Porites distribution modelling

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The **thermal threshold** required to protect at least **half** of the **coral reefs** worldwide is estimated to lie at or below a **1.5°C** mean increase in global average temperature

Prof. Ove Hoegh-Guldberg

What happened?

- Symbiosis between corals and zooxanthellae
- Vulnerable to thermal stress
- Coral bleaching
- Fast growing coral is susceptible to bleaching
- *Porites* is more resistant to bleaching
- Its presence is crucial for reefs to survive global warming

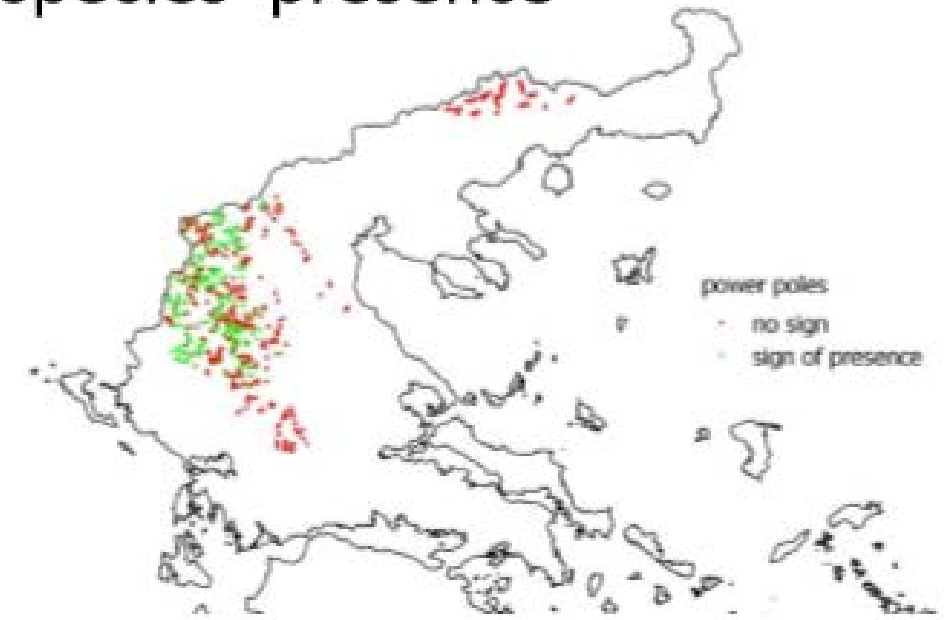
https://phys.org/news/2013-07-coral-symbiont-genome-decoded.html

But .....

- Unlike coral cover, coral genera presence data are difficult to find
- This is making coral conservation and management difficult and therefore the zonation process become ignorant to coral diversity
- Species Distribution Model can provide predictive maps of species distribution in various scenarios

Species Distribution Model

Partial information on the species' presence



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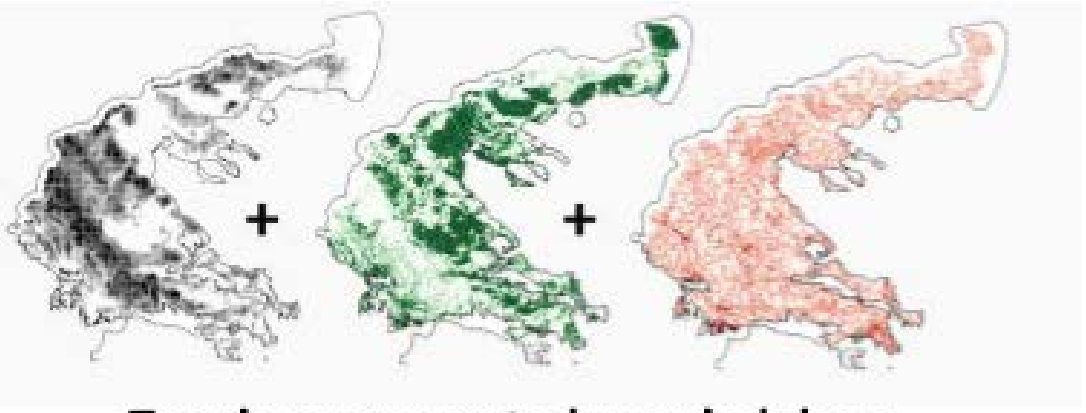
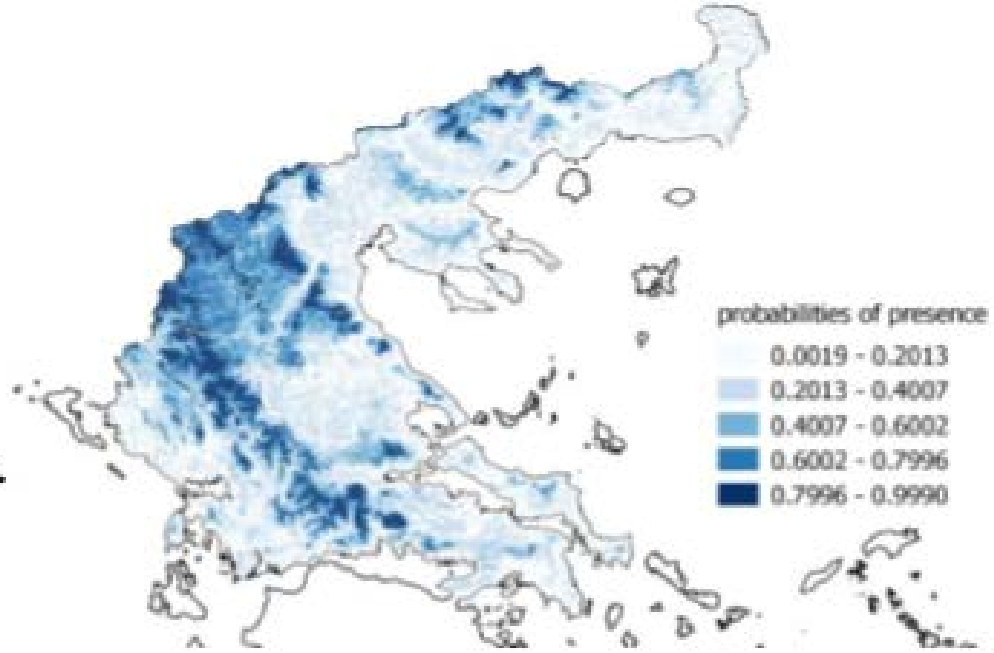


