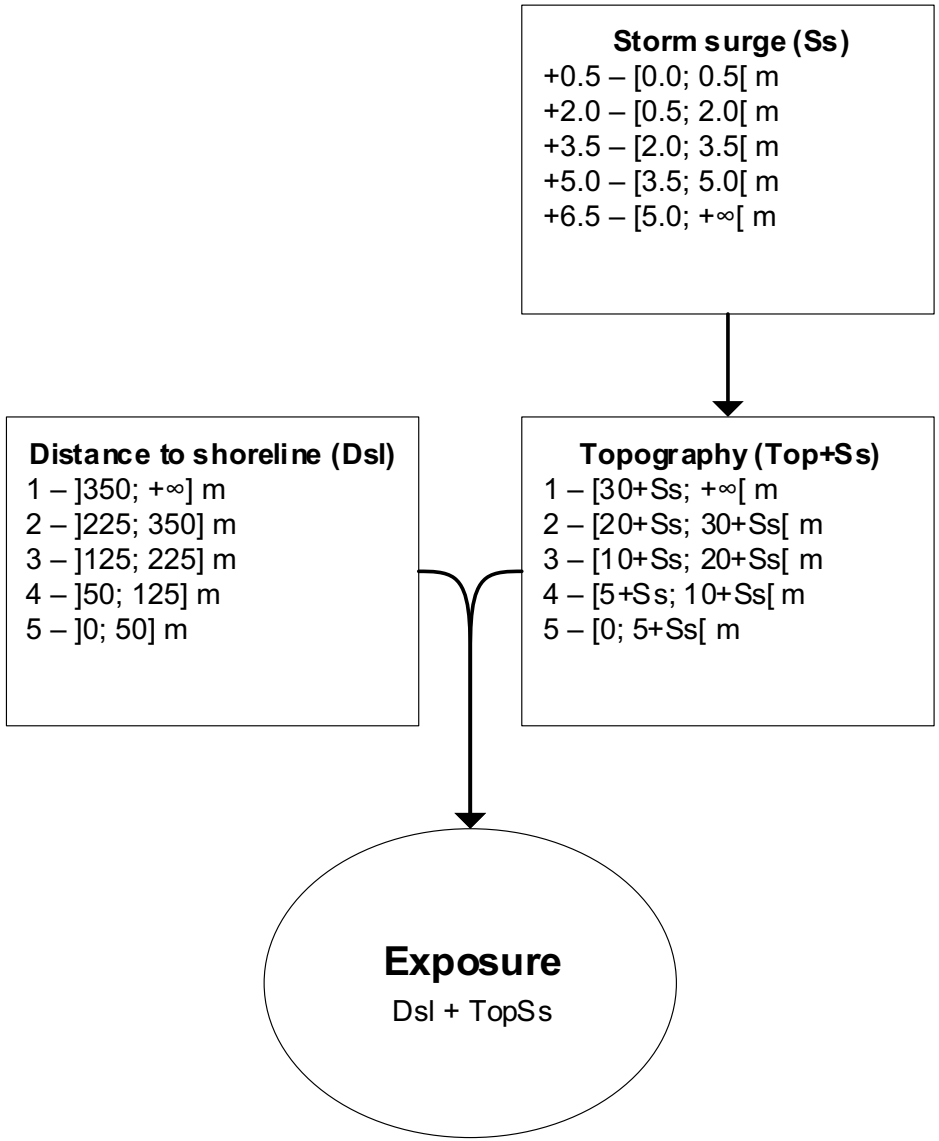
Geomorphology classes	
Very Low 1	Rock coast Fiord Fiard
Low 2	Consolidated sedimentary cliffed coast Indented coast
Moderate 3	Saltmarsh Coral reef Mangroves
High 4	Pebble beach Protected beach Beach with significant dune presence
Very high 5	Barrier system Exposed sand beach Mudflat Deltas



