A Preliminary Investigation on Effects of the Indian Ocean tsunami on Coastal Morphology of Indrapurwa Settlement of Aceh Besar, Indonesia

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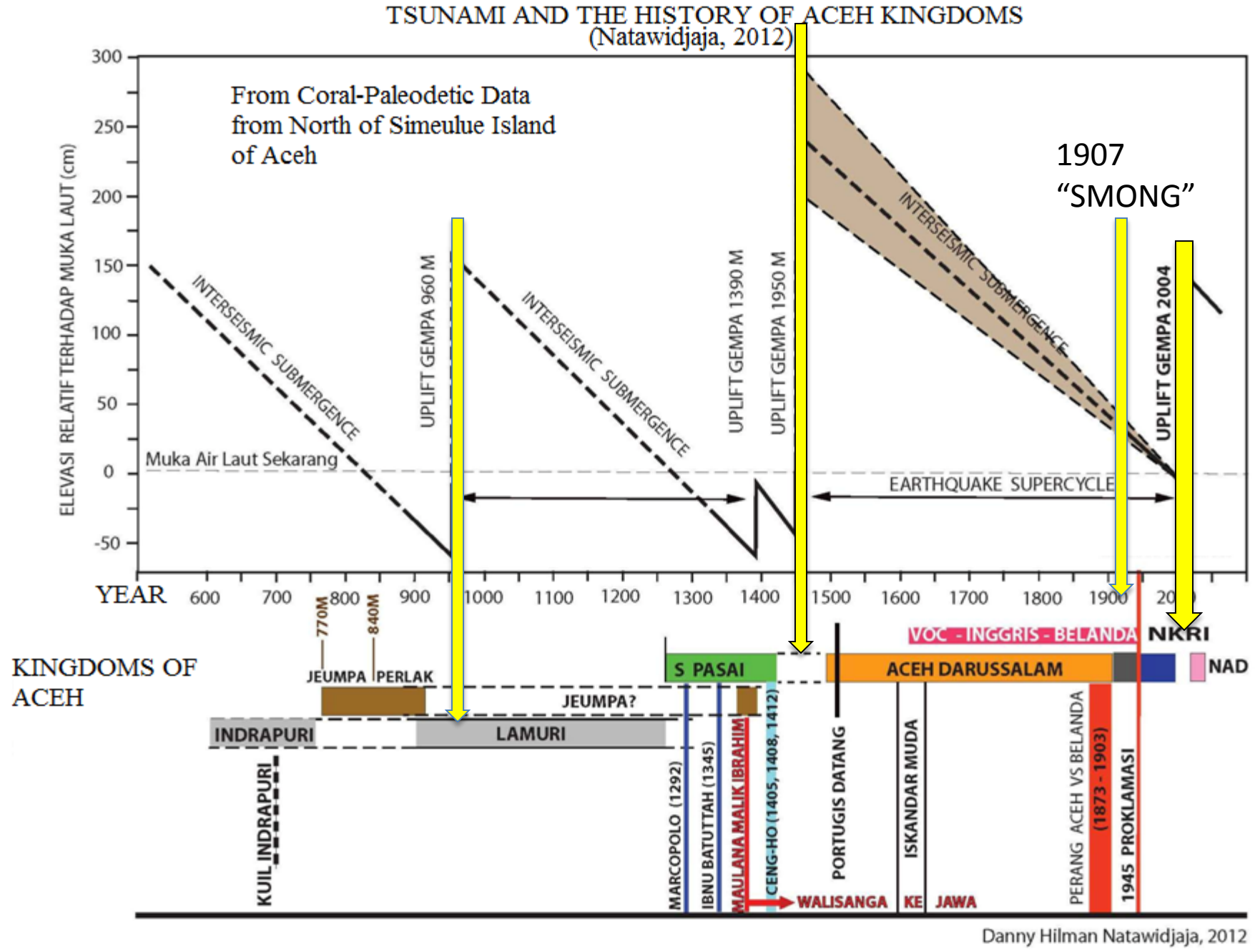
Background

- A series of tsunamis are believed to attack the Ujong Pancu Coast of Aceh Besar, which is located about 10 km to the west of Banda Aceh. The coast was a place where an old Hindu settlement of Indrapurwa situated around 960 AC.

- The tsunamis, there were 960 AC, 1390 AC, and 1450 AC struck this area forcing the settlement to move move to other area for temporary.

- However, it seems that the community keep return to this area and lesson learned from the previous tsunami did not pass to the next generation.


TSUNAMI AND THE HISTORY OF ACEH KINGDOMS
(Natawidjaja, 2012)
From Coral-Paleodetic Data
from North of Simeulue Island
of Aceh
1907
"SMONG"
ELEVASI RELATIF TERHADAP MUKA LAUT (cm)
300
250
200
150
100
50
0
-50
Muka Air Laut Sekarang
INTERSEISMIC SUBMERGENCE
UPLIFT GEMPA 960 M
INTERSEISMIC SUBMERGENCE
UPLIFT GEMPA 1390 M
UPLIFT GEMPA 1950 M
INTERSEISMIC SUBMERGENCE
UPLIFT GEMPA 2004
EARTHQUAKE SUPERCYCLE
YEAR
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
770M
840M
KINGDOMS OF
ACEH
JEUMPA
PERLAK
JEUMPA?
INDRAPURI
LAMURI
KUIL INDRAPURI
S PASAI
VOC - INGGRIS - BELANDA
NKRI
ACEH DARUSSALAM
NAD
MARCOPOLO (1292)
IBNU BATUTTAH (1345)
MAULANA MALIK IBRAHIM
CENG-HO (1405, 1408, 1412)
PORTUGIS DATANG
ISKANDAR MUDA
WALISANGA
KE
JAWA
PERANG ACEH VS BELANDA
(1873 - 1903)
1945 PROKLAMASI
Danny Hilman Natawidjaja, 2012

