COASTAL EROSION RISK ASSESSMENT AT PORTUGUESE SPEAKING COUNTRIES

Past and Future Development

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PRESENTATION STRUCTURE

- Introduction
  - Risk Definition;
  - Identified Methodologies.
- Work Plan
  - Tasks;
  - Project Schedule.
- Work Developed
  - GIS and Python;
  - Applied Methodology;
  - Study Site;
  - Results.
- Final Remarks and Future Development

INTRODUCTION

RISK DEFINITION

Probability x Consequence

Hazard	Exposure	Vulnerability	Social
Coastal Erosion	Waves Tides	Coastal Zone Characteristics Coastal Defenses External factors	Economic Heritage Environment Tourism (…)

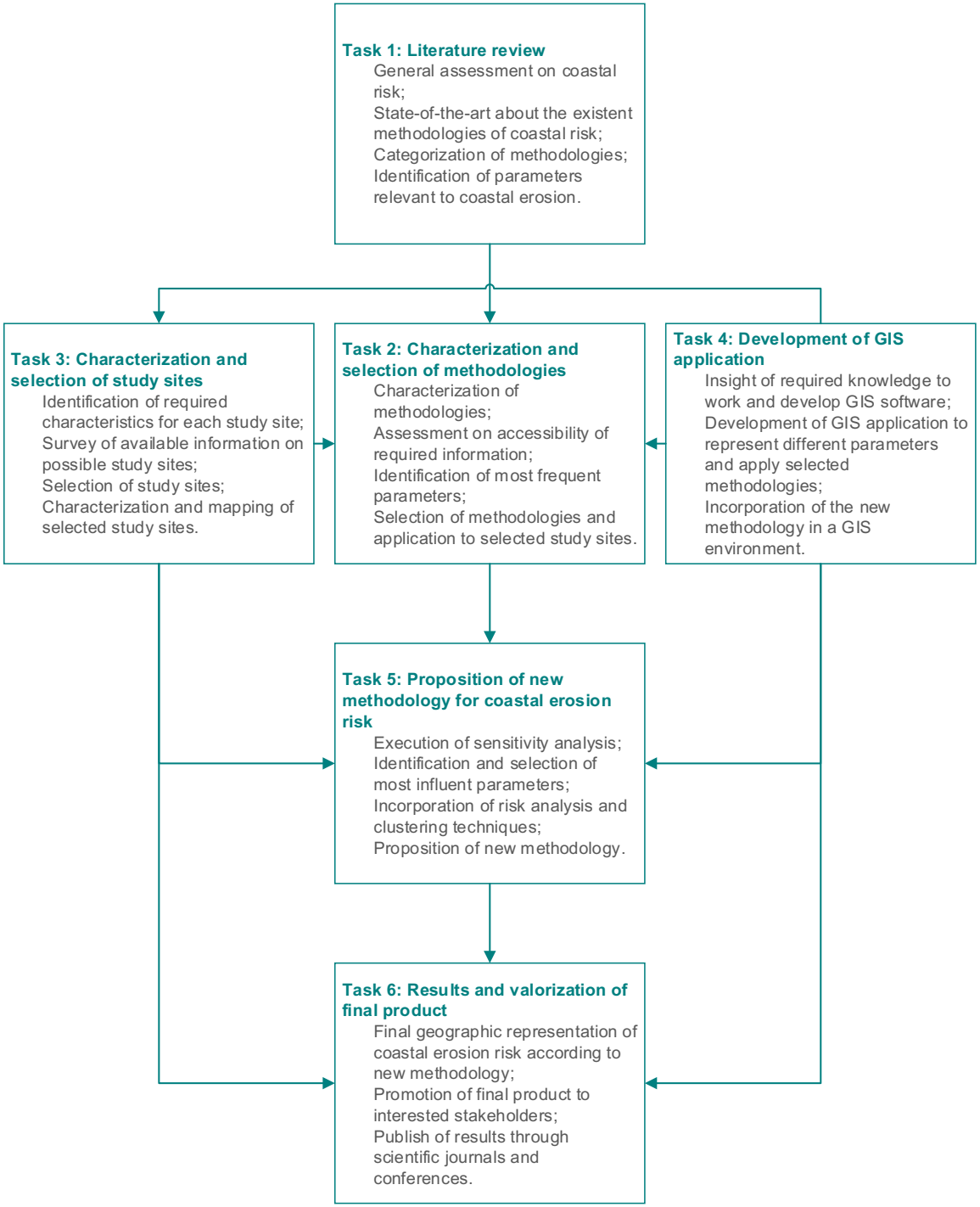
METHODOLOGIES TO ASSESS COASTAL RISK

- Process based methodologies:
  - IPCC Common Methodology;
  - SMART;
  - Veloso-Gomes Methodology;
  - USGS CVI;
  - Coelho Methodology;
  - Smartline Approach;

- GIS based methodologies:
  - DIVA;
  - Coastal Simulator;
  - DESYCO;
  - SimCLIM;
  - THESEUS DSS.

WORK PLAN OVERVIEW

- Work plan divided in 6 tasks;
- First 3 dedicated to data gathering;
- Last 3 dedicated to development;
- Task 1 to 4 already started development in the last year.



WORK PLAN

Task 1: Literature review

- General assessment on coastal risk;
- State-of-the-art about the existent methodologies of coastal risk;
- Categorization of methodologies;
- Identification of parameters relevant to coastal erosion.

