Shoreline Evolution over the Past Four Decades in Koh Kong, Cambodia

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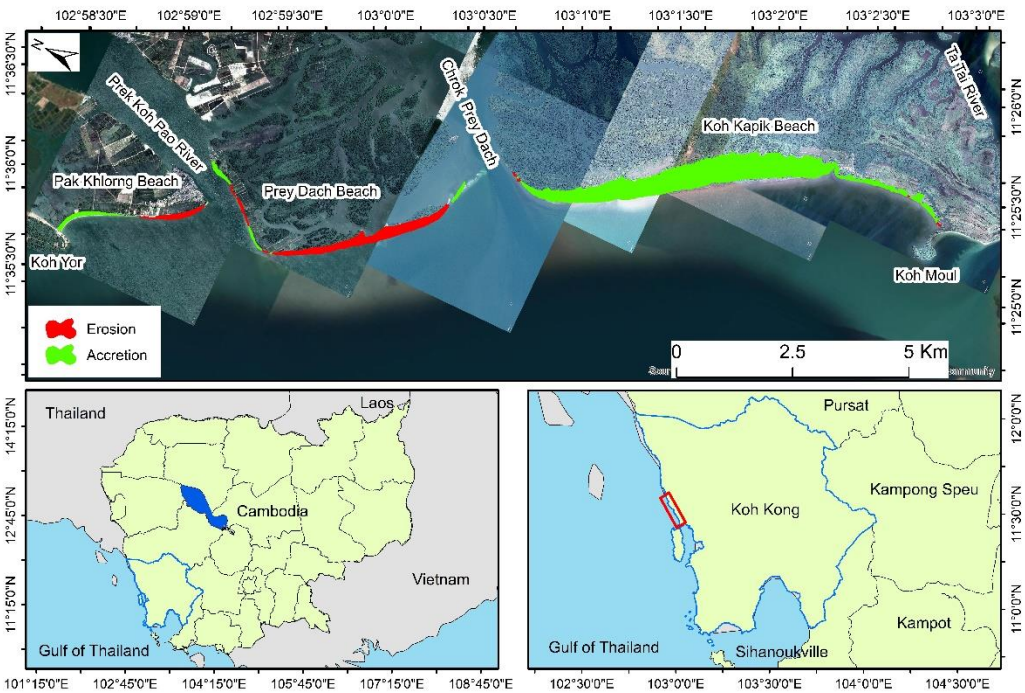
1. Introduction

- **Coastal regions** are landforms dynamically shaped by the interaction of riverine and coastal sediment processes.
- **Climate change** and **anthropogenic pressure** have caused a major concern for sustainable development and natural resources in this region.
- **Cambodian coastal region** is exposed to various natural and human-induced factors, including tides, waves, storm surges, land use changes, sand mining, and coastal development.