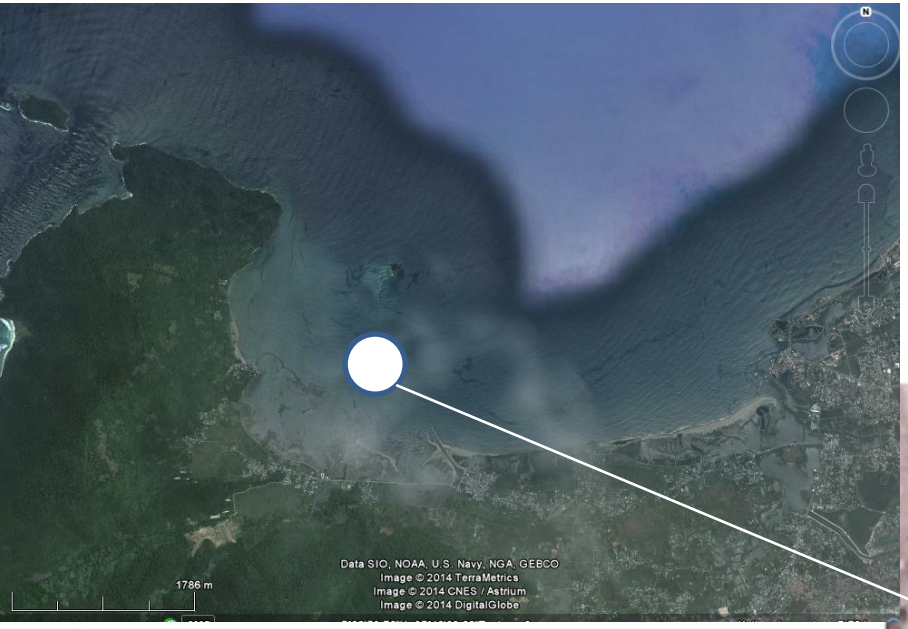
Some remains in the Indrapurwa Settlement

The history of Hindu Indrapurwa settlement

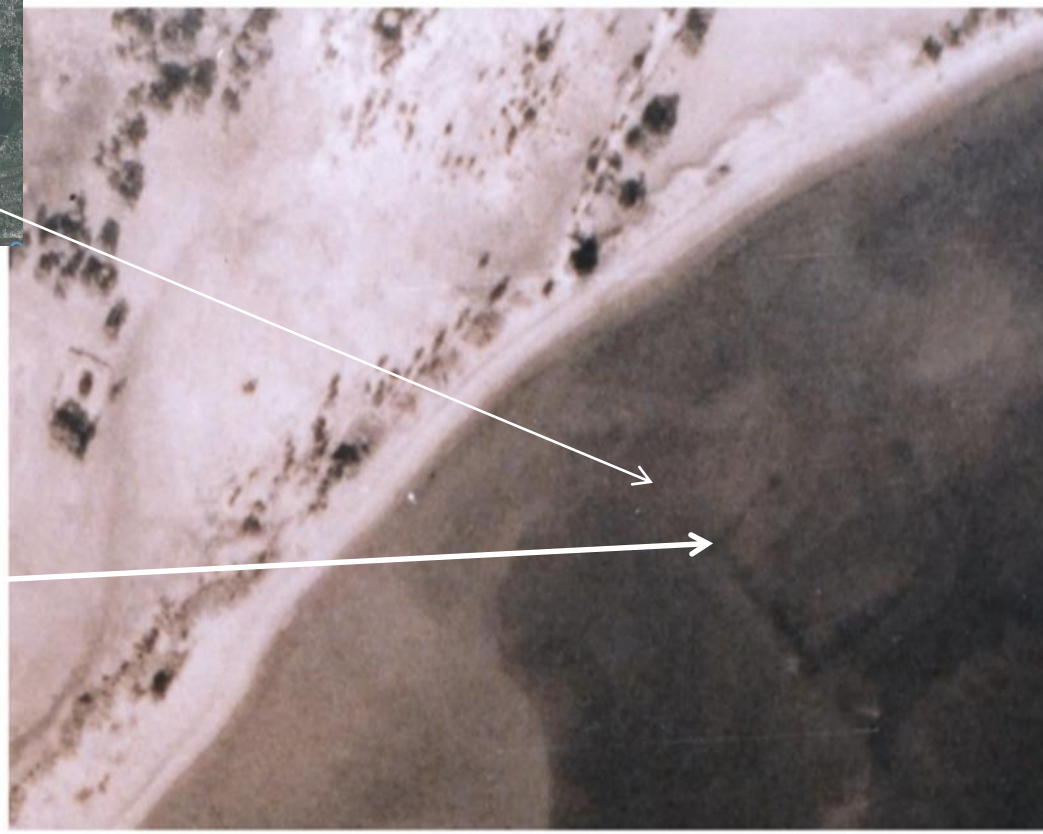
The Indrapurwa Mosque
(Photo from: paragraflepas.blogspot.com)

The explanation of the tsunami wave heights in 2004

Underwater Structures, presumed to be part of impact of previous tsunamis



(McKinnon, 2013)