WORK PLAN

Task 2: Characterization and selection of methodologies

- Characterization of methodologies;
- Assessment on accessibility of required information;
- Identification of most frequent parameters;
- Selection of methodologies and application to selected study sites.

WORK PLAN

Task 3: Characterization and selection of study sites

- Identification of required characteristics for each study site;
- Survey of available information on possible study sites;
- Selection of study sites;
- Characterization and mapping of selected study sites.

WORK PLAN

Task 4: Development of GIS application

- Insight of required knowledge to work and develop GIS software;
- Development of GIS application to represent different parameters and apply selected methodologies;
- Incorporation of the new methodology in a GIS environment.

WORK PLAN

Task 5: Proposition of new methodology for coastal erosion risk

- Execution of sensitivity analysis;
- Identification and selection of most influent parameters;
- Incorporation of risk analysis and clustering techniques;
- Proposition of new methodology.

WORK PLAN

Task 6: Results and valorization of final product

- Final geographic representation of coastal erosion risk according to new methodology for selected study sites;
- Promotion of final product to interested stakeholders;
- Publish of results through scientific journals and conferences.

WORK PLAN SCHEDULE

Task	Trimester															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1																
2																
3																
4																
5																
6																

Present date

WORK DEVELOPED

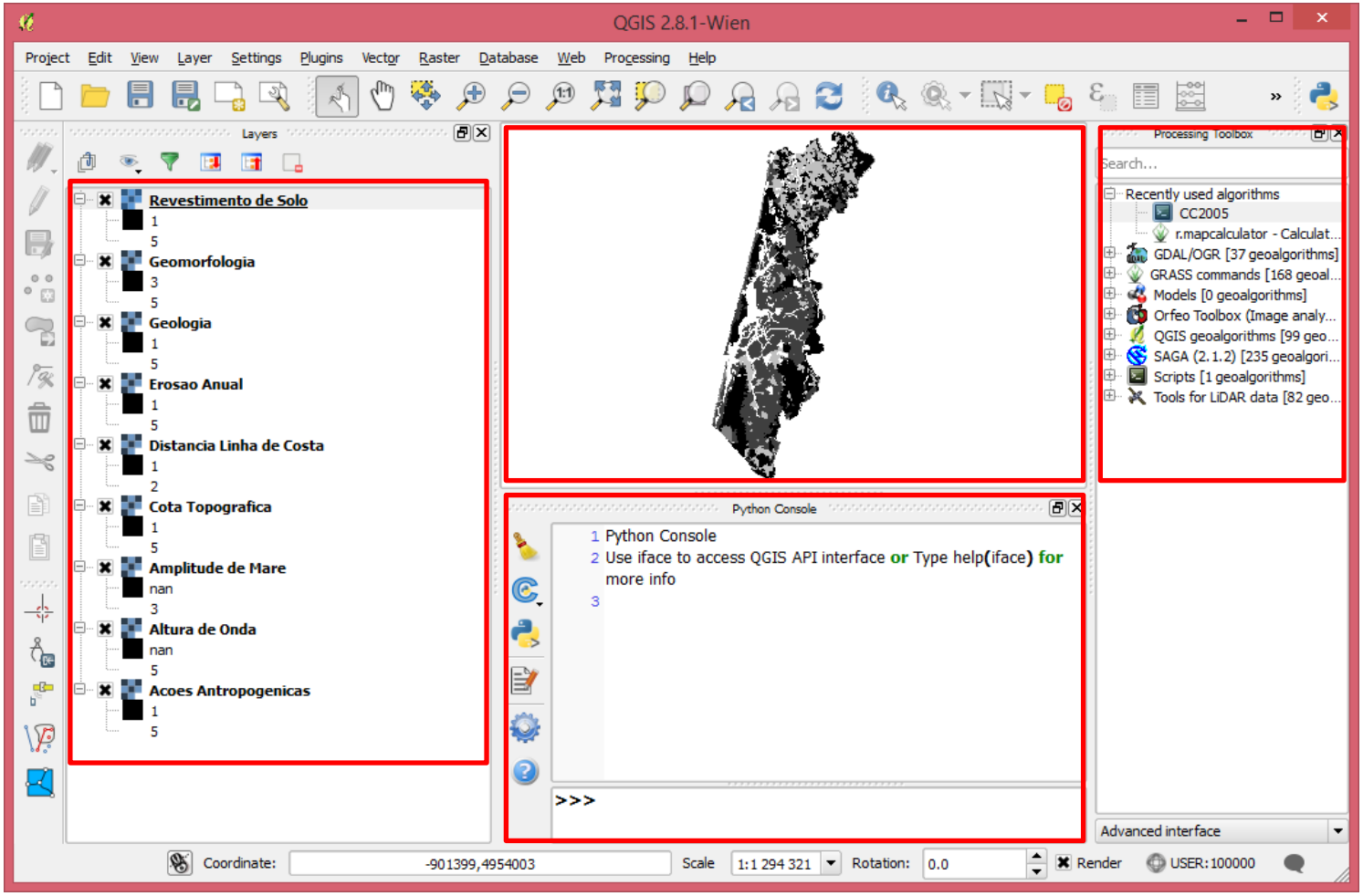
- Tasks 1 to 4 started development:
  - Literature review (task 1);
  - Characterization and application of Coelho Methodology (task 2);
  - Data collection from Aveiro (task 3);
  - Learn skills required for GIS development (task 4);
  - Development of GIS application to evaluate vulnerability to coastal erosion (task 4).

GIS and PYTHON

- GIS software – QGIS:
  - Open-source;
  - Constant development;
  - Active development community.

