Project Title: A Coastal Erosion Monitoring Platform Based on Wireless Sensor Networks and 3D Point Clouds from Airborne LiDAR

- Coastal erosion is a growing concern for numerous coastal communities and ecosystems and raises a global issue.
- Sustainable coastal management practices and protective measures are necessary.
- Comprehensive and reliable information is crucial for the implementation of protective measures with minimal impact.
- A data center platform that offers both raw and processed data is indispensable.
  - data can be sourced from a variety of local and remote techniques,
    - Sensors,
    - Video monitoring systems,
    - 3D point clouds, and weather stations.
- Data sources + AI algorithms based on past experiences: we can gain a more nuanced understanding of the factors contributing to erosion.
- Therefore, we propose a platform for collecting, monitoring, and processing environmental data in coastal areas.
- This platform is designed to support decision-making by providing recommendations or predictions based on data analysis.

Objectives: 1) built a data center and data collection platform to provide information to policy makers and general people and 2) research data collection and processing techniques, models for prediction, classification, segmentation, etc., related to coastal erosion.

Speaker: Mr. Surasak Boonkla, PhD., National Electronics and Computer Technology Center (NECTEC), Thailand

Project Members:

Institutions	Names
National Electronics and Computer Technology Center, Thailand	Dr. Surasak Boonkla*, Dr. Jessada Karnjana, Dr. Kasorn Galajit, Dr. Sutat Saetang
School of Engineering, Thammasat University, Thailand	Dr. Akkharawoot Takhom, Mr. Pasut Insung, Mr. Pasut Insung
School of Information, Computer, and Communication Technology (ICT), Sirindhorn International Institute of Technology, Thammasat University, Thailand	Dr. Somrudee Deepaisarn
Faculty of Informatics, Burapha University, Thailand	Dr. Waranrach Viriyavit, Dr. Pichet Wayalun, Mr. Worawit Werapan, Dr. Komate Amphawan, Dr. Supawadee Srikamdee
Universiti Teknologi Malaysia, Malaysia	Dr. Sharifah Hafizah Syed Ariffin, Dr. Shafishuhaza Sahlan
Institut Teknologi National Bandung, Indonesia	Dr. Soni Darmawan, Dr. Didin Permadi, Dr. Dian Noor Handiani, Dr. Yessi Nirwana Kurniad
Cambodia Academy of Digital Technology, Cambodia	Dr. Phutphalla Kong, Dr. Hongly Va

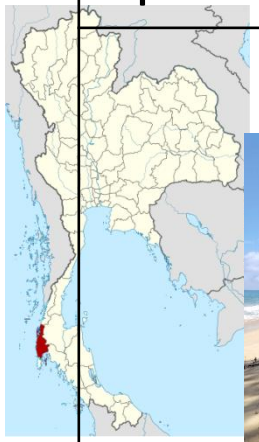
Project Budget: 40000 USD/year

Project Duration : 2 years, Apr. 2024 – Mar. 2026

Project Activity Plan: Coastal Change Monitoring Using 3D point cloud by NECTEC, DMCR, and TU

2024 → 2025

Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar



Data collection before and after rainy season using UAV LiDAR

Develop sand volume change estimation method from 3D point cloud data within controlled conditions

Apply the sand volume change estimation method to the data collected on the beaches.

Develop low-cost UAV LiDAR, 3D point cloud dataset

Develop low-cost UAV LiDAR, 3D point cloud dataset

Apply the sand volume change estimation method to the data collected on the beaches.

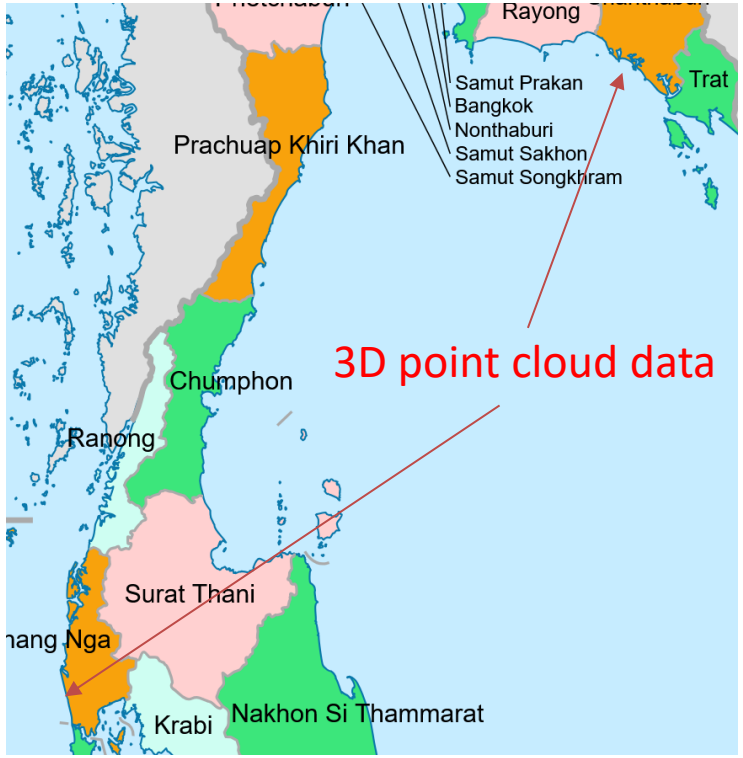
Expected output: one 3D point cloud dataset of a beach, two publications, and a low-cost UAV with LiDAR.

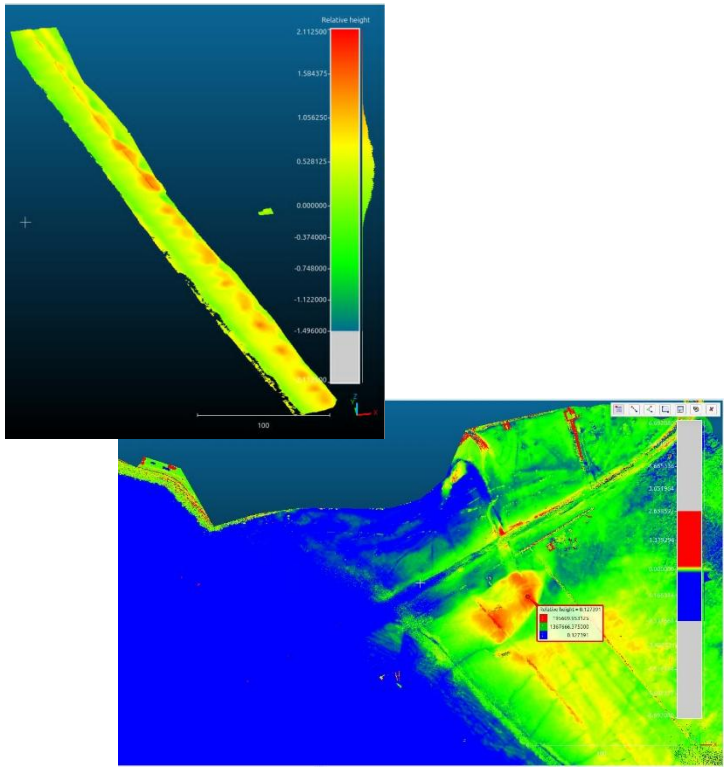
2026 → End

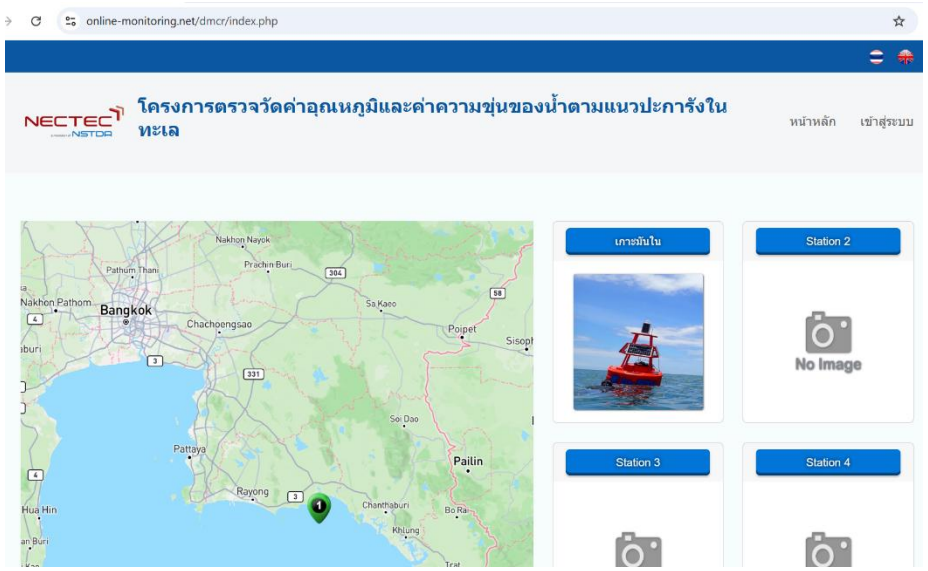
Project Output: Coastal Change Monitoring Using 3D point cloud by NECTEC, DMCR, and TU

NECTEC & DMCR:
- 2 time series of 3D point cloud data, 16 km along the testing site.
- 12 time series of 3D point cloud data in Chanthaburi province, Thailand
- Main contributors of 6 publications.
- Water quality sensor monitoring system for coral breaching study.
- Install sand fences by DMCR to mitigate coastal erosion.