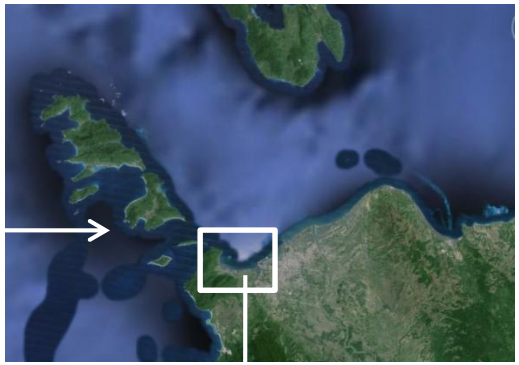


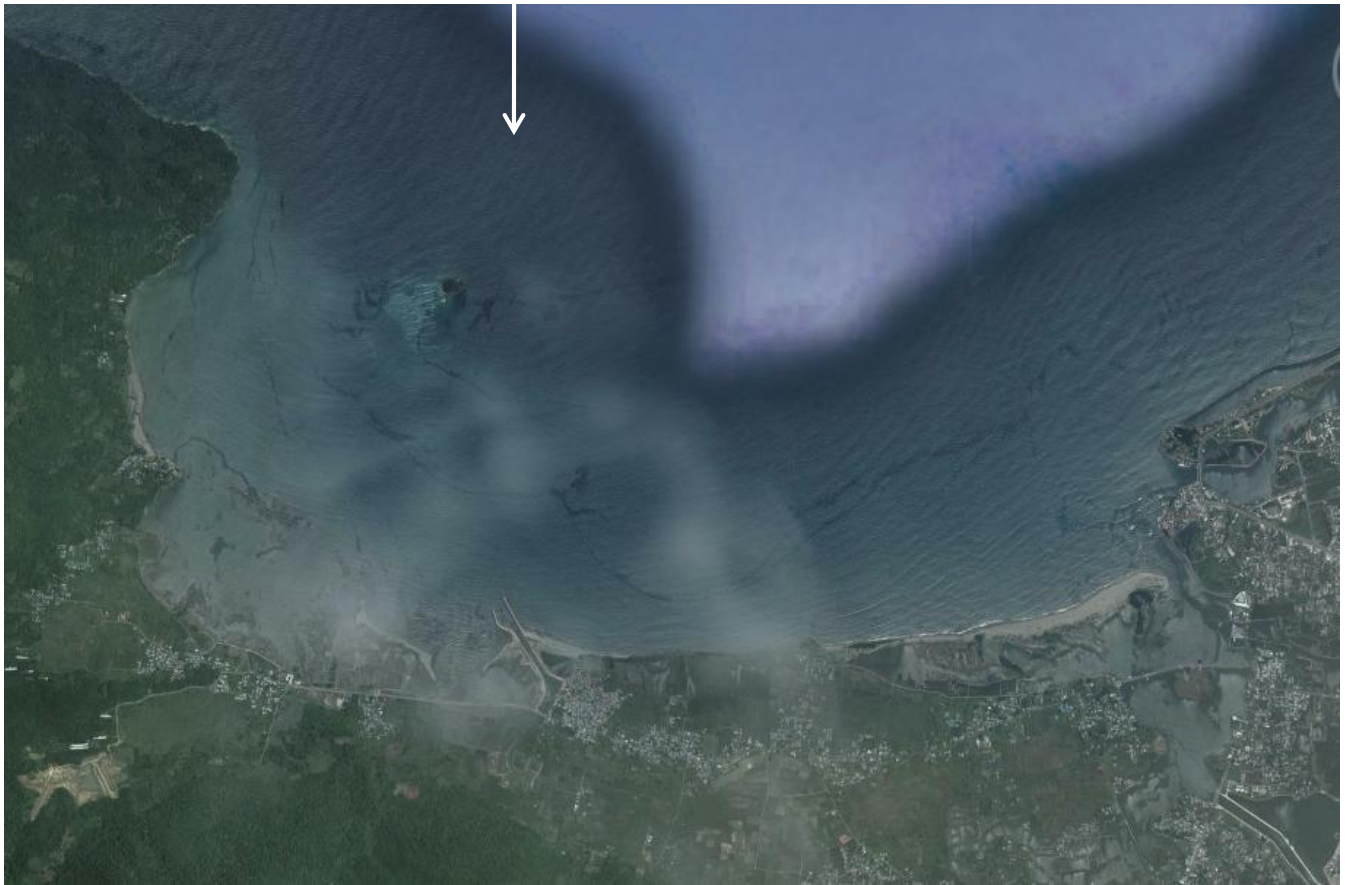
Objectives

- This study is aimed at investigating the effects of tsunamis to deform the coastal morphology that later drove the change of the settlement of Indrapurwa.

- To support information for setting-up the Indrapurwa area as part of tsunami heritages in Aceh.

Study Area



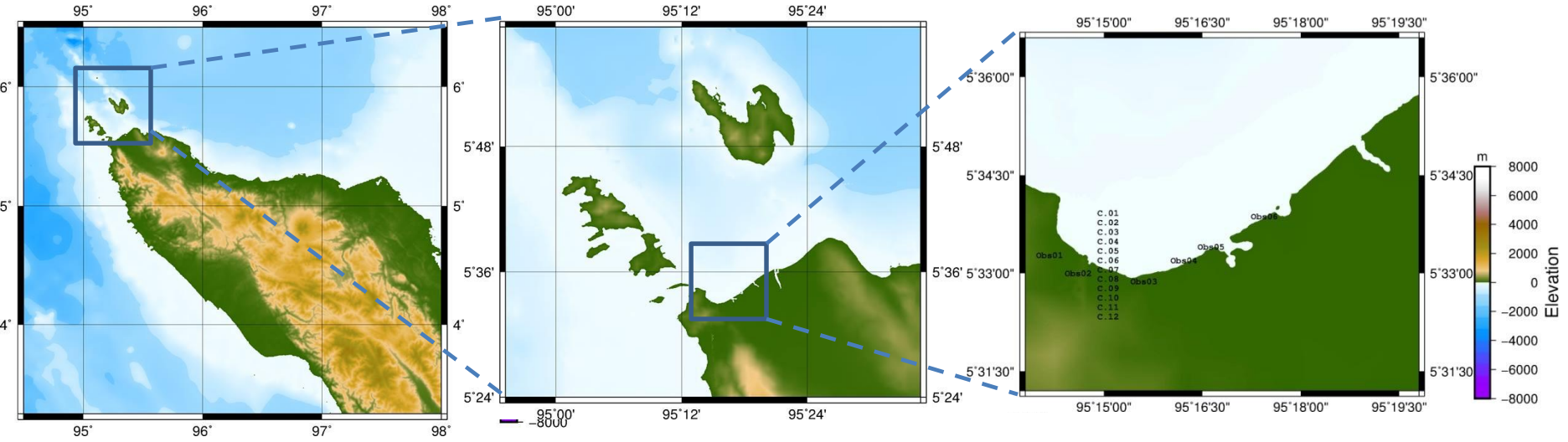


Methods

- This study was conducted in two methods, i.e.:
  - Analyzing a series of coastal morphology dynamic before and after tsunami;
  - Numerical simulations using COMCOT; rupture area was adopted using Romano (2008) fault mechanism scenario.