- Programming Language – Python:
  - Object-oriented;
  - Integrates with QGIS;
  - PyQGIS.

QGIS INTERFACE



METHODOLOGY APPLIED

- Methodology in GIS application:
  - Coelho Methodology (Coelho, 2005; Coelho et al., 2007; Coelho and Arede, 2009; Pereira and Coelho, 2013).

- Advantages:
  - Easy application;
  - Vast and accessible documentation;
  - Prior results allow for better assessment on application accuracy.

METHODOLOGY APPLIED

Vulnerability	Very low 1	Low 2	Moderated 3	High 4	Very high 5
Distance to shoreline (m)	> 1000	201 to 1000	51 to 200	21 to 50	≤ 20
Topography elevation (m)	> 30	21 to 30	11 to 20	6 to 10	≤ 5
Geology	Magmatic rocks	Metamorphic rocks	Sedimentary rocks	Non-consolidated coarse sediments	Non-consolidated fine sediments
Geomorphology	Mountains	Rock cliffs	Erosive cliffs, sheltered beaches	Exposed beaches, plain	Dunes, river mouths, estuaries
Ground cover	Forest	Vegetation, cultivated	Non covered	Rural urbanized	Urbanized or industrial
Anthropogenic actions	Shoreline stabilization intervention	Intervention without sediment sources reduction	Intervention with sediment sources reduction	Without interventions or sediment sources reduction	Without interventions and with sediment sources reduction
Maximum significant wave height (m)	< 3.0	3.0 to 4.9	5.0 to 5.9	6.0 to 6.9	≥ 6.9
Maximum tidal range (m)	< 1.0	1.0 to 1.9	2.0 to 4.0	4.1 to 6.0	> 6.0
Average erosion/accretion rates (m/year)	> 0.0 Accretion	0.0 to -0.9	-1.0 to -2.9	-3.0 to -4.9	≤ -5.0 Erosion

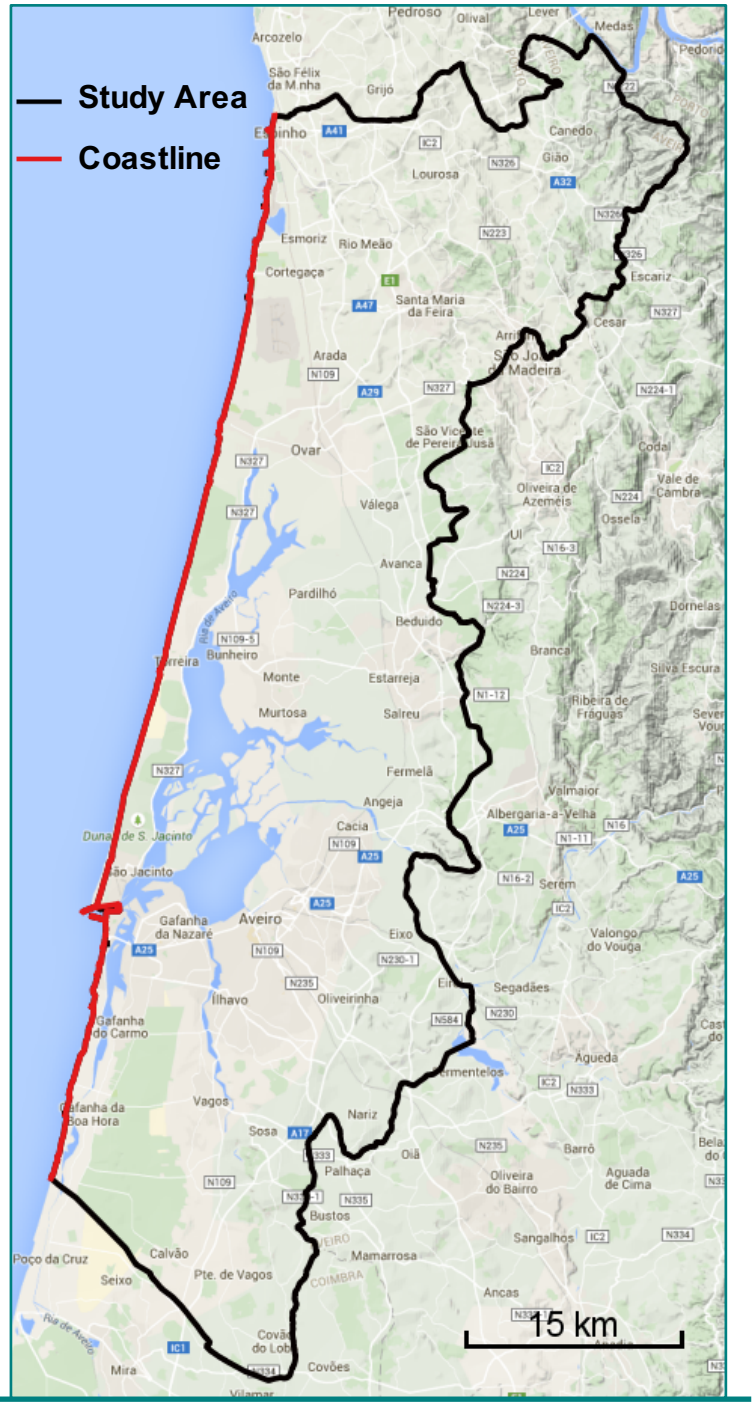
METHODOLOGY APPLIED

Vulnerability	Distance to shoreline (d)		
	< 100 m	100 to 5000 m	> 5000 m
Distance to shoreline	0.214	$\frac{6}{28}+\frac{0.665(d-100)}{4900}$	0.879
Topography elevation	0.214	$\frac{6}{28}-\frac{0.665(d-100)}{4900}\frac{6}{22}$	0.033
Geology			
Geomorphology	0.071	$\frac{2}{28}-\frac{0.665(d-100)}{4900}\frac{2}{22}$	0.011
Ground cover			
Maximum significant wave height			
Average erosion/accretion rates			
Maximum tidal range	0.036	$\frac{1}{28}-\frac{0.665(d-100)}{4900}\frac{1}{22}$	0.005
Anthropogenic actions			