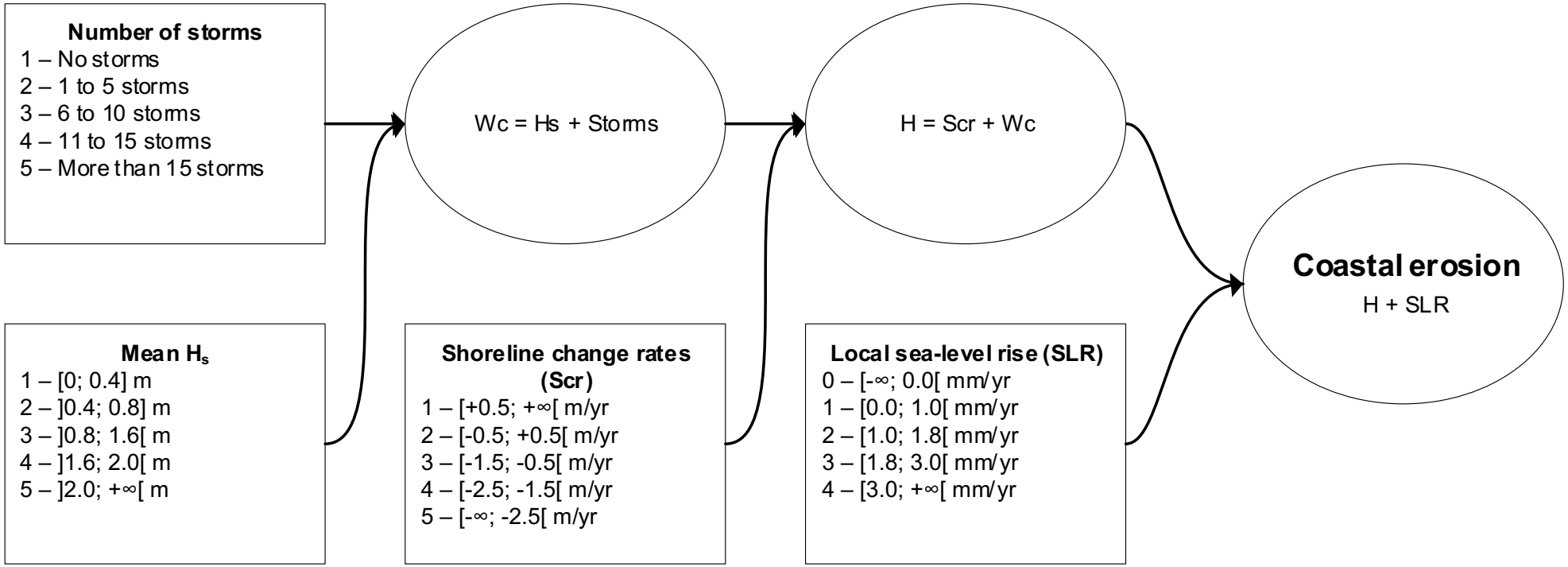
CERA2.0 FRAMEWORK – VALUE MODULE



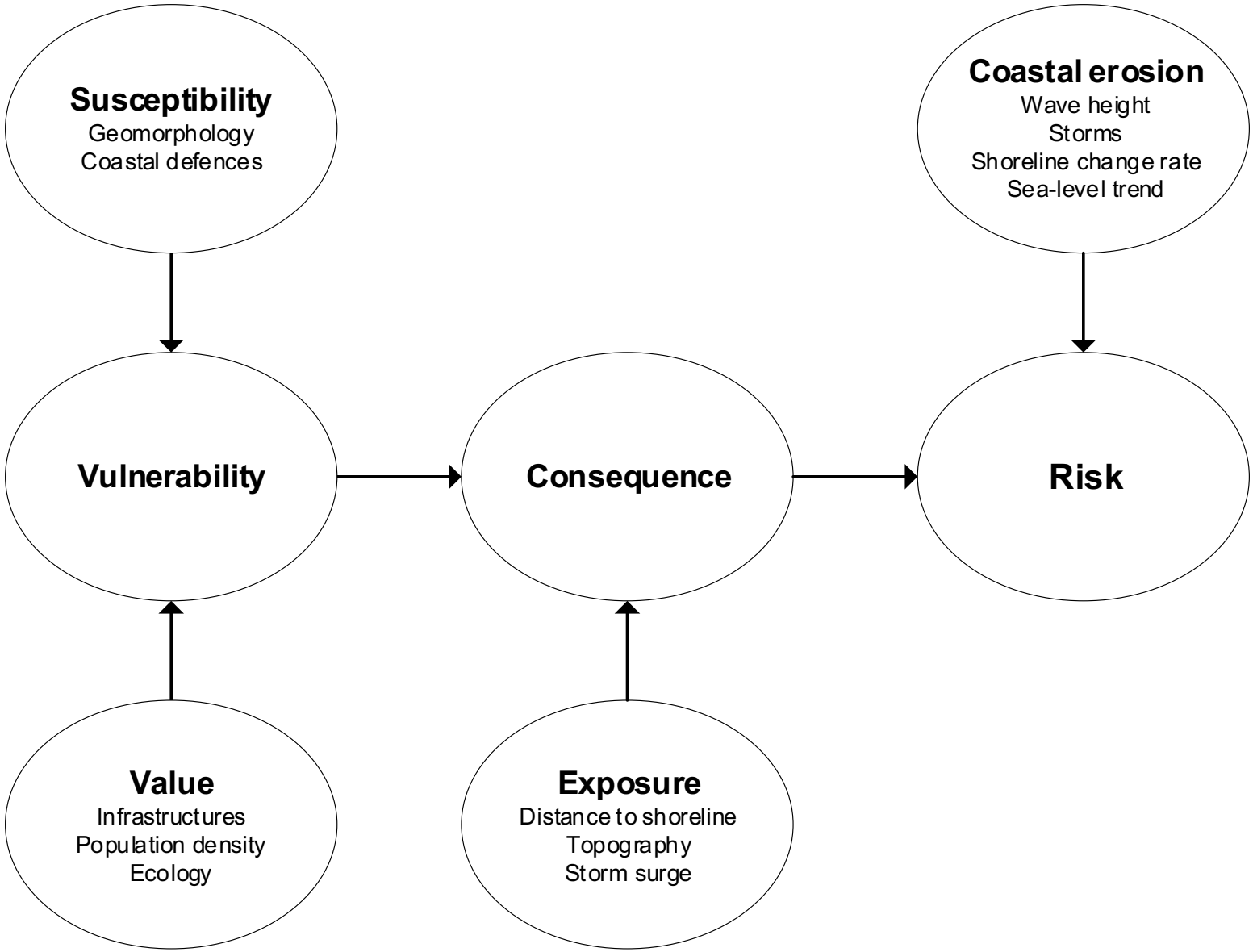
CERA2.0 FRAMEWORK – EXPOSURE MODULE



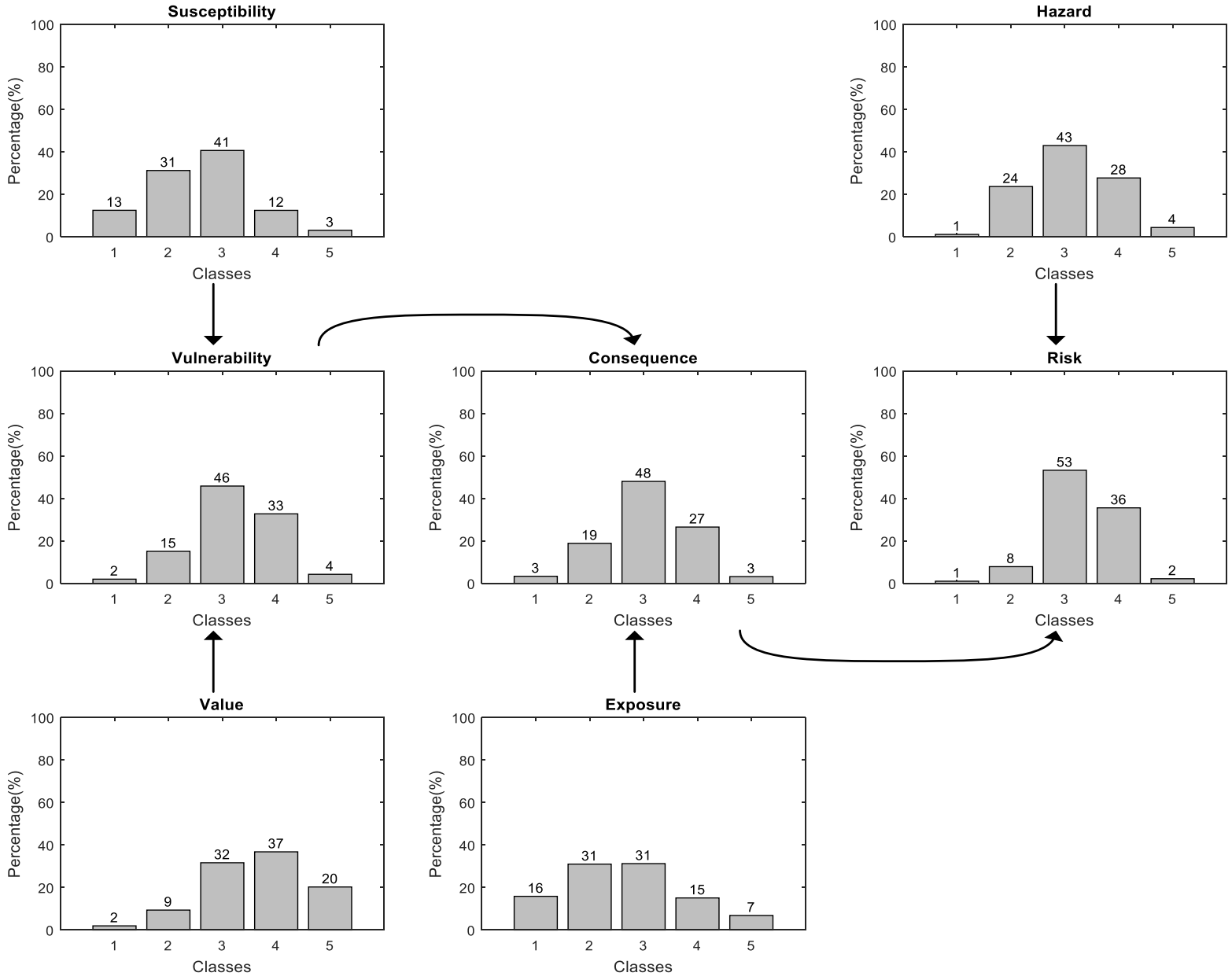
CERA2.0 FRAMEWORK – COASTAL EROSION MODULE