TU:
- 1 Publication
- 1 Software for 3D point cloud pre-processing.







Water quality sensor near Mannai island for Coral bleaching study

Project Activity Plan: Develop a Visualization and Clustering Technique for Segmenting Temporal 3D Point Cloud Data by CADT

- Collect temporal 3D point cloud data
- Data covers various time intervals to capture changes in the coastal environment.

- Clean and normalize
- Annotate and label
- Align and register the datasets from different time intervals

- Choose an appropriate clustering algorithm
- Apply clustering to the preprocessed point cloud data
- Analyze the resulting clusters.

- Select a segmentation technique
- Apply segmentation

- Down-sampling technique
- Change Detection and Analysis
- Validation
- Reporting and Visualization

Expected output: Clustered and segmented data, visualization, and a research manuscript

Results: Two internship students
- Multilabel classification and segmentation of coastal areas
- 3D point cloud based coastal volume change analysis of muddy beach in Chanthaburi, Thailand

Main Activity	Activity in Detail	Indicative Timeline (month)																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Project Initialization	1.1 Resource Allocation																		
	1.2 Tool and Setup																		
	1.3 initial literature review																		
2. Data Acquisition	2.1 Data Source Identification																		
	2.2Data Collection																		
	2.3Point Cloud Visualization																		
3. Data Pre-processing	3.1 Data Cleaning and Normalization																		
	3.2 Data Annotation and Labeling																		
4. Clustering and Segmentation	4.1 Clustering Algorithm Selection																		
	4.2 Clustering Implementation																		
	4.3 Segmentation Technique Selection																		
	4.4 Segmentation Implementation																		
5. Post-Processing	5.1 Down-sampling																		
	5.2 Visualization Development																		
6. Reporting and Documentation	6.1 Manuscript Preparation																		
	6.2 Presentation Preparation																		

Project Activity Plan: Coastal Change Prediction and Shoreline Detection from Images Recorded by Satellites and Drones by BUU

Coastal Change Prediction

- Sea level rise
- Storm intensity and frequency
- Wave action and currents
- Sediment supply and transport
- Geological factors (e.g., subsidence)
- Historical shoreline data
- Oceanographic data (waves, tides, currents)
- Climate models and projections
- Land use and coastal development information

Activities	2024									2025										2026		
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Literature review Survey available dataset	←			→																				
Data Collection - Satellite images - Meteorology data and other							→																	
Develop Shoreline detection model - Submit Conference								→			X													
Develop Coastal Change prediction model - Coastal Change from Historic Satellite images - Coastal Change from Meteorology data and other (expect image) - Submit Conference													→						X					
Conclusion and Report																			→					

Shoreline Detection

- Satellite Imagery: Covers multi-spectral analysis, SAR, and high-resolution sensors.
- Drone Imagery: high resolution capabilities, flexible deployment, and 3D mapping.

Expected output: one publication

Outputs: main contributor in 3 publications, one of which is the first author.

Project Activity Plan: Processing of 3D Point Cloud Data and Orthogonal Images

RESEARCH PLAN

- Pre-processing of 3D point cloud data.
- Registration of the 3D point cloud on the image acquired from the same area.
- Determine differences in the coastal area over time.
- Applied object detection techniques to detect, e.g. green areas, houses intruding into the coastal area, etc.

PROPOSED BUDGET

- 2,000 USD Approx. to cover registration fees and travel cost for APSIPA 2025 conference between 22-24 OCT 2025 in Singapore.

COLLABORATION

- Working closely with our NECTEC team and international partners.
- Acquiring a group of students.
- Co-supervise the student participating in this collaborative project.
- An expected international conference paper.

Study of sand volume change estimation using 3D point cloud data: under progress

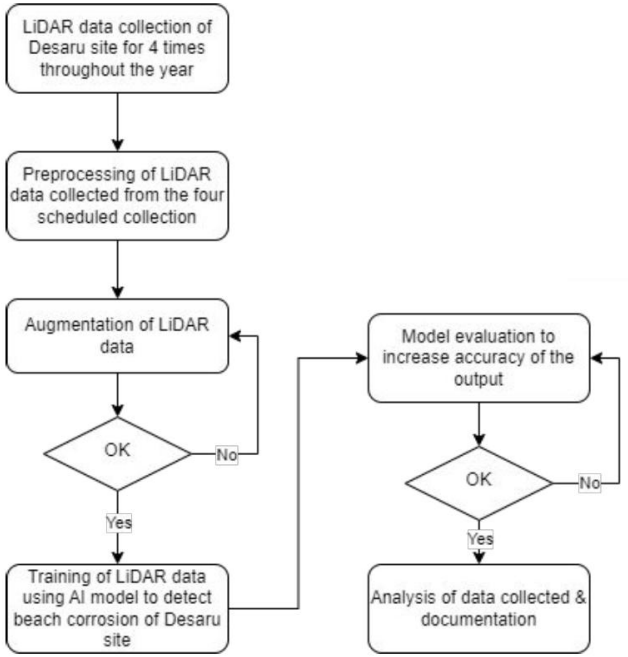
Project Activity Plan: Development of a Coastal Erosion Risk Prediction Using Machine Learning by UTM

		2024			2025				2026
	Month	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
No	Task								
1	Investigate suitable deep learning for 3d point cloud data	■							
2	Discussion with Geo Satellite Lab on usage of 3D point cloud Lidar		■						
3	Plan data collection & Tech acquisition			■					
4	Data Analysis & Paper writing				■				
5	Augmented data & Model training Paper presentation					■			
6	Model Evaluation						■		
7	Report Writing							■	■

Expected output: one 3D point cloud dataset of Desaru beach and one publication (Research under progress)

Desaru Site and Data Collection Specifications

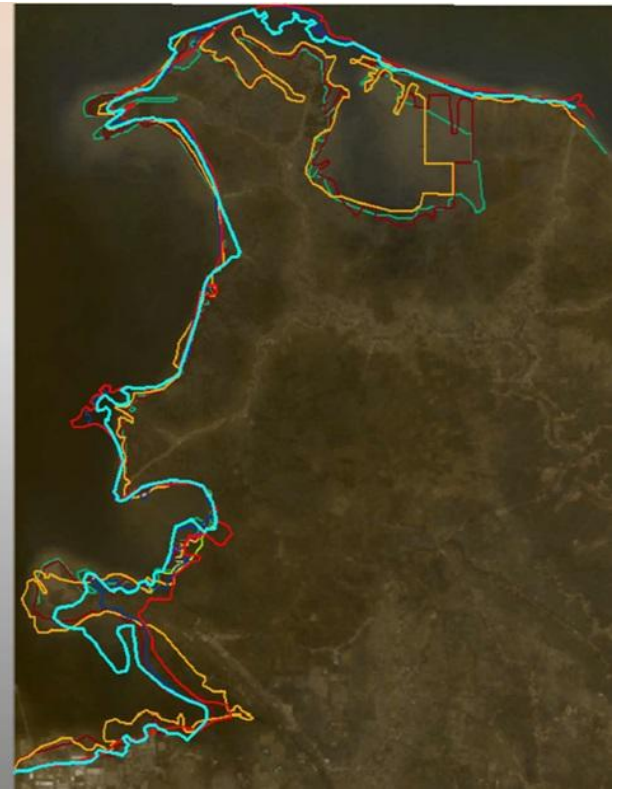
- Scanning area : 500m x 300m = 150000m2 = 15ha
- LiDAR sensor point density: 200 points/ meter squared
- LiDAR Measurement accuracy: +/- 5cm
- LiDAR Absolute accuracy: <15cm
- Establishing **base station** for data accuracy control.
- Establishing **check point** for data accuracy checking.
- Processing LiDAR data in terms of point cloud and trajectory file
- Performing **ortho rectification process** of aerial image
- Final data will be delivered in LAS format (Industry standard LiDAR data)



Project Activity Plan: Coastal Vulnerability Index Assessment, Coastal Line Changes Monitoring, and Rip Current Identification by ITENAS

- Coastal Vulnerability in North Coast of Bekasi Regency using Composite Vulnerability Index (CVI), PI: **Dr. rer. nat. Dian N Handiani +** Meteorological prediction (**Dr. Didin Agustian P**)
- Using remote sensing for monitoring of coastal line changes (Cirebon), PI: **Dr. Soni Darmawan**
- Rip current identification at the southern coastal areas in Java Island (Ciamis, Pangandaran), PI: **Yessi Nirwana, Ph.D**

- Erosion and accretion very fast in the study area.
- Need more investigation on the quantitative approach for estimating erosion and accretion, as well as its impact on the environment.