Objectives

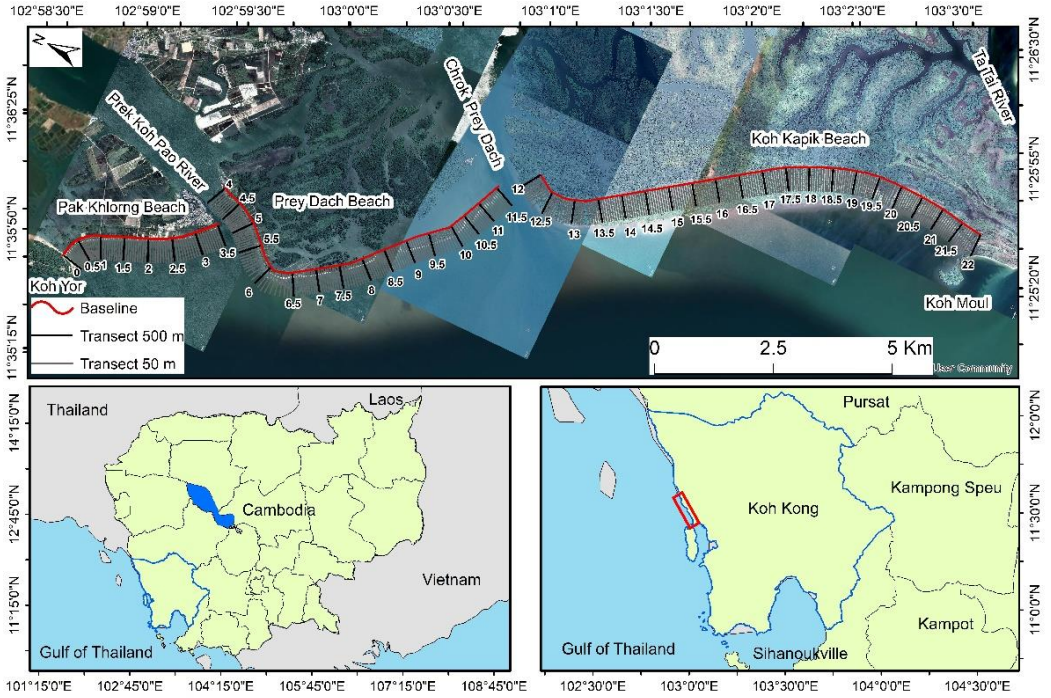
1. Investigate **coastline evolution between 1985-2023** along the Pak Khlong (PK), Prey Dach (PD), and Koh Kapik (KK) coasts in Koh Kong.
2. Evaluate the **factors influencing** the shoreline evolution along these coastlines

2. Materials and Method

- **Koh Kong** is abundant in **natural resources** and has the **longest coastline** (237 km) in Cambodia.
- **Koh Kong** is developed to be a major economic region in Cambodia as several mega infrastructures have been constructed.
- The **PK** coast covers the coastline between Koh Yor and the Prek Koh Pao (PKP) river mouth of around 3,500 m.
- The **PD** coast covers the coastline between the PKP river mouth to Chrok Prey Dach of around 7,300 m.
- The **KK** coast is covered between the CPD and Ta Tai (TAT) River mouth of around 11,050 m.

