ICCE 2018
36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018
Baltimore, Maryland | July 30 – August 3, 2018
The State of the Art and Science of Coastal Engineering

TOHOKU UNIVERSITY

ADAPTATIONS ASSESSMENT TO FUTURE BEACH LOSS DUE TO SEA LEVEL RISE IN THAILAND

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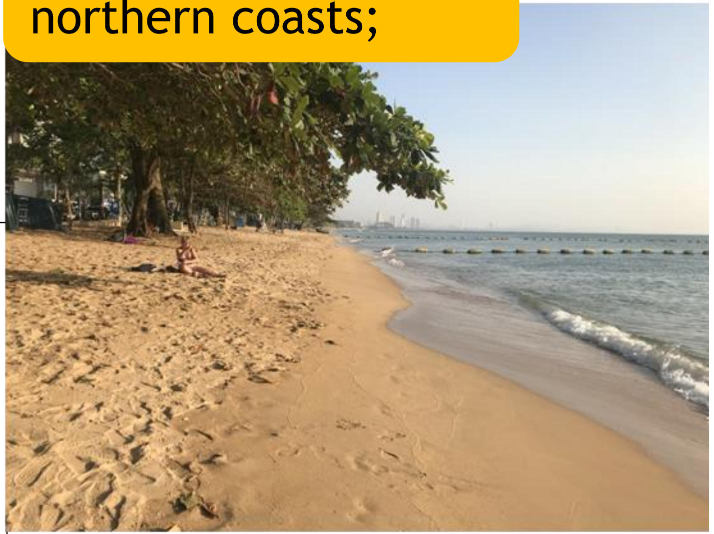
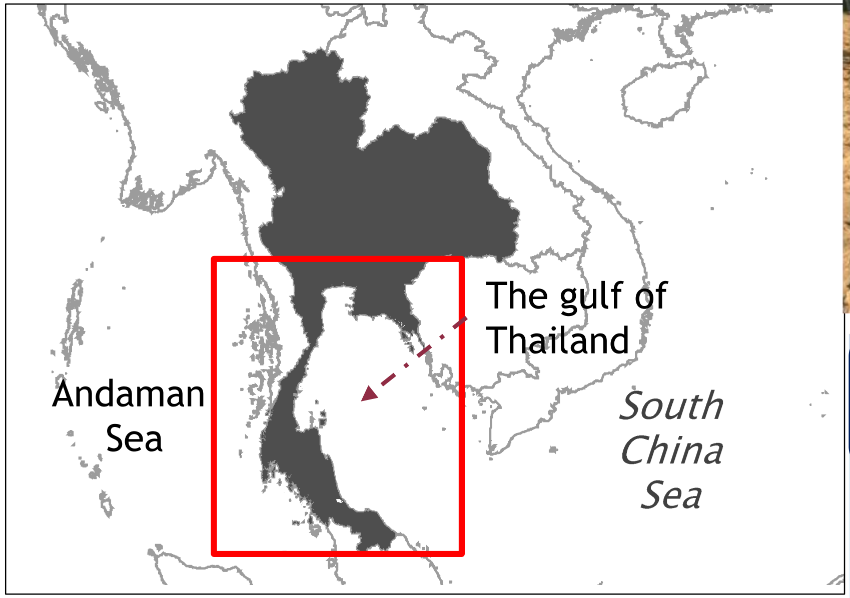
Backgrounds & Introduction

Fishery Village

Small beach width in northern coasts;





Tourism

Recreational Area
for Local People in Southern Coasts

Poor Coastal Management

Beach debris problem in Urban Beaches

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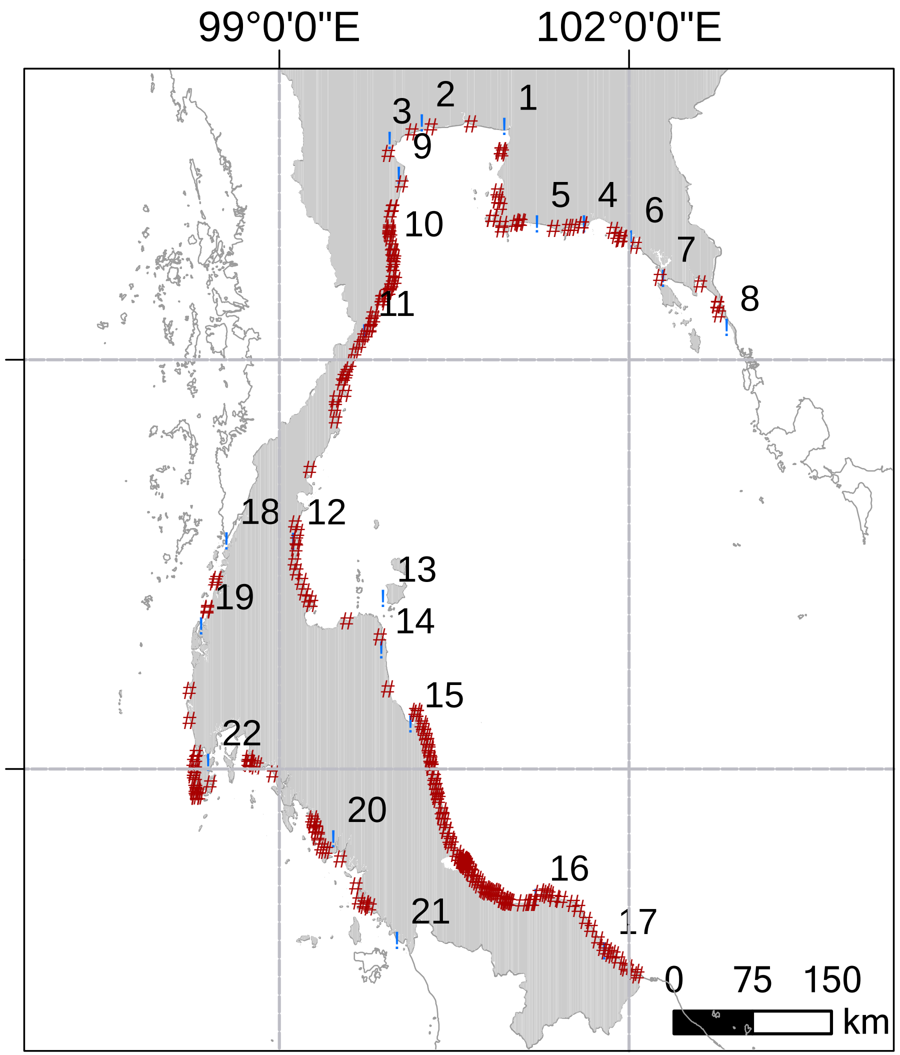
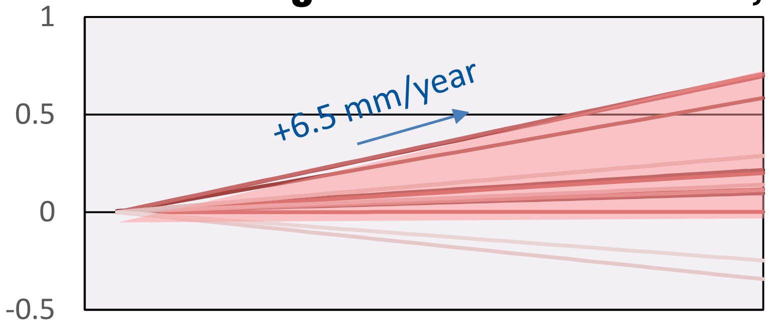
Backgrounds & Introduction