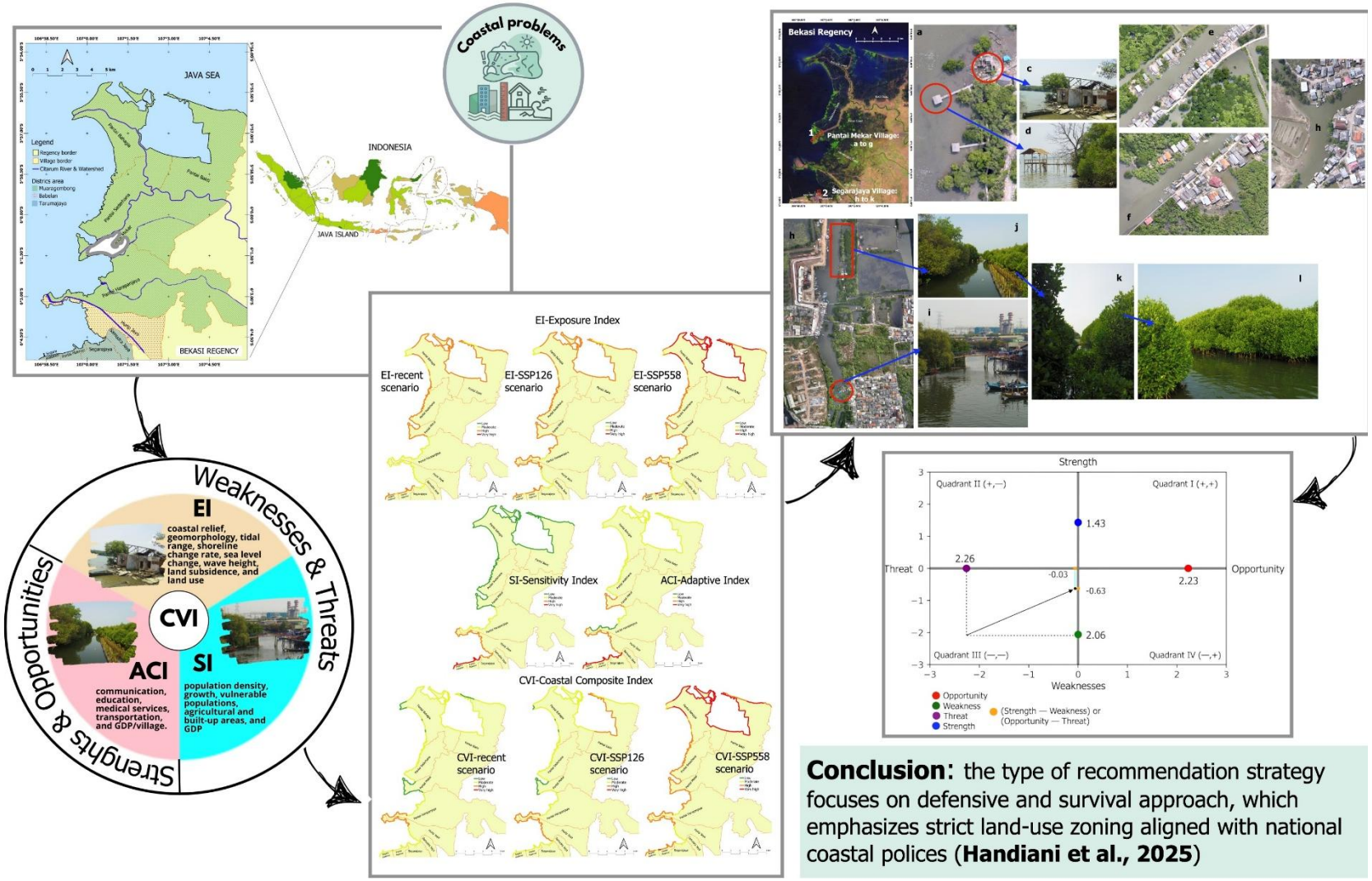


No	Activity	July	Augt	Sept	Oct	Nov	Dec
1.	Testing site-Field survey						
2.	International conference						
3.	Journal submission						
4.	Book chapter (draft)						

Expected output: 2 submitted articles to international journals, 2 Scopus indexed international proceeding, and 1 book chapter draft.

Project Activity Plan: Coastal Vulnerability Index Assessment, Coastal Line Changes Monitoring, and Rip Current Identification by ITENAS

STRENGTHENING LOCAL RESILIENCE TO GLOBAL CLIMATE CHANGE THROUGH AN INNOVATIVE INTEGRATION OF COASTAL VULNERABILITY AND SWOT ANALYSIS