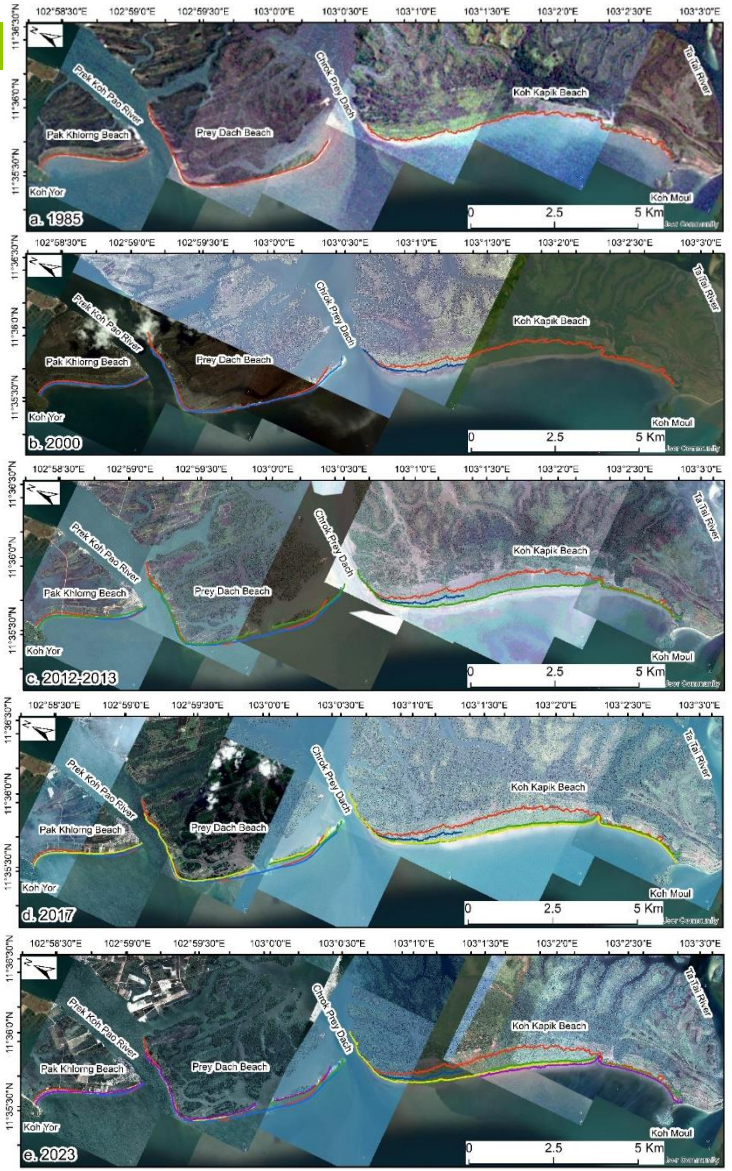
a. Economic region in Koh Kong

b. National Road 10



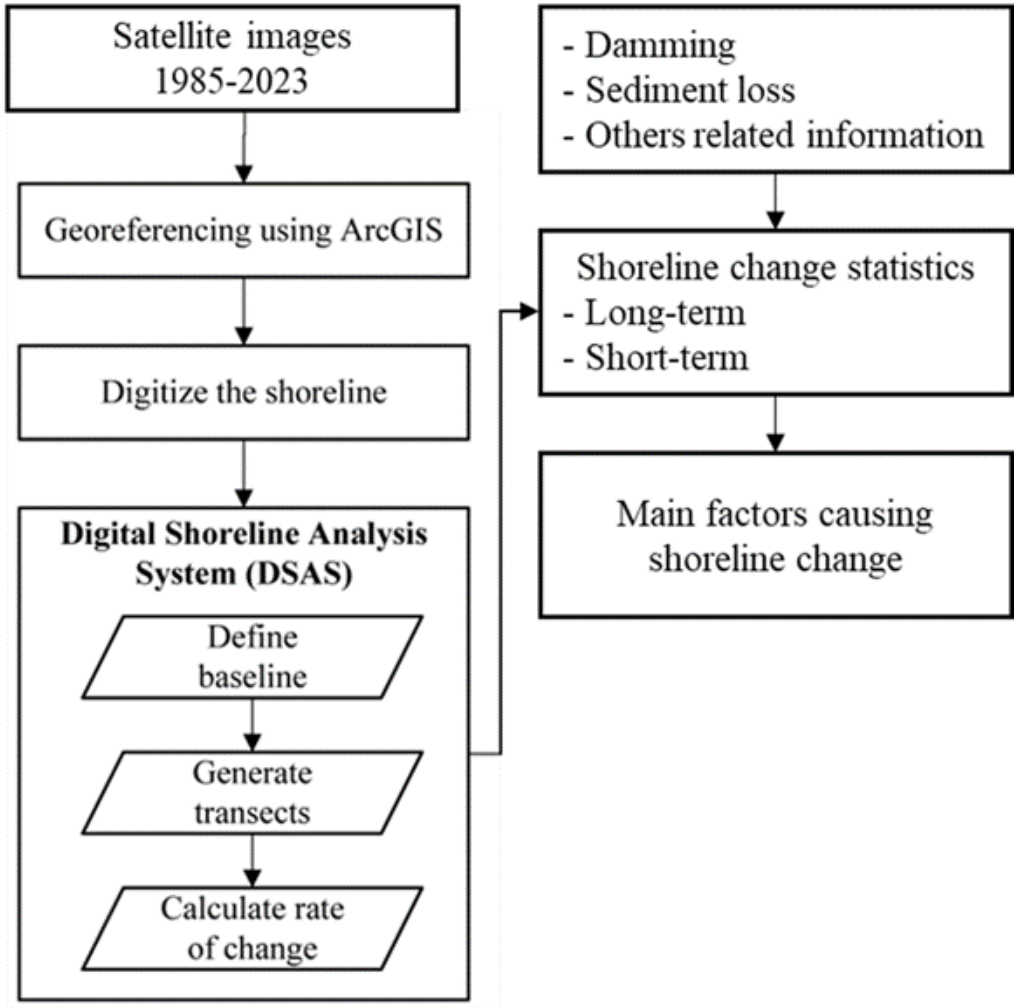
2. Materials and Method (Cont.)