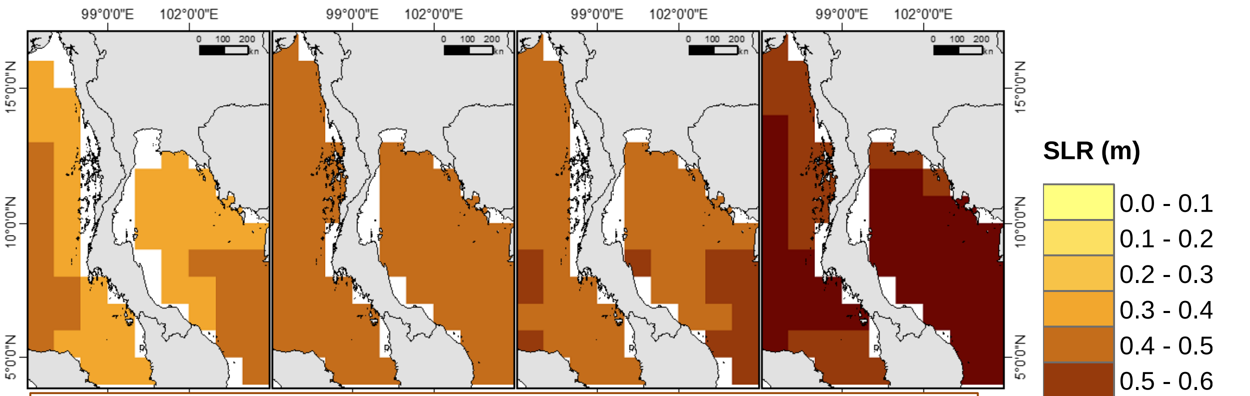


Putcharapitchakon and Ritphring (2012) **analyzed the sea level change in Thailand from water level records from 22 tide gauge stations in the Gulf of Thailand (GOT) and the Andaman Sea during 1972–2011 and indicated that the sea level had risen at an entirely averaged rate of 6.5 mm/yr.**

Average trend of Water level, m



IPCC (2013) Projection of Sea level rise data (2081-2100) the ensemble-mean regional sea level rise data of 21 CMIP5 models for the RCP2.6, RCP4.5, RCP6.0, and RCP8.5 scenarios



RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
0.39 m.	0.46 m.	0.48 m.	0.61 m.

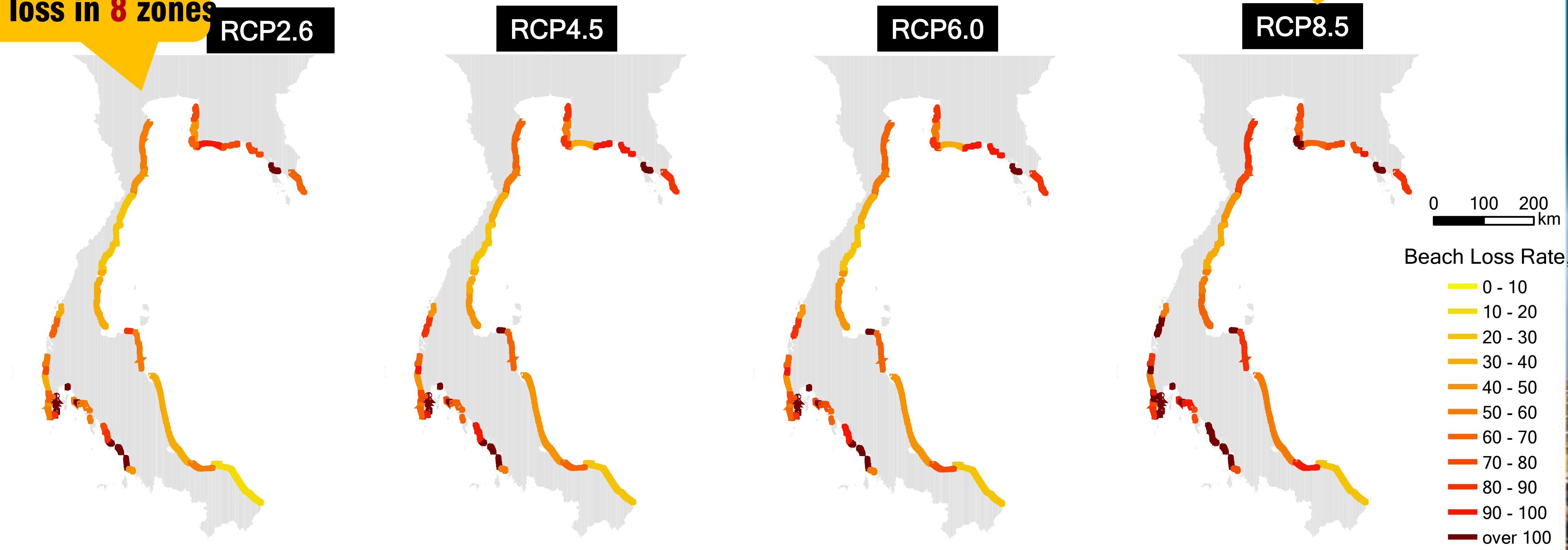
(IPCC, 2013)