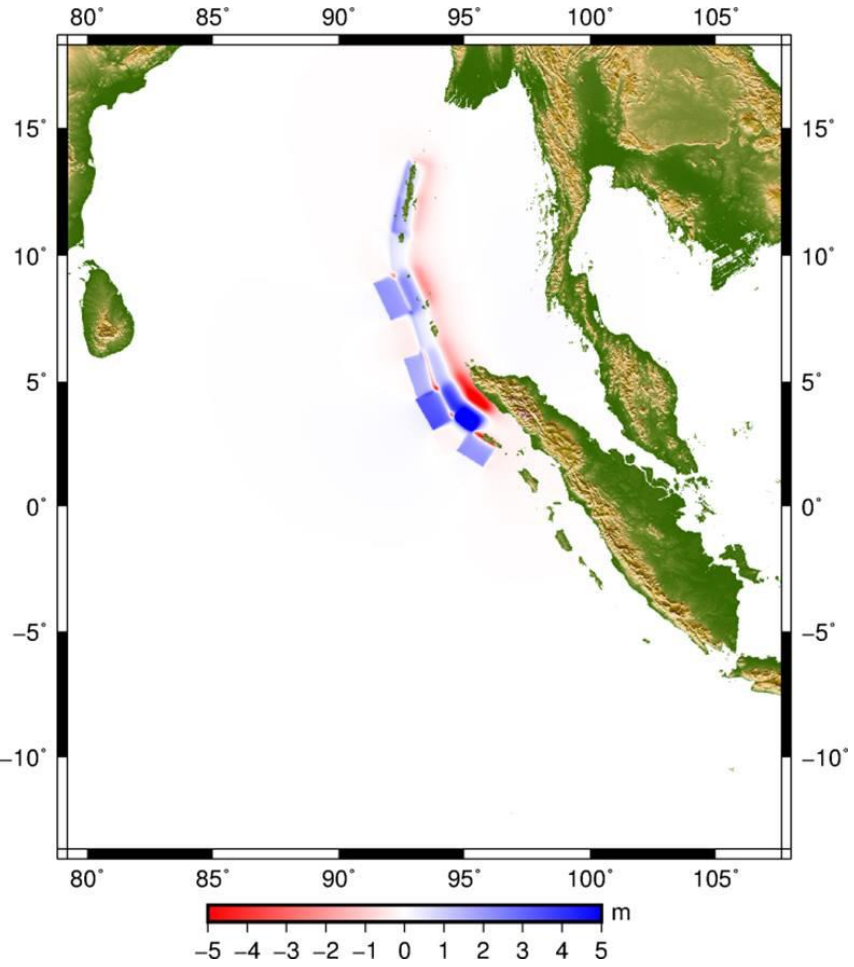
Domain for simulations

Layer Id	Extent of grid (geographic, WGS84)		Grid Spacing	Grid size	Coordinate System	Type of SWE
	Longitude	Latitude				
1	79.2-107.6	-13.6 - 18.1833	1 min 1851m	1705 x 1908	Spherical	Linear
2	94.61 - 97.79	3.41 - 6.29	0.2 min 370.2m	955 x 865	Spherical	Linear
3	94.91 - 95.57	5.412 - 5.978	0.04 min 74.04m	980 x 850	Spherical	Linear
4	95.23 - 95.329	5.52 - 5.639	0.008 min 14.808m	745 x 895	Spherical	Non-Linear