- **Satellite images** (1985-2023) are acquired from Maxar Technologies, CNES, and Airbus satellites using **Google Earth Pro** software.
- All images were georeferenced into **UTM projection Zone 48** with the **WGS 84** and were rectified with the **latest satellite image** (2023).
- **Coastline**: we utilized the outer line of closed mangroves or vegetation edge as the shorelines along the coast.
- **Shoreline positions** were extracted by on-screen **digitization** at a scale of 1:1000 but at a scale of 1:5000 in 1985.



2. Materials and Method (Cont.)

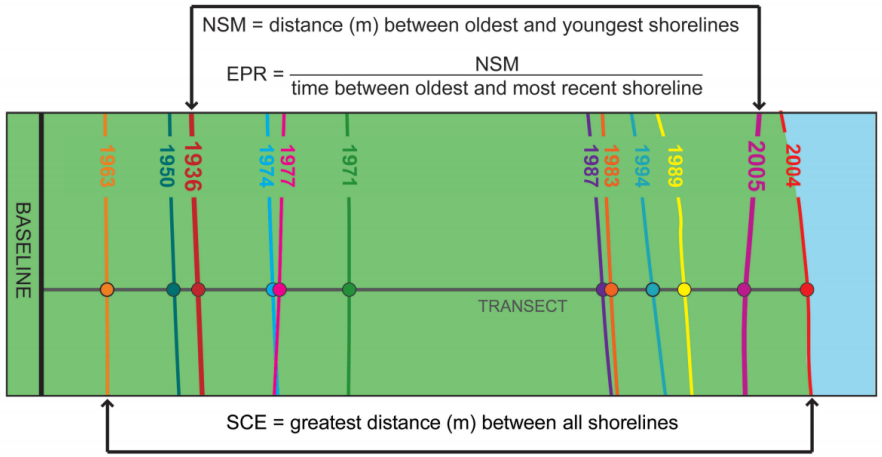
- **Shoreline change statistics** were estimated using the Digital Shoreline Analysis System (**DSAS)**.
- **Long- and short-term shoreline change** statistics were assessed in this study.
- **Short-term shoreline change** is crucial to evaluate changes in shoreline movement patterns that have responded to **recognized climatic** and **human activities** at certain times.