Projection of Future Beach Loss (2081-2100): based on differences RCP scenarios

- Ritphring et al.,2018 projected future beach loss based on the **Brunn Rule** **(1962).**

50% loss in 36 zones
100% loss in 8 zones

50% loss in 48 zones
100% loss in 19 zones



	RCP2.6	RCP4.5	RCP6.0	RCP8.5
Beach Loss Rate	45.78 %	55.05 %	56.89 %	71.79 %
Area Loss	25.36 km^2	30.49 km^2	31.51 km^2	39.77 km^2

Total of 51 Zones of Sandy Beaches

Beach loss area = Shoreline Recession (R) x Zone length
Beach loss rate = {Shoreline Recession (R)/Existing Beach width} x Zone length

Objectives

Future Projection of Shoreline Retreat → Future Projection of Beach Loss

Present Beach Width → Future Projection of Beach Loss

Future Projection of Beach Loss → Identify the Vulnerable Beach Zone

Identify the Vulnerable Beach Zone → Select Adaptation Options

Select Adaptation Options:

- Option 1: 10 m Beach Nourishment
- Option 2: 20 m Beach Nourishment
- Option 3: 30 m Beach Nourishment
- Option 4: Keep Present Shoreline (Average of 34.8 m.)

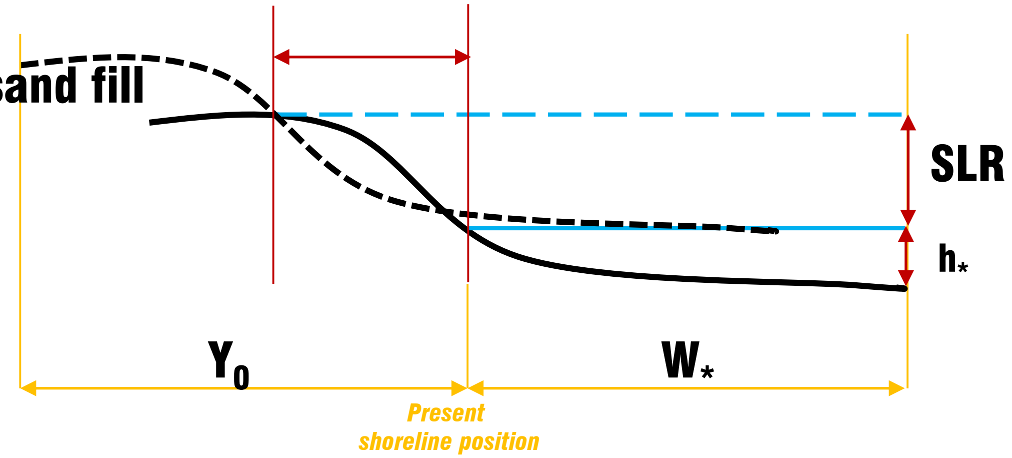
Since, there is no adaptation plans developed in Thailand

Objectives

This study aims to provide a framework to adapt to sea level rise considering cost of Beach Nourishment for each beach use purpose.

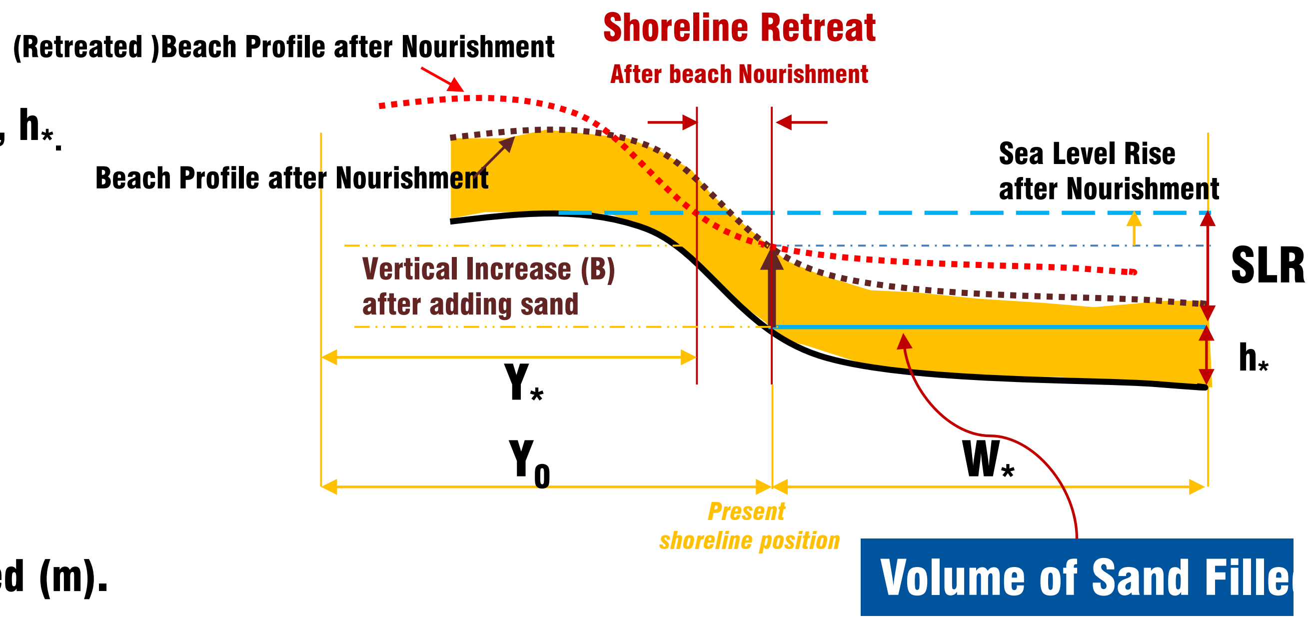
Volume Placed Calculation *(Yoshida & Udo, 2014)*