CERA2.0 FRAMEWORK – COMBINATIONS AND OUTPUTS



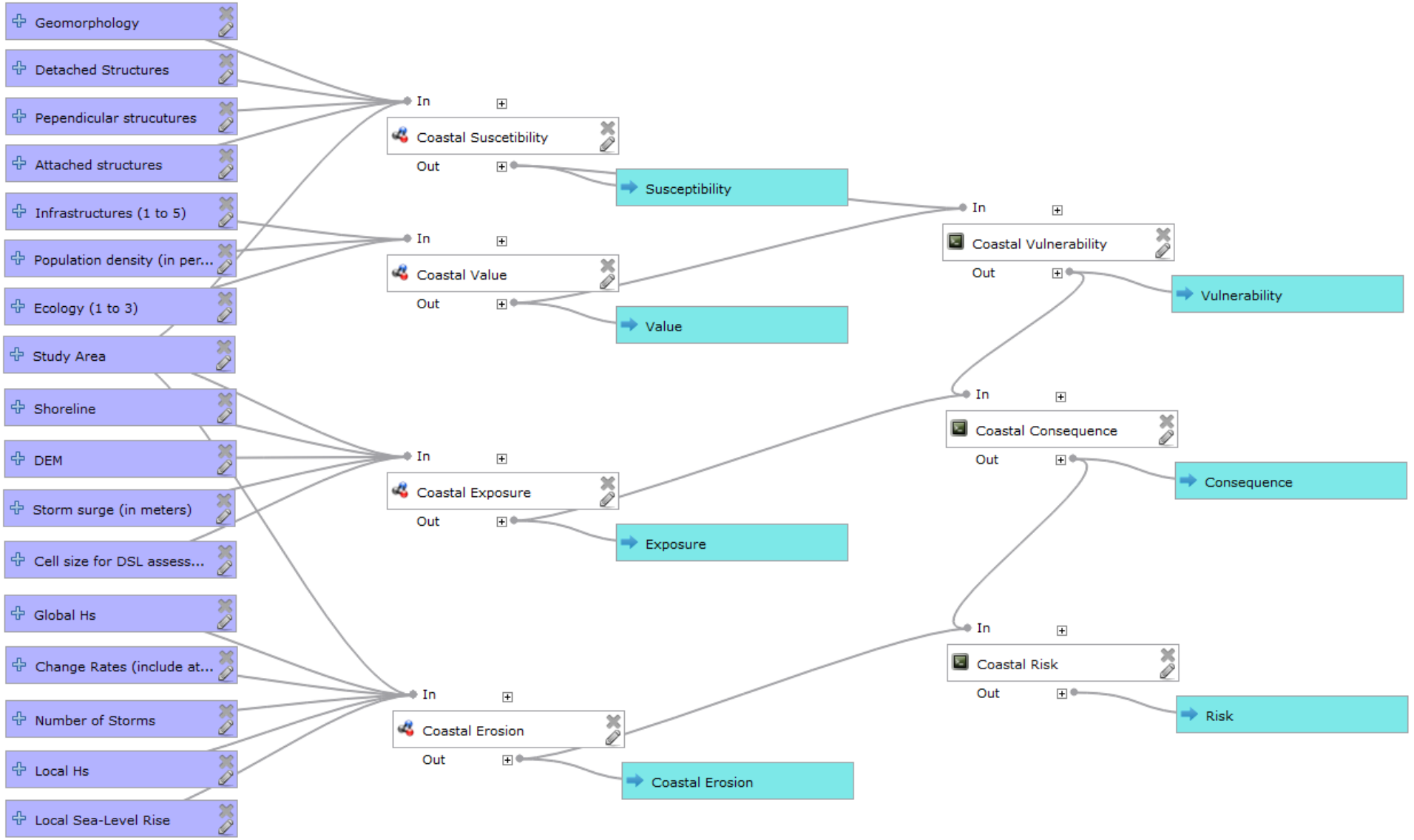
CERA2.0 FRAMEWORK – SENSITIVITY ANALYSIS



CERA2.0 FRAMEWORK – SENSITIVITY ANALYSIS

		Minimum class					Maximum class					PI
		1	2	3	4	5	1	2	3	4	5	
Geomorphology	Vuln.	11,3	88,7	0,0	0,0	0,0	0,0	1,9	14,9	48,5	34,6	83,1
	Cons.	19,3	33,5	47,1	0,0	0,0	0,3	16,1	36,1	36,6	10,9	47,5
	Risk	5,2	23,0	56,6	15,2	0,0	0,3	5,0	47,4	42,1	5,1	32,1
Coastal defences	Vuln.	7,6	58,0	26,1	8,3	0,0	1,9	14,7	33,6	32,6	17,3	41,6
	Cons.	12,7	27,4	49,7	9,6	0,6	3,2	18,7	44,2	27,9	6,0	23,7
	Risk	3,5	16,8	56,2	23,0	0,6	1,0	7,8	51,6	36,5	3,2	16,0
Infrastructures or Population	Vuln.	18,7	33,2	35,8	11,7	0,5	1,2	37,1	28,1	23,1	10,5	21,4
	Cons.	14,0	27,9	43,7	13,5	0,9	6,4	21,9	47,6	20,2	3,9	9,7
	Risk	3,8	17,8	53,5	24,0	0,9	1,9	10,9	53,9	31,2	2,1	8,5
Ecology	Vuln.	13,1	34,8	34,0	16,1	2,0	0,0	37,5	26,7	24,1	11,7	17,7
	Cons.	11,6	26,0	45,3	15,6	1,5	5,9	21,5	47,7	20,7	4,2	7,8
	Risk	3,2	15,6	53,8	26,2	1,2	1,7	10,4	53,9	31,8	2,3	6,6
Distance to shoreline	Vuln.	4,7	36,3	30,5	21,8	6,6	4,7	36,3	30,6	21,8	6,6	---
	Cons.	19,3	45,4	35,3	0,0	0,0	0,7	9,5	47,4	30,9	11,5	42,4
	Risk	5,3	25,7	57,6	11,3	0,0	0,3	3,8	48,8	42,0	5,1	35,7
Topography	Vuln.	4,7	36,3	30,6	21,8	6,6	4,7	36,3	30,6	21,8	6,6	---
	Cons.	24,7	48,7	26,5	0,0	0,0	1,4	14,2	50,7	25,2	8,4	33,6
	Risk	6,7	30,4	54,3	8,5	0,0	0,5	5,4	52,5	37,8	3,8	33,0
Storm surge	Vuln.	4,8	36,3	30,6	21,8	6,6	4,7	36,3	30,6	21,8	6,6	---
	Cons.	10,0	26,1	45,1	16,7	2,2	6,5	20,9	48,7	20,5	3,5	5,0
	Risk	2,8	14,4	54,1	27,3	1,4	1,9	10,7	53,8	31,6	2,0	4,9
Hs or number of storms	Vuln.	4,7	36,3	30,6	21,8	6,6	4,7	36,3	30,6	21,8	6,6	---
	Cons.	7,9	23,1	47,1	18,9	2,9	8,0	23,1	47,1	18,9	2,9	---
	Risk	5,3	18,2	64,9	11,6	0,1	1,1	10,1	46,0	38,6	4,2	31,2
Shoreline change rates	Vuln.	4,7	36,3	30,6	21,8	6,6	4,7	36,3	30,6	21,8	6,6	---
	Cons.	8,0	23,1	47,1	18,9	2,9	8,0	23,1	47,1	18,9	2,9	---
	Risk	10,0	27,1	62,5	0,4	0,0	0,0	8,1	33,6	51,5	6,9	58,0
Sea-level trends	Vuln.	4,7	36,3	30,5	21,8	6,6	4,7	36,3	30,6	21,8	6,5	---
	Cons.	7,9	23,1	47,1	18,9	2,9	8,0	23,1	47,1	18,9	2,9	---
	Risk	3,3	14,3	56,4	24,9	1,1	1,5	10,9	51,7	33,6	2,3	9,9