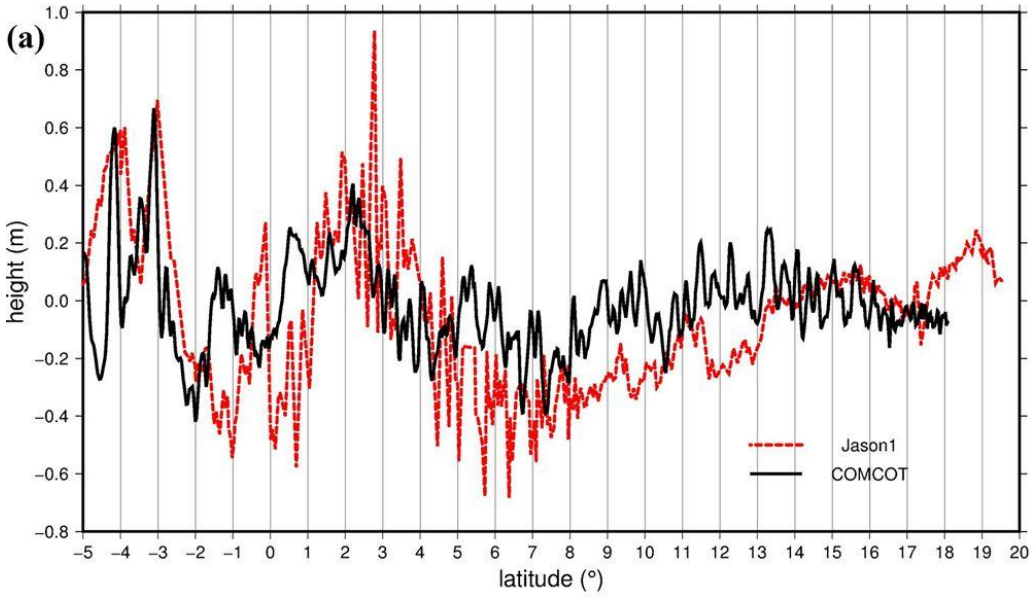


Layer 2 Layer 3 Layer 4

Results Validation

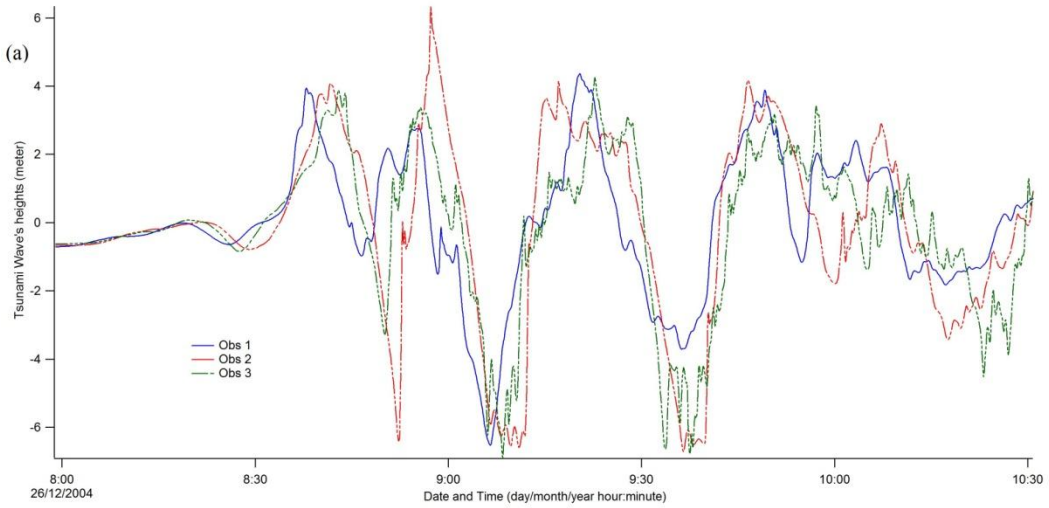


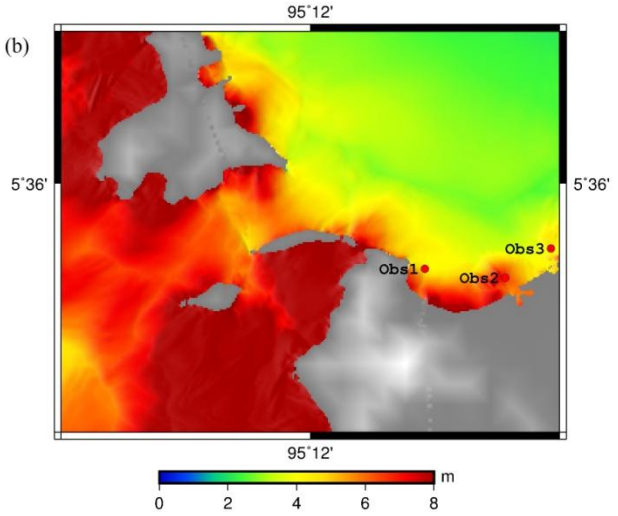
Initial Waves



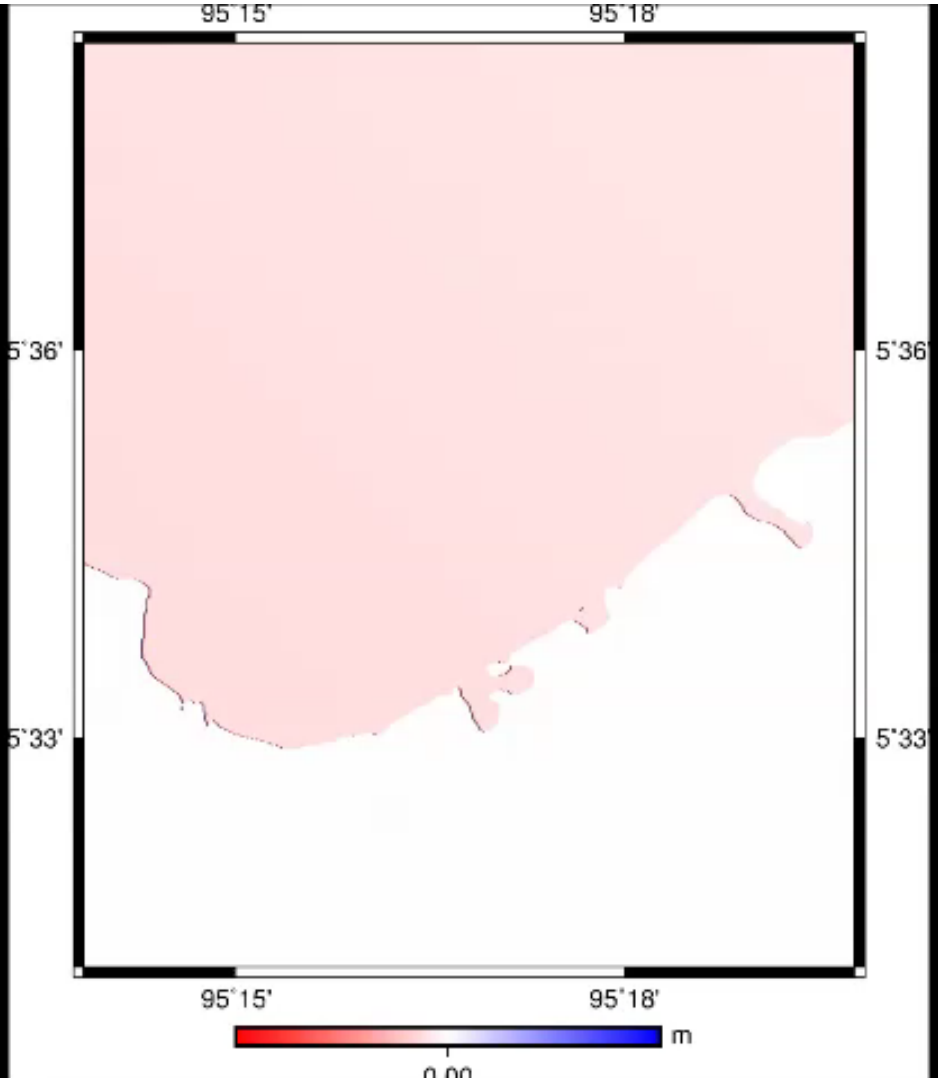
Validation of tsunami wave heights from Jason1