Environmental variables

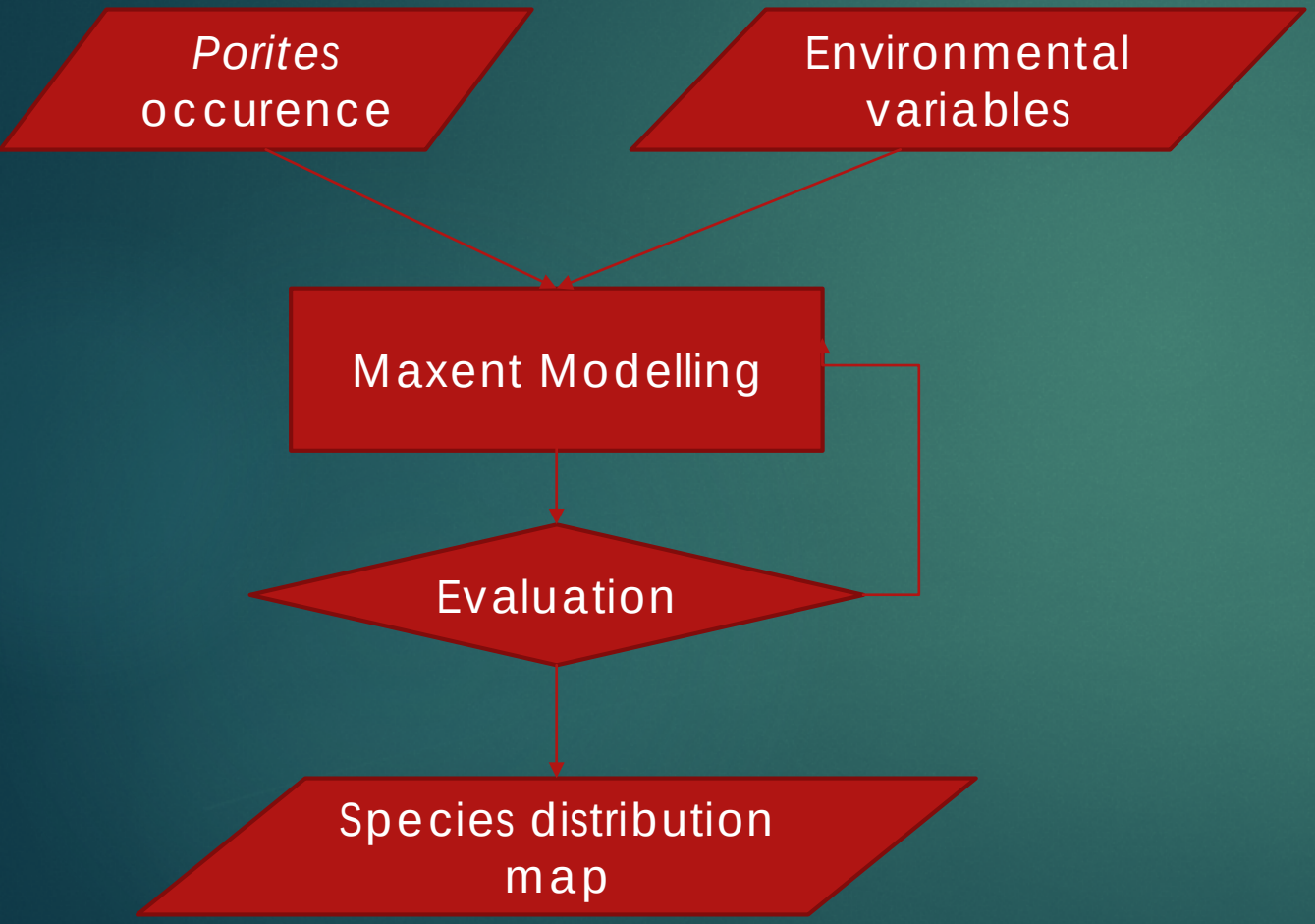


Probabilities of presence in the whole area of interest

Objective

- to create *Porites* distribution map to support coral reefs conservation and management in Indonesia

Methodology



- Environmental variables
  - Substrate type
  - Chlorophyll A
  - Bathymetry
  - Sea surface temperatures
  - Particulate organic carbon

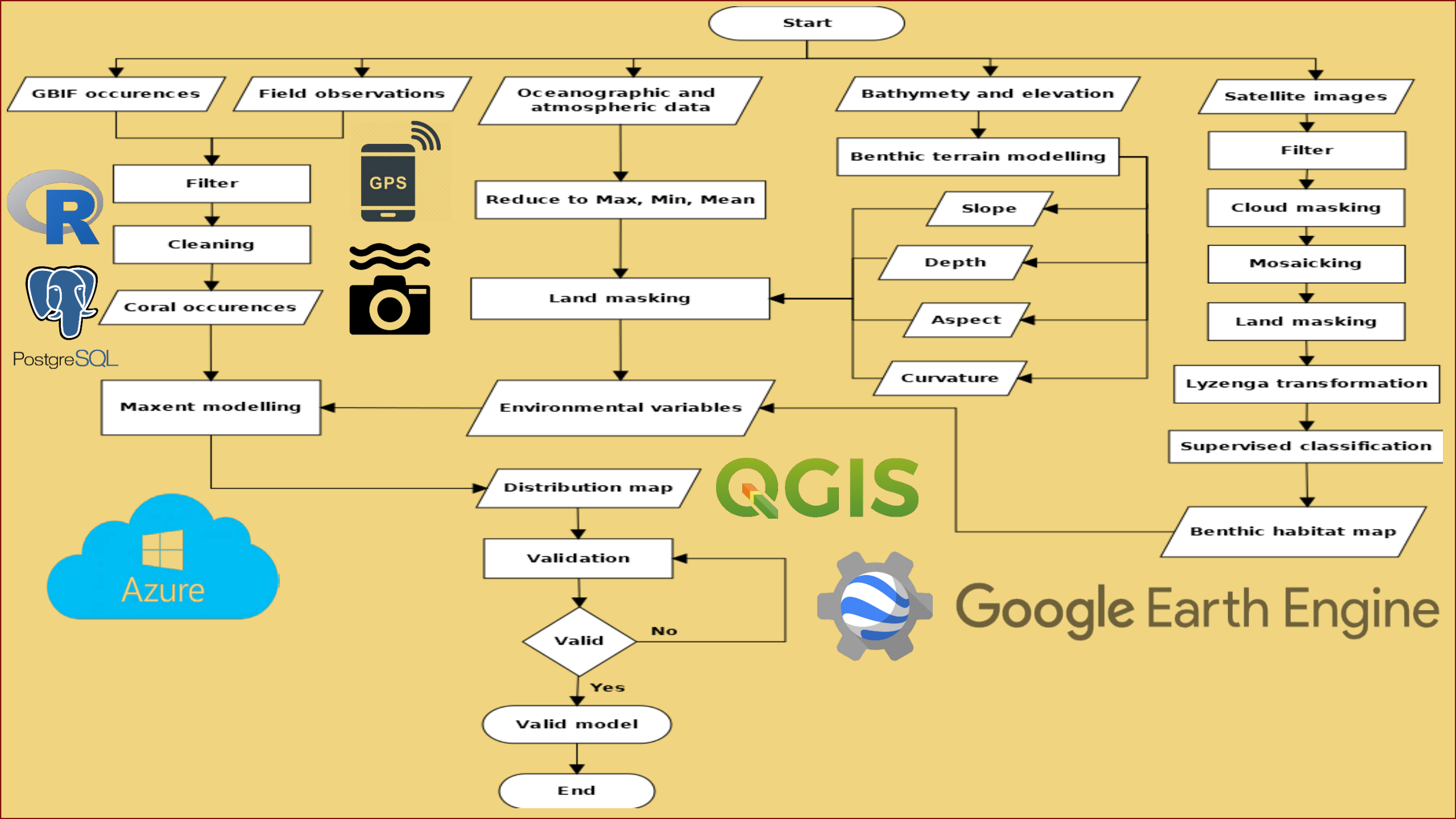
- *Porites* occurrence
  - Specimens from GBIF
  - Field observations