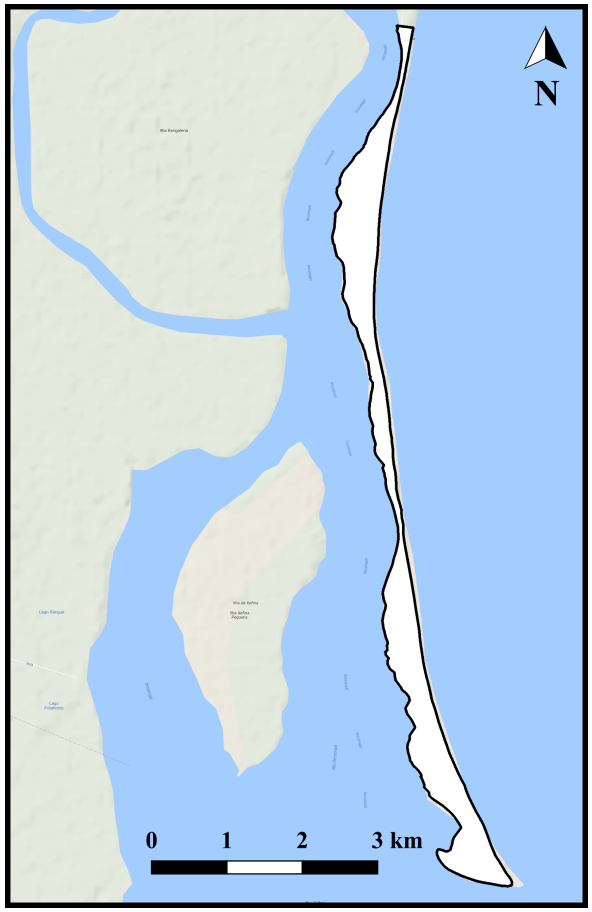
INTEGRATION OF CERA2.0 IN QGIS



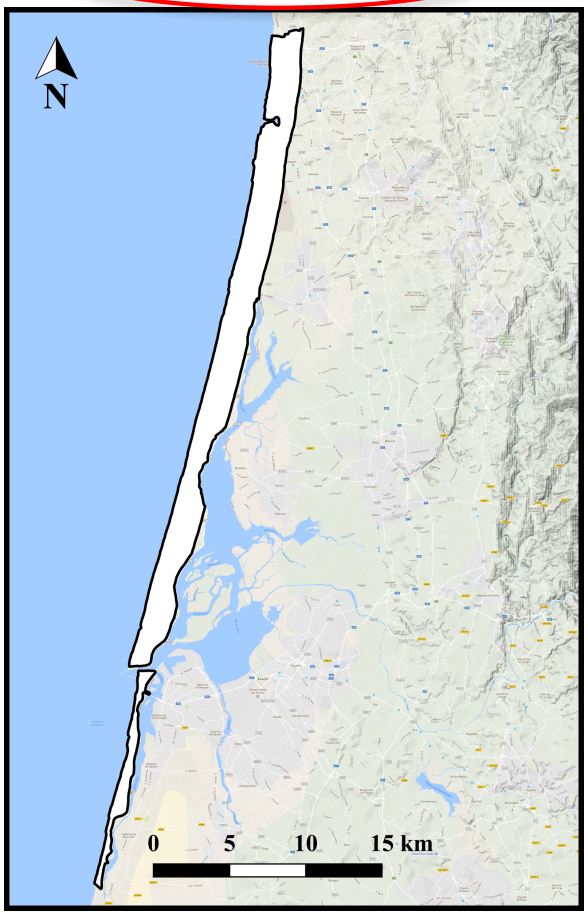
INTEGRATION OF CERA2.0 IN QGIS

APPLICATION OF CERA2.0 – CASE STUDIES

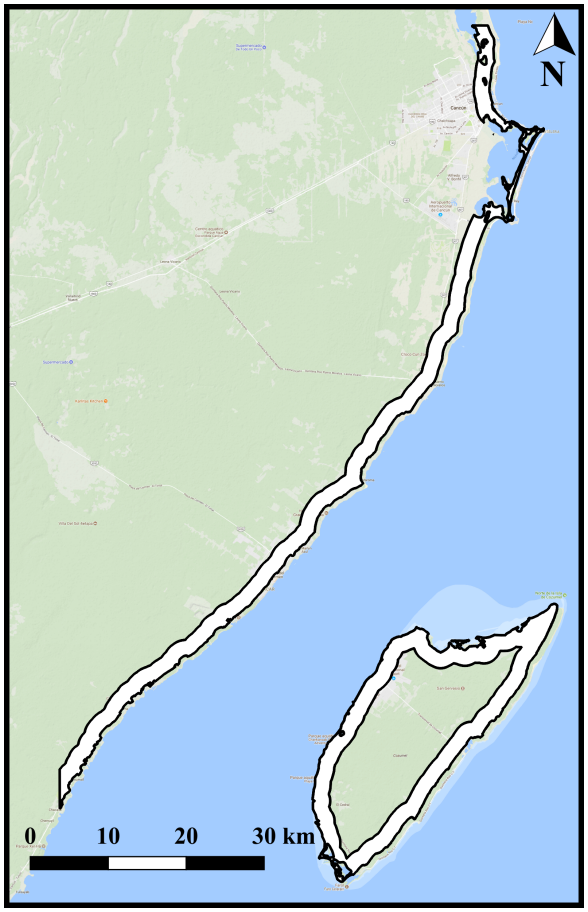
MACANETA, MOZAMBIQUE



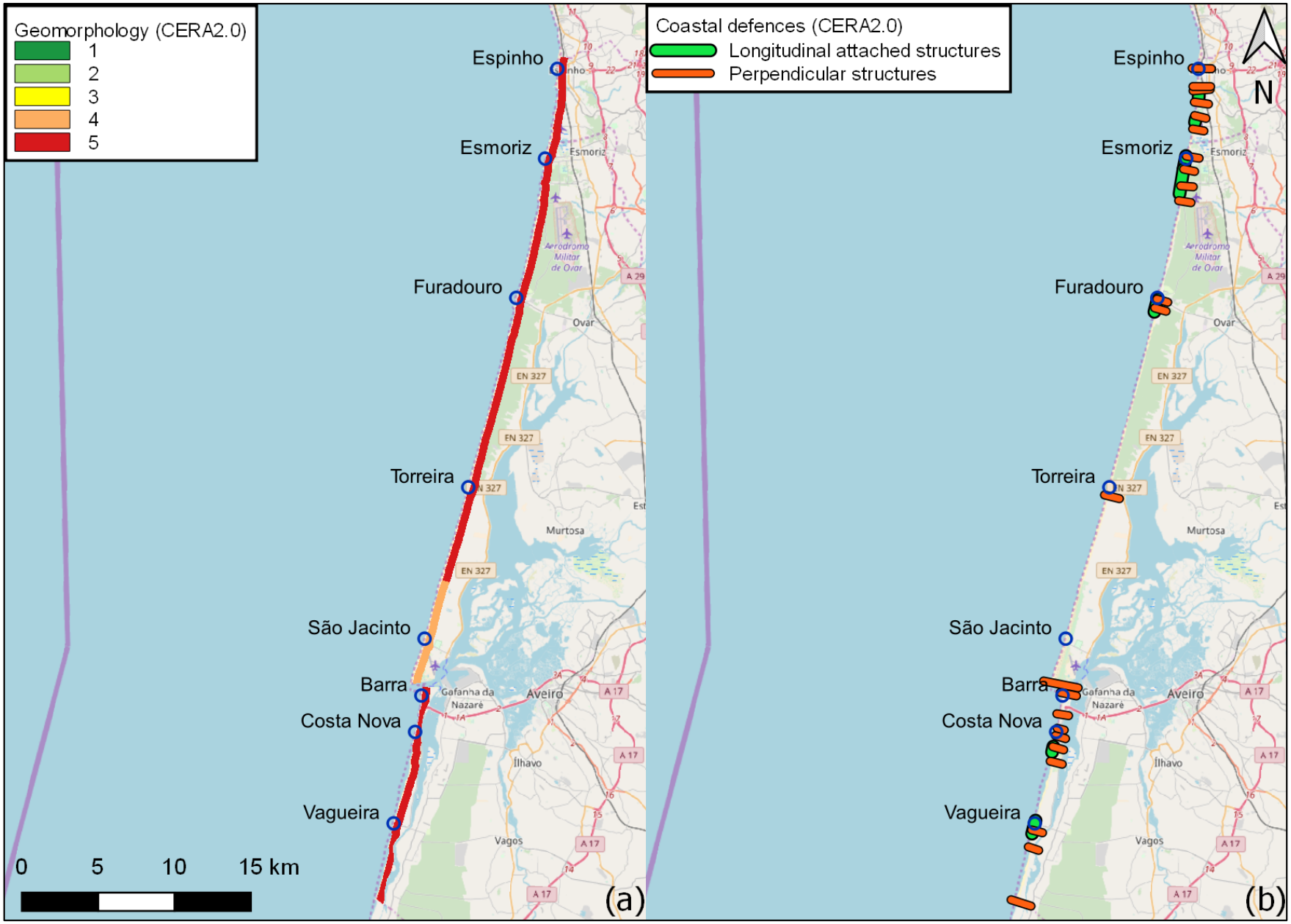
AVEIRO, PORTUGAL



QUINTANA ROO, MEXICO

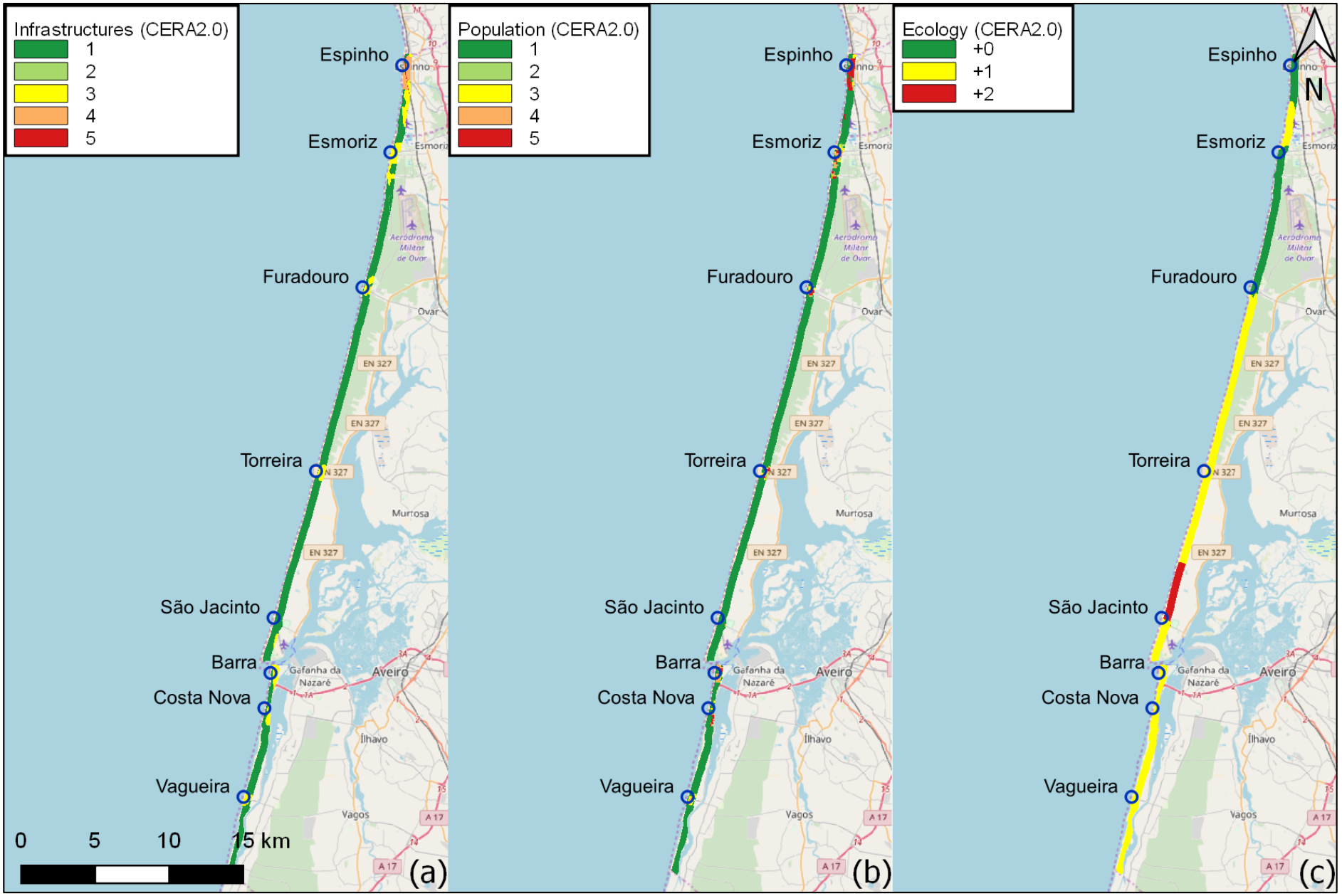


APPLICATION TO AVEIRO – SUSCEPTIBILITY MODULE

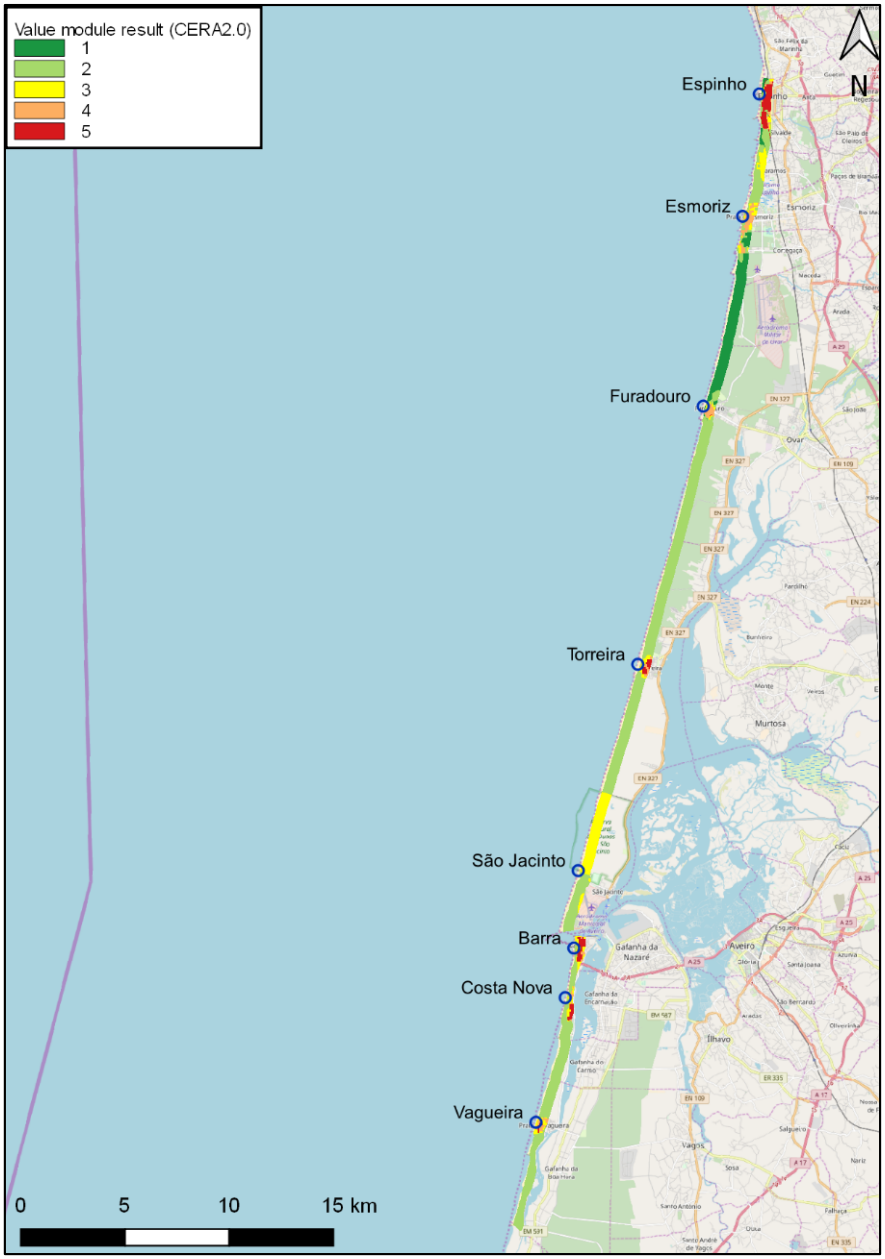


APPLICATION TO AVEIRO – SUSCEPTIBILITY RESULT

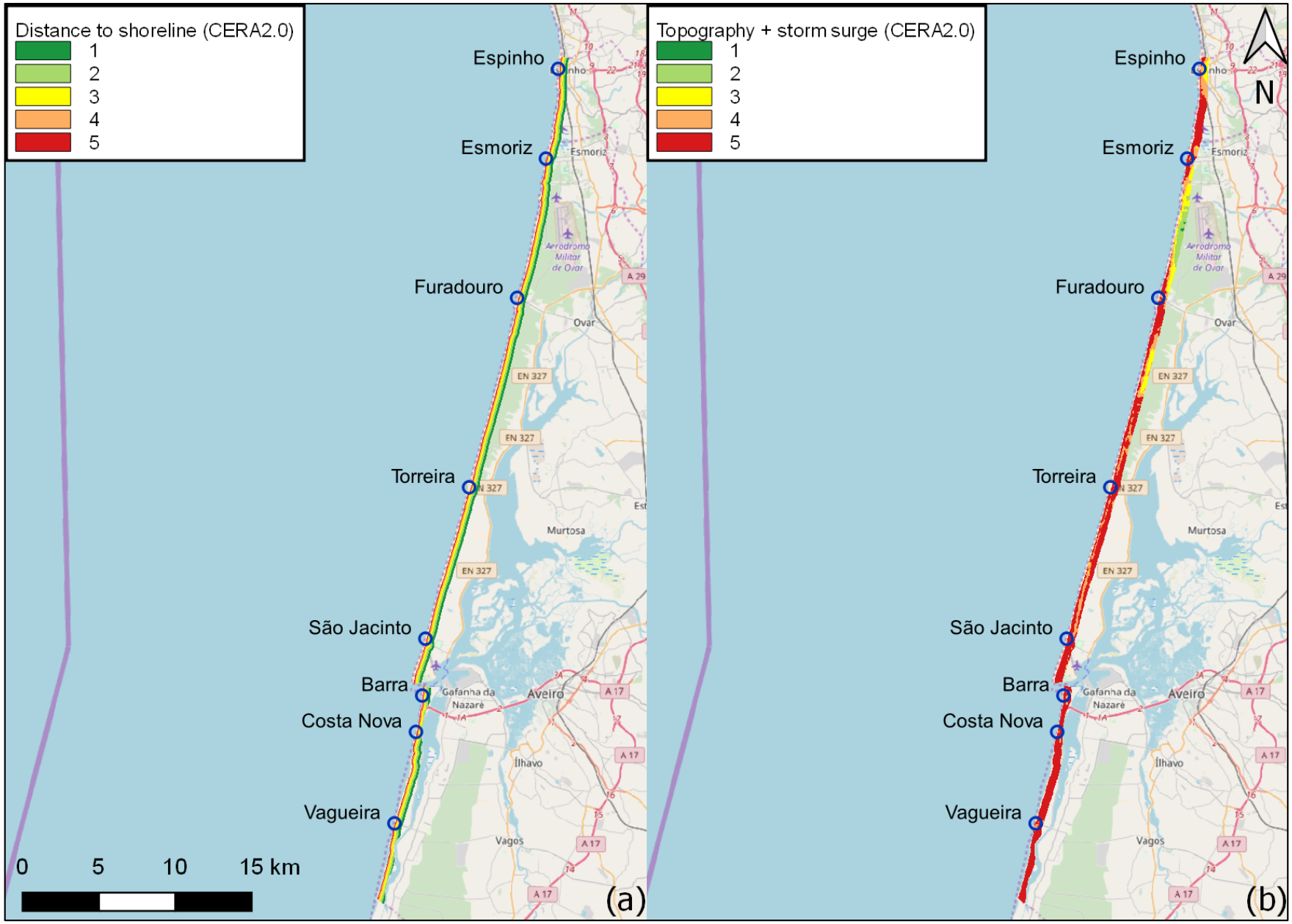
APPLICATION TO AVEIRO – VALUE MODULE