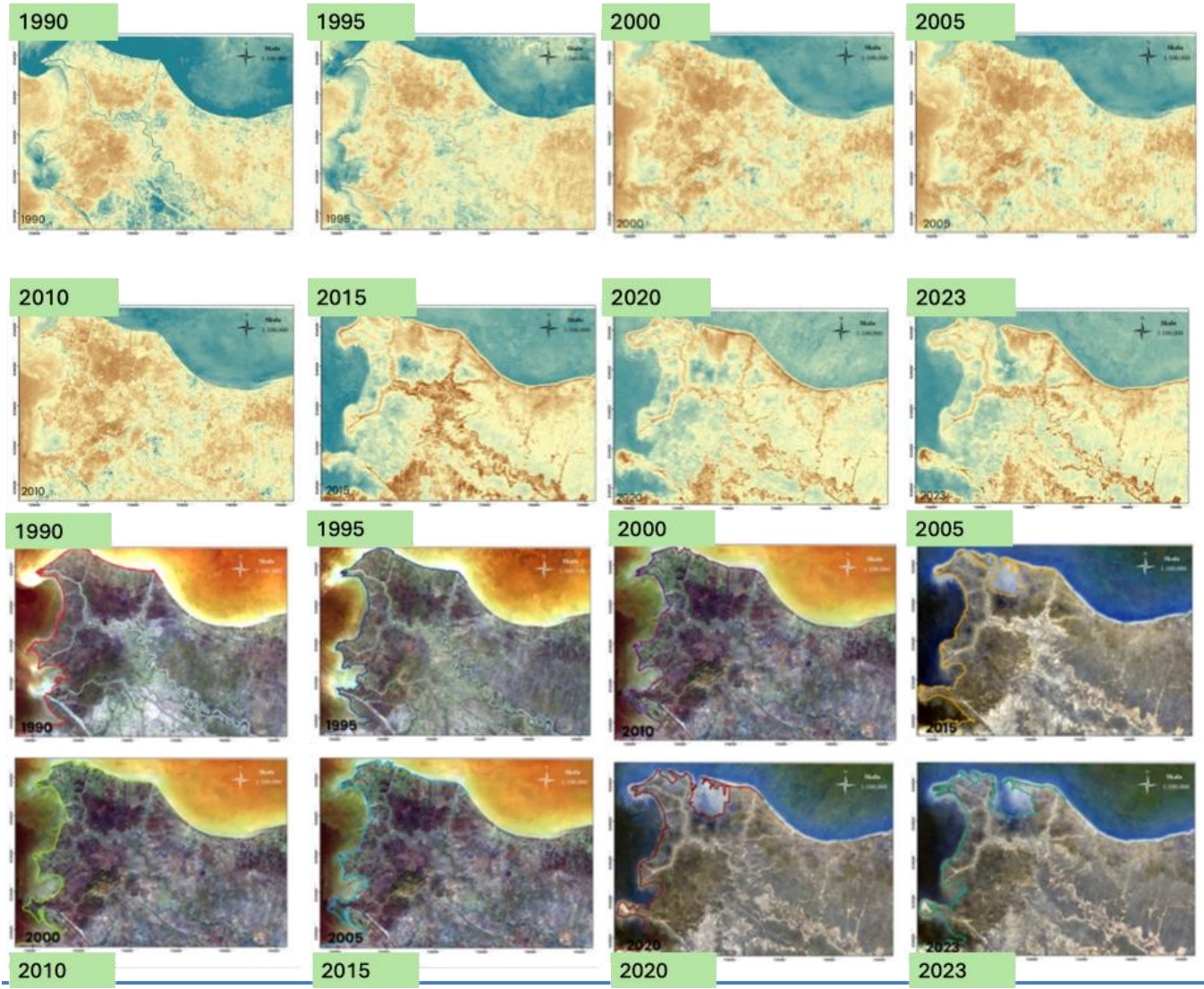


Conclusion: the type of recommendation strategy focuses on defensive and survival approach, which emphasizes strict land-use zoning aligned with national coastal polices (**Handiani et al., 2025**)

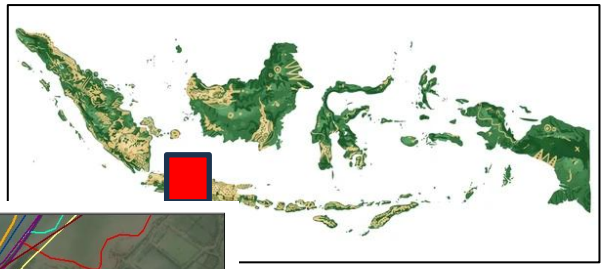
Progress research activity – Coastal Vulnerability in North Coast of Bekasi Regency using Composite Vulnerability Index (CVI), PI: **Dr. rer. nat. Dian N Handiani**, + Meteorological prediction **Dr. Didin Agustian P**

1) Submitted to ***Geosystems and Geoenvironment*** and is currently undergoing a second round of review (as of October 22, 2025)
2) In print international proceeding, International Conference on Green Technology and Design (ICGTD 2024) – Bandung December, 2024 – Publish in AIP Publishing

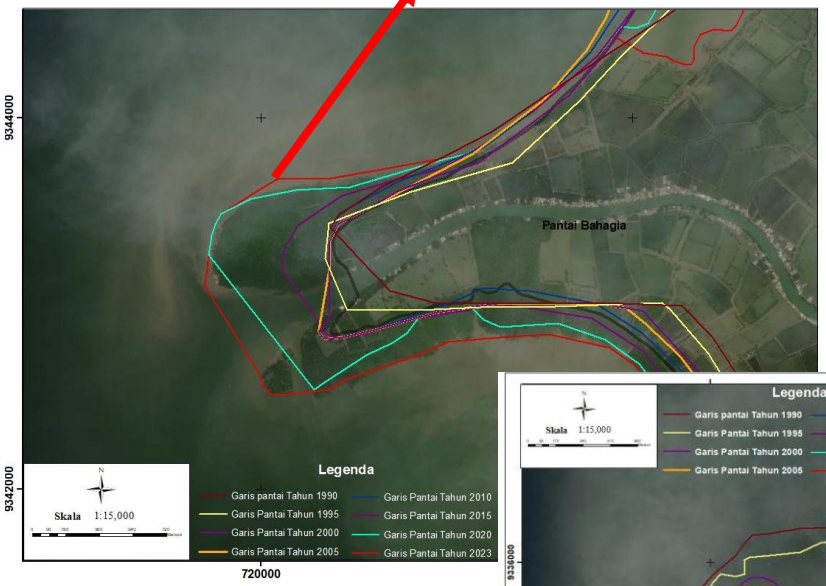
Shoreline Monitoring in North Coast of Bekasi, West Java, Indonesia 1990 – 2023



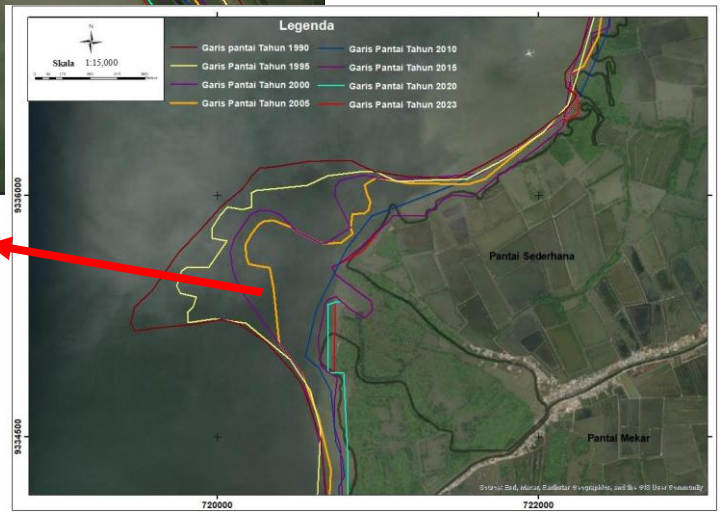
PI: **Dr. Soni Darmawan**



Fast Accretion



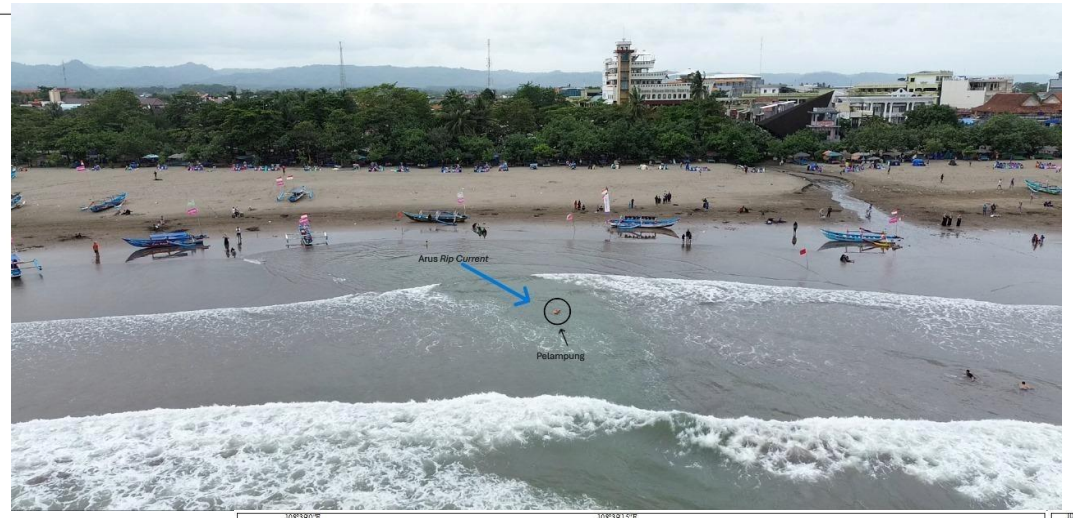
Fast Erosion

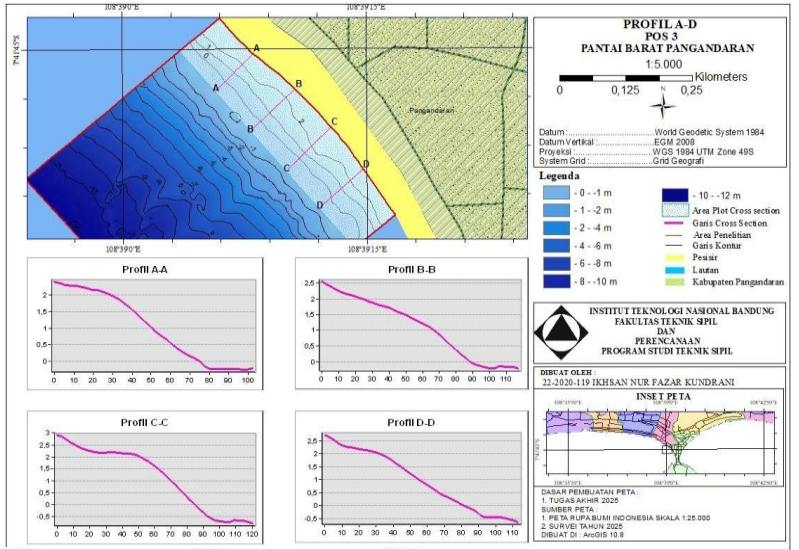


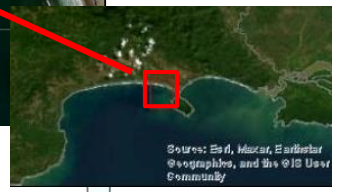
***Published international proceeding at IEEE Asia-Pacific Conference on Geoscience, Electronics and Remote Sensing Technology (AGERS)*, 2024.**