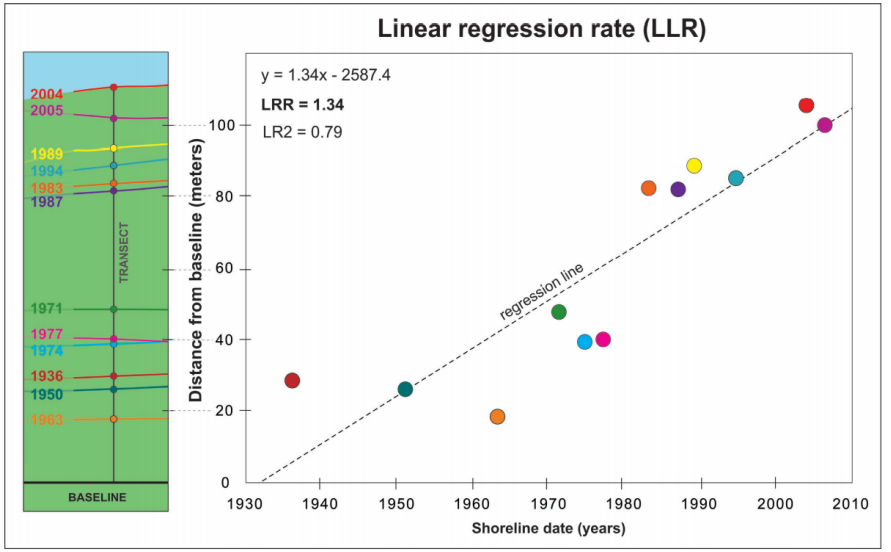
Research Framework

2. Materials and Method (Cont.)

- The **Linear Regression Rate (**LRR) and **Net Shoreline Movement** (NSM) methods were used to determine the rate of long-term shoreline change for each transect. However, the End Point Rate (EPR) and NSM methodologies were used to calculate short-term rates of shoreline change.
- **NSM** was used to estimate the length of the shoreline movement.
- **EPR** was employed to estimate shoreline change rates, respectively.
- **LRR** is a linear regression rate-of-change statistic computed by fitting a least-squares regression line to all shoreline points of each transect, and the slope of the regression line represents the rate of shoreline change.



The computation of NSM, SCE, and EPR. Source: Thieler et al., (2017)



The computation of LRR. Source: Thieler et al., (2017)

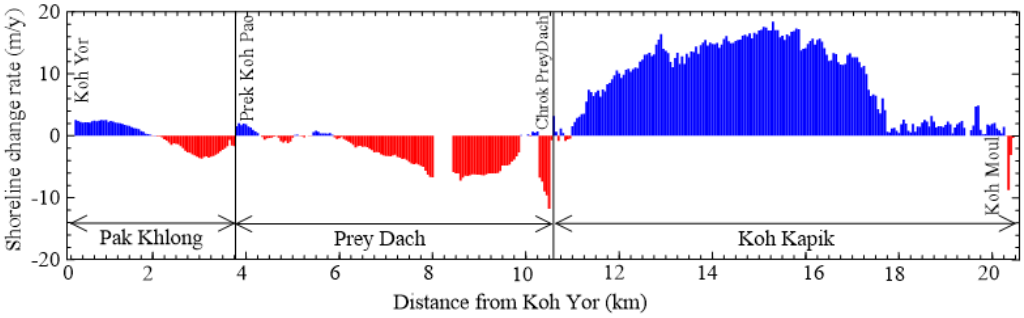
3. Results

Long-term shoreline change (1985-2023)

- Net land loss
  - 10.2 ha with -2.3±0.1 m/y at PK
  - 54.8 ha with -4.0±0.1 m/y at PD
  - 2.7 ha with -2.5±0.1 m/y at KK
- While there was land growth
  - 11.6 ha in PK with 2.6±0.1 m/y
  - 4.1 ha in PD with 1.3±0.1 m/y
  - 202.0 ha in KK with 9.7±0.1 m/y

Results of long-term shoreline change

Data	PK	PD	KK
Land loss (ha)	10.2	54.8	2.7
Land growth (ha)	11.6	4.1	202.0
Retreat (%)	44.3	62.4	3
Accretion (%)	42.9	10.3	91.5
Stable (%)	12.9	20.3	5.5
Shoreline change rate using LRR (m/y)			
Mean rate	-0.2±0.1	-2.4±0.1	8.8±0.1
Max. retreat rate	-3.7±0.1	-7.2±0.1	-8.7±0.1
Mean retreat rate	-2.3±0.1	-4.0±0.1	-2.5±0.1
Max. accretion rate	2.6±0.1	2.1±0.1	18.4±0.1
Meanaccretionrate	2.0±0.1	1.3±0.1	9.7±0.1



Long-term shoreline change rates

3. Results (Cont.)

Short-term shoreline changes

a. 1985-2000: most of the accretion

- 73% with 3.3±0.1 m/y at PK
- 69% with 2.8±0.1 m/y at PD
- 87% with 6.7±0.1 m/y at KK