Tsunami wave heights around the near shore area

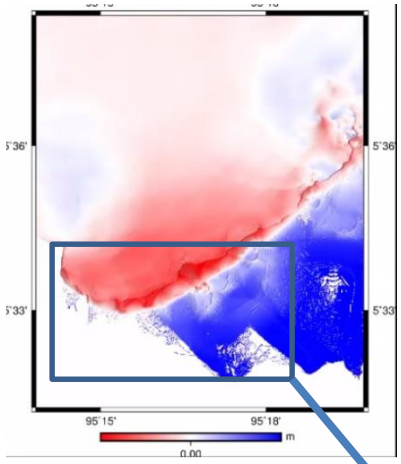


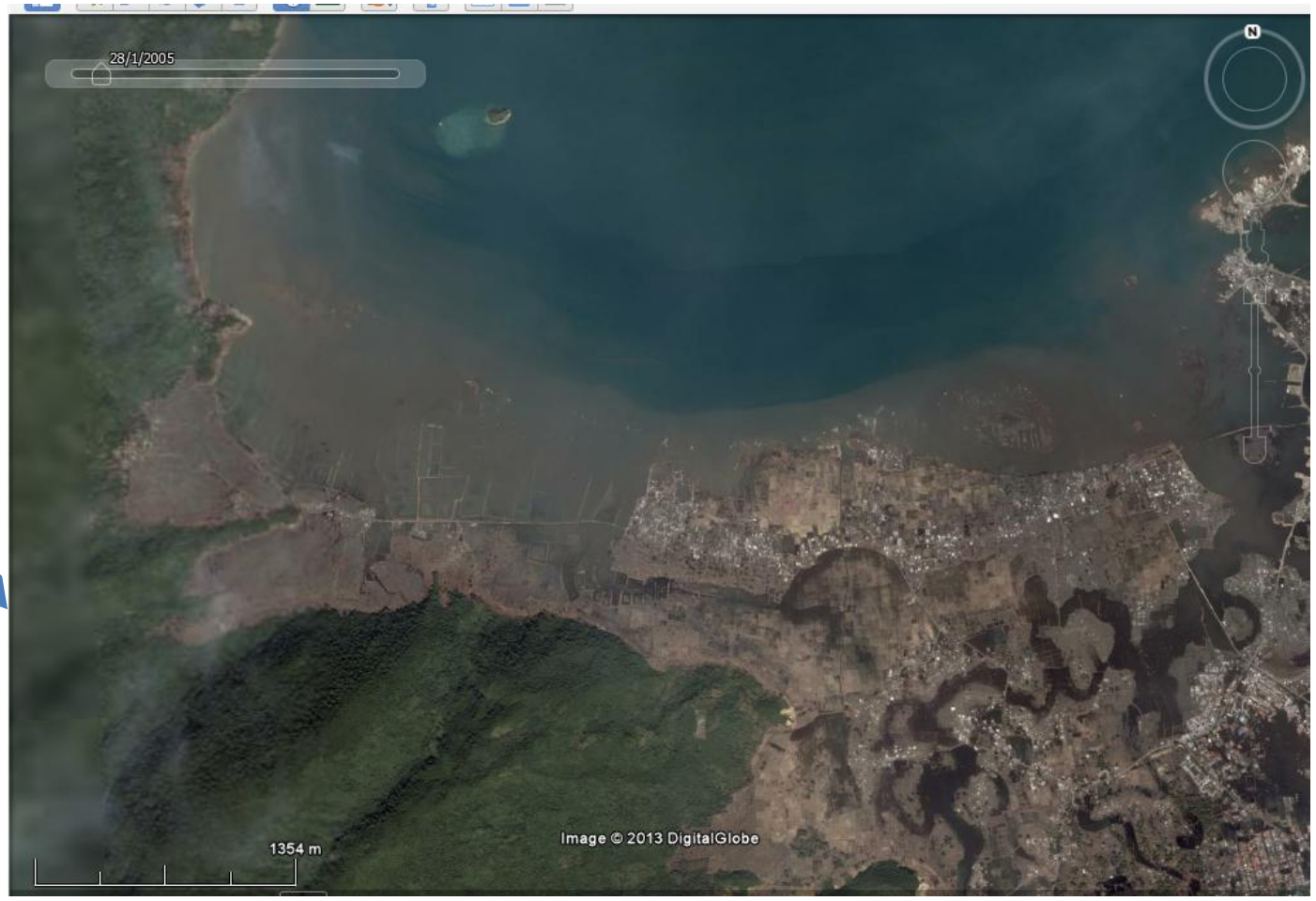


Tsunami Waves Propagation around the Indrapurwa