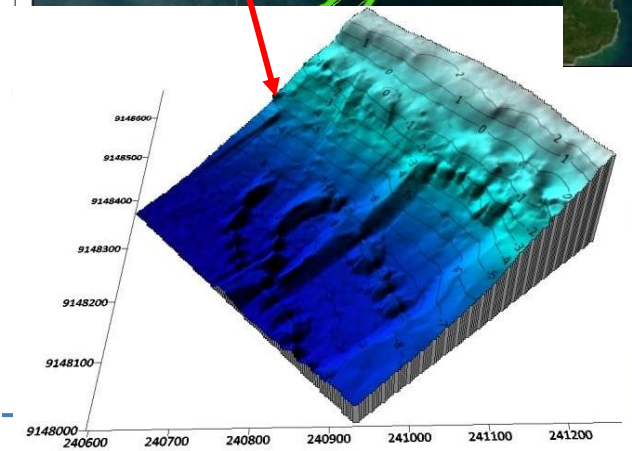
Project Activity Plan: Coastal Vulnerability Index Assessment, Coastal Line Changes Monitoring, and Rip Current Identification by ITENAS

Bathymetry and shoreline measurement, also rip current observations using buoys equipped with Handheld GPS and aerial monitoring with drones. PI: **Yessi Nirwana, Ph. D.**

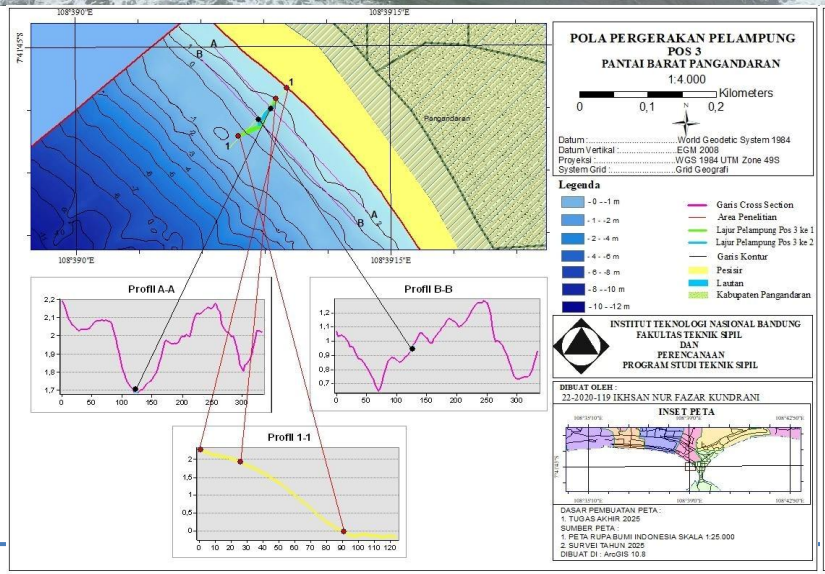


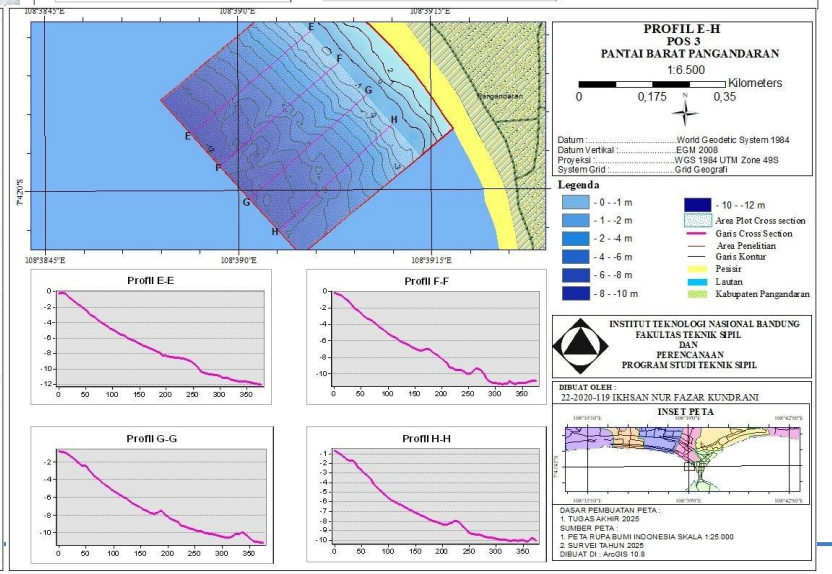




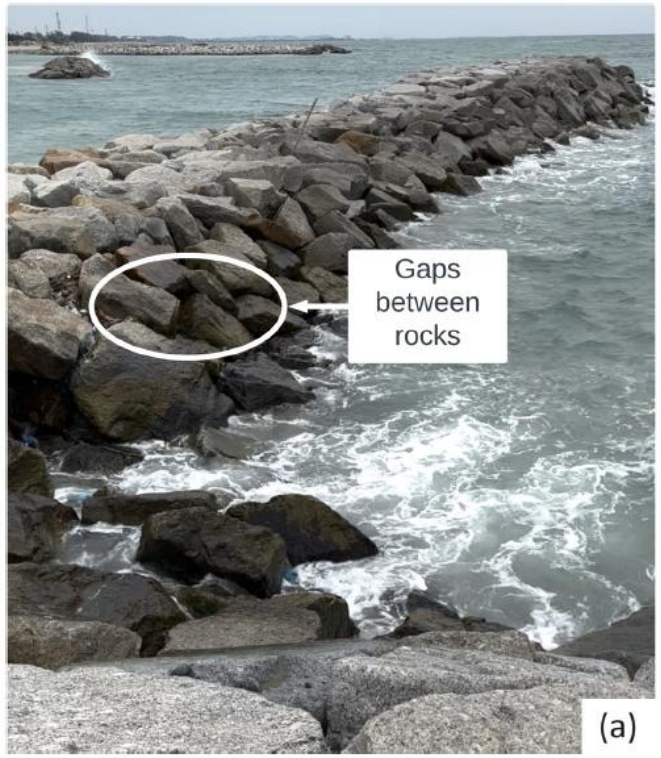


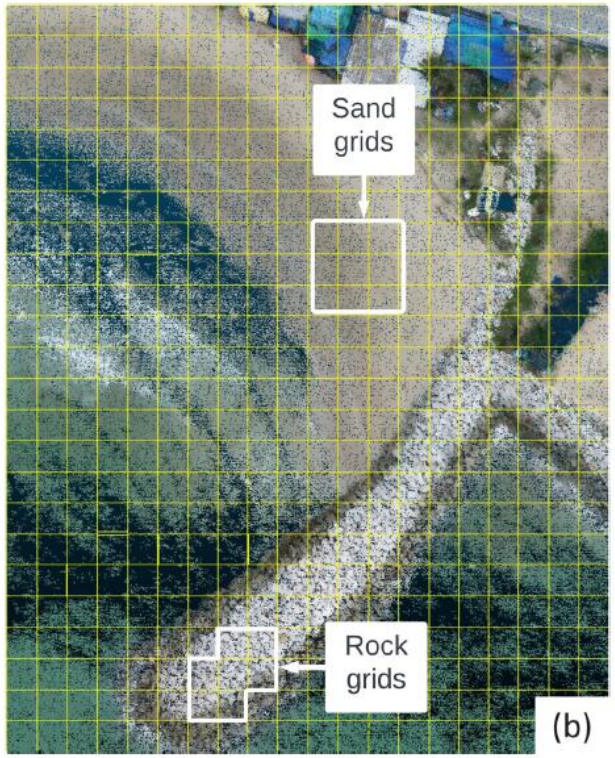
3D Model for bathy-metry and morphology profile