b. 2000-2013: most of the retreat

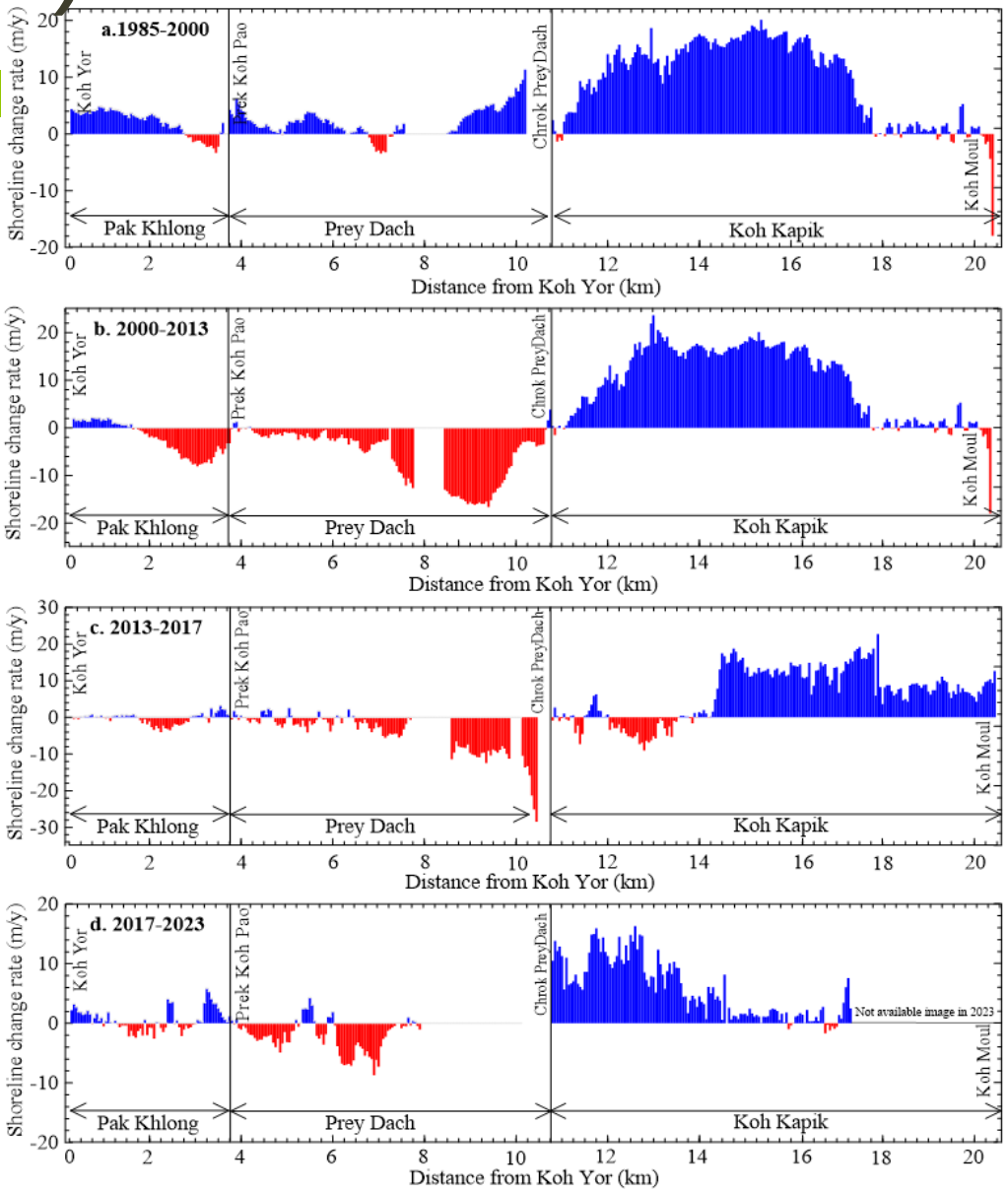
- 57% with -4.6±0.1 m/y at PK
- 87% with -6.8±0.1 m/y at PD
- 89% with 11.7±0.1 m/y at KK was accretion

c. 2013-2017: experienced a retreat

- 34% of -2.0±0.1 m/y at PK
- 78% of -4.6 ±0.1 m/y at PD
- 19% with -3.6±0.1 m/y at KK

d. 2017-2023:

