# P&S outputs, coastal vulnerability model

7/1/2014

# A few slides on how the model works

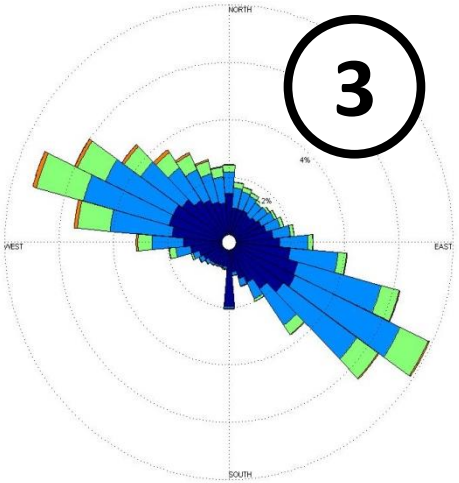
- Users guide chapter:

http://ncp-dev.stanford.edu/~dataportal/invest-releases/documentation/current_release/coastal_vulnerability.html

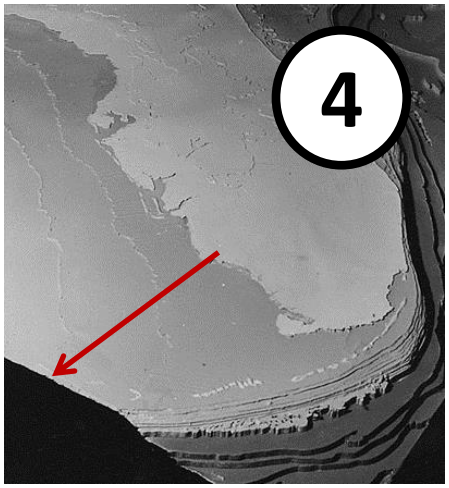
# Biophysical inputs


**GEOMORPHOLOGY**

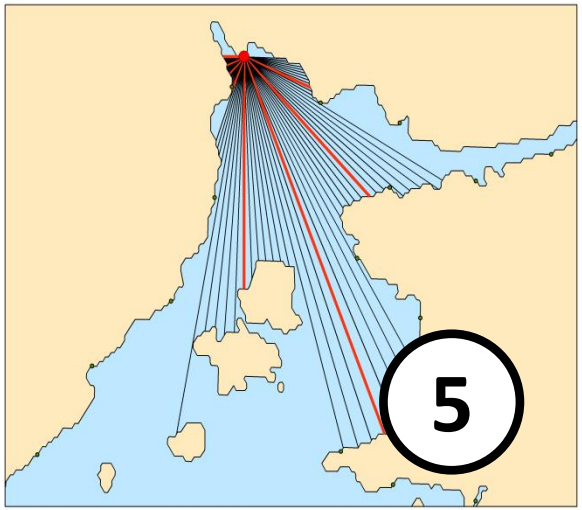

**NATURAL HABITATS**




**WIND EXPOSURE**

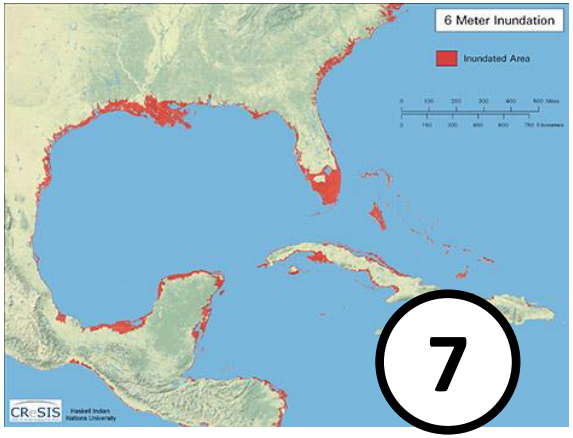



**SURGE POTENTIAL**




**WAVE EXPOSURE**


**RELIEF**




**SEA LEVEL RISE**

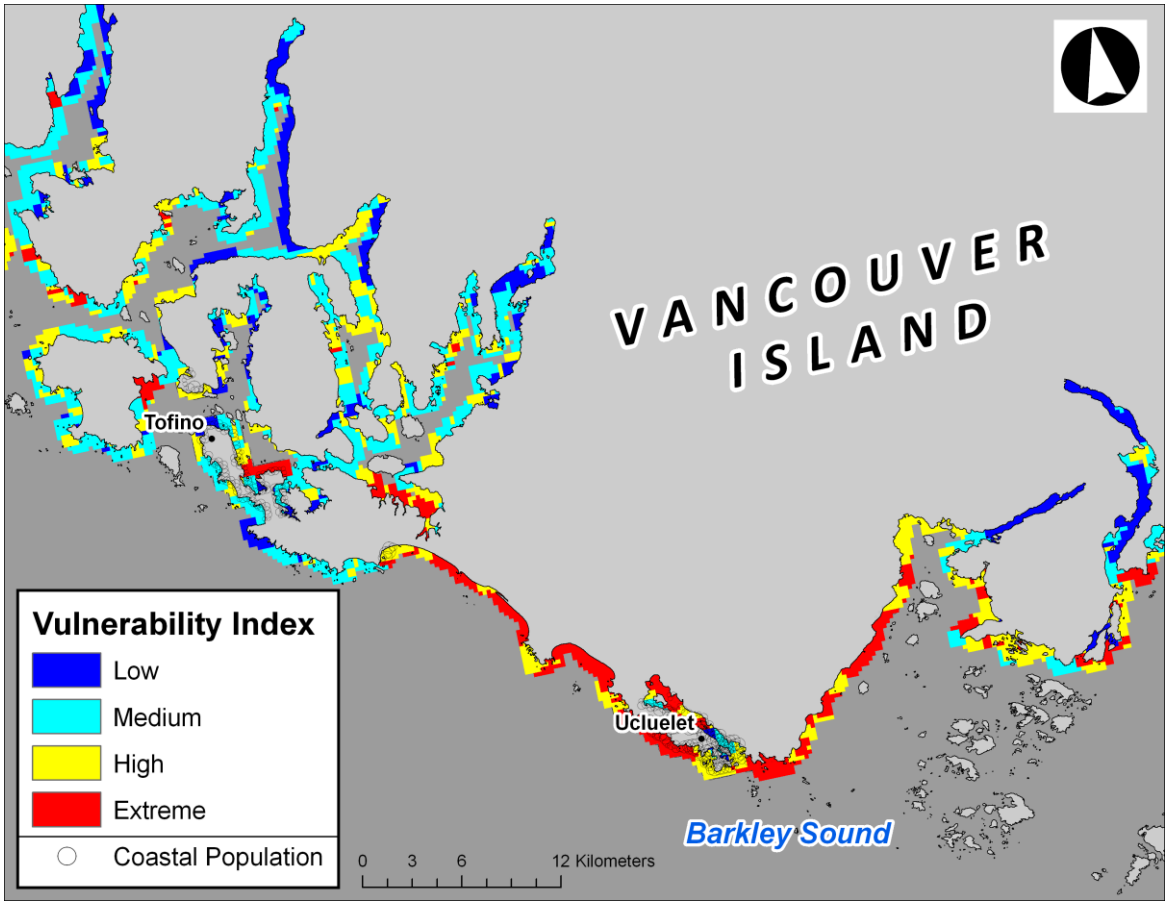
# Coastal Vulnerability Index

| Rank | Very Low | Low | Moderate | High | Very High |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Geomorphology | Rocky; high cliffs; fiord; fiard | Medium cliff; indented coast | Low cliff; glacial drift; alluvial plain | Cobble beach; estuary; lagoon; bluff | Barrier beach; sand beach; mud flat; delta |
| Relief | > 90th Percentile | > 75th Percentile | Average value | < 25th Percentile | < 10th Percentile |
| Natural Habitats | Coral reef; mangrove; coastal forest | High dune; marsh | Low dune; oyster reef | Seagrass; kelp | No habitat |
| Sea Level Change | Net decrease | | ±1 | | Net rise |
| Wind Exposure | < $10^{th}$ Percentile | < $25^{th}$ Percentile | Average value | > $75^{th}$ Percentile | > $90^{th}$ Percentile |
| Wave Exposure | < $10^{th}$ Percentile | < $25^{th}$ Percentile | Average value | > $75^{th}$ Percentile | > $90^{th}$ Percentile |
| Surge Potential | No exposure | < $25^{th}$ Percentile | Average value | > $75^{th}$ Percentile | > $90^{th}$ Percentile |

Qualitative assessment of vulnerability based on mixture of relative and absolute rankings

# Vulnerability Index Output

$$VI = \sqrt{\frac{R_{Geomorphology} R_{Relief} R_{Habitats} R_{SLR} R_{WindExposure} R_{WaveExposure} R_{Surge}}{Count_{Var}}}$$

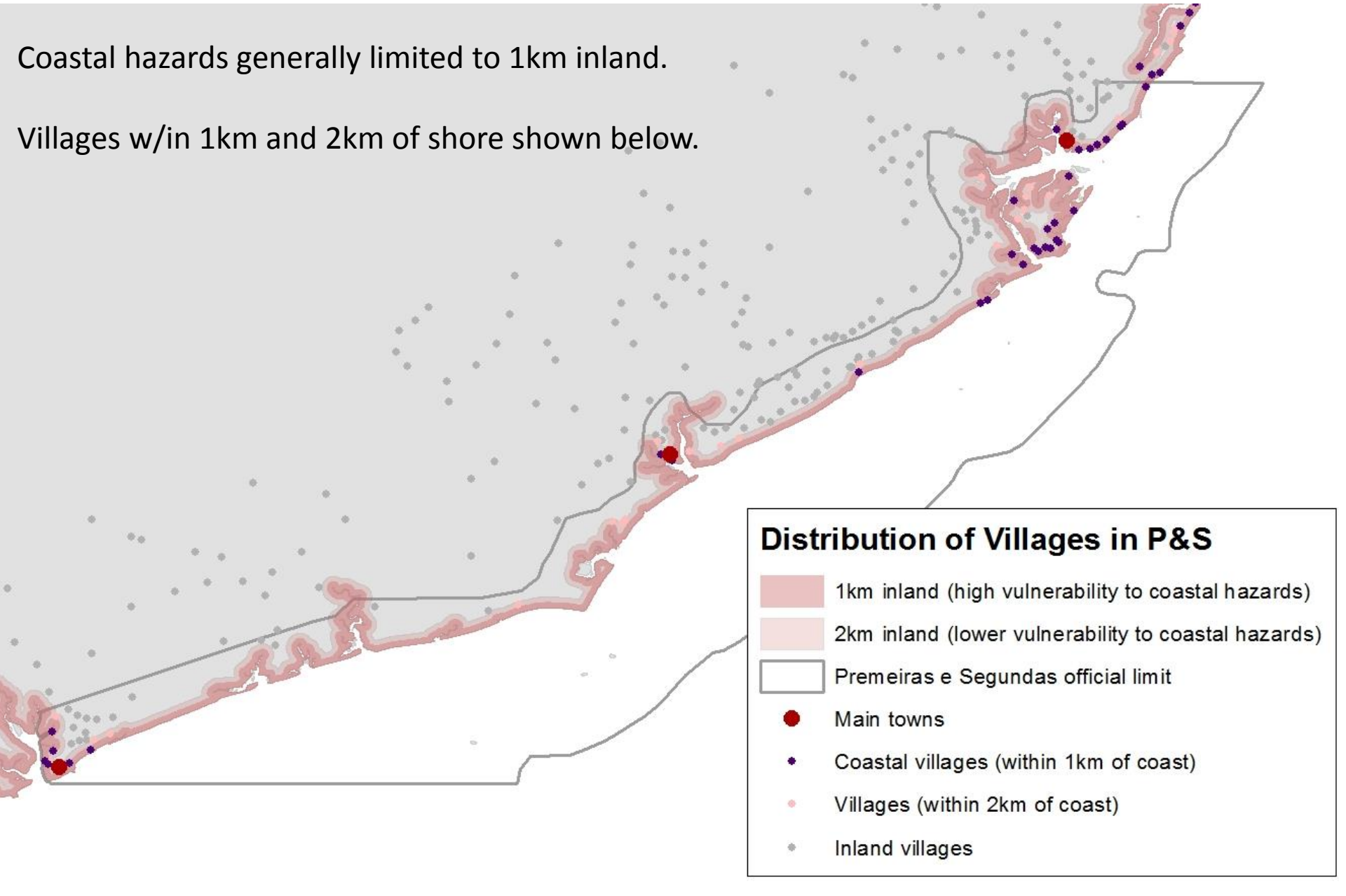


# Results from P&S analysis

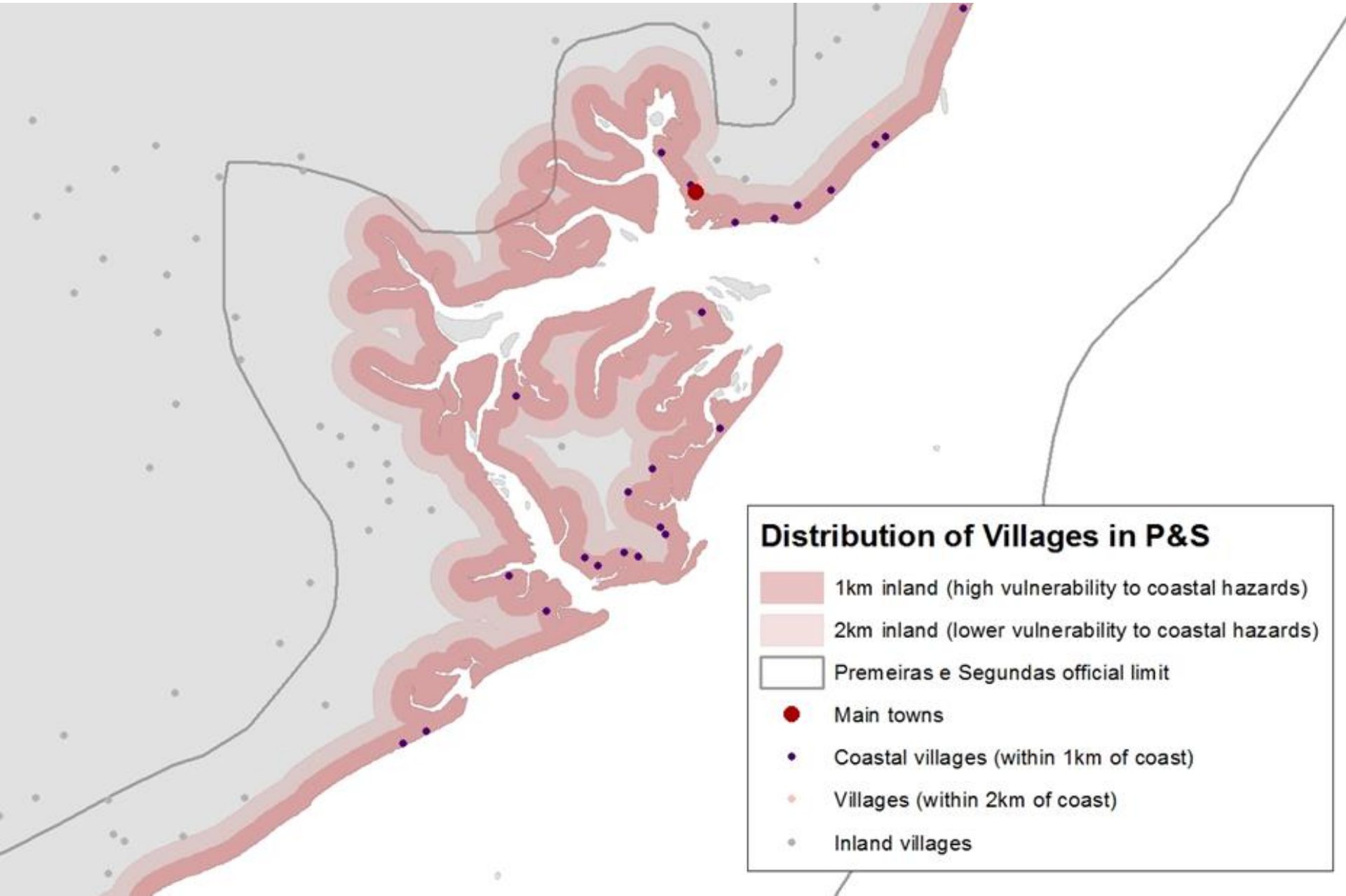
Summary of population data for P&S. Village-level data with corresponding pop'n figures from INE 2007 census.

Coastal hazards generally limited to 1km inland.

Villages w/in 1km and 2km of shore shown below.



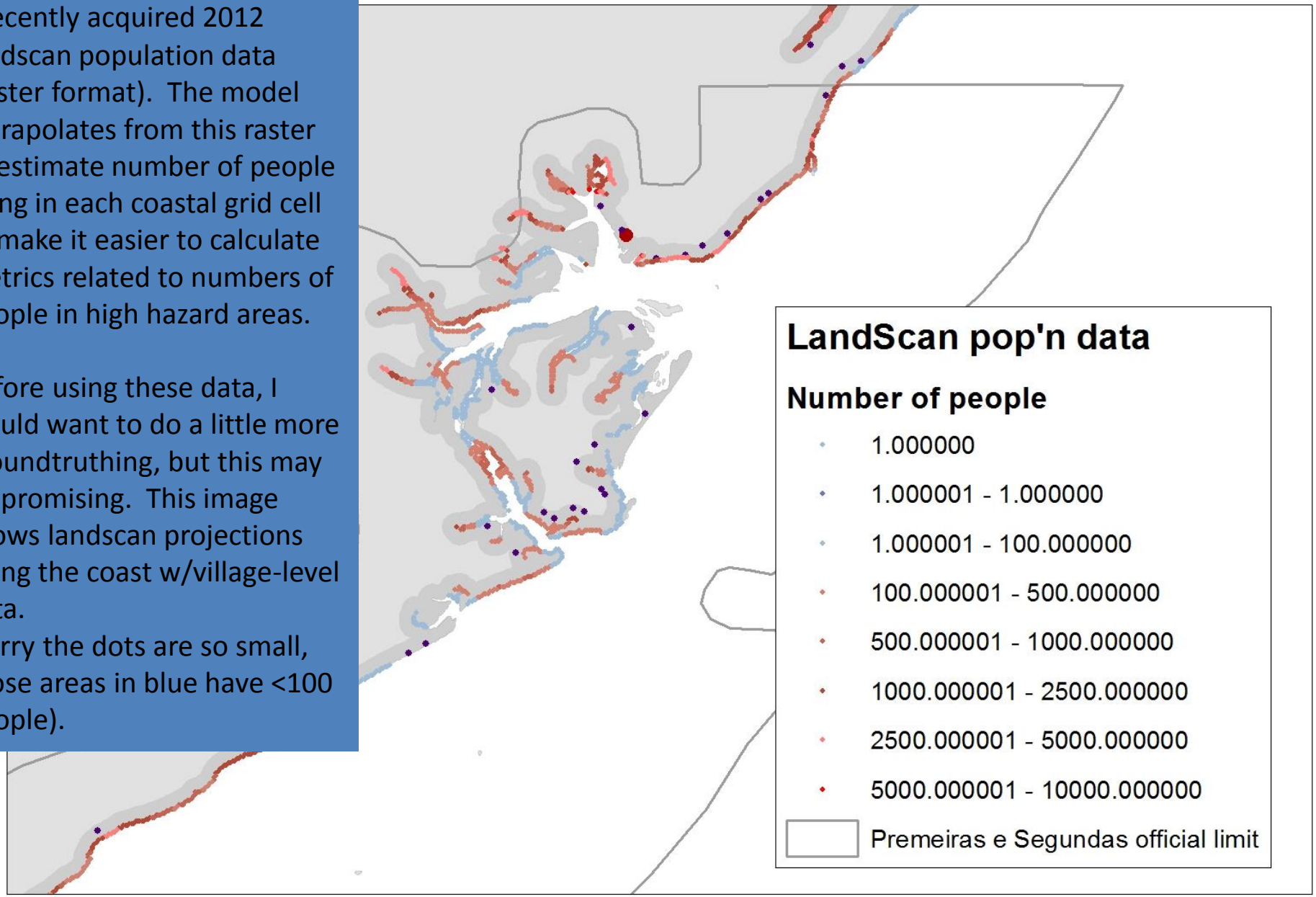
Zoom in of village-level data from Angoche area.



# Land Scan population data (2012)

I recently acquired 2012 landscan population data (raster format). The model extrapolates from this raster to estimate number of people living in each coastal grid cell to make it easier to calculate metrics related to numbers of people in high hazard areas.

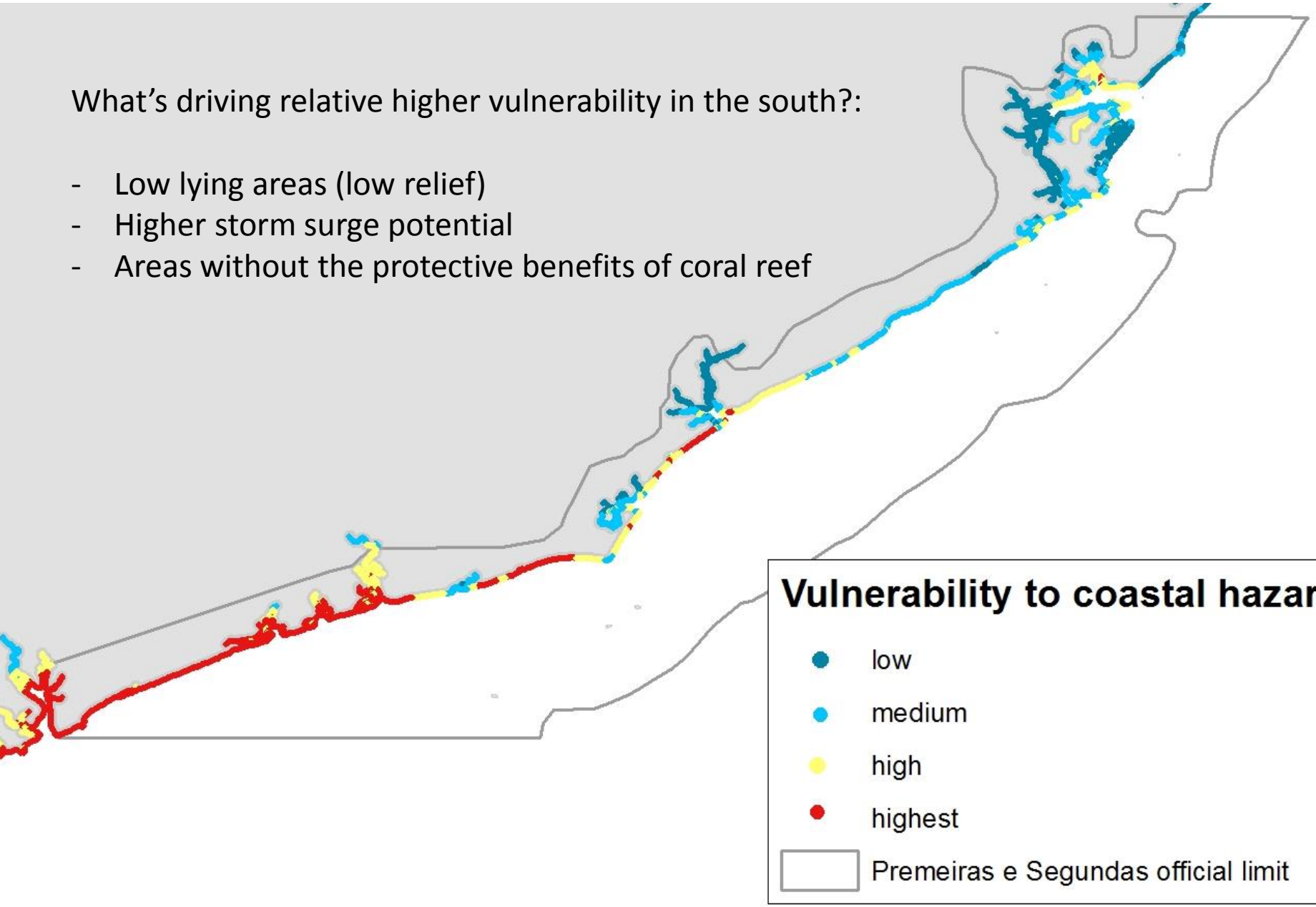
Before using these data, I would want to do a little more groundtruthing, but this may be promising. This image shows landscan projections along the coast w/village-level data.
(sorry the dots are so small, those areas in blue have <100 people).

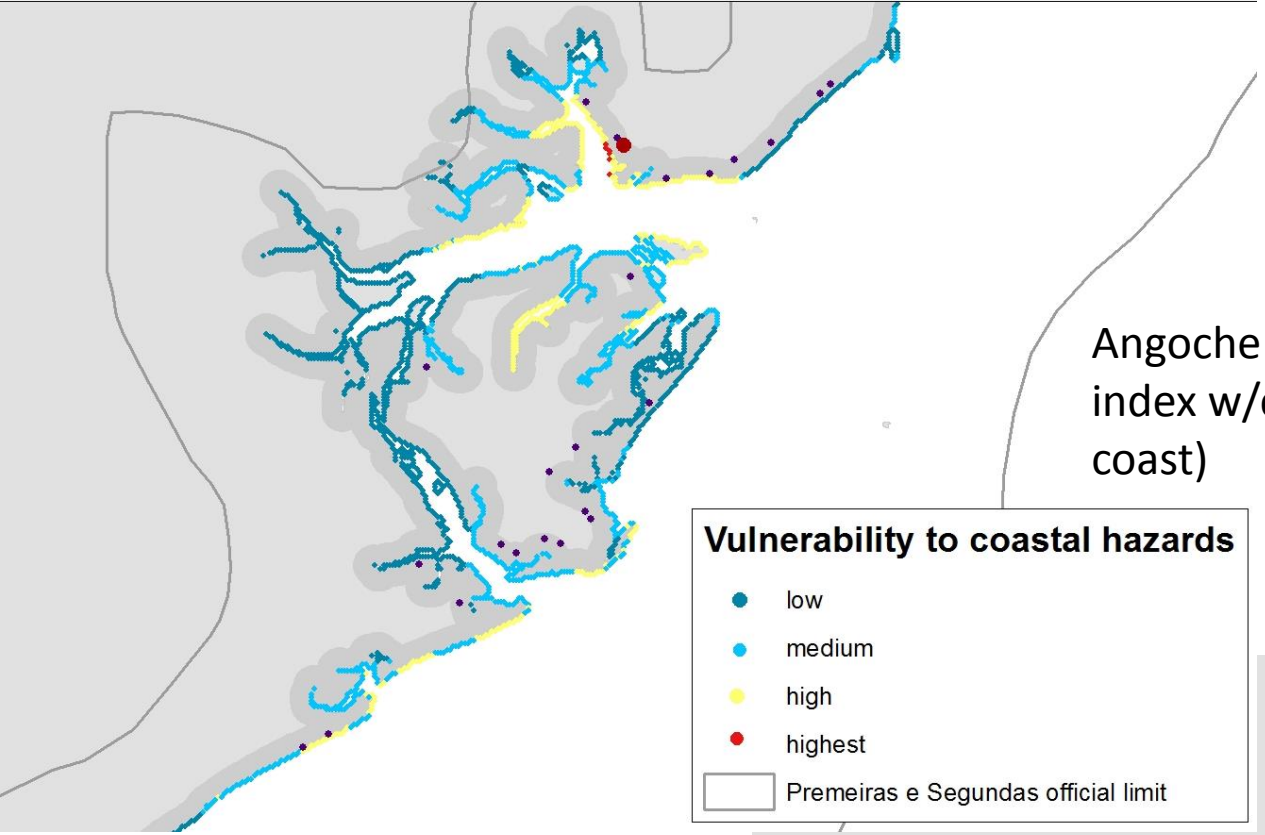


Coastal vulnerability index:  shows relative vulnerability of coastline segments to hazards (biophysical only, does not include population information).

What's driving relative higher vulnerability in the south?:

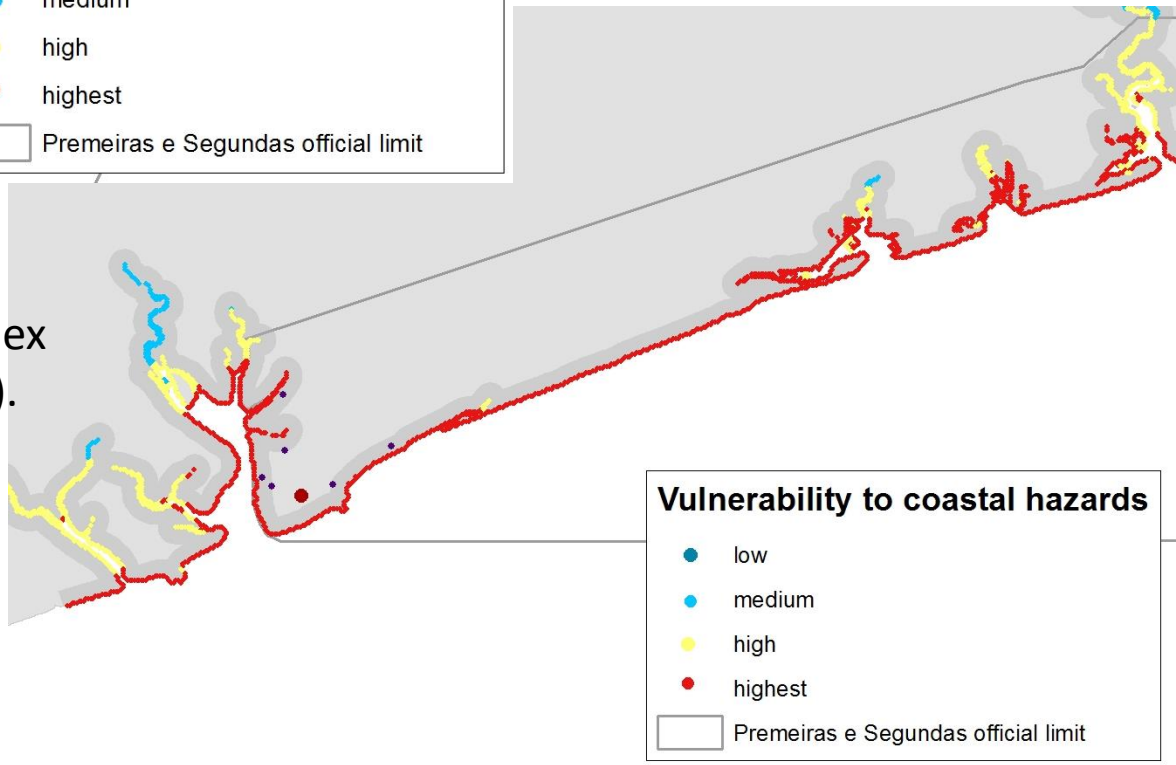
- Low lying areas (low relief)
- Higher storm surge potential
- Areas without the protective benefits of coral reef



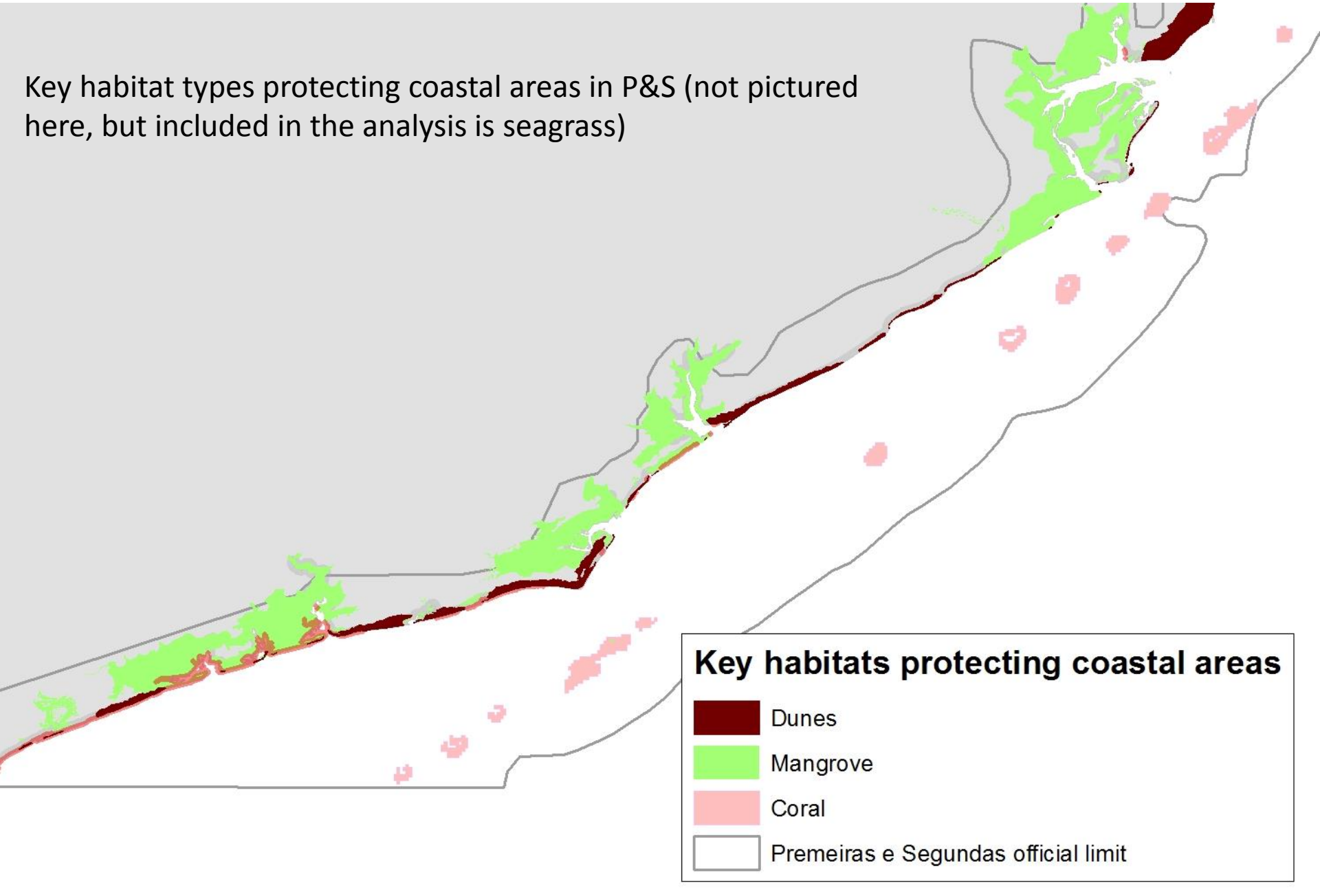



Angoche area, coastal vulnerability index w/coastal villages (w/in 1km of coast)

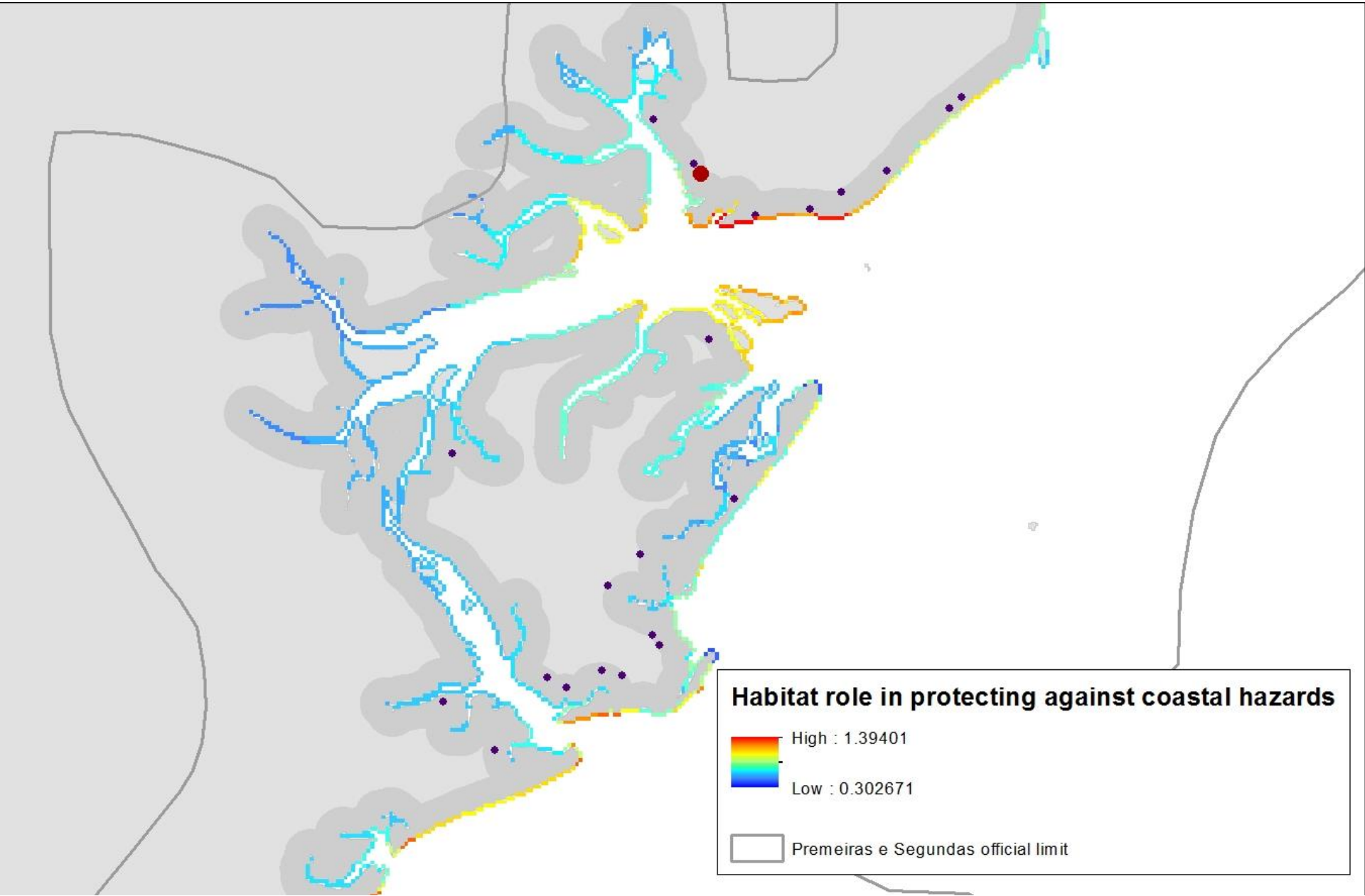
Pebane area, coastal vulnerability index w/coastal villages (w/in 1km of coast).



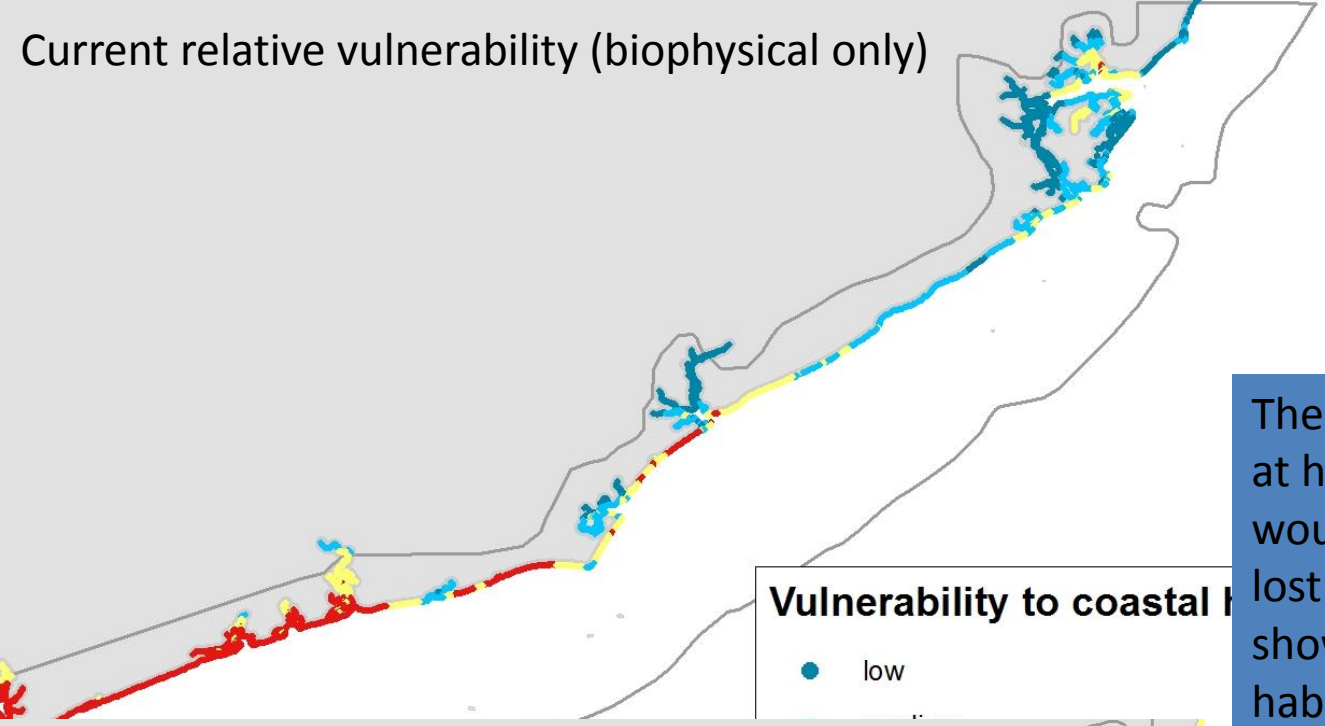
Key habitat types protecting coastal areas in P&S (not pictured here, but included in the analysis is seagrass)



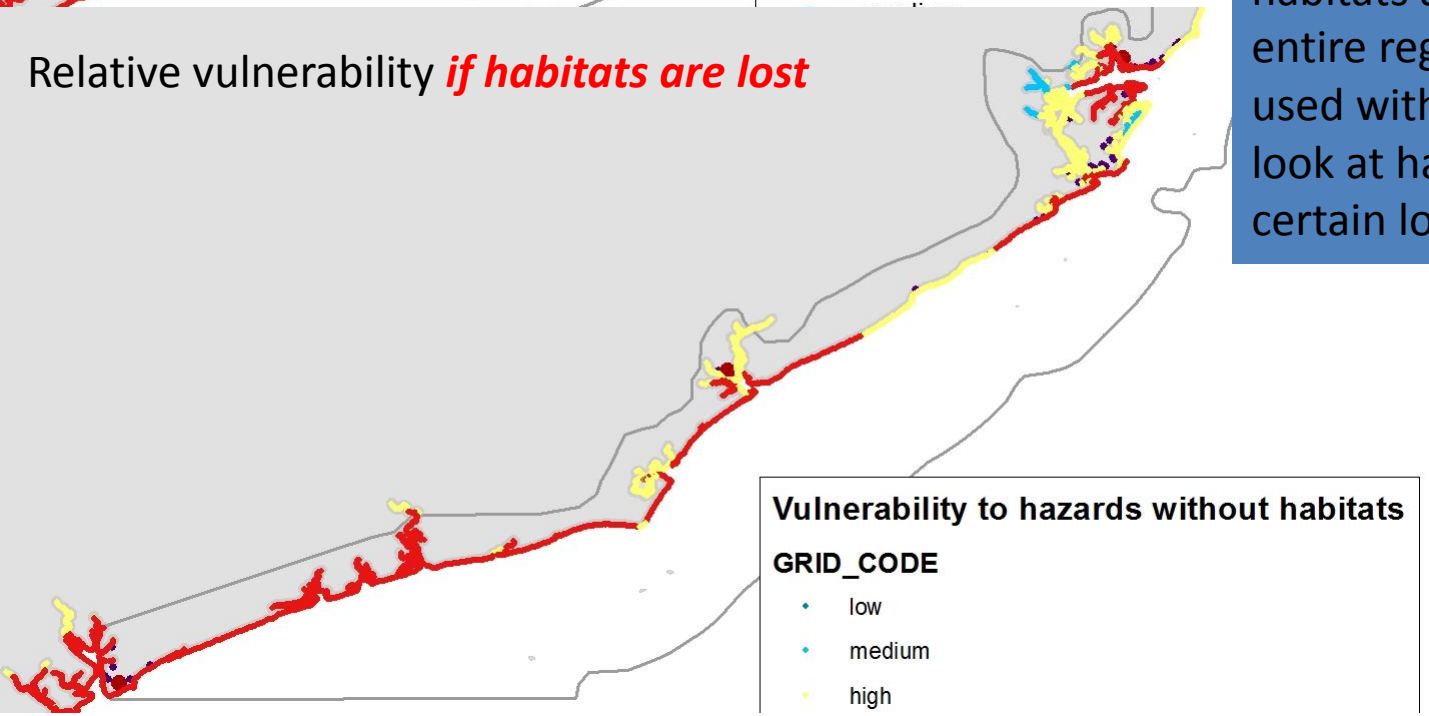
Model output showing the relative importance of habitats ('habitat role') in reducing vulnerability.



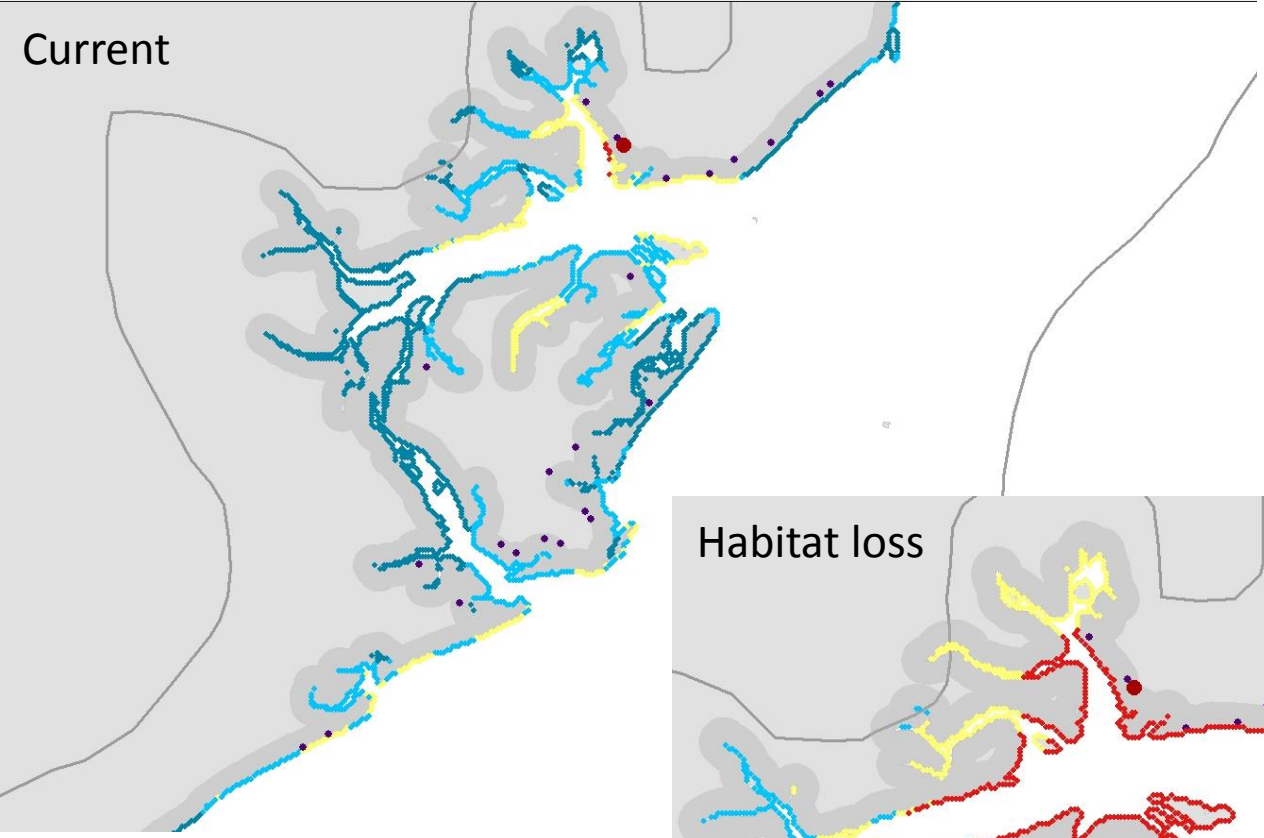
Current relative vulnerability (biophysical only)

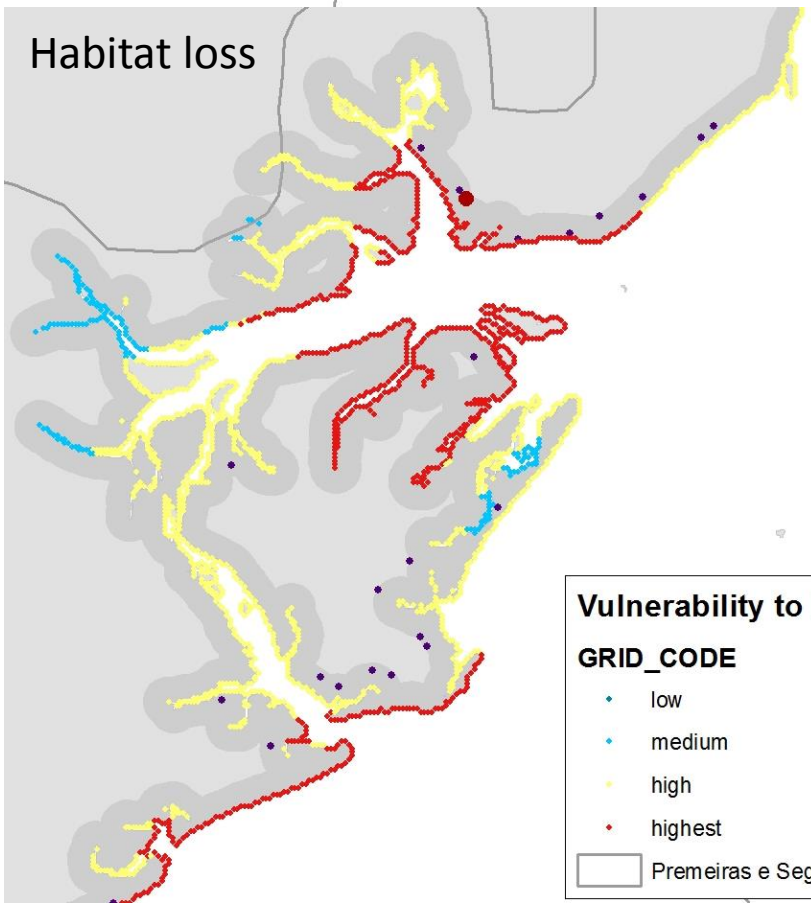



Relative vulnerability ***if habitats are lost***

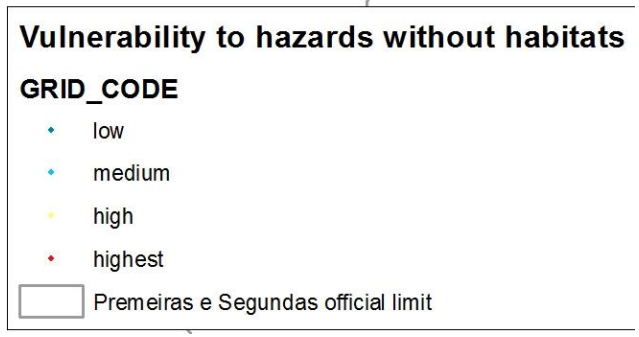



The model can be used to look at how relative vulnerability would change if habitats were lost (or restored). This example shows a scenario where habitats are lost across the entire region. This could be used with more specificity to look at habitat loss and gain at certain locations.

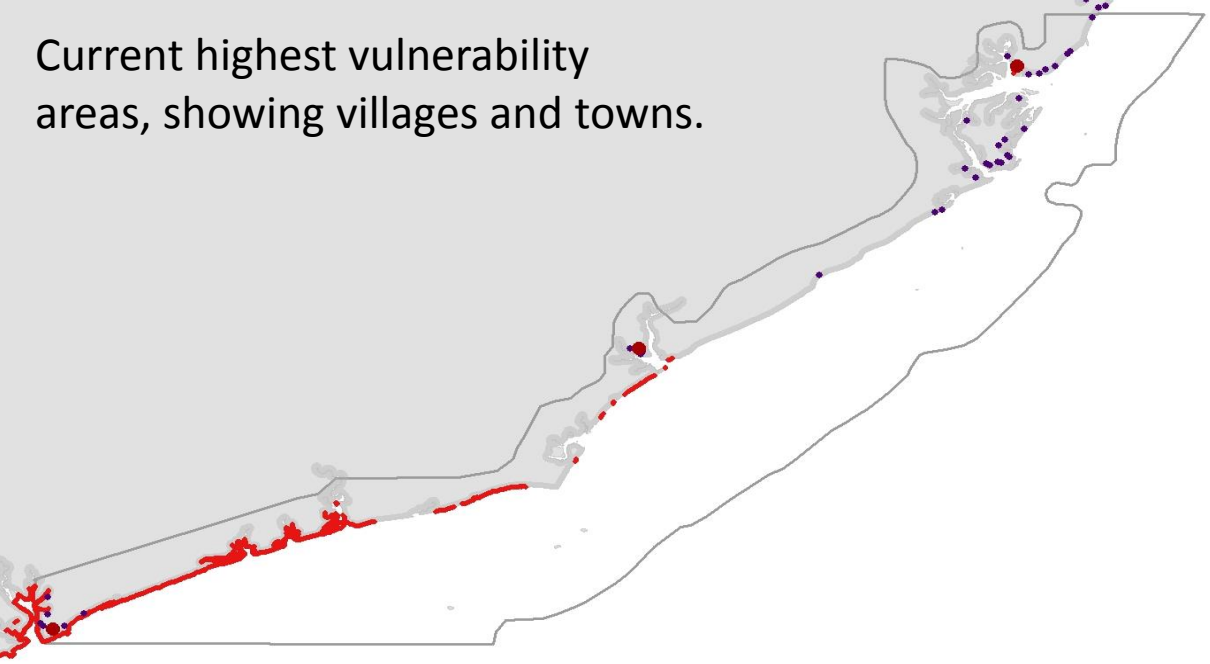


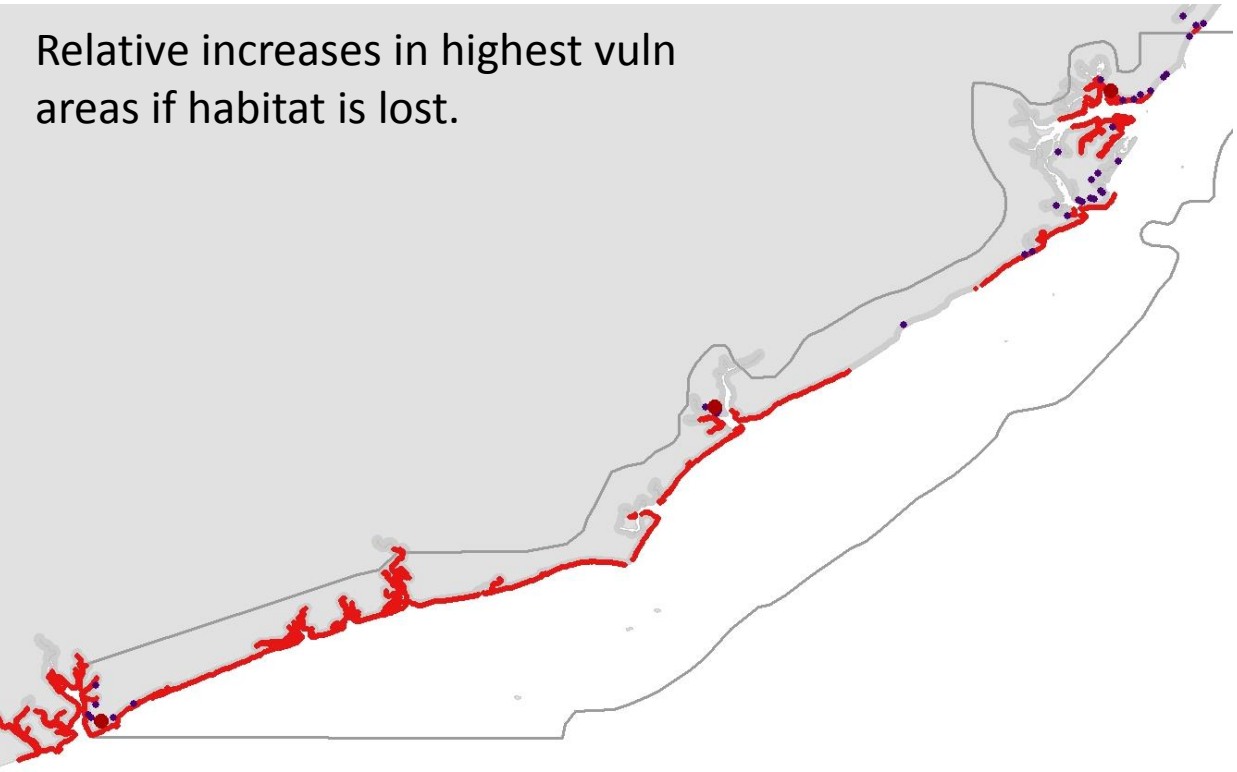

Same as previous slide,
Angoche area zoom.



Current highest vulnerability areas, showing villages and towns.



Relative increases in highest vuln areas if habitat is lost.

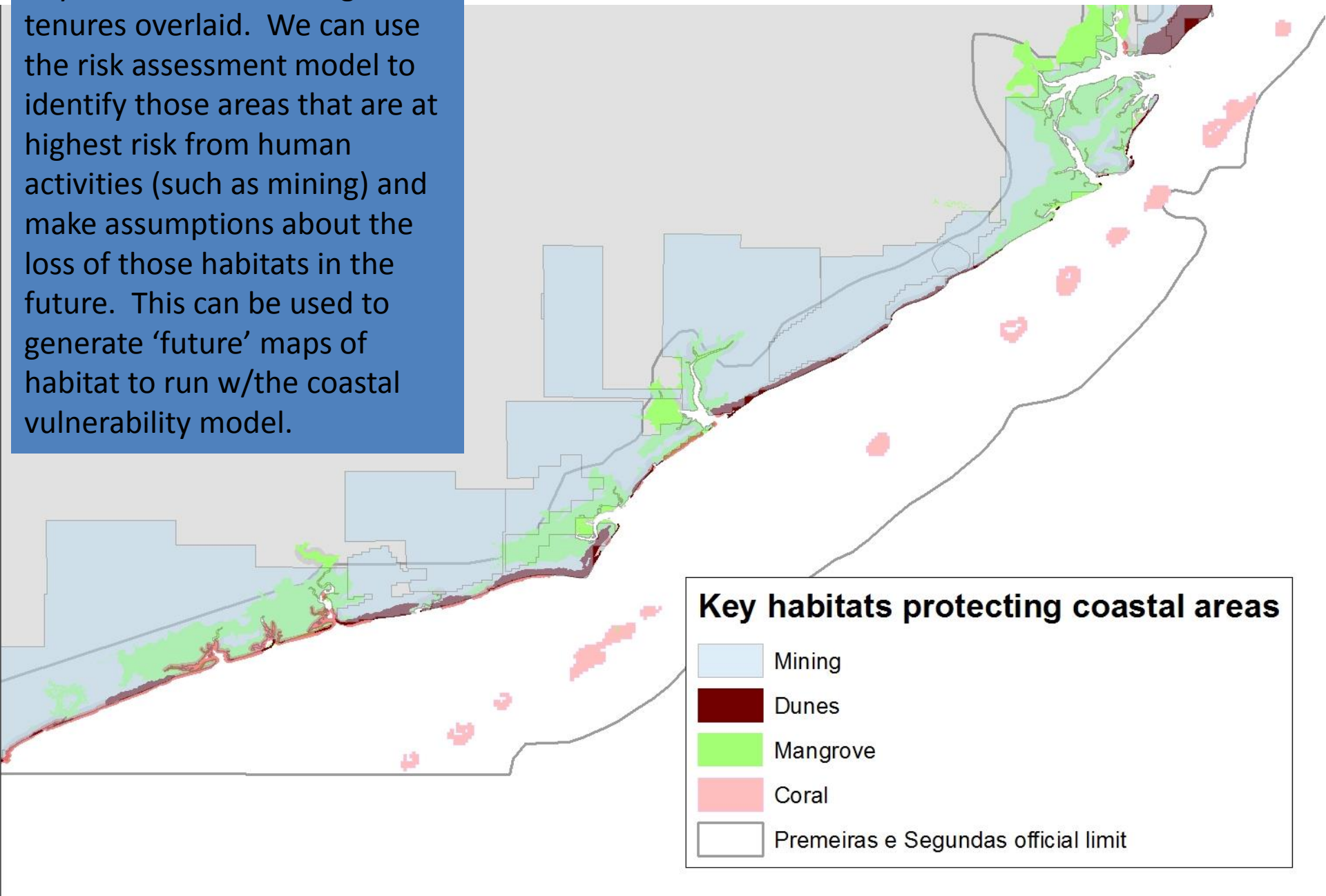


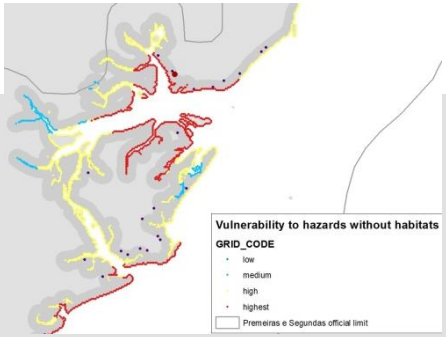
This is the same as the previous slides, but visualizing only those areas that fall at the highest end of vulnerability distribution. Several metrics can be calculated from this type of result including the number of people, villages and the area (sq km), for example, that will see increased vulnerability as a result of habitat loss.

Just looking at this, you can see notable increase in vuln in relatively unpopulated areas (e.g. south of Moma), and more heavily populated areas (Angoche).

Mining overlay, and example scenario

Key habitats with mining tenures overlaid. We can use the risk assessment model to identify those areas that are at highest risk from human activities (such as mining) and make assumptions about the loss of those habitats in the future. This can be used to generate 'future' maps of habitat to run w/the coastal vulnerability model.






Angoche area showing potential mining extent, location of current dunes, towns and villages and current coastal vulnerability. Habitat loss (see inset) would result in signficant increases in vuln in populated areas. Identifying areas that have moderate or high vulnerability *and* are populated can help identify where mining may be restricted, for example.

**Key habitats protecting coastal areas**

- Dunes
- Mining
- low
- medium
- high
- highest
- Premeiras e Segundas official limit

A note about where to go with these results –

- People do a lot of different things with these results. For starters, we can calculate some simple metrics looking at number of people, villages, etc. in hazard areas at present, and if habitats were lost.
- If $ values of property or infrastructure can be obtained, we can value coastal protection services.
- We can show where fronting dunes currently protect mining infrastructure (i.e. value to mines) and conversely, where mines threaten dunes that currently protect people and property.
- We can do a simple SLR scenario to look at how, the distribution of vulnerability might change with a 1m SLR, for example.