R&D results by NECTEC, TU, and BUU



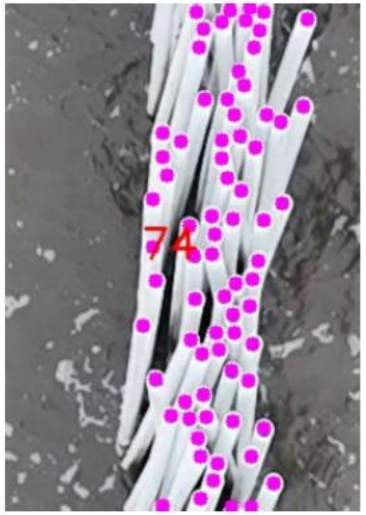


	Precision		Recall		F_1 score		Accuracy		Balanced Accuracy	
	v_1	v_2	v_1	v_2	v_1	v_2	v_1	v_2	v_1	v_2
Decision Tree	**98.25**	95.66	**98.18**	95.71	**98.20**	95.66	**98.21**	95.67	**98.21**	95.68
SVM	97.27	**100.00**	**99.20**	93.17	**98.22**	96.45	**98.21**	96.59	**98.20**	96.59
Logistic Regression	97.27	**100.00**	**99.20**	93.17	**98.22**	96.45	**98.21**	96.59	**98.20**	96.59

Detect fake coastal change in rocky area from point cloud data

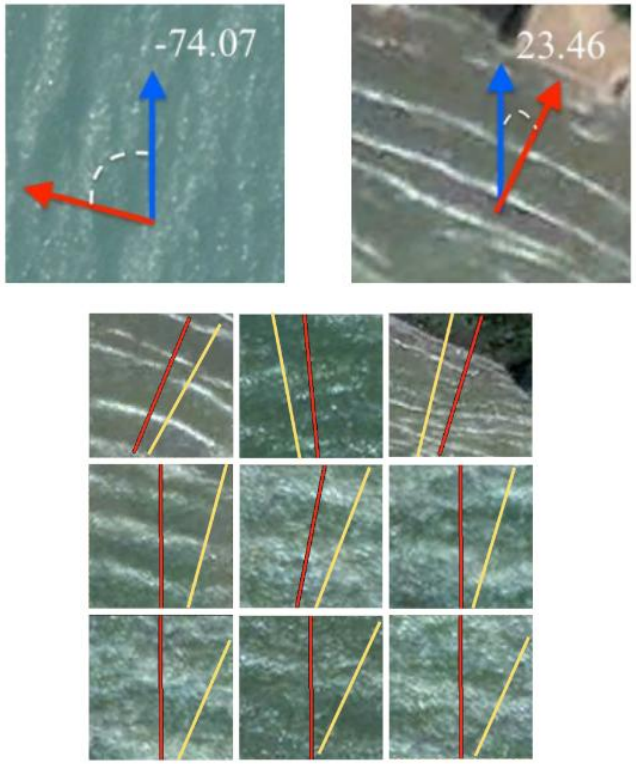
Sand fence monitoring: count the remaining bamboo rods

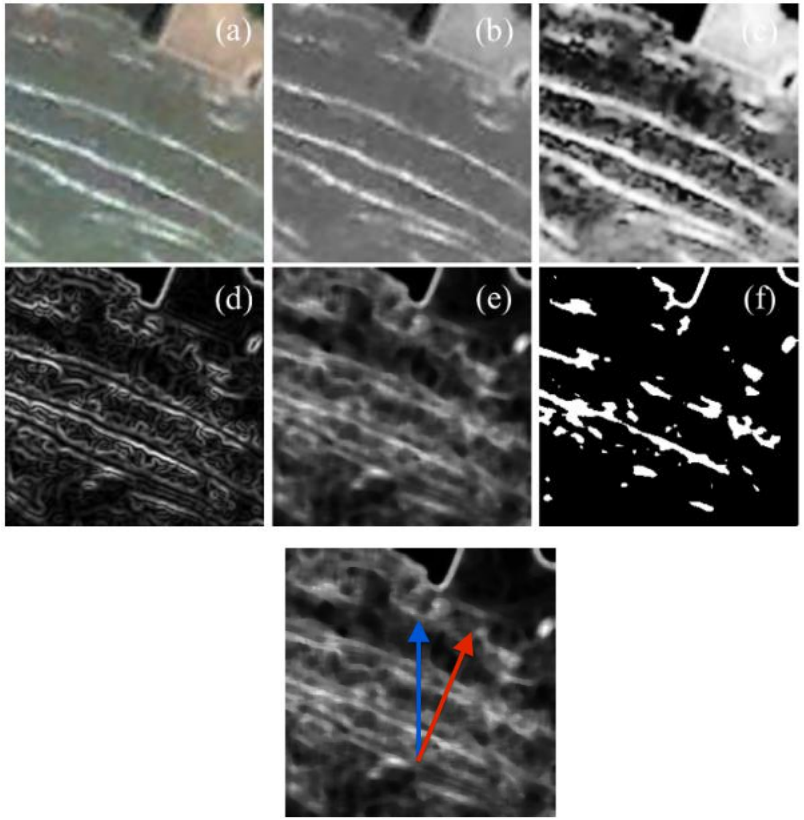
Metric	180 px	360 px	520 px
Ground Truth Count	22,232	22,214	22,186
AI Predicted Count	21,925	22,671	22,486
Absolute Difference (%)	2.60	2.18	1.54
Overcount Rate (%)	2.60	2.12	1.45
Missed Detection Rate (%)	1.99	0.06	0.09



R&D results by NECTEC and BUU

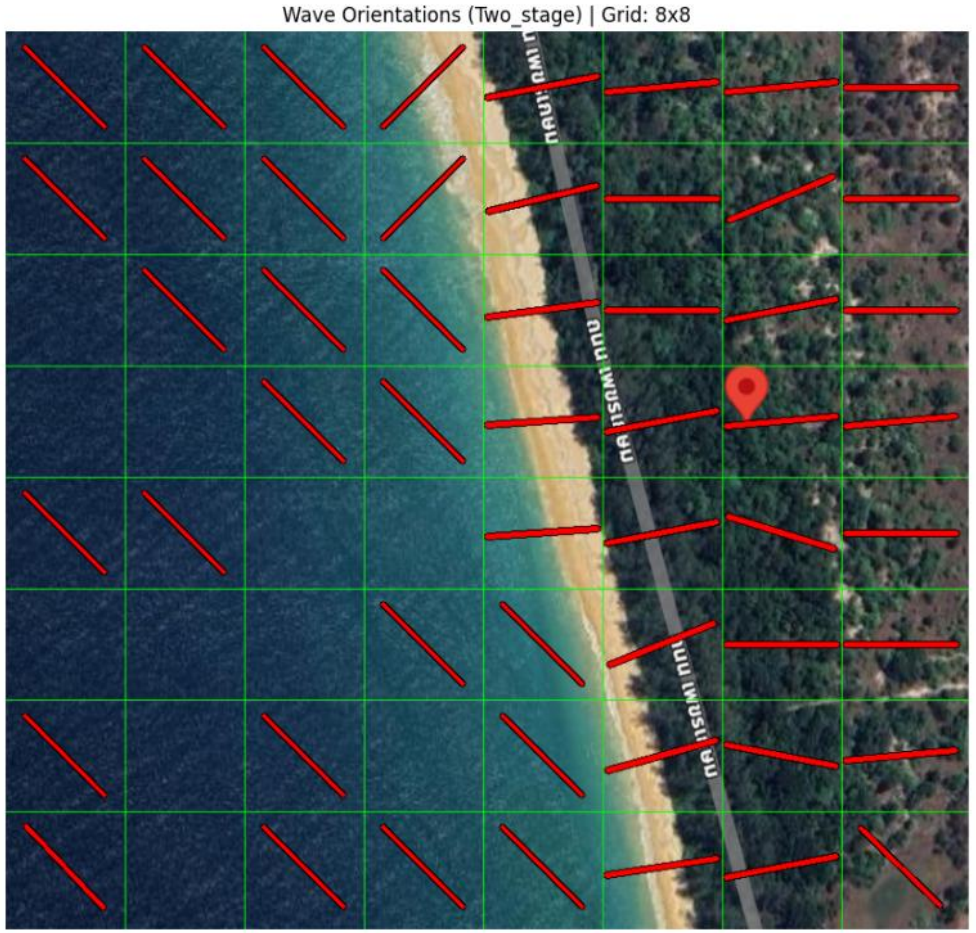
Wave Direction Estimation





	Standard	Two-Stage	Interpolation
MAE (°)	13.23	12.96	12.95
RMSE (°)	15.63	15.24	15.22
Within ±10° (%)	37.72	39.21	38.96
Within ±20° (%)	79.65	81.39	81.14
Within ±30° (%)	96.77	97.27	97.27

Model	MAE (°)	RMSE (°)	Accuracy within ±15° (%)	Small Flips
No median filter	22.07	28.15	40.40	30
Median filter with $k = 5$	**9.54**	**11.02**	**80.90**	**52**
Median filter with $k = 7$	9.57	11.04	79.70	55
Median filter with $k = 9$	9.71	11.19	77.40	53



Ocean and forest classification is required.