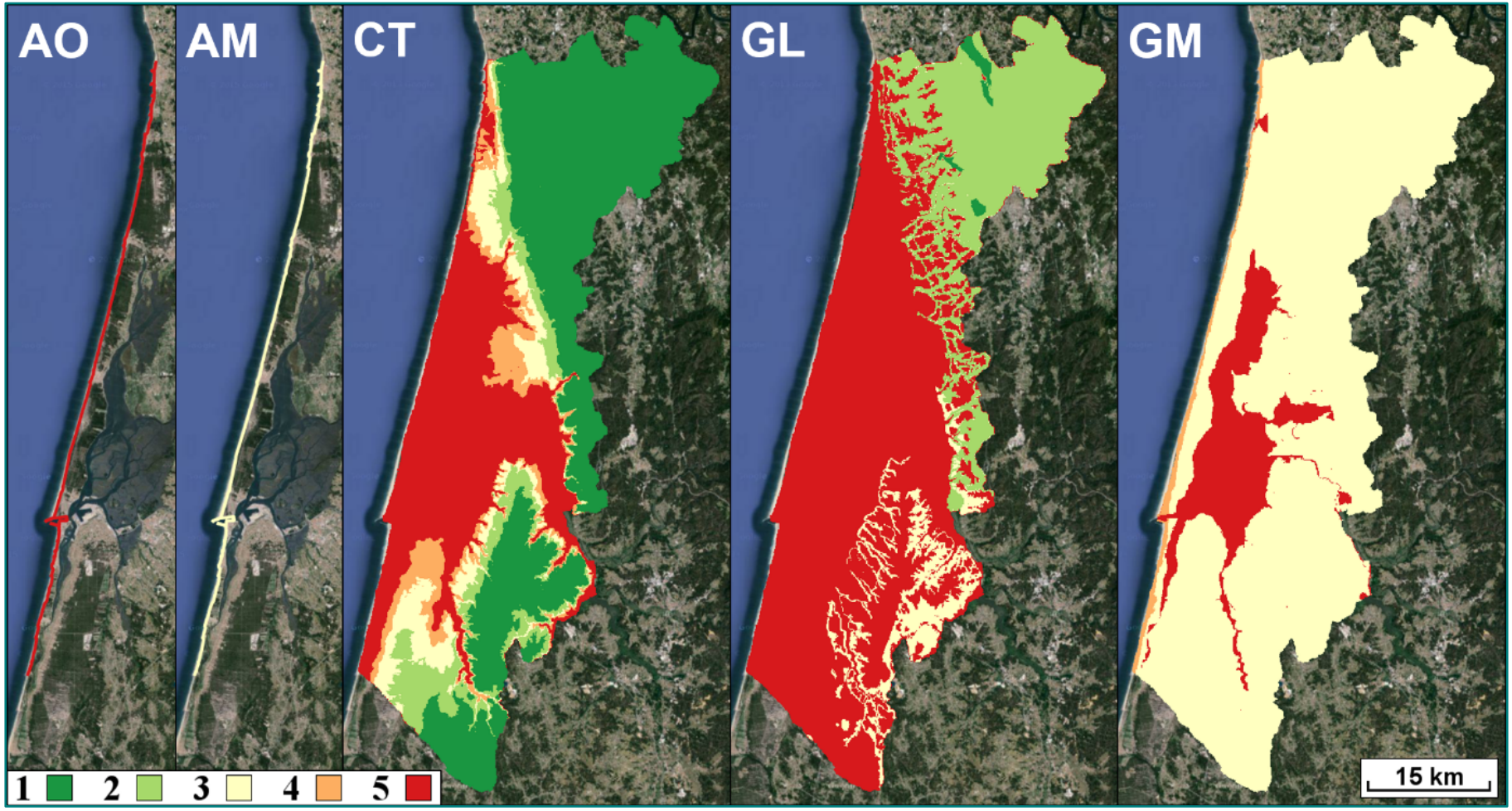
STUDY SITE

- Municipalities:
  - Espinho;
  - Ovar;
  - Estarreja;
  - Murtosa;
  - Aveiro;
  - Ílhavo;
  - Vagos;
  - Sta. Maria da Feira.

- Main Characteristics:
  - Sandy open coast;
  - Highly energetic wave climate;
  - Coastal defenses;
  - Reduced sediment supplies;
  - Low topography;
  - Ria de Aveiro.