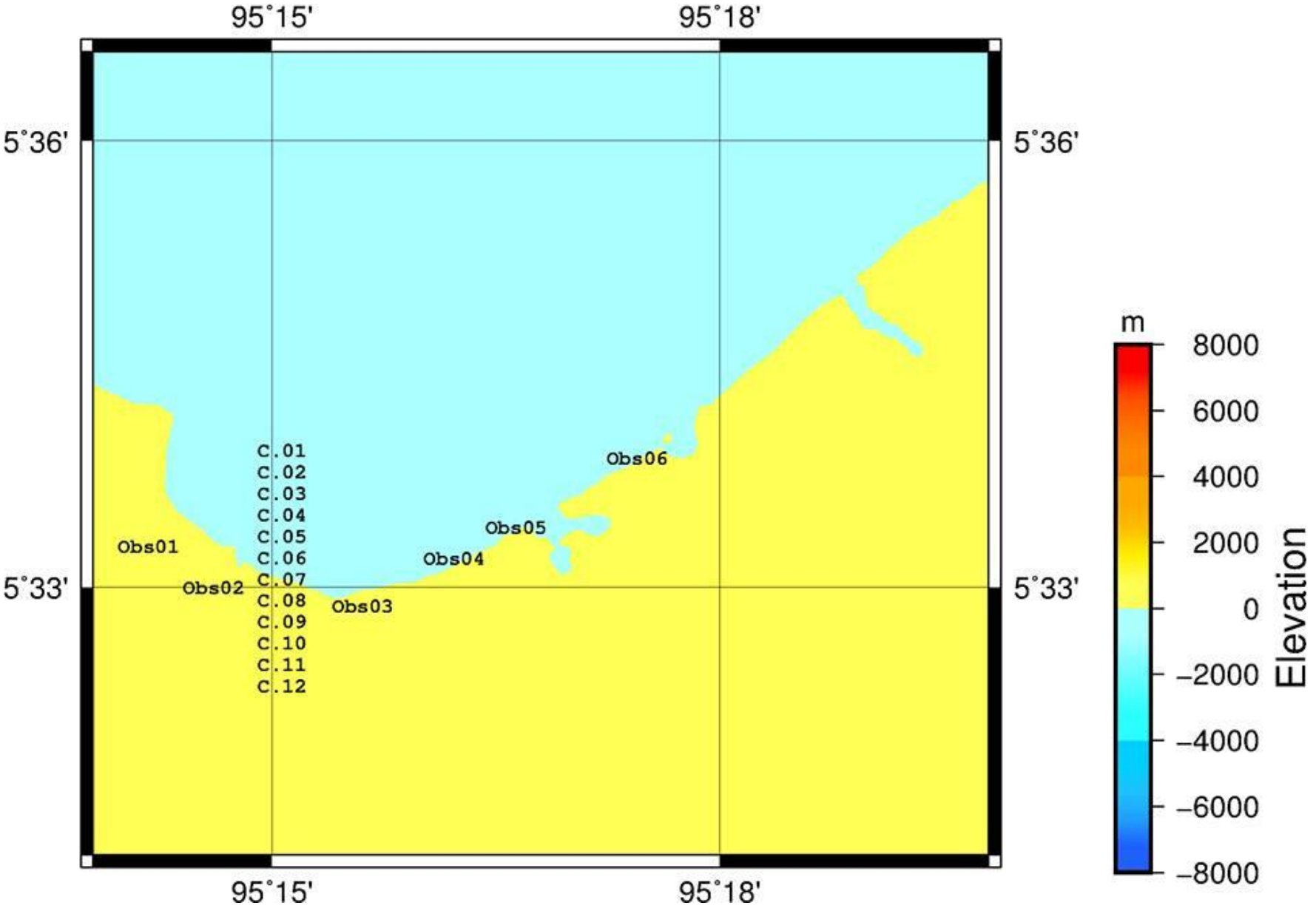
Inundation Area



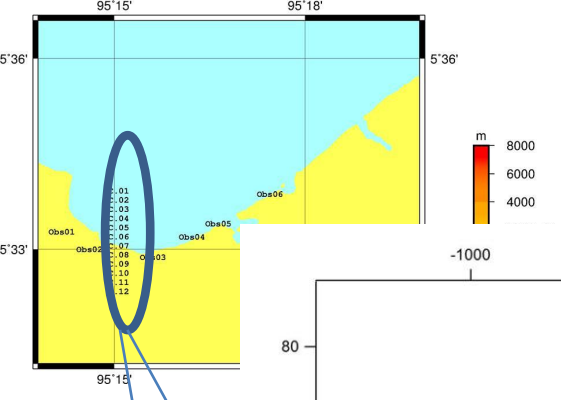


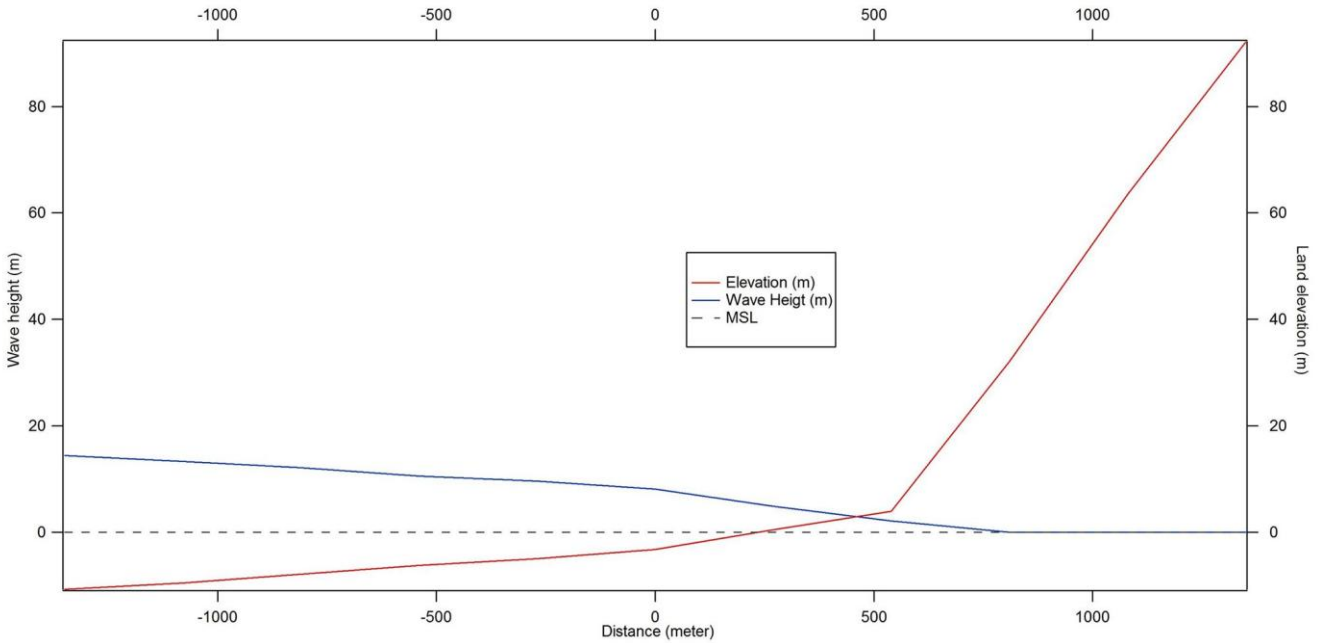
Aerial image of the area after the 2004 tsunami