R&D results by NECTEC

Adaptive Sampling Approach Using Signal Variance-Based Method for Coastal Wave Analysis

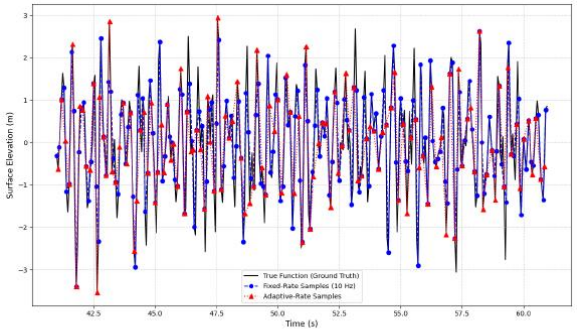


Fig. 3. Comparison of Sampling Methods on Synthetic Wave Signal.

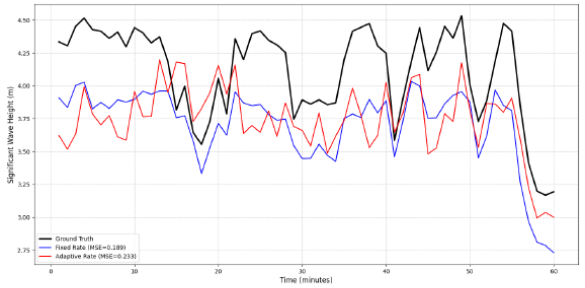
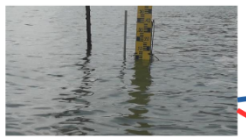


Fig. 4. Significant Wave Height (H_s) Comparison Over Time

TABLE I
PERFORMANCE COMPARISON OF SAMPLING METHODS

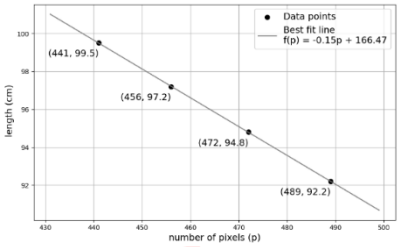
Performance Metric	Fixed (10 Hz)	Adaptive (2–10 Hz)
Total Samples Collected	36,000	19,654
Data Reduction vs. Fixed	–	45.4%
MSE of H_s $[\mathrm{m}^2]$	0.0194	0.0248
MSE of f_{dom} [Hz]	0.0039	0.0051

Water Surface Level Estimation Based on the Fast Segment Anything Model for Coastal Monitoring Systems

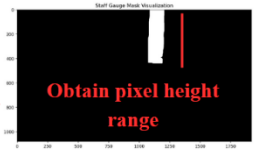


4 Random Frames from the video

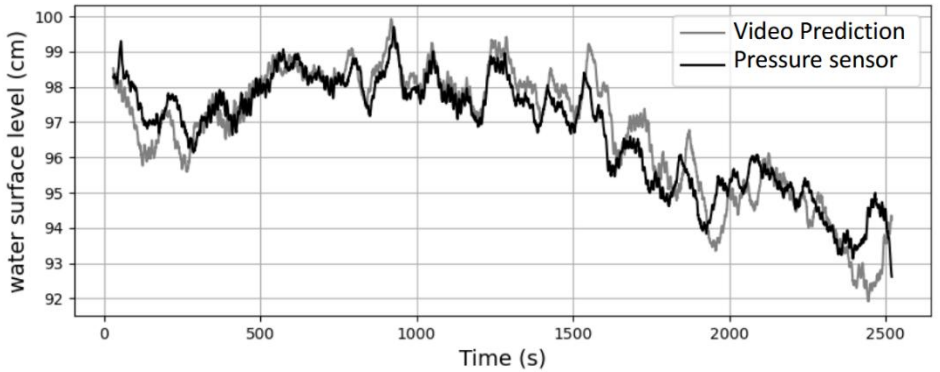
Manual Observation



FastSAM



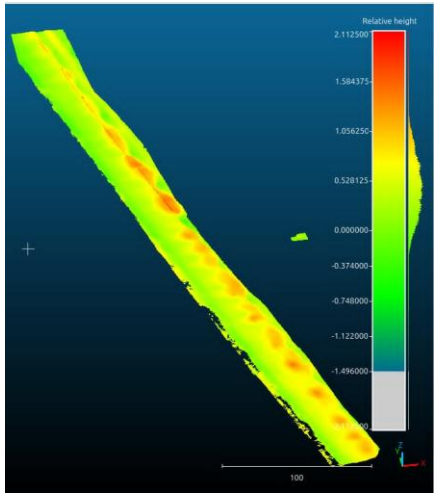
Mask obtain through a point prompted FastSAM

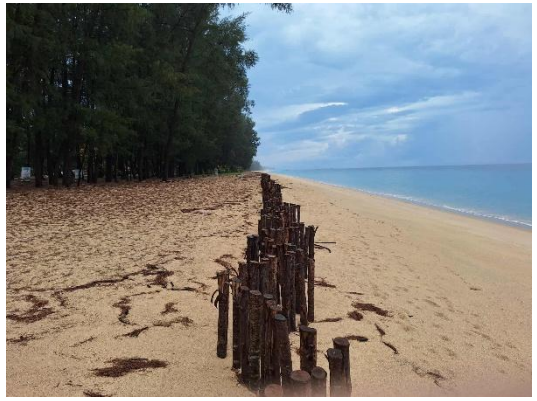


linear correlation = 0.92

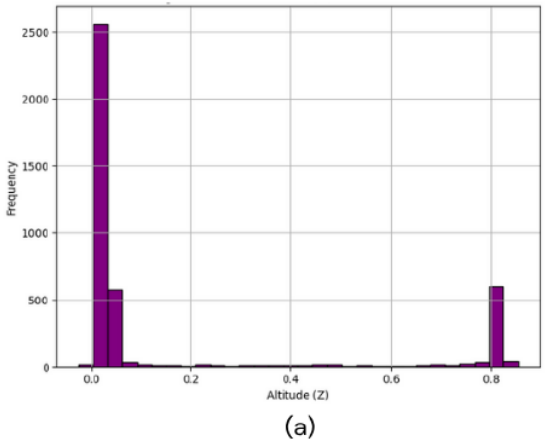
RMSE = 1.0 cm

R&D results by NECTEC and CADT

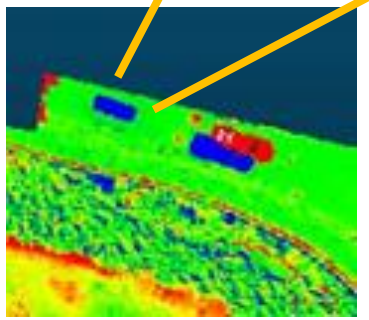


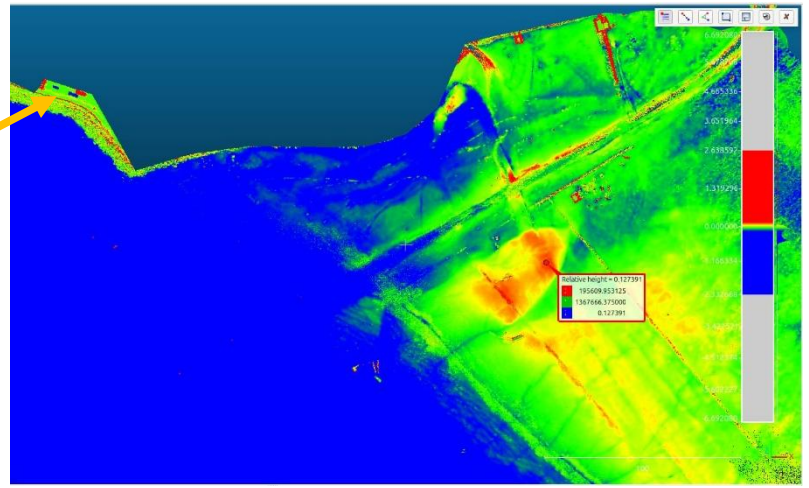


Study of beach volume change estimation using 3D point cloud data.