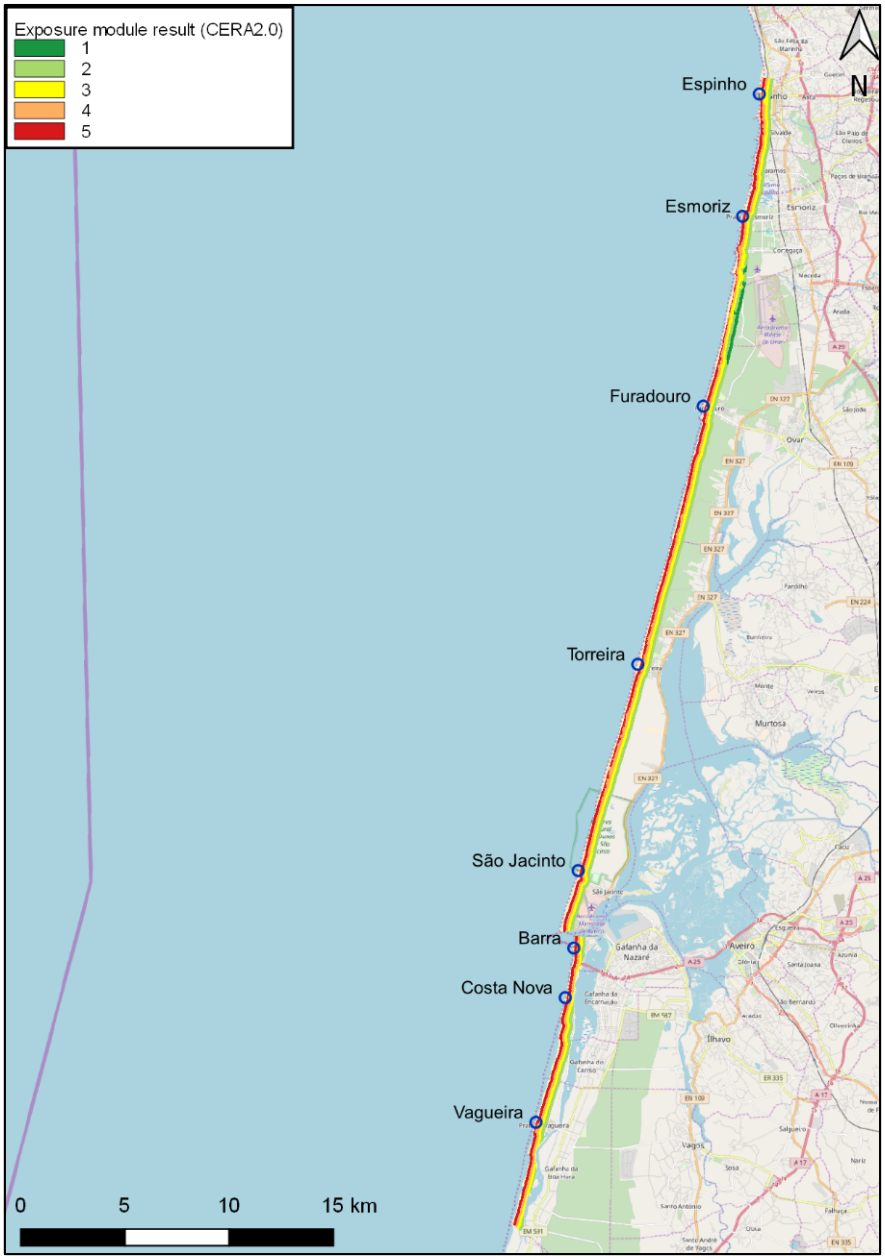
APPLICATION TO AVEIRO – VALUE RESULT



APPLICATION TO AVEIRO – EXPOSURE MODULE

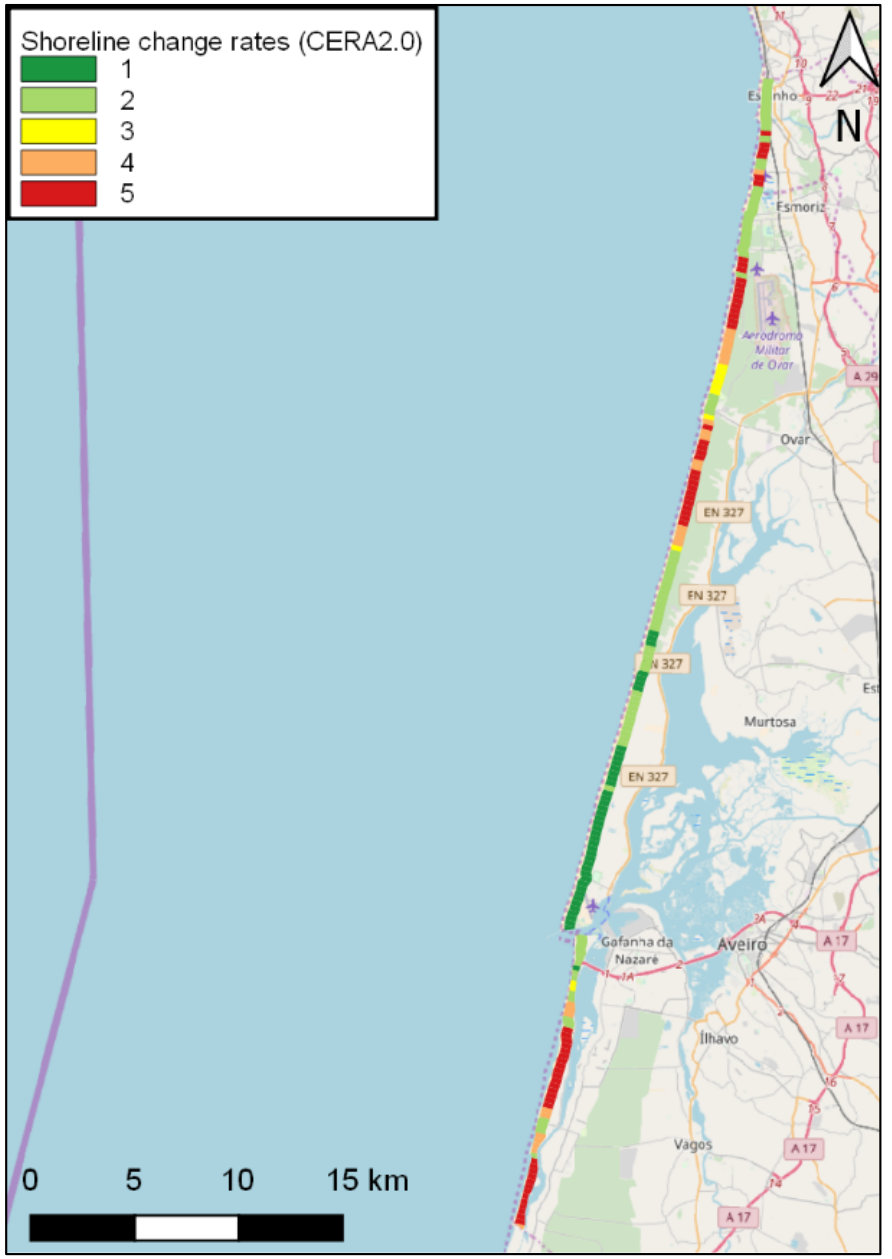


Application to Aveiro – Exposure result

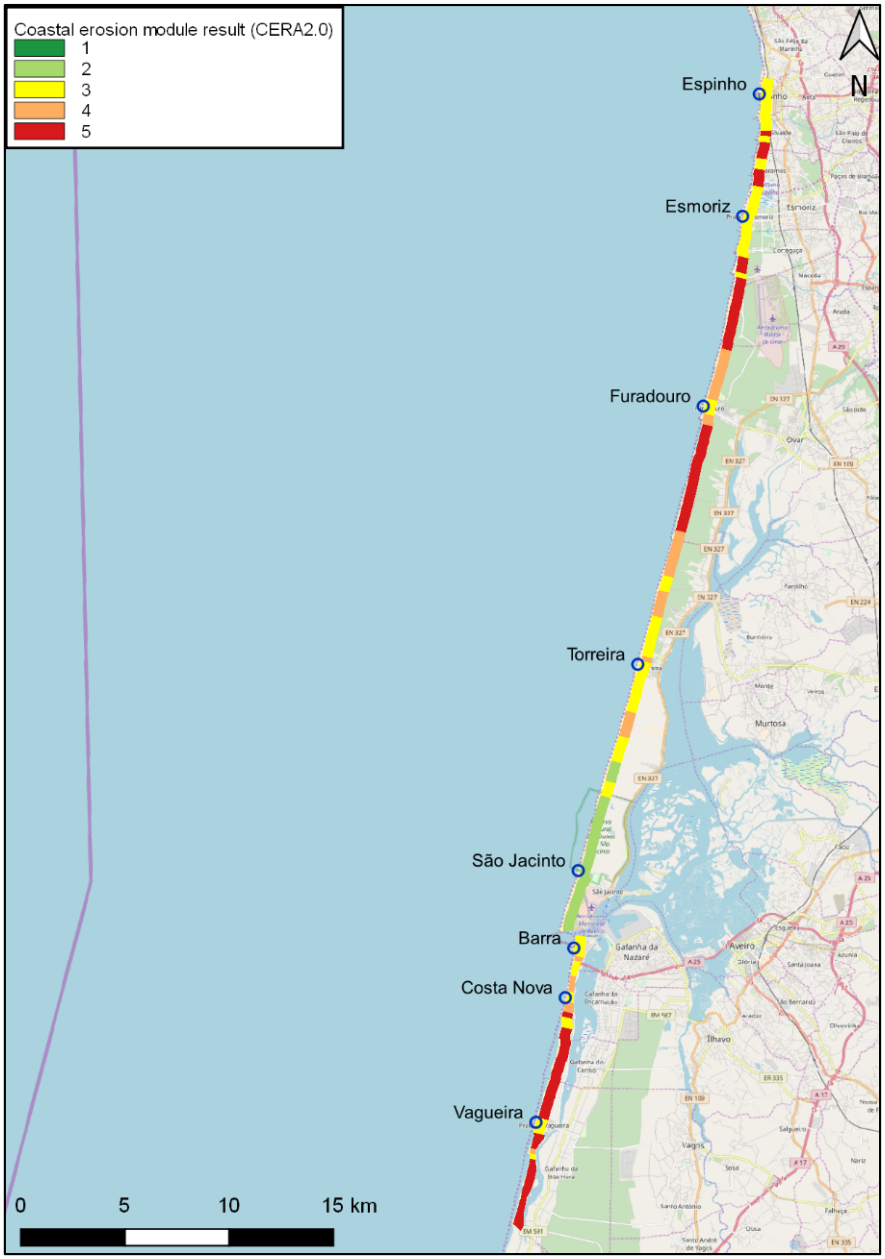


APPLICATION TO AVEIRO – COASTAL EROSION MODULE

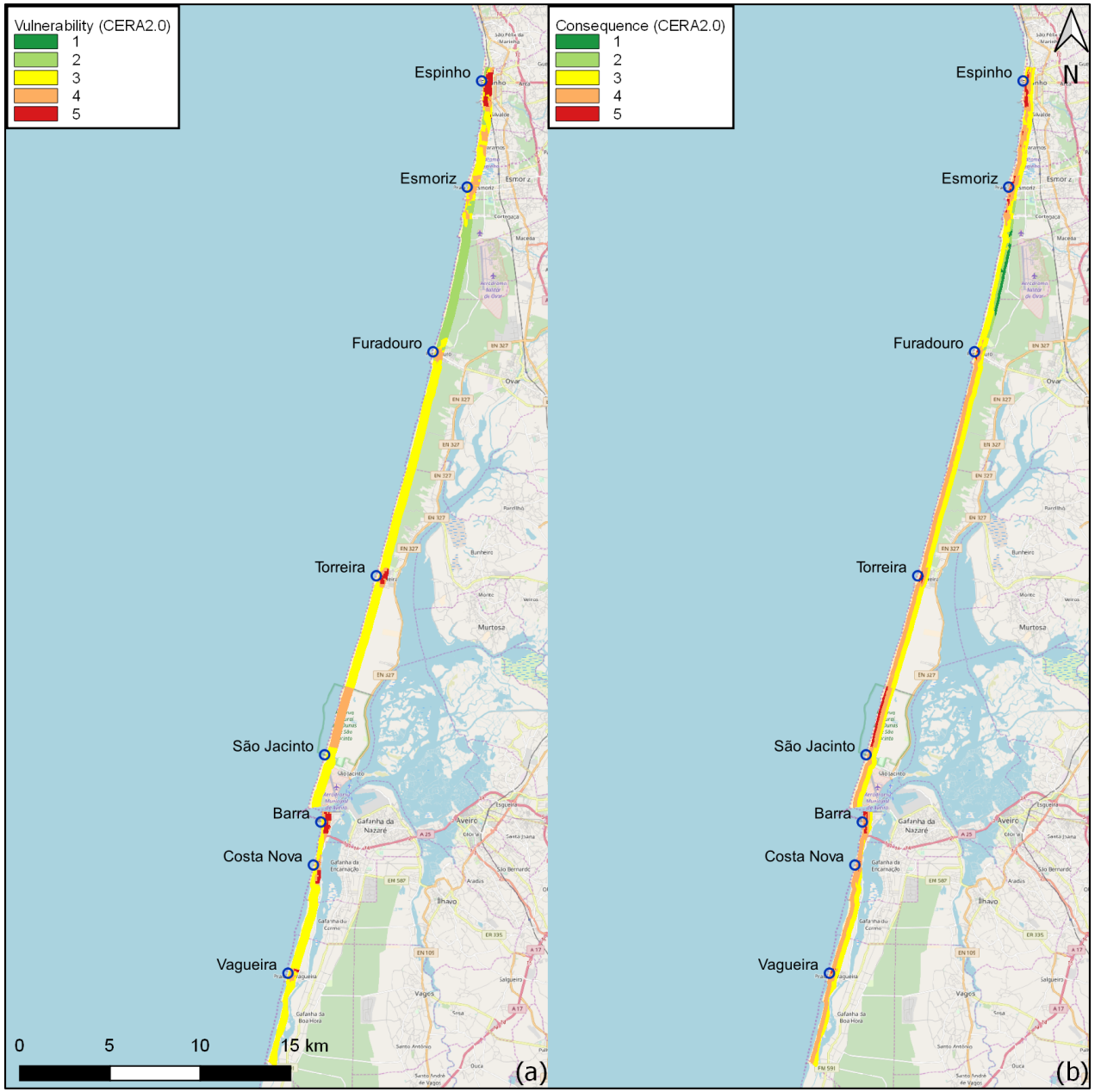
- **A mean of 10 storms per year were estimated for Aveiro, considering 50 years of wave height data;**
- **Storms were identified when wave height surpasses 1.5 times mean significant wave height for a time interval greater than 12 hours;**
- **Mean wave height is 2.16 meters;**