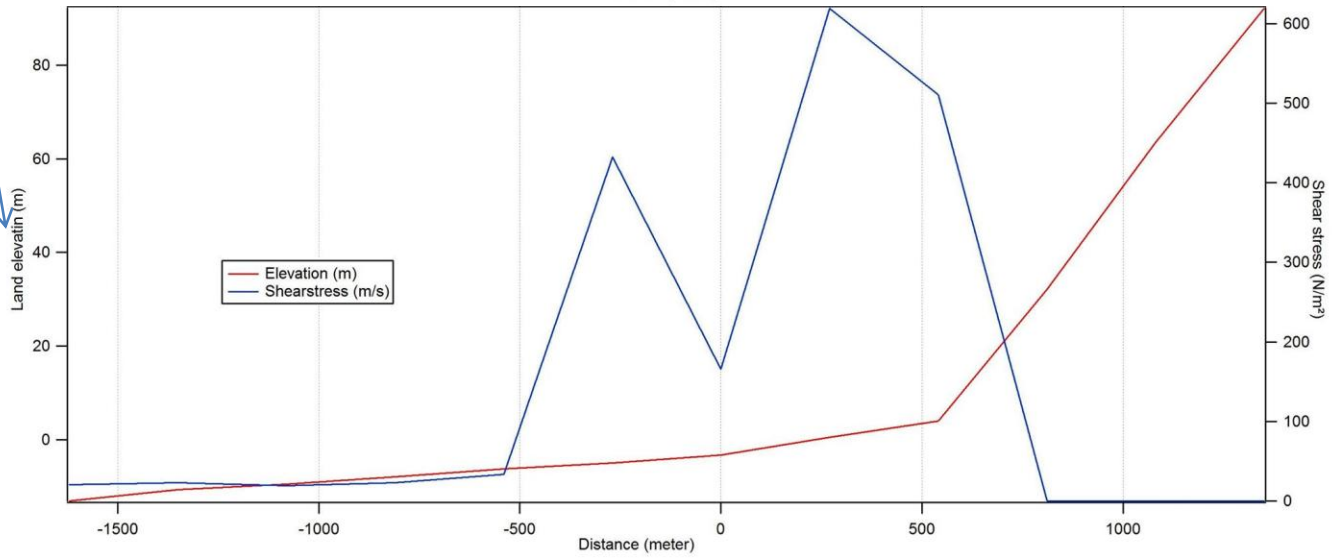
Numerical Observation Points



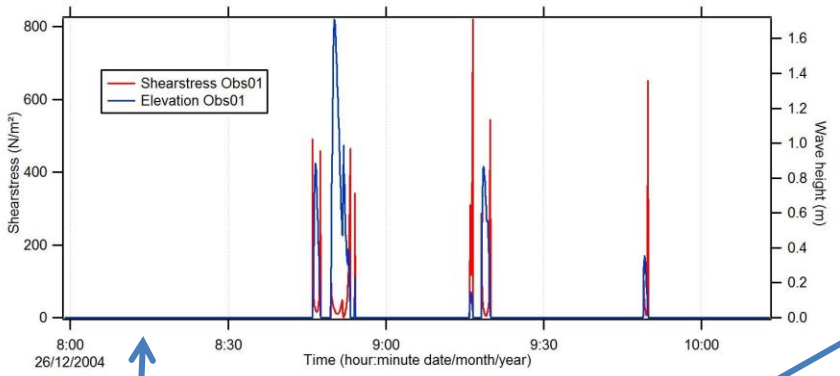
Tsunami Water Heights and Shear Stress

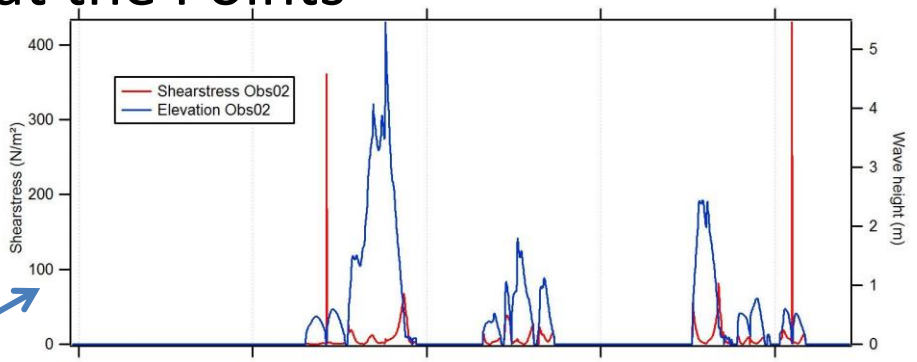


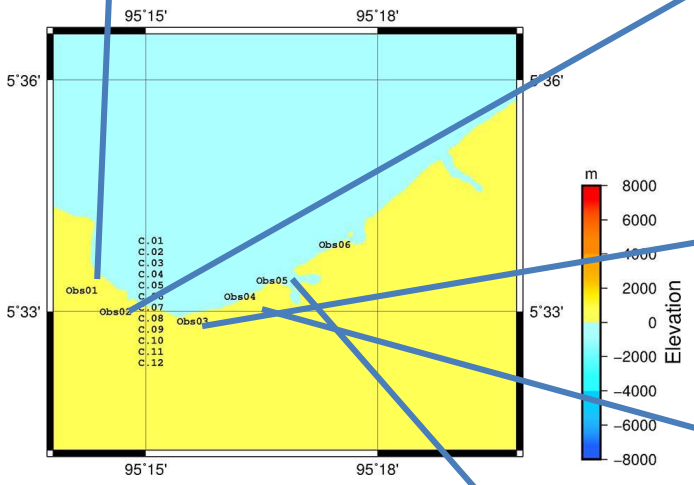


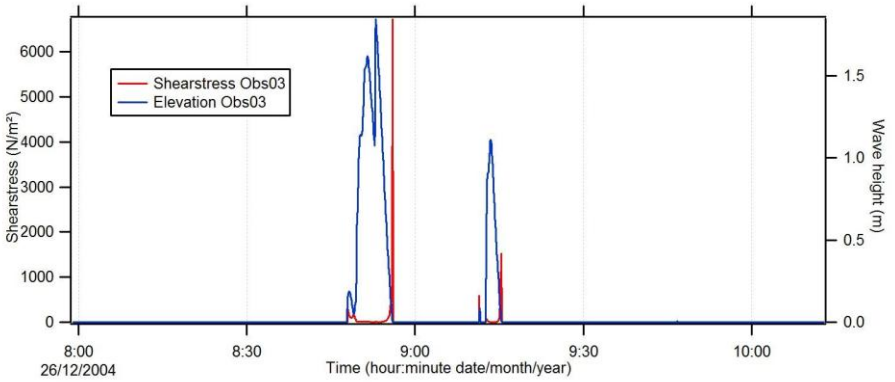


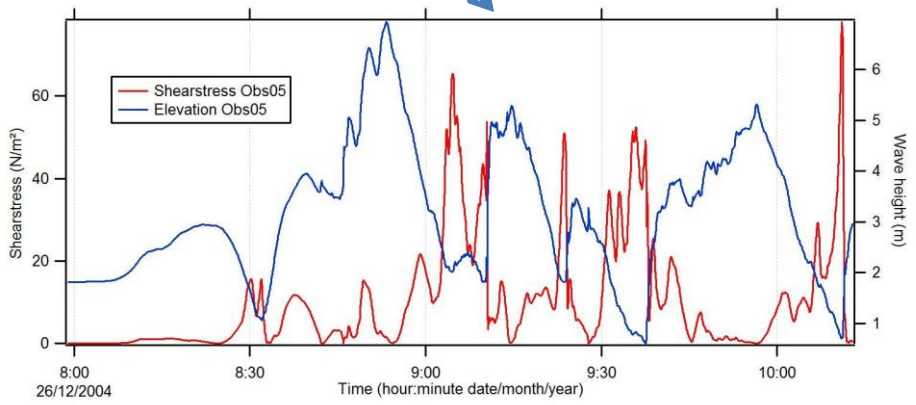
Shear Stresses at the Points

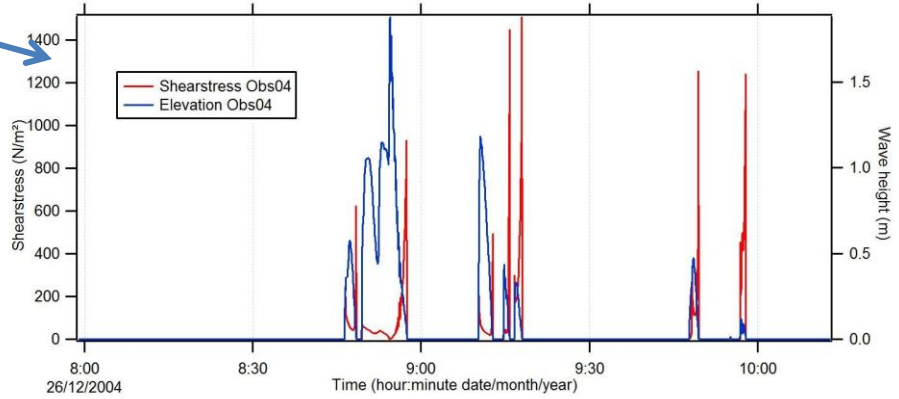