(a)





Scientific Contribution : Conferences

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1	Utilizing a Classification Tree for Rocky Terrain Detection in 3D Point Clouds for Coastal Erosion Studies	Pasut Insung, Peerapat Supasri, Phattarakorn Limsuwat, Setthanan Thitathanapat, Akkharawoot Takhom, Kasorn Galajit, Surasak Boonkla, Jessada Karnjana	TU, NECTEC	Society of Instrument and Control Engineers (SICE)	30 Aug. 2024	Kochi, Japan
2	Wave Direction Estimation from Optical Satellite Imagery Using Multi-Stage Gabor Filter	Waranrach Viriyavit, Komate Amphawan, Chanyut Lisawat, Kittipisut Chansri, Somrudee Deepaisarn, Paweena Kanokhong, Chakapat Chokchaisiri, Woramet Simrum, Akkharawoot Takhom, Phutphalla Kong, Didin Agustian Permadi, Sharifah Hafizah Syed Ariffin, Surasak Boonkla, Kasorn Galajit, and Jessada Karnjana	BUU, SIIT, TU, UTM, ITENAS, NECTEC	The 16th International Conference on ICT Convergence (ICTC 2025)	14 – 17 Oct. 2025	Jeju Island, South Korea
3	Adaptive Sampling Approach Using Signal Variance-Based Method for Energy-Efficient Wireless Sensor Networks in Coastal Monitoring	Aung Kyaw Min, Bachu Chewang Pelden, Jessada Karnjana, Kasorn Galajit and Surasak Boonkla	SIIT, NECTEC	The 20th International Joint Symposium on Artificial Intelligence and Natural Language Processing (*iSAI-NLP 2025*)	12-14 Nov. 2025	Phuket, Thailand
4	Wave Direction Estimation Based on Local Gradient Techniques from Satellite Imagery for Coastal Dynamics Monitoring	Woramet Simrum, Paweena Kanokhong, Chakapat Chokchaisiri, Somrudee Deepaisarn, Kittipisut Chansri, Chanyutt Lisawat, Waranrach Viriyavit, Akkharawoot Takhom, Phutphalla Kong, Didin Agustian Permadi, Sharifah Hafizah Syed Ariffin, Surasak Boonkla, Kasorn Galajit, and Jessada Karnjana	SIIT, BUU, TU, ITENAS, UTM, NECTEC	The 17th Asian Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA 2025)	22 – 24 Oct. 2025	Shangri-la, Singapore

Scientific Contribution : Conferences

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
5	YOLOv11-Enhanced Detection of Bamboo in Shoreline Protection Fences	Kasorn Galajit, Titirat Dadngam, Atibodee Chuenmee, Waranrach Viriyavit, Supawadee Srikamdee, Chatchanan Khamtonwong, Somrudee Deepaisarn, Akkharawoot Takhom, Phutphalla Kong, Didin Agustian Permadi, Sharifah Hafizah Syed Ariffin, Apaporn Siripornprasarn, Supachai Soongying, Surasak Boonkla and Jessada Karnjana	NECTEC, BUU, SIIT, TU, ITENAS, CADT, department of marine and coastal resources (DMCR)	The 20th International Joint Symposium on Artificial Intelligence and Natural Language Processing (*iSAI-NLP 2025*)	12-14 Nov. 2025	Phuket, Thailand
6	Water Surface Level Estimation Based on the Fast Segment Anything Model for Coastal Monitoring Systems	Julathit Chetsawang, Kaweewat Sricharoenchit, Krittapak Jairak, Warit Yuvaniyama, Peeravich Teerapatanapan, Kittin Traisiwakul, Tawin Supmahaudom, Akkharawoot Takhom, Phutphalla Kong, Didin Agustian Permadi, Sharifah Hafizah Syed Ariffin, Kasorn Galajit, Surasak Boonkla & Jessada Karnjana	SIIT, TU, CADT, ITENAS, UTM, NECTEC	Integrated Uncertainty in Knowledge Modelling and Decision Making (IUKM 2025)	17-19 Mar. 2025	Ho Chi Minh City, Vietnam

Contribution to academic society

- 3D point cloud and orthogonal images datasets for coastal volume change estimation.
- Two internship students from CADT
- Water quality data for coral breaching study.

Contribution to human society

- Mitigate coastal erosion by installing sand fence.
- Provide public information of water quality for travel (diving).

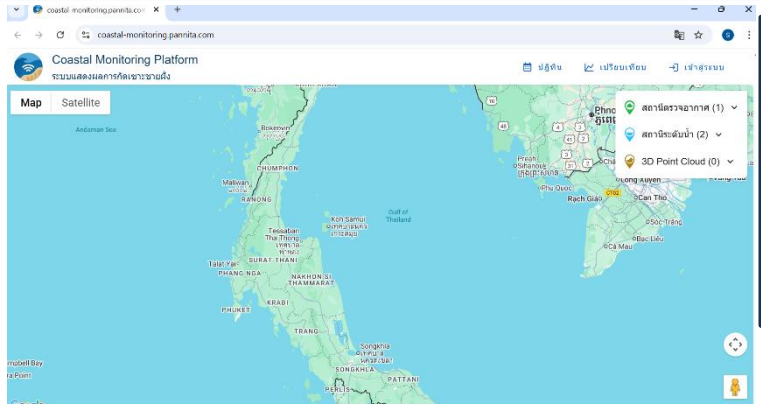
Conclusion:

- 3D point cloud and orthogonal images datasets for coastal volume change estimation.
  - 2 time series of 3D point cloud data, 16 km along the testing site.
  - 12 time series of 3D point cloud data in Chanthaburi province, Thailand
  - Two internship students from CADT are processing the data.
  - A software for preprocessing by TU
- Water quality data for coral breaching study data center by NECTEC and DMCR.
  - Saltation
  - Clearness, transparency
  - Temperature surface and under water temperature
- Sand fences for coastal erosion mitigation by DMCR
- Wave direction estimation method by BUU and NECTEC.
  - To study the effect of wave direction to coastal erosion
- Wave height estimation method NECTEC and SIIT
  - To estimate the efficiency of the break water.
- Shoreline change, rip current, and beach profile studies by ITENAS

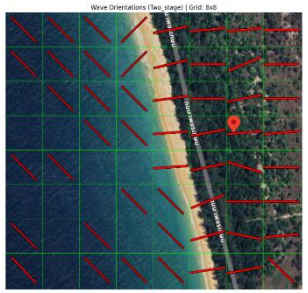
Future works: The Coastal Erosion Monitoring Platform

Integrate techniques for coastal monitoring. More considerations on

- Data sources, Data pre-processing
- Data storage (centric or distributed)



Web page



Satellite

Big data

Images

[Citizen science]

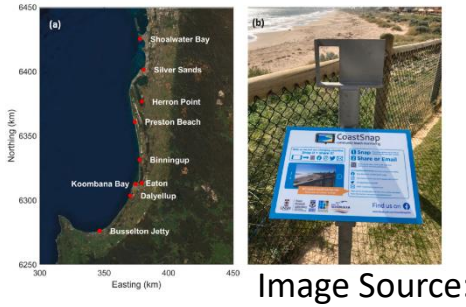
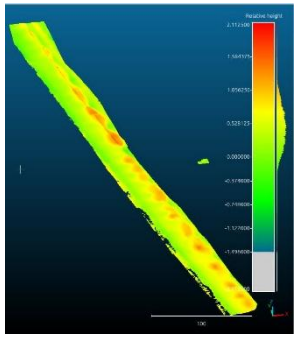


Image Source: coastsnap project

Pre-processing

(Manual or semi)

Server + Auto Processing



LiDAR

[Citizen science]

Raw data is too large.

DEM, DSM, and DTM are smaller.

Sensor nodes

- Temperature
- Humidity
- Wind direction
- Etc.

Big data analytics, time series data

- Wave, wind direction
- Wave height
- Temperature, humidity, etc.
- 3D point cloud