The idea is that the area of under the curve of profile after sand fill subtracted by the area under curve of original profile.



$$V_p = BY_0 + \int_0^{W_*} \left(Ay^{2/3} + B\right) dy - \int_0^{W_*} \left(Ay^{2/3}\right) dy$$

V_p is the volume to be filled per coastal section (m^3/m).
B is Amount of vertical increase of equilibrium profile. (m)
Y_0 is dry beach width (at present). (m)
A is scale parameter.
W_* is the cross shore distance to the closure depth, h_*.



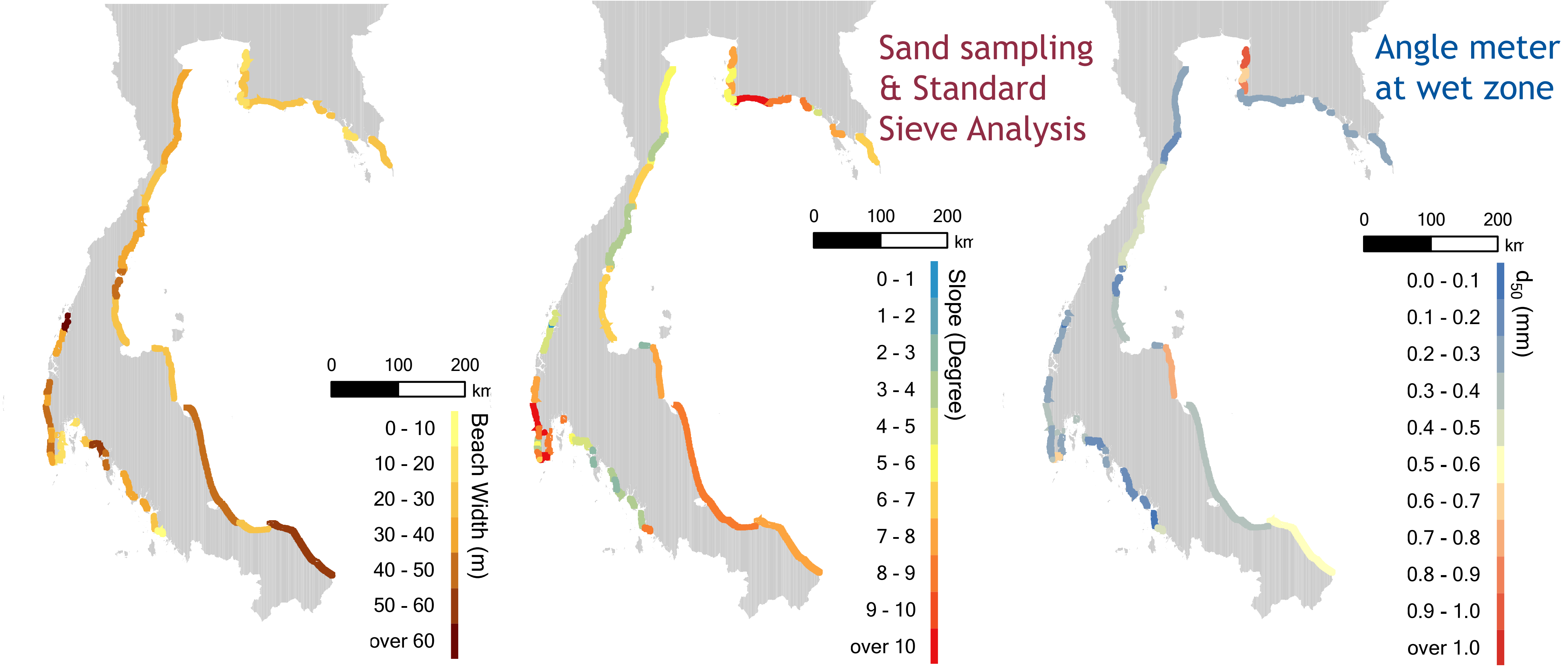
Where B can be calculated by.

$$B = S - \left(\frac{h_* + B_h}{W_*}\right)(Y_0 - Y_*)$$

S = Sea Level Rise (m).
B_h = Berm height (m).
Y_* = Designed beach width after shoreline retreated (m).

Methodology

Previous Study (Ritphring et al.,2018) collected beach characteristics; slope, grain size and calculated beach width by field measurement over **230 locations** for all beach zones.



Average Beach width for each zone.