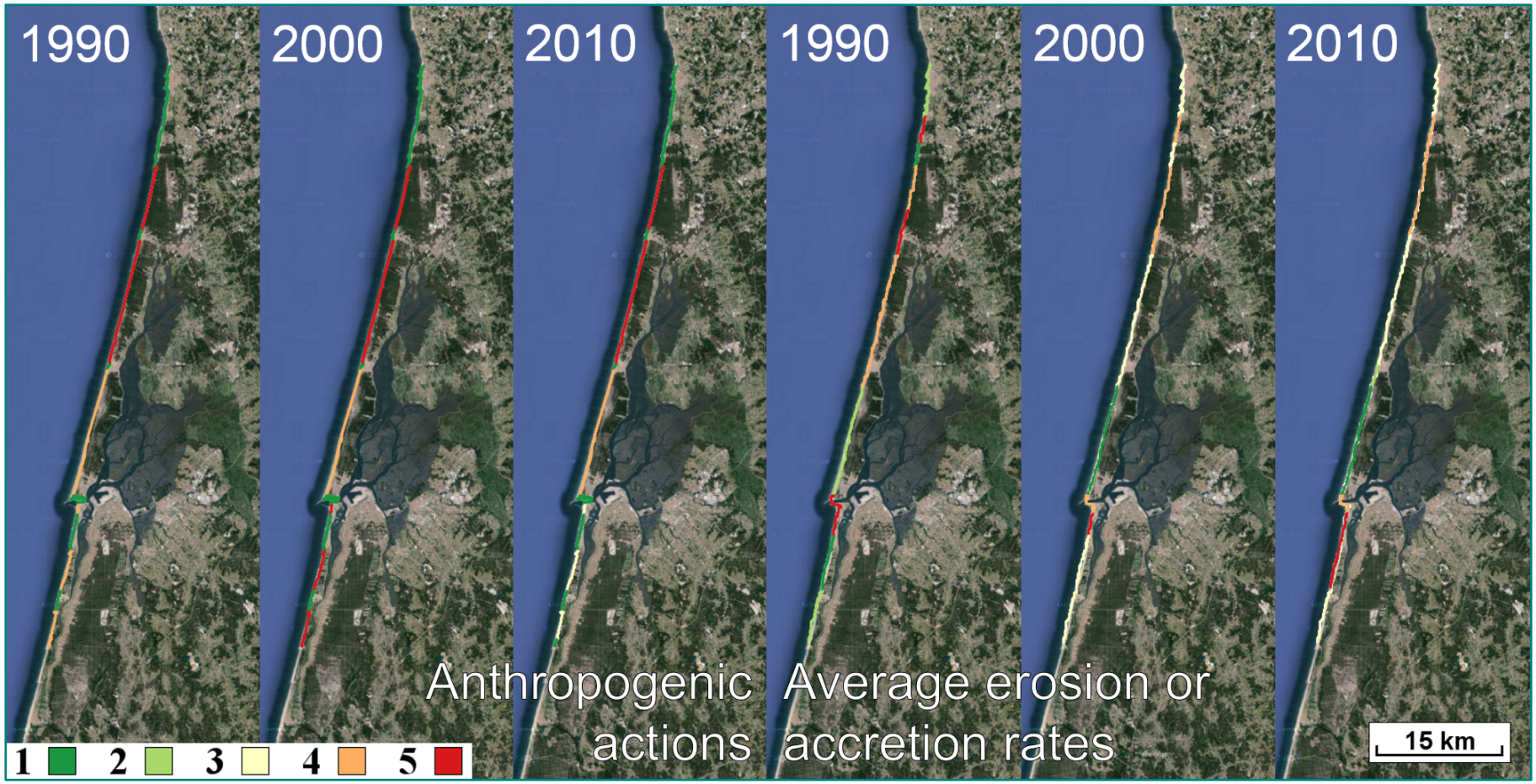


DATA COLLECTION



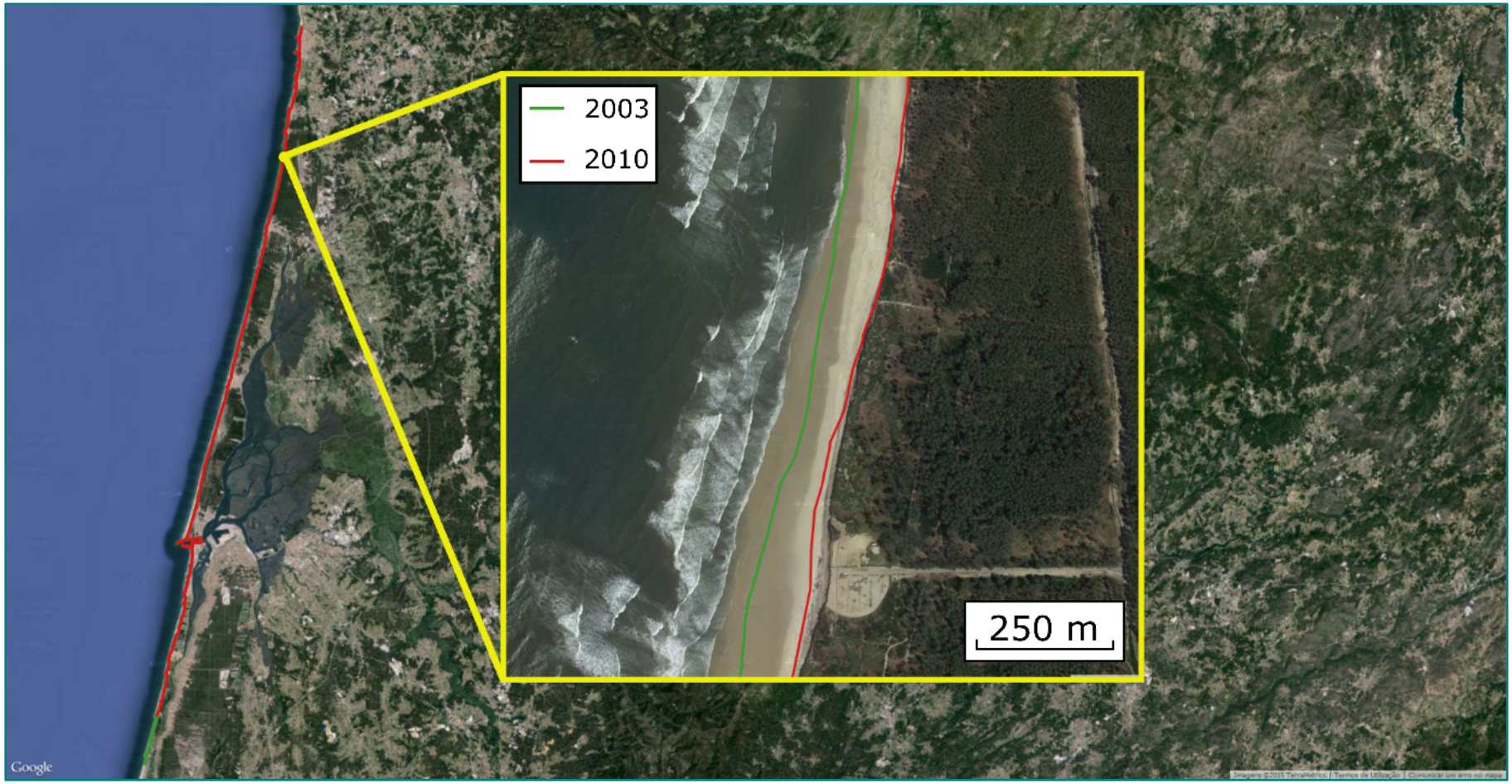
Classification maps referent to parameters who are considered as unchangeable over time: Maximum significant wave height (AO); Maximum tidal range (AM); Topography (CT); Geology (GL); Geomorphology (GM).