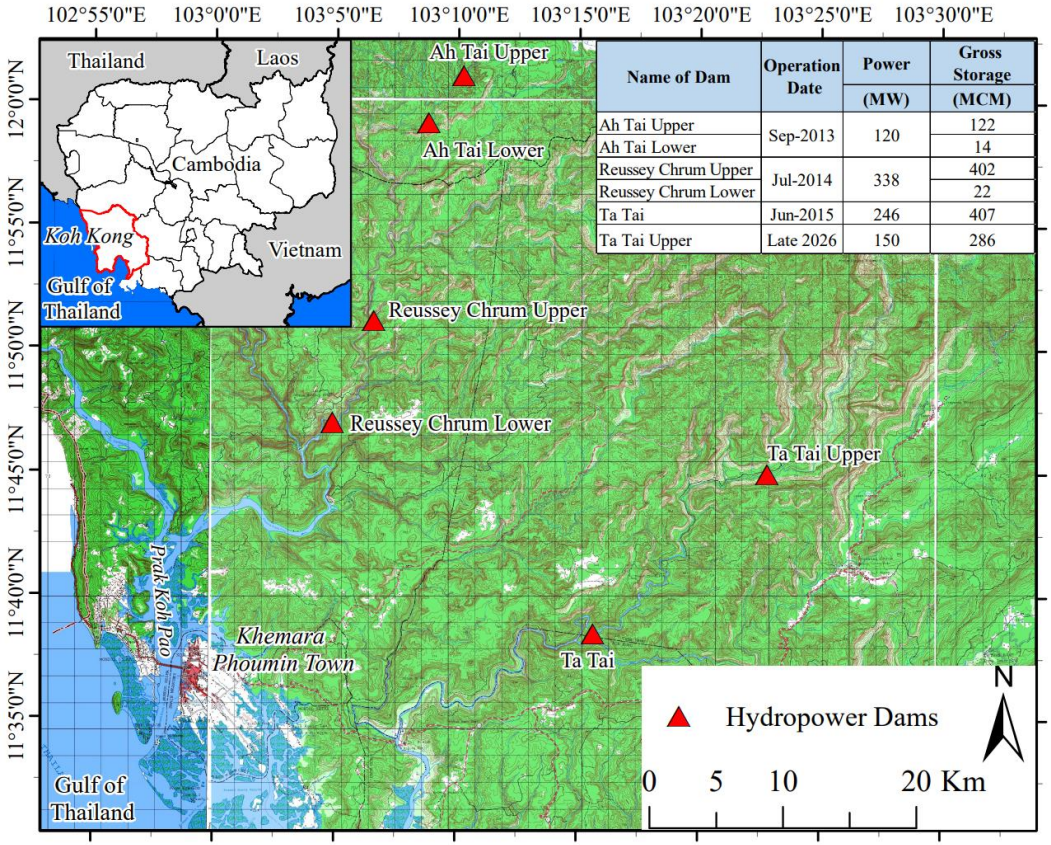
- 44% with 2.3±0.1 m/y at PK
- 45% with -3.3±0.1 m/y at PD
- 87% with 6.4±0.1 m/y at KK was accretion



4. Discussion

Hydropower Dam Development in Koh Kong

- There are 5 hydropower dams in operation and another 1 is under construction.
- Total gross storage: 1,253 Million Cubic Meter
- Total Power: 854 MW
- The earliest operation of the hydropower dam was in September 2013.



Name of Dam	Operation Date	Power (MW)	Gross Storage (MCM)
Ah Tai Upper	Sep-2013	120	122
Ah Tai Lower			14
Reussey Chrum Upper	Jul-2014	338	402
Reussey Chrum Lower			22
Ta Tai	Jun-2015	246	407
Ta Tai Upper	Late 2026	150	286

4. Discussion (Cont.)

There are seven storms along the Gulf of Thailand, while erosion of three coasts has mainly occurred since 2000.