Average Beach Slope for Each Zone

Average Sediment Size for Each Zone

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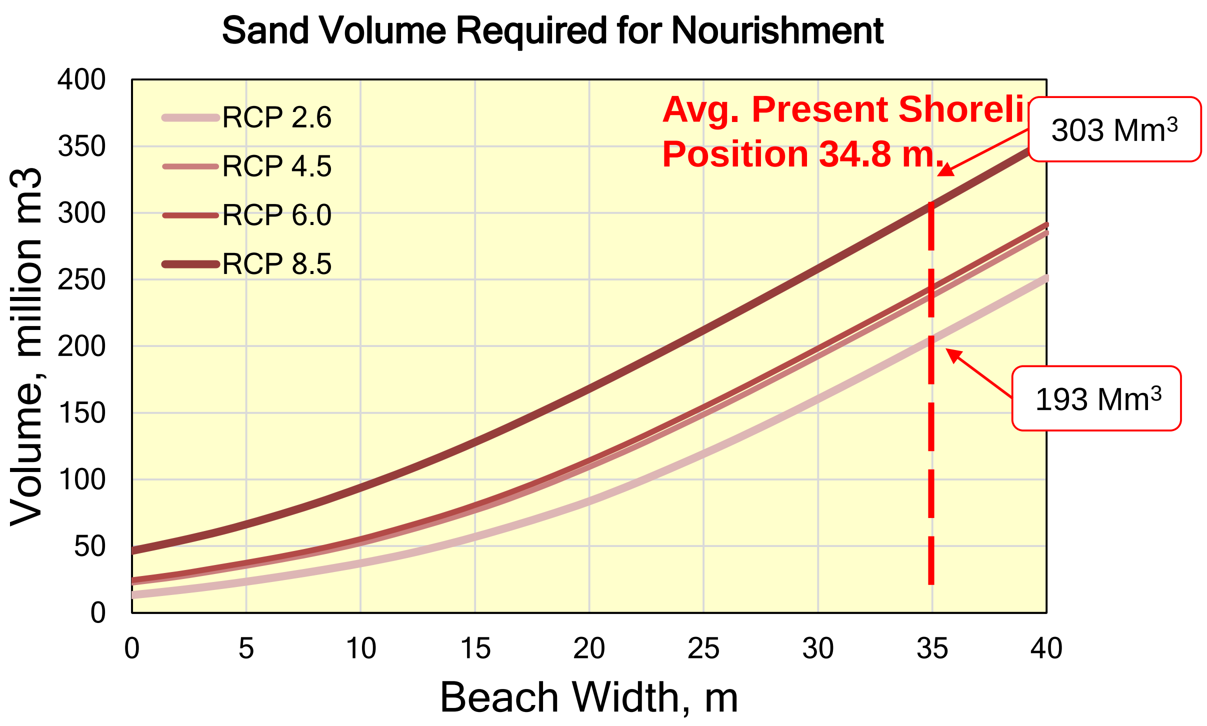
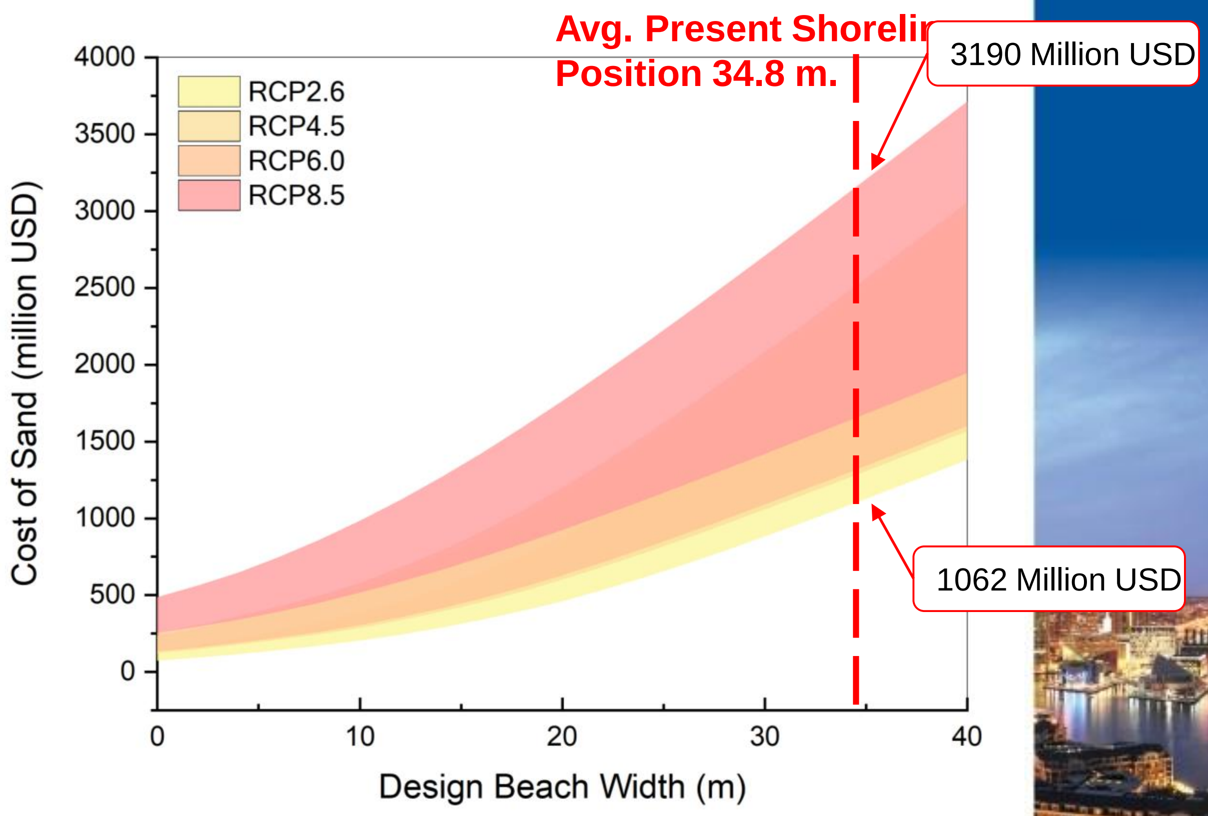
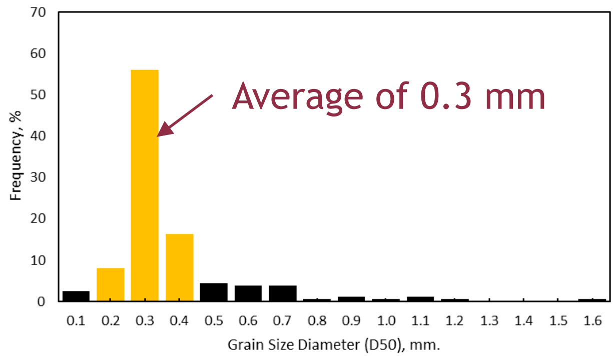
Results: Sand Volume required for Beach Nourishment

The figure shows total sand volume required for beach nourishment for scenarios.
Assume that filling sediment size is same as native sediment size.