Maximum Entropy: The basic idea

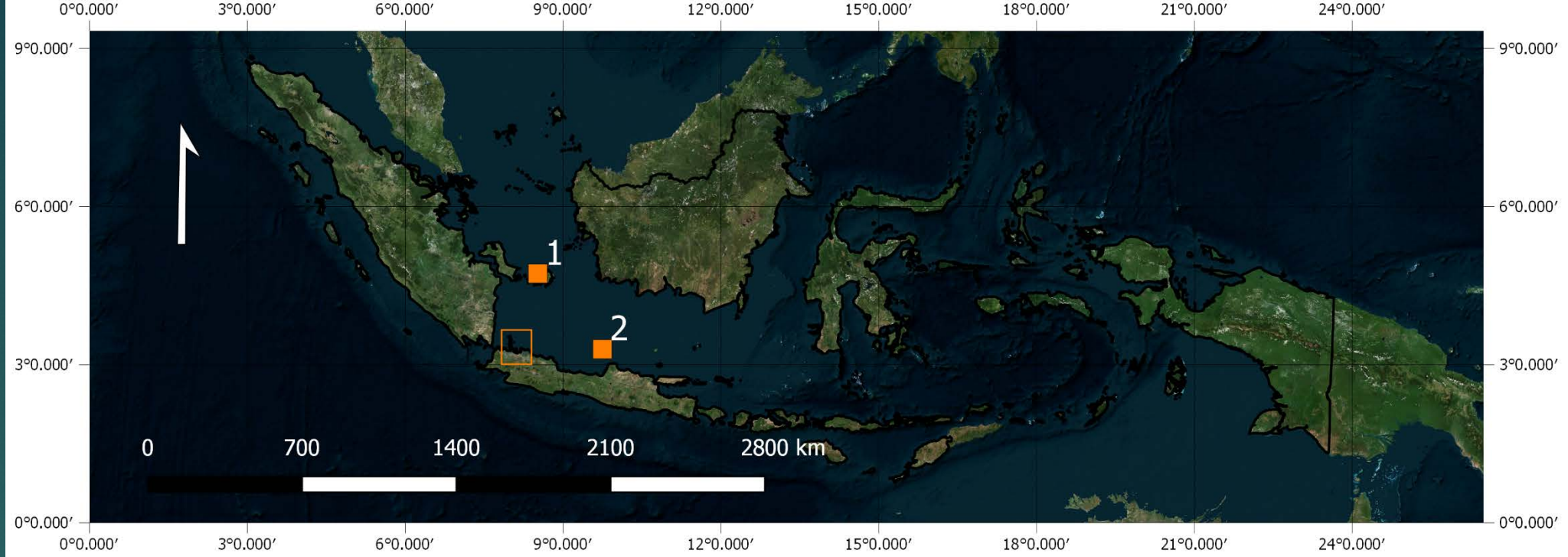
- Goal: estimate p
- Choose p with maximum entropy (H) subject to the constraints (z) where a species can be present (y=1) or absent (y=0).

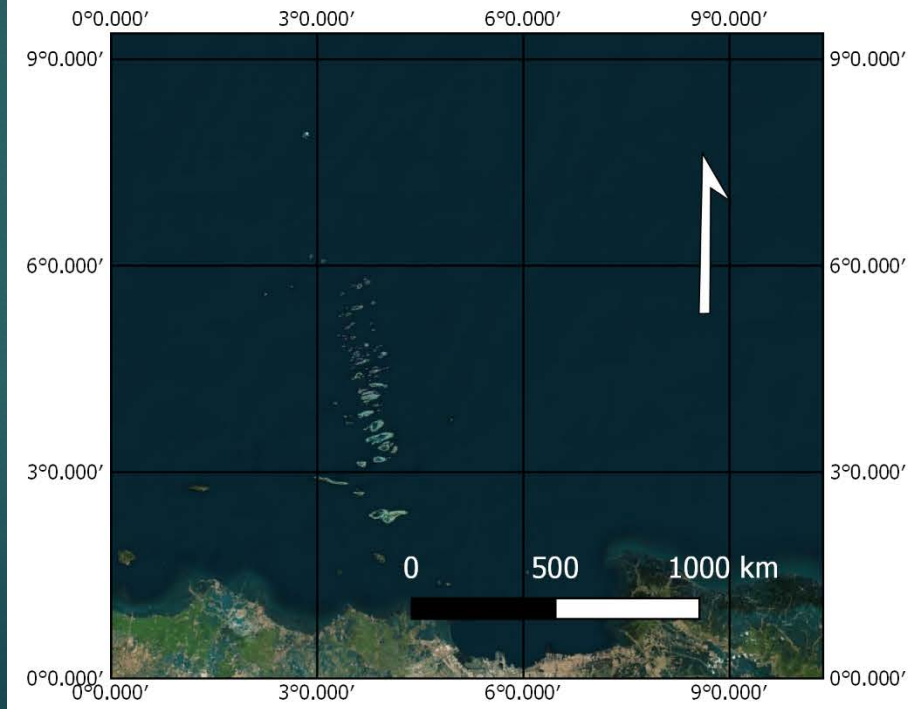
$$H(p) = -\sum_{x \in A \times B} p(x) \log p(x)$$

p(y=1 | z) = f1(z)p(y=1) / f(z)


Start
GBIF occurences
Field observations
Oceanographic and atmospheric data
Bathymety and elevation
Satellite images
Filter
Cleaning
Coral occurences
GPS
Reduce to Max, Min, Mean
Land masking
Benthic terrain modelling
Slope
Depth
Aspect
Curvature
Filter
Cloud masking
Mosaicking
Land masking
Lyzenga transformation
Supervised classification
Benthic habitat map
Environmental variables
Maxent modelling
Distribution map
Validation
Valid
No
Yes
Valid model
End
PostgreSQL
Azure
QGIS
Google Earth Engine