Record storm along the Gulf of Thailand

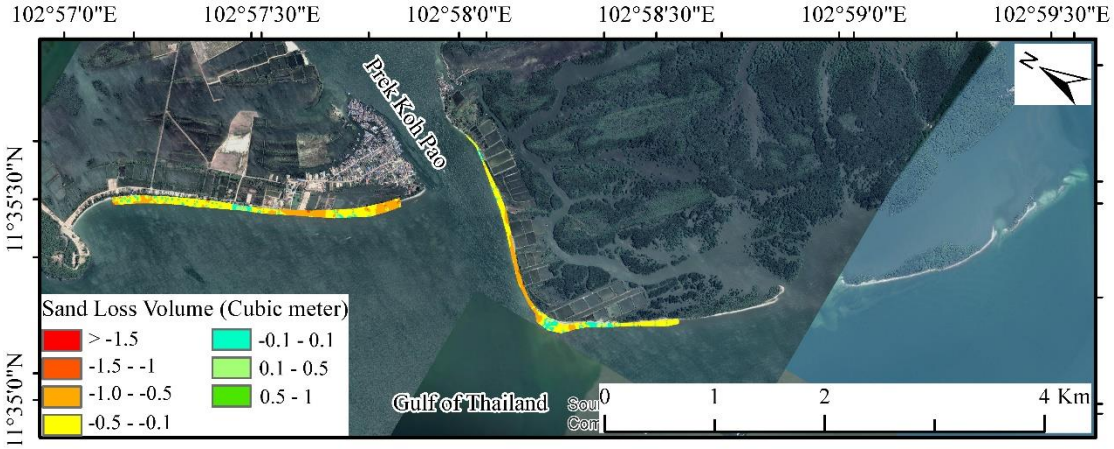
Year	Storm Name	Maximum Category in the GOT	Duration		Max. Wind Spend in the GOT
			start	End	kt
2004	Muifa	Tropical Storm	13-Nov-04	26-Nov-04	40
2006	Durian	Tropical Storm	24-Nov-06	09-Dec-06	35
2010	Jal	Tropical Depression	31-Oct-10	08-Nov-10	20
2013	Not_named	Tropical Depression	01-Nov-13	21-Nov-13	25
	Lehar	Tropical Depression	19-Nov-13	29-Nov-13	20
2017	Tembin	Tropical Depression	20-Dec-17	26-Dec-17	20
	Not_Named	Tropical Depression	03-Nov-17	08-Nov-17	25
2018	Oraji:Torji	Tropical Depression	16-Nov-18	21-Nov-18	30
	Pabuk	Tropical Storm	30-Dec-18	07-Jan-19	50
2020	Krovanh	Tropicle Depression	17-Dec-20	25-Dec-20	30

Source from https://coast.noaa.gov/hurricanes/

4. Discussion (Cont.)

Sand loss due to storm

- DGPS A3 RTK was used to survey profiles of beach face along Pak Khlong and Prey Dach coasts during Low tides:
- April 2023 (pre-storm season)
- November 2023 (post-storm season)



Coastline	Sand loss (m^3)	Sand gain (m^3)
Pak Khlong	72,036	1,801
Prey Dach	49,138	2,167

5. Conclusions and Recommendations

- The results indicate a net **land loss** of approximately **10.2** ha, **54.8** ha, and **2.7** ha in PK, PD, and KK, respectively, while there was **land growth** of roughly **11.6** ha in PK, **4.1** ha in PD, and **202.0** ha in KK, throughout the study period.
- **Coastal processes** (waves, tides, and currents) are major causes of shoreline erosion along these three coastlines. In addition, mangrove collapses are caused by **storms** and the **cutting of mangroves** for charcoal products.
- **Substant mangrove colonization** seaward along the KK coast is possibly caused by longshore **sediment transport** from the PD coast and **riverine sediment supply** from the TAT river.
- **Hydropower dams** seem **not to be a major** cause of shoreline erosion.
- **Sand mining** should be considered in future studies because sand mining activities have **occurred both** in the river and coastal regions.
- **A hydrodynamic model** should be developed to fully understand the **coastal processes** and **sediment transport** in this region.

Q&A

THANK YOU FOR ATTENTION