The figure shows costs of sands required for entire coastlines.



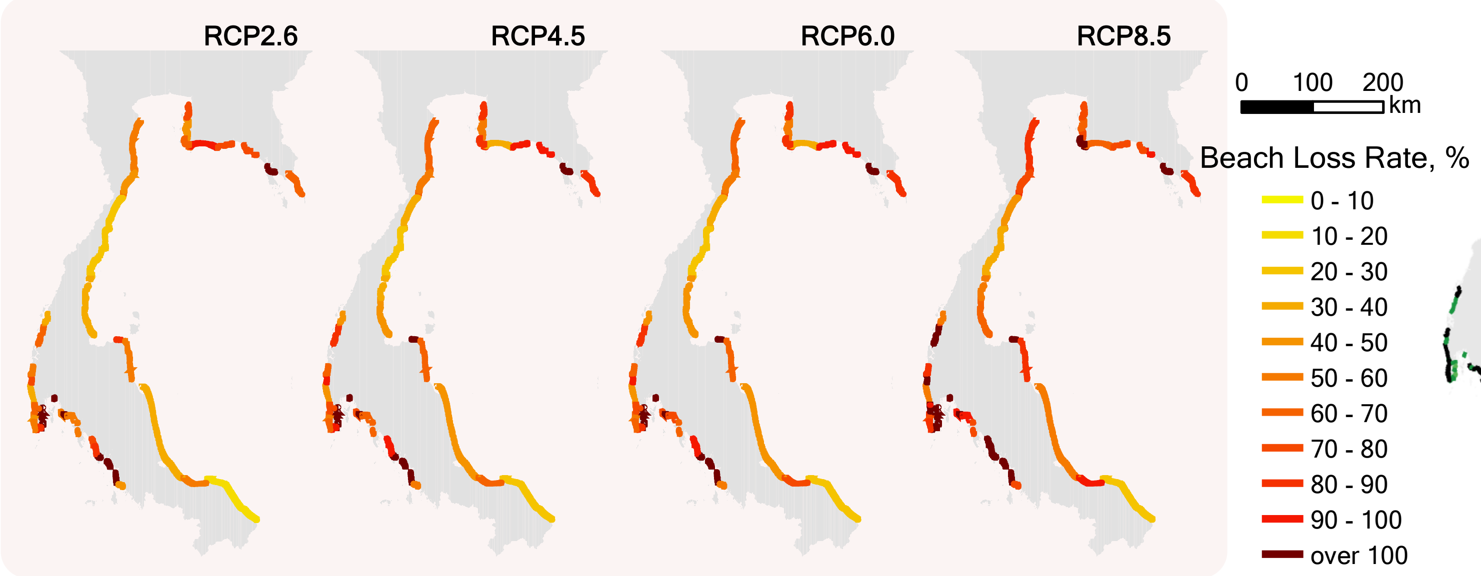


Histogram of grain size for Thailand sandy beaches.

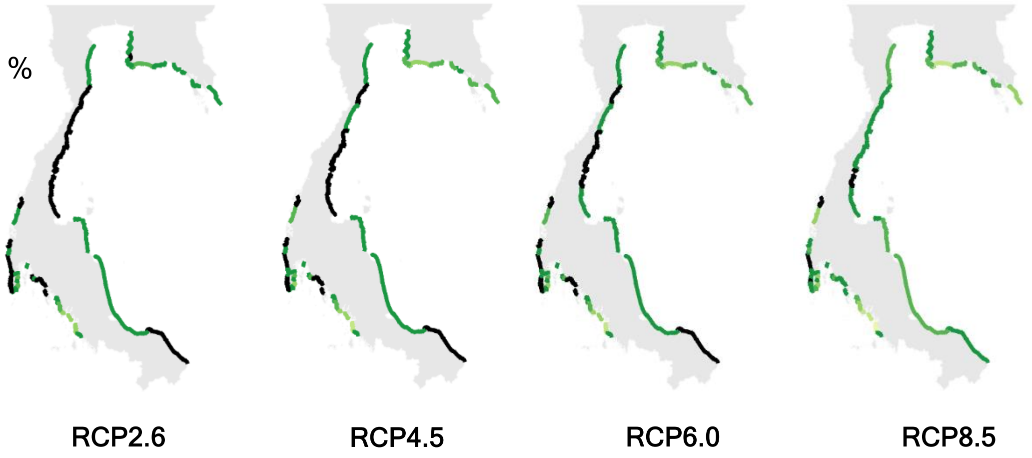
referenced cost of 5.5 (minimum) to 10.5 USD/m^3 (maximum) from Thai Government Costal Engineering Project Report.