- **The local sea-level rise is 1,27 mm/year.**



APPLICATION TO AVEIRO – COASTAL EROSION RESULT



APPLICATION TO AVEIRO – VULNERABILITY AND CONSEQUENCE



APPLICATION TO AVEIRO – RISK

CONCLUSIONS

- **CERA2.0 (Coastal Erosion Risk Assessment v2.0) is the new developed framework for coastal erosion risk assessment;**
- **It considers 12 indicators and is deeply rooted in GIS (Geographic Information Systems);**
- **CERA2.0 was applied to 3 study sites so far (Aveiro, Macaneta and Quintana Roo);**
- **CERA2.0 presents more nuanced results than the previous version, making it easier to interpret results and identify high risk areas;**
- **Does not have a set weight attributed for each indicator, rather relying on the conceptual model SPRC for risk propagation;**
- **Contrary to most methods, it has inland classification, which is more suitable for area delimitation asked by government programs;**
- **It is an absolute risk classification, promoting cohesion in the results and allowing comparison between different assessments/locations;**
- **Does not require modelling, which shortens the required application time.**

FUTURE DEVELOPMENTS

- **Promote the use of CERA2.0 by interested stakeholders, such as APA (Agência Portuguesa do Ambiente);**
- **Application to other coastal environments, in order to check CERA2.0 performance and attest its applicability to other areas;**
- **Further develop integration in QGIS, focusing on automation processes;**
- **In medium to long-term, the creation of alternative modules to address other use cases (*e.g.* creation of a new coastal erosion module using modelling, for a second stage assessment);**
- **Integration in complete packages of coastal management software.**

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Thank you for your attention and feedback!