DATA COLLECTION



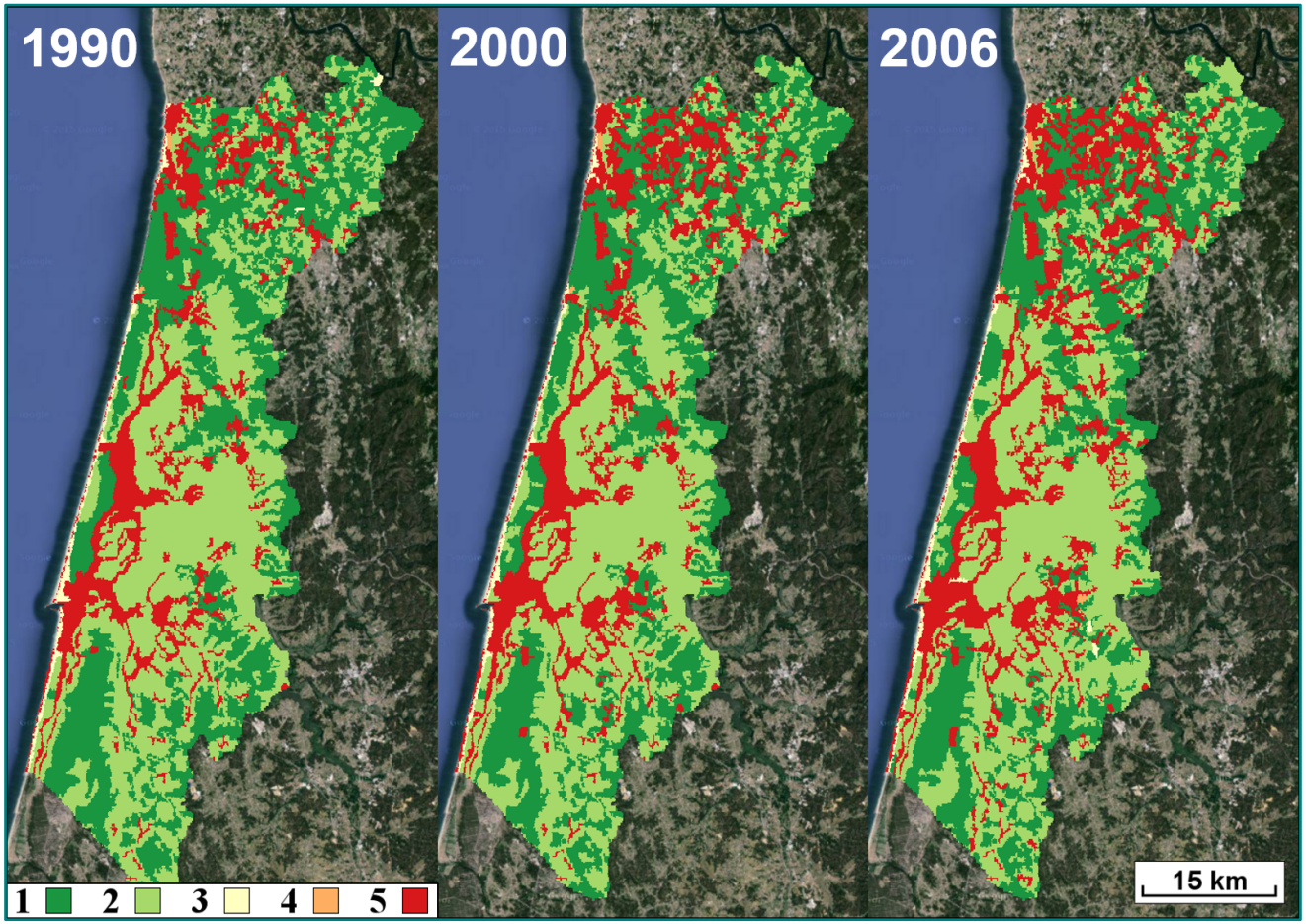
Classification maps for parameter of anthropogenic actions and average erosion/accretion rates over time.

DATA COLLECTION



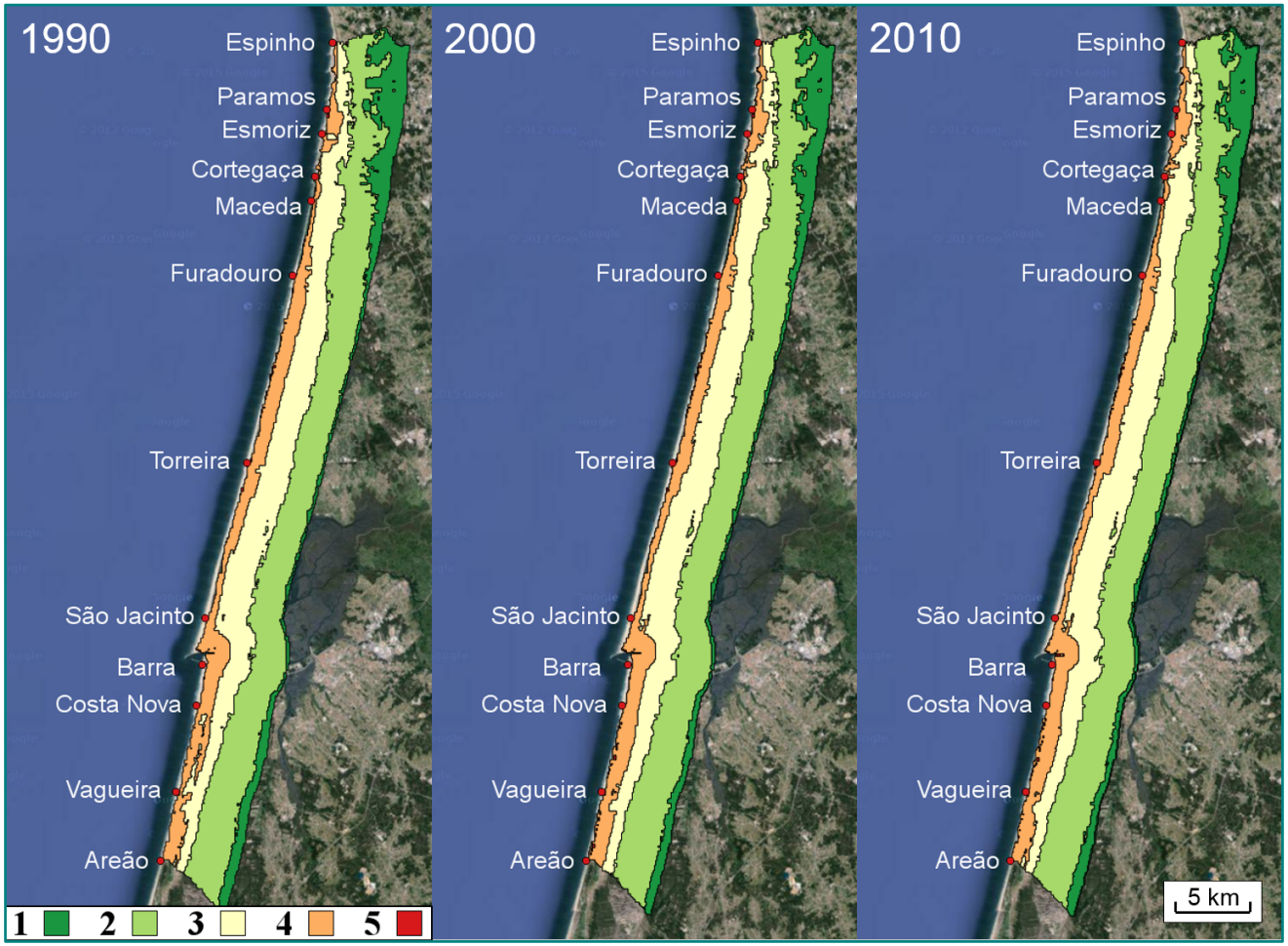
Coastline position in the years of 2003 and 2010 and zoom in of Maceda beach.

DATA COLLECTION



Classification maps for ground cover over time.

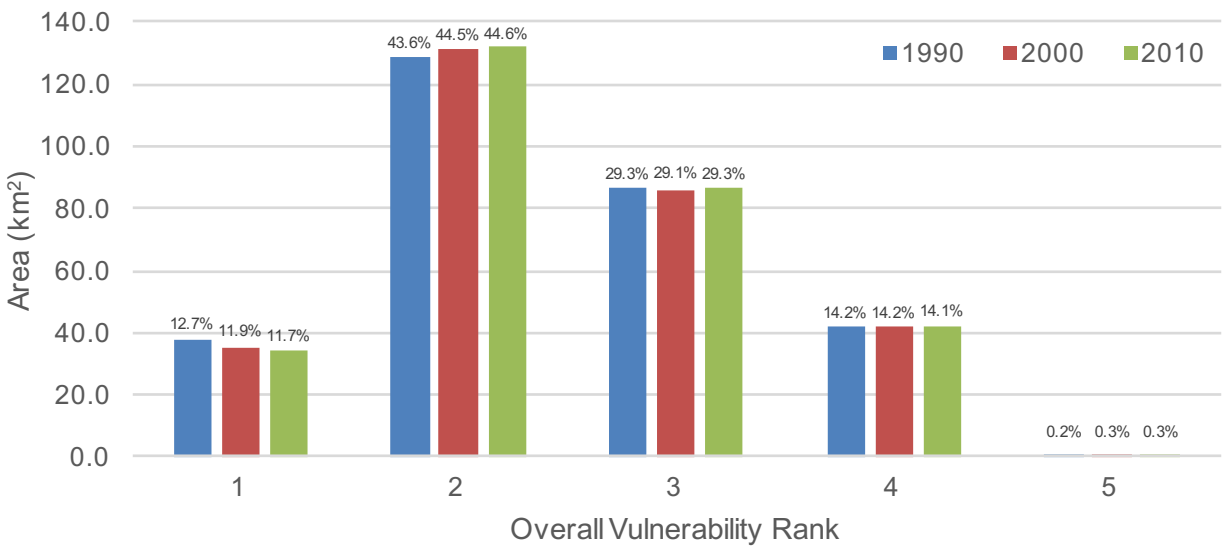
RESULTS

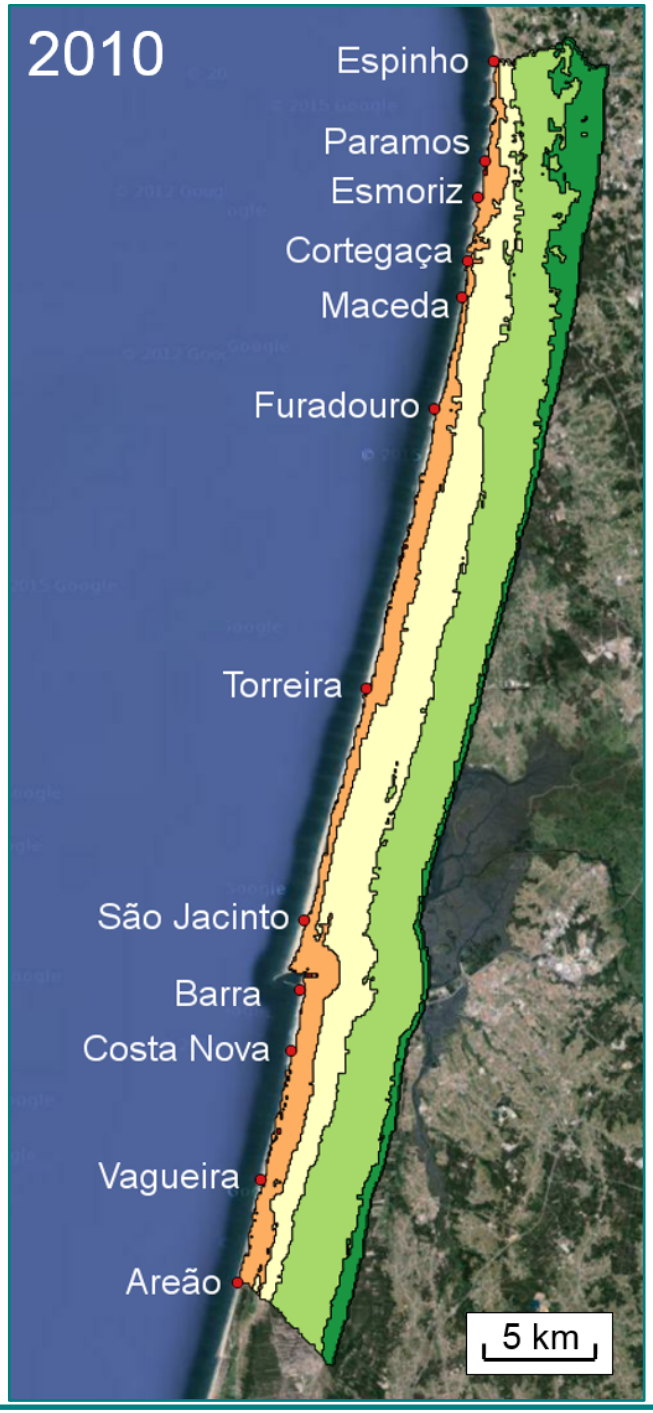


Overall vulnerability to coastal erosion over time.

RESULTS

- Stripe of 5km to inland was analyzed;
- High vulnerability (rank 4) across all coastline – around 14% of the total area analyzed;
- Small changes were noticed through the time periods analyzed.





FINAL REMARKS

- Aim: Develop a GIS-based coastal erosion risk methodology;
- Work plan with 6 distinct tasks;
- Development progress:
  - Literature review;
  - Characterization of Coelho methodology;
  - Characterization of Aveiro coastline;
  - Acquisition of GIS and Python skills;
  - Development of GIS-based application;
  - Classification of Aveiro vulnerability:
    - All coastline analyzed classified as highly vulnerable.

FUTURE DEVELOPMENT

- Characterization and application of other methodologies;
- Incorporation of consequence parameters in Coelho methodology;
- Characterization of new study sites:
  - Macaneta (Mozambique);
  - Macau (Brazil).
- Further development of GIS application:
  - Automatic evaluation of several parameters (topography, coastline);
  - Acceptance of maps in vectorial format;
  - Incorporation of new methodologies;
  - Application to the new study sites;
  - Development of a Graphical User Interface.

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Thank you for your attention and feedback!