Results: Sand Volume for each beach zones

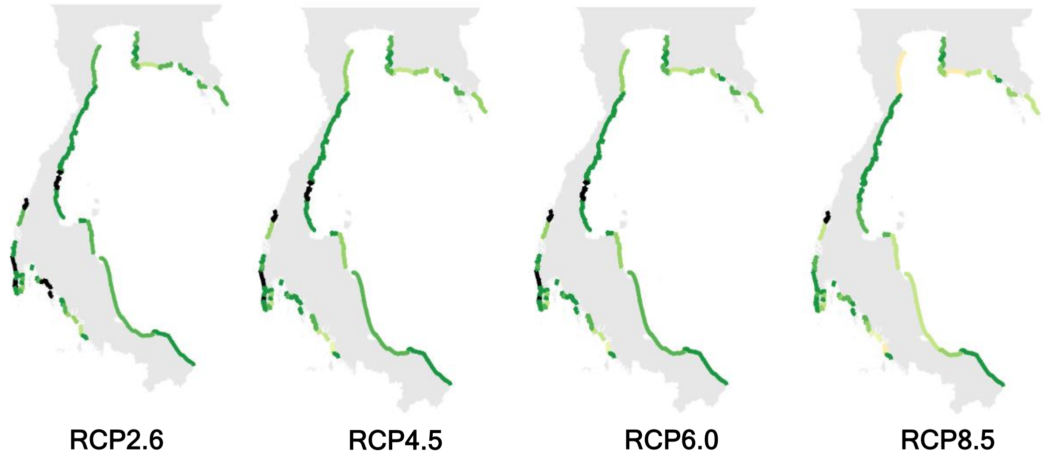
Beach Loss **The value shows the profile volume of sand required for each nourishment.**

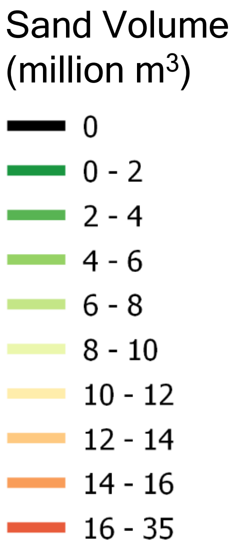


To maintain beach width for 10

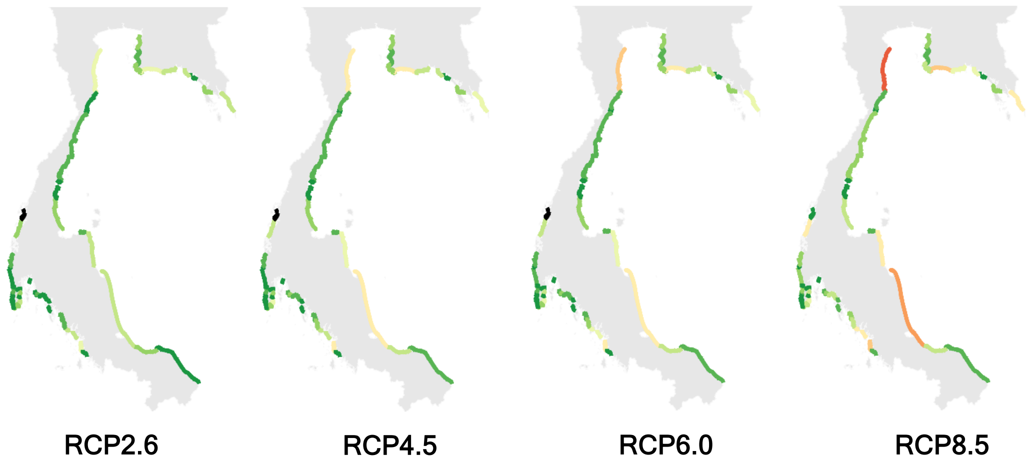


To maintain beach width for 20 m.