Research Location





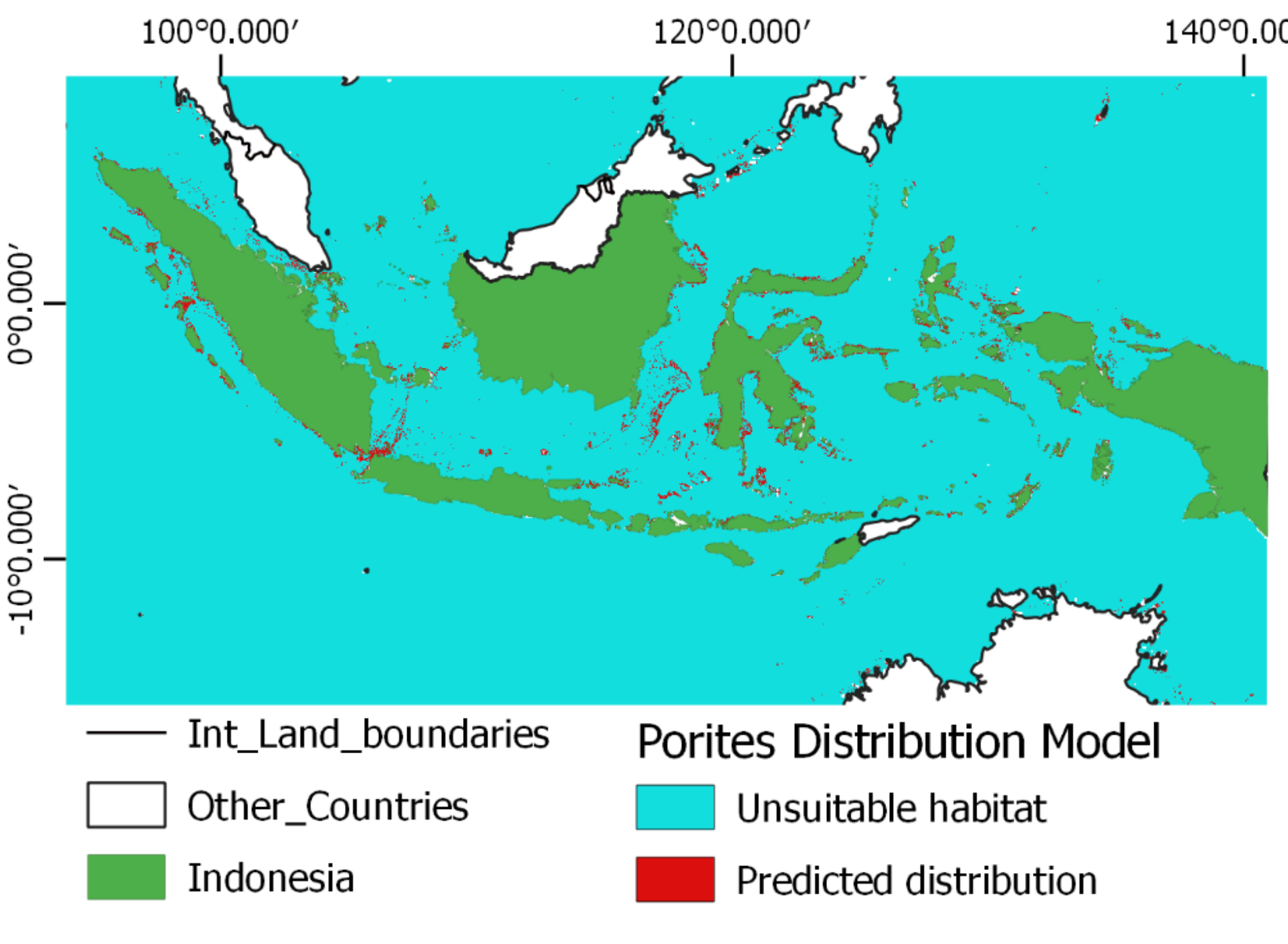
Research Location

- Field observations
  1. Belitung Island
  2. Karimun Jawa Islands

Inset
Focus Area: Seribu Islands

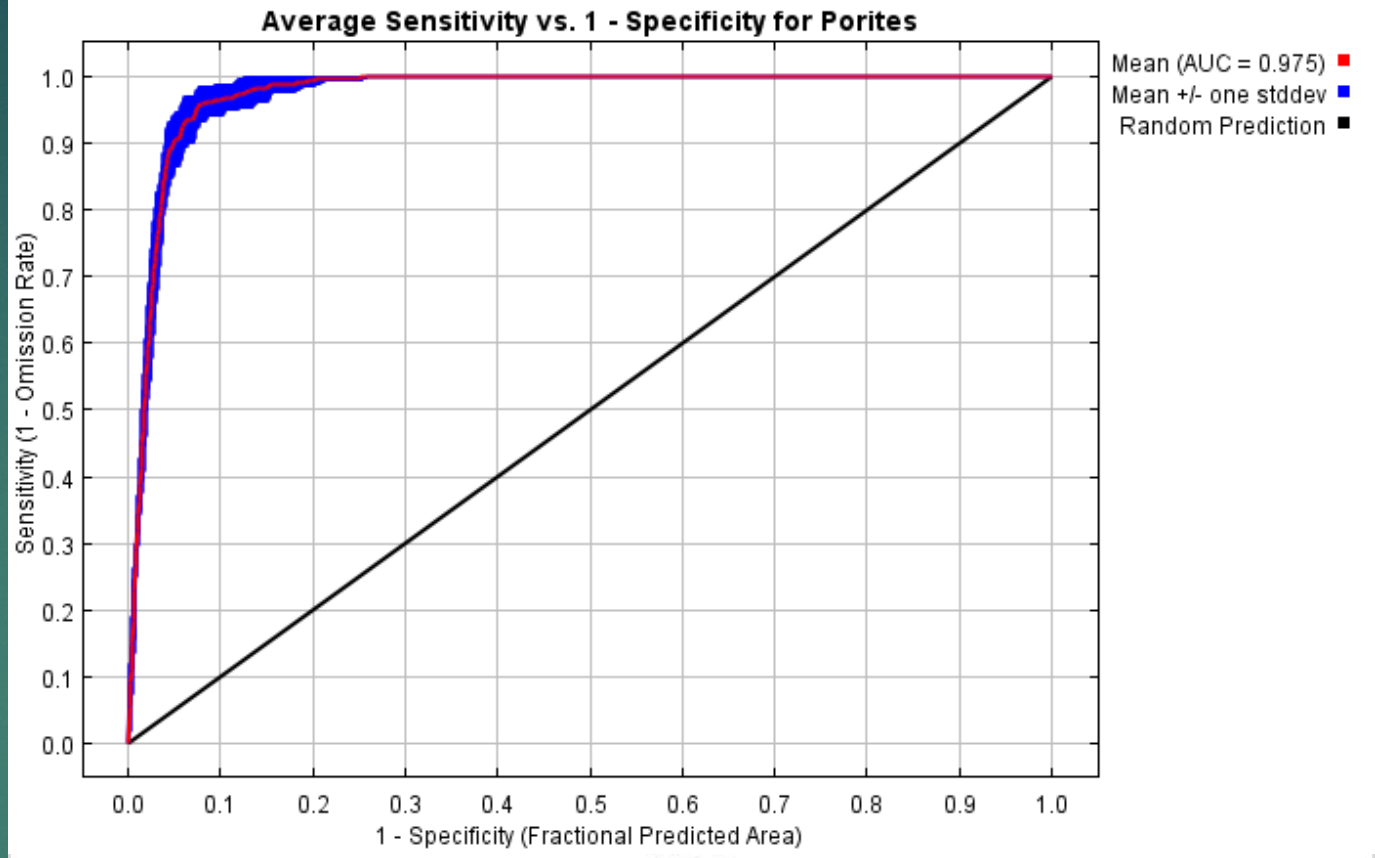
Results

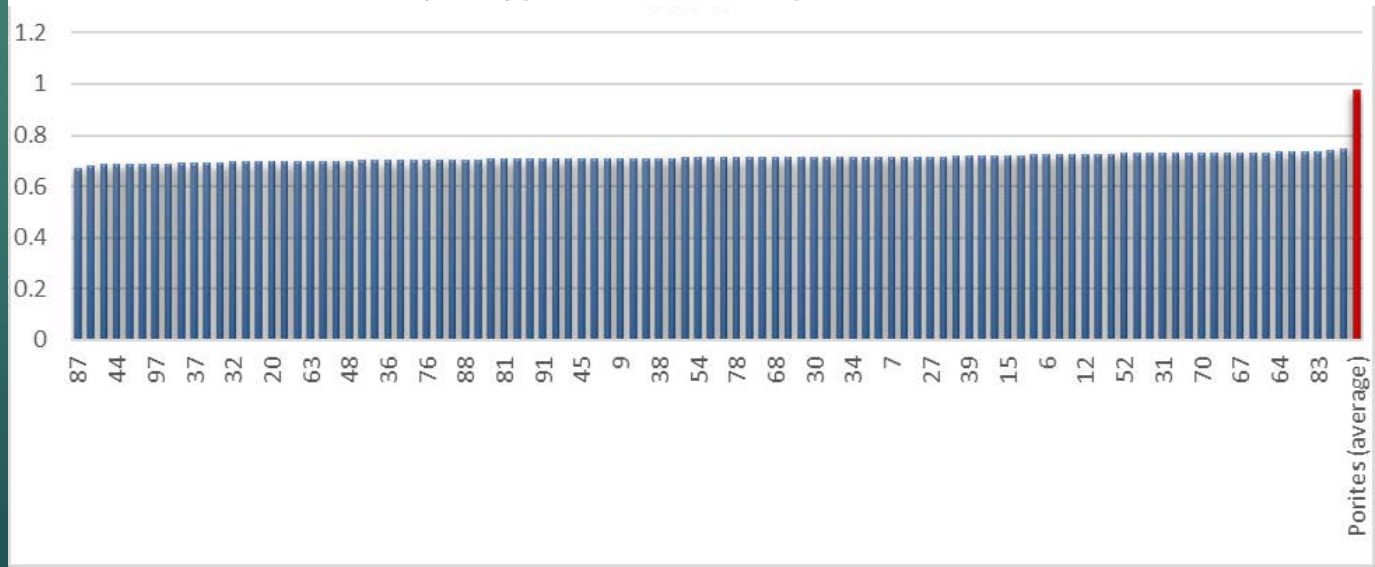
Porites distribution in Indonesia with 217,185.323 km^2 of total habitable area



Performance

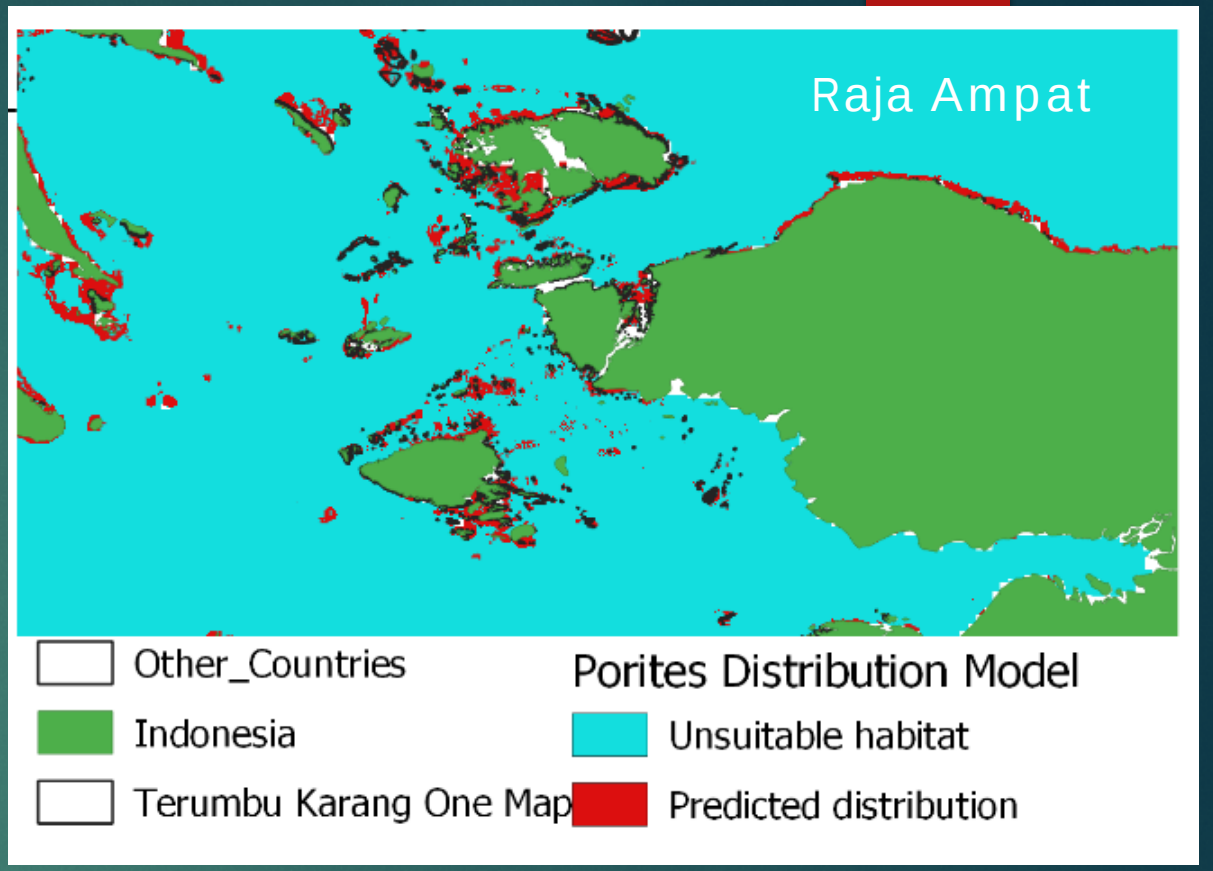
- the model performs quite well with test AUC value of 0.9747 and AUC standard deviation of 0.003.
- If compared to the 99 null distributions, the test AUC is considered statistically significant compared to the top 5% of null distribution's AUC, which is 0.7348

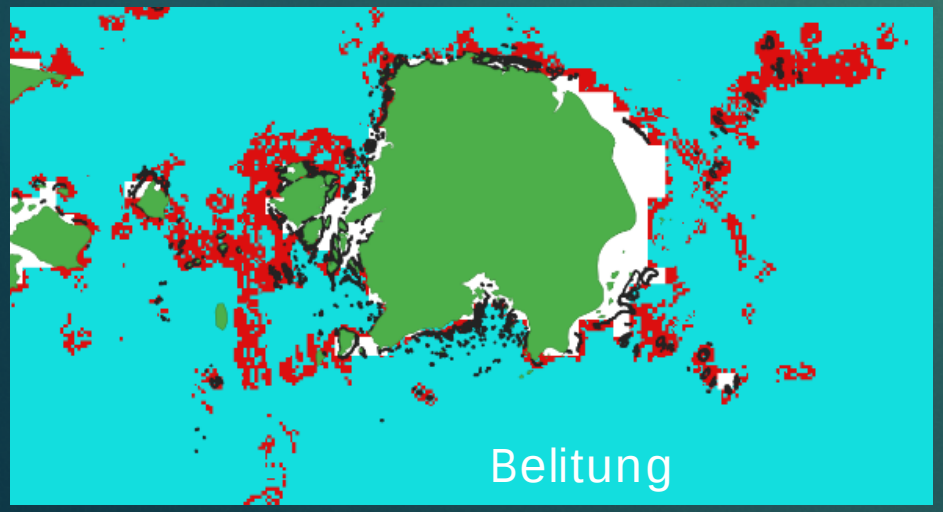


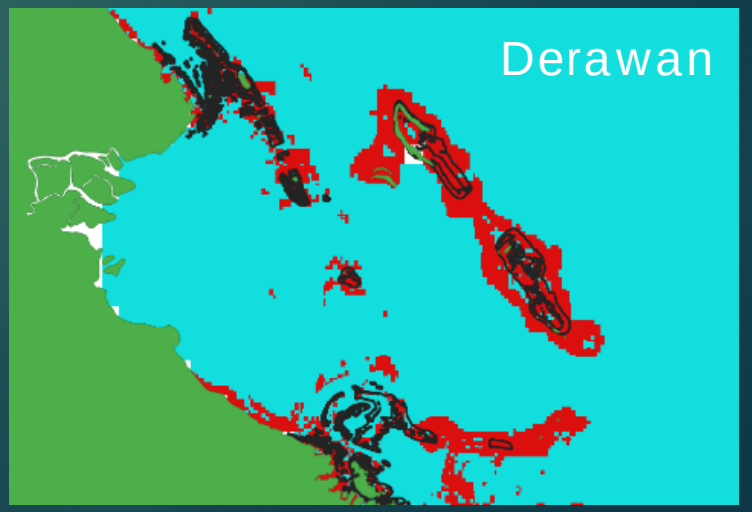


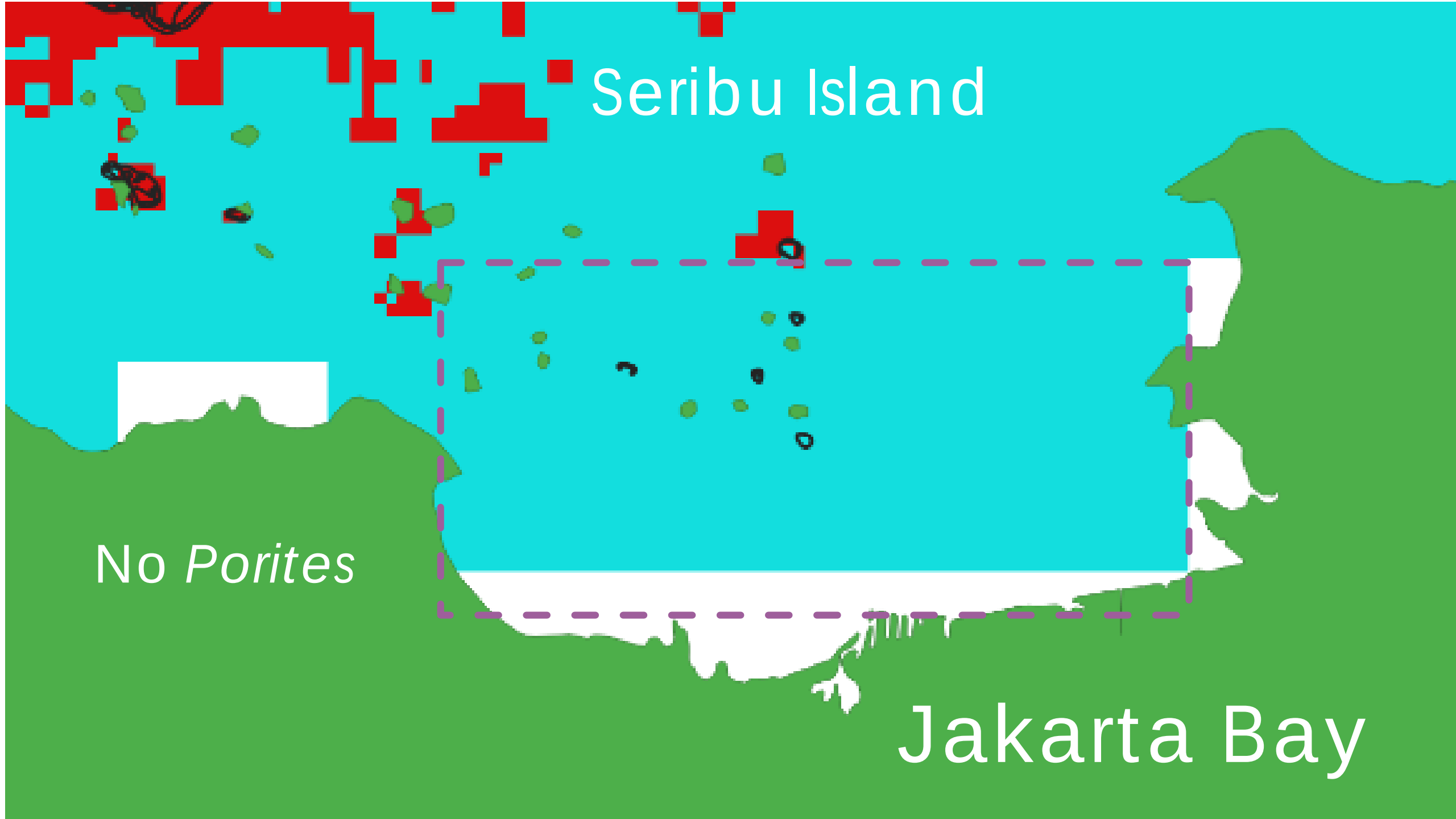
Results

- *Porites* is present on all focus area, such as Seribu Islands, Belitung Island, and Karimun Jawa Island. *Porites* also distributed evenly in Derawan Island, Bunaken Island, North Minahasa, Lembeh Island, and Raja Ampat.



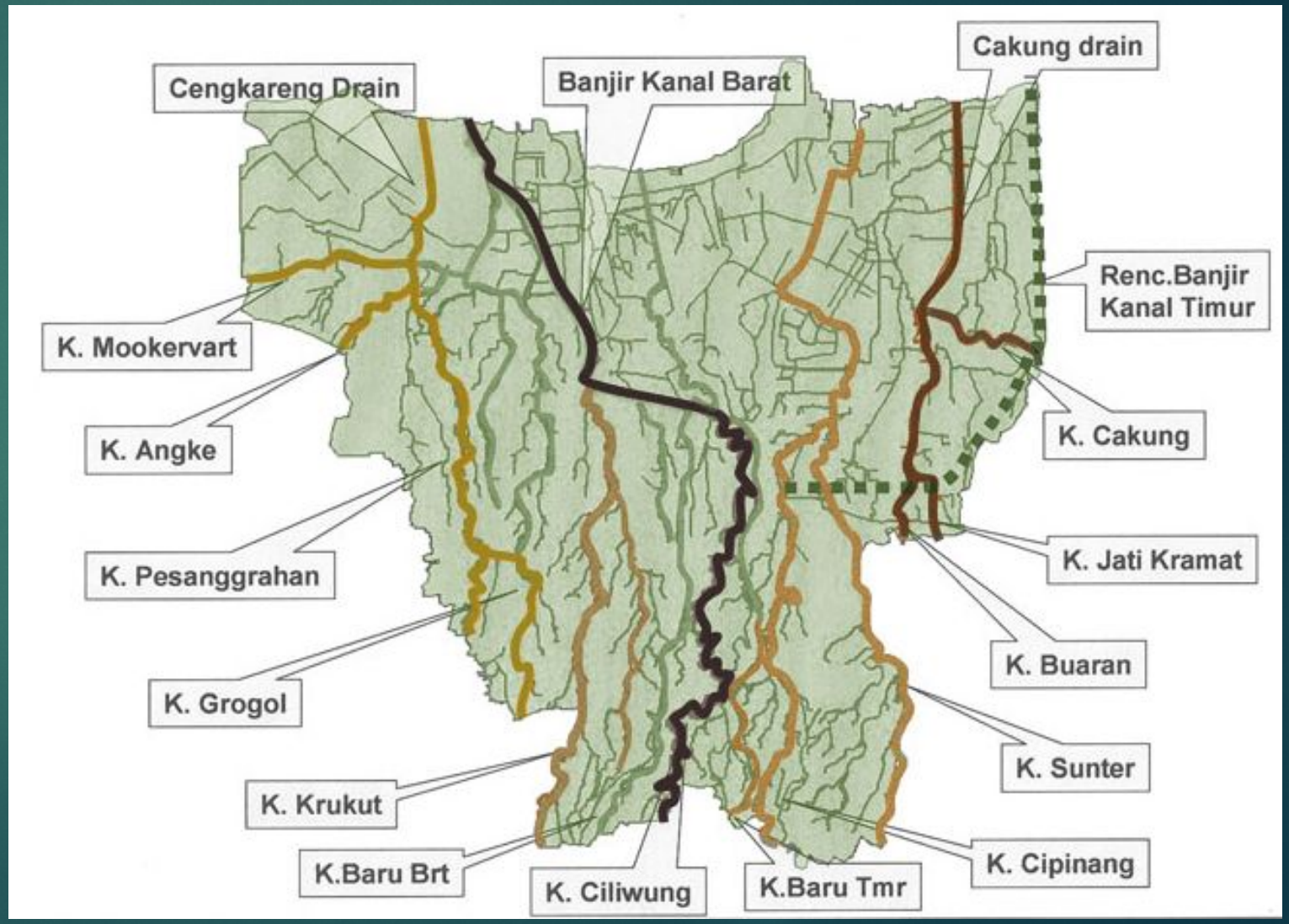





Seribu Island
No *Porites*
Jakarta Bay

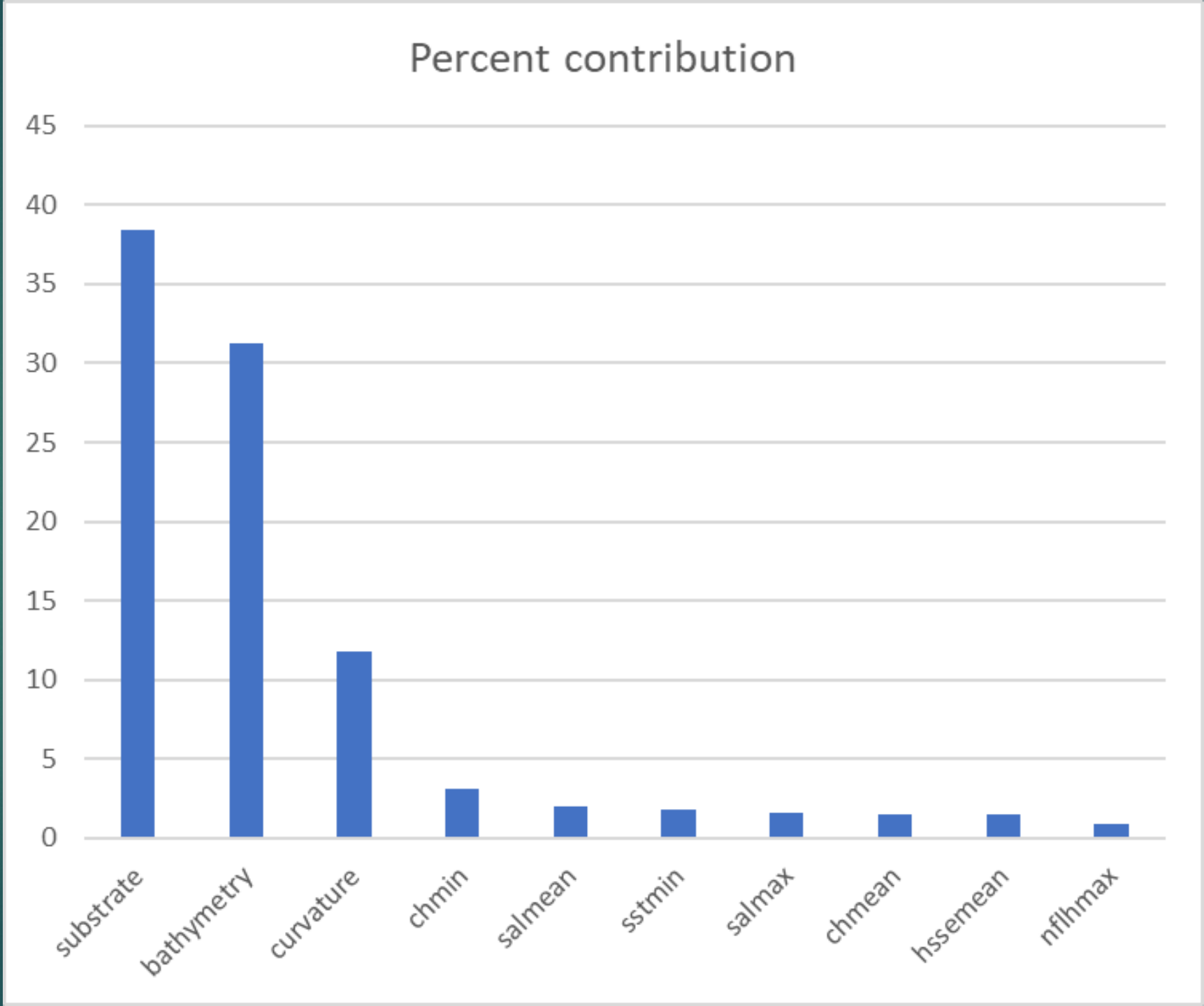
Porites absence in Jakarta Bay

- 13 polluted rivers dumping their sediment, heavy metal, liquid and solid waste altogether, this area has high sedimentation that made life hard for corals and they are unable to photosynthate
- Sediment accumulation rate is up to 0.852 cm/year
- Jakarta will experience coastal reclamation, that will increase the benthic sediment thickness to 2.49 m compared to 0.84 m today



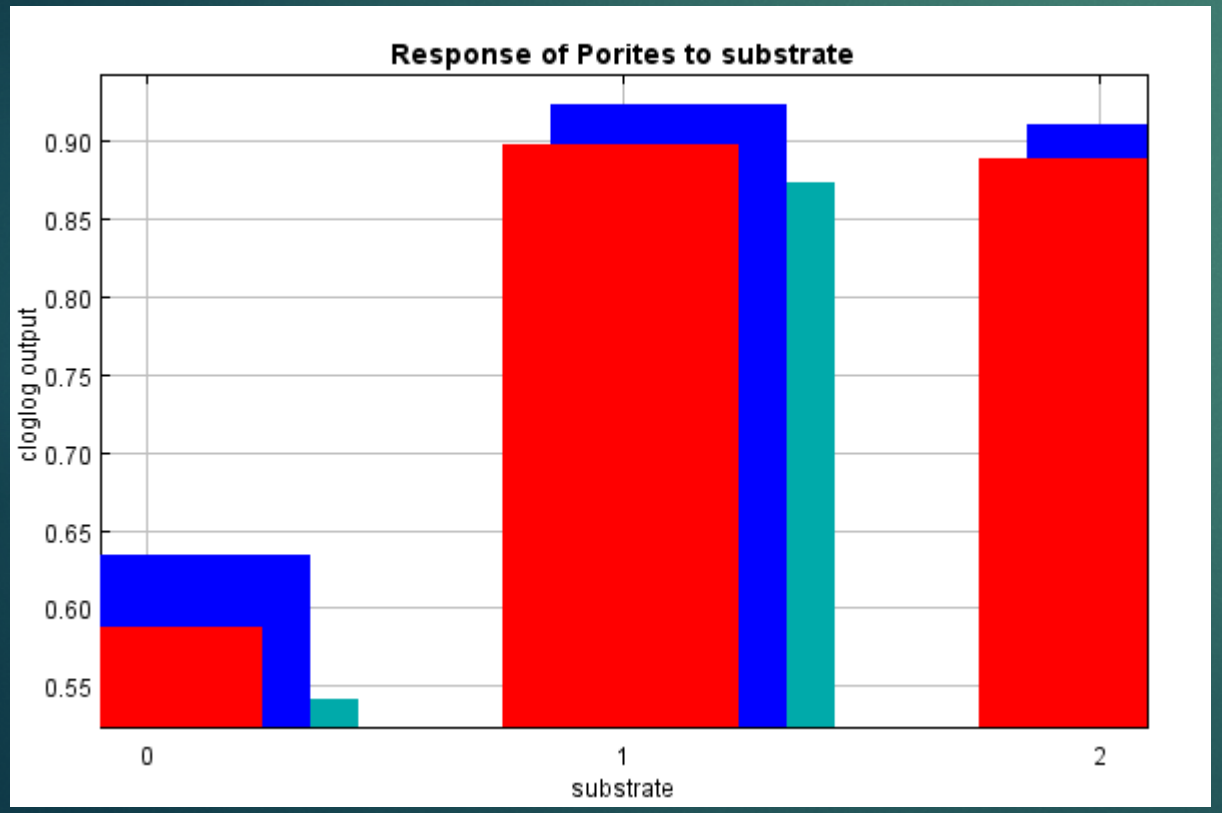
Variable's contribution

- Substrate type, bathymetry and curvature gave the highest contribution towards gain.



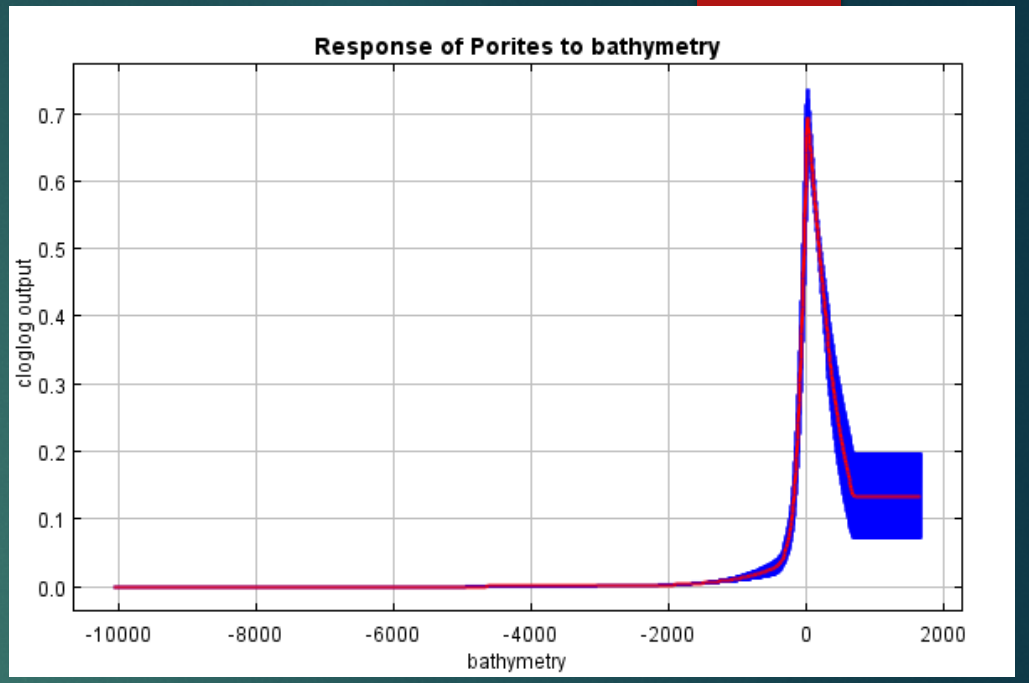
Substrate type

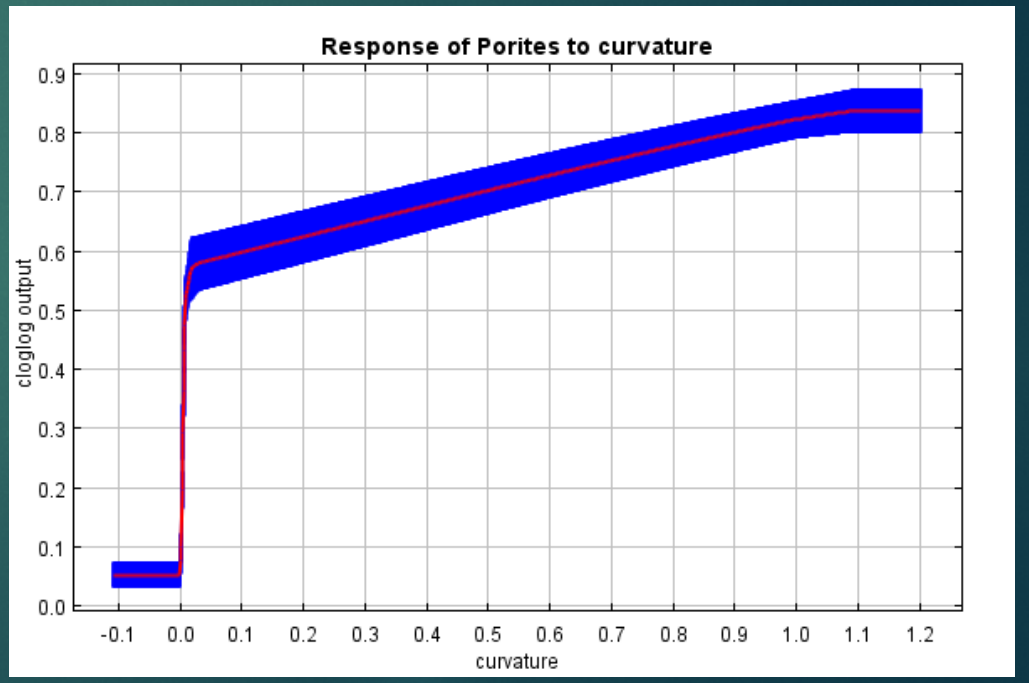
- Porites preferred coral dominated reefs (1) than sand dominated reefs (2)



Bathymetry and Curvature

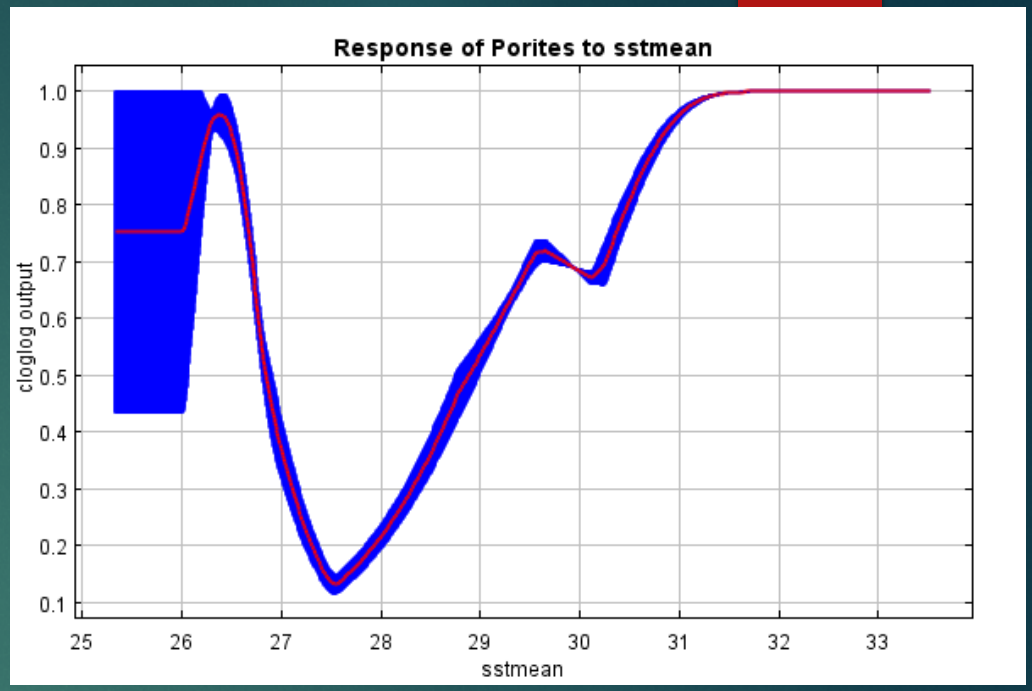
- Most habitable is shallow water
- Most preferred is reefs with curvature from 0 - 1°

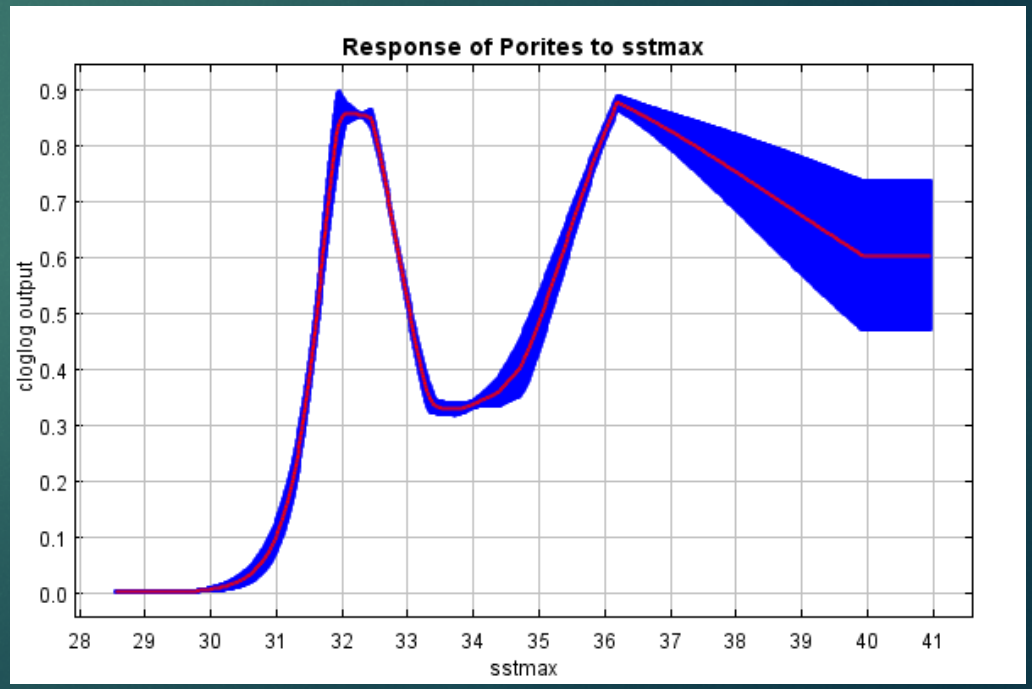




Sea Surface Temperature

- *Porites* shows mixed response toward SST.
- With mean temperature 25 -26°C it response increase, suddenly falls to 28 °
- It then steadily increase from 28 to 32°
- It is less sensitive to maximum SST with contribution only 0.1%
- The tolerance before the response falls is 32° but the response increases on 34° and permanently decline on 36°





Conclusion

- Reefs with *Porites* have chance to survive temperature induced bleaching
- Environmental variables contributed most to *Porites* distribution are substrate type, bathymetry and curvature
- The model performs very good and can be used for marine spatial planning or conservation planning
- SDM can be used to complement field observations where data is scarce

Thank you very much

- Questions
- Critics
- Suggestions

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