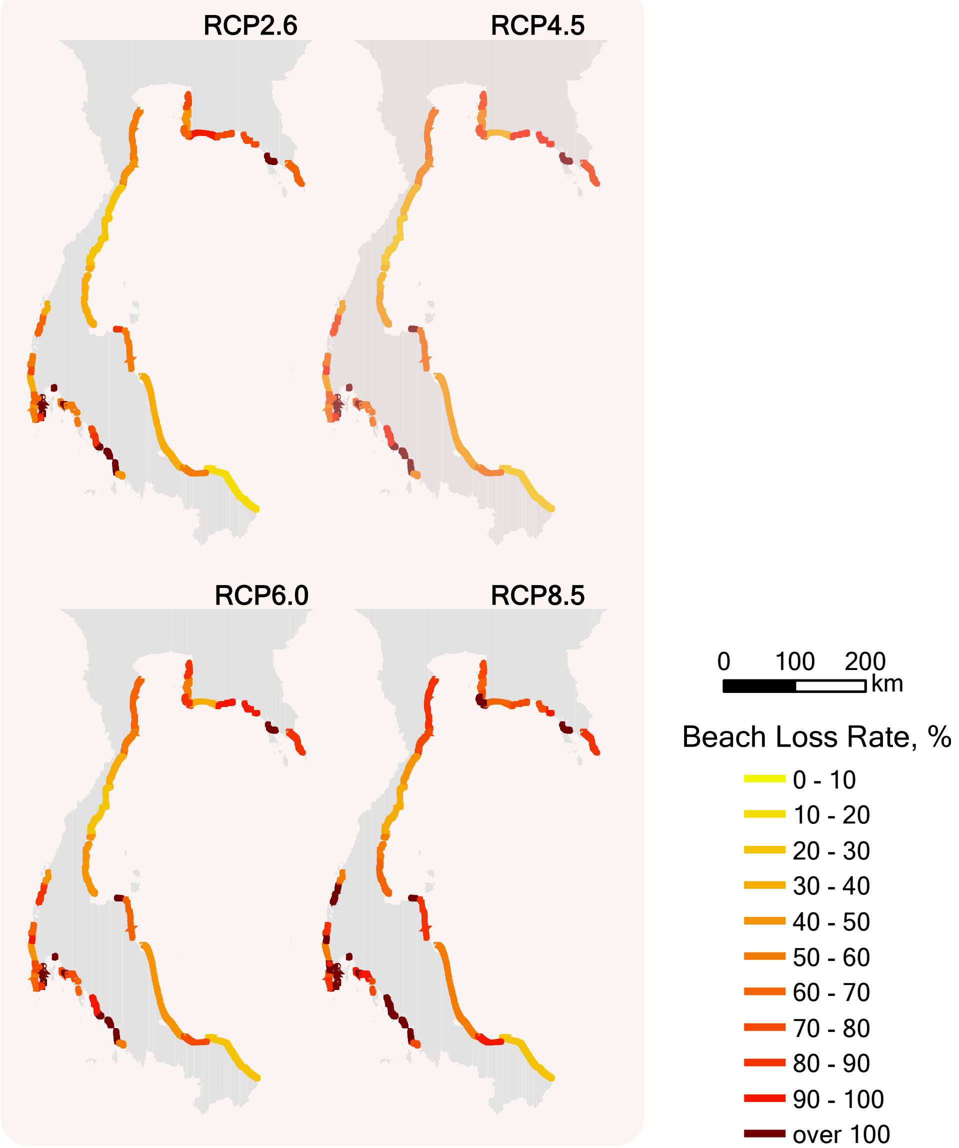
To maintain beach width for 30



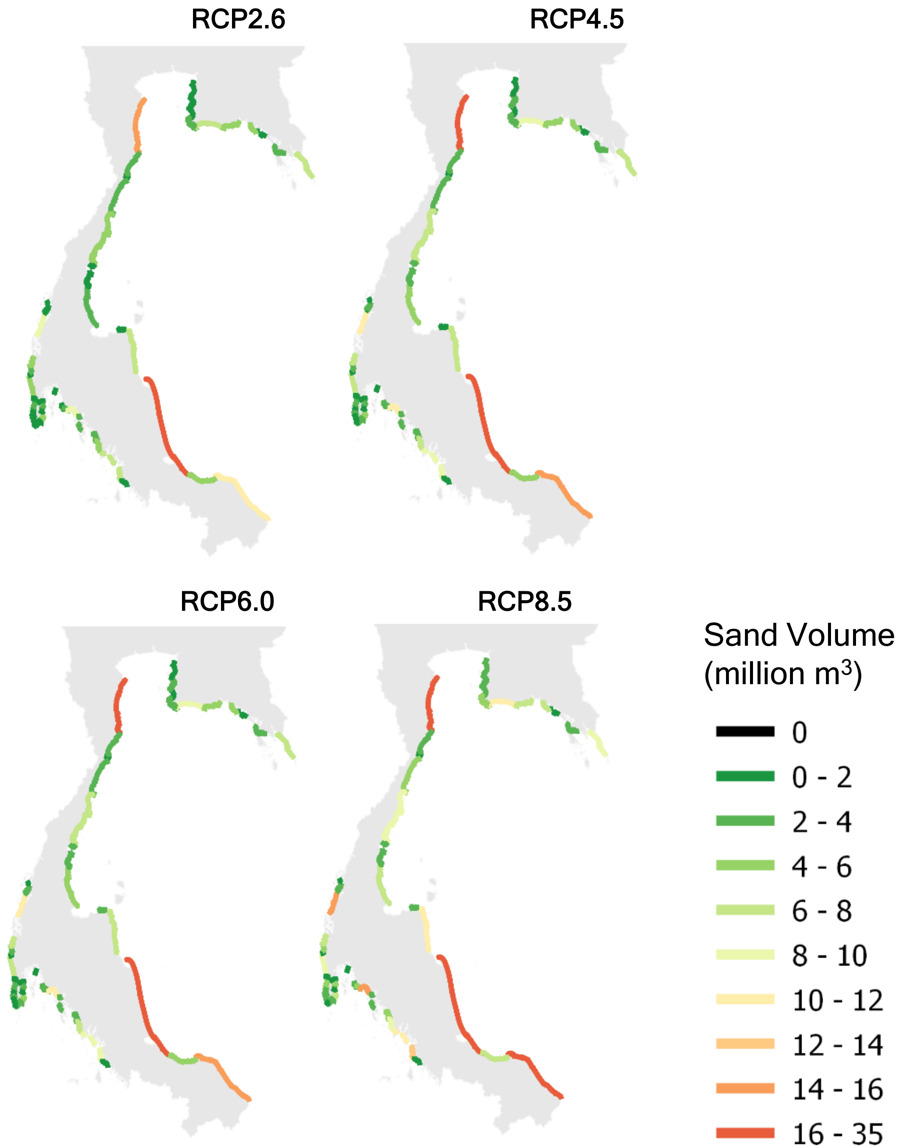
Results: Sand Volume for each beach zones

The value shows the profile volume of sand required for each nourishment.

Beach Loss



To maintain the present shoreli



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Discussion & Conclusion

- **This study provides preliminary results of sand volume and costs required for beach nourishment for each coastal zones in Thailand.**

- **The results are relied on the assumption that filling sediment size is the same the native one.**
  - **It would requires minimum of 1062 million USD (RCP2.6) to maximum of 3190 million USD (RCP8.5)**
    to keep the all the beaches at present width by using beach nourishment practice.
  - **Thailand has 38 million people who has salary. They needed to pay at least 28 USD to maximum 84 USD to compensate beach loss.**

- **This is only one time nourishment (to future period, 2081-2100) and this study consider beach the impact of Sea-Level Rise only. Beach replacement time interval should be assessed in future work**

- **Benefit of the beach is needed to be evaluate in order to determine optimum beach widths.**

- **Further cost-benefit analysis is required for realistic nourishment in design practice.**

References

1. Bruun, P., 1962. Sea-Level rise as a cause of shore erosion, *Journal Waterways and Habors Division*. ASCE, 88, 117-132.

2. Putcharapitchakon, K., and Ritphring, S., 2012. Sea Level Change in Thailand. *Ladkrabang Engineering Journal*, 29(3), 55-60 (in Thai).

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4. Yoshida, J., Udo, K., Takeda, Y., Mano, A., 2014. Framework for proper beach nourishment as adaptation to beach erosion due to sea level rise. *In:* Green, A.N. and Cooper, J.A.G. (eds.), *Proceedings 13th International CoastalSymposium* (Durban, South Africa), *Journal of Coastal Research*, Special Issue No. 70, pp. 467-472, ISSN 0749-0208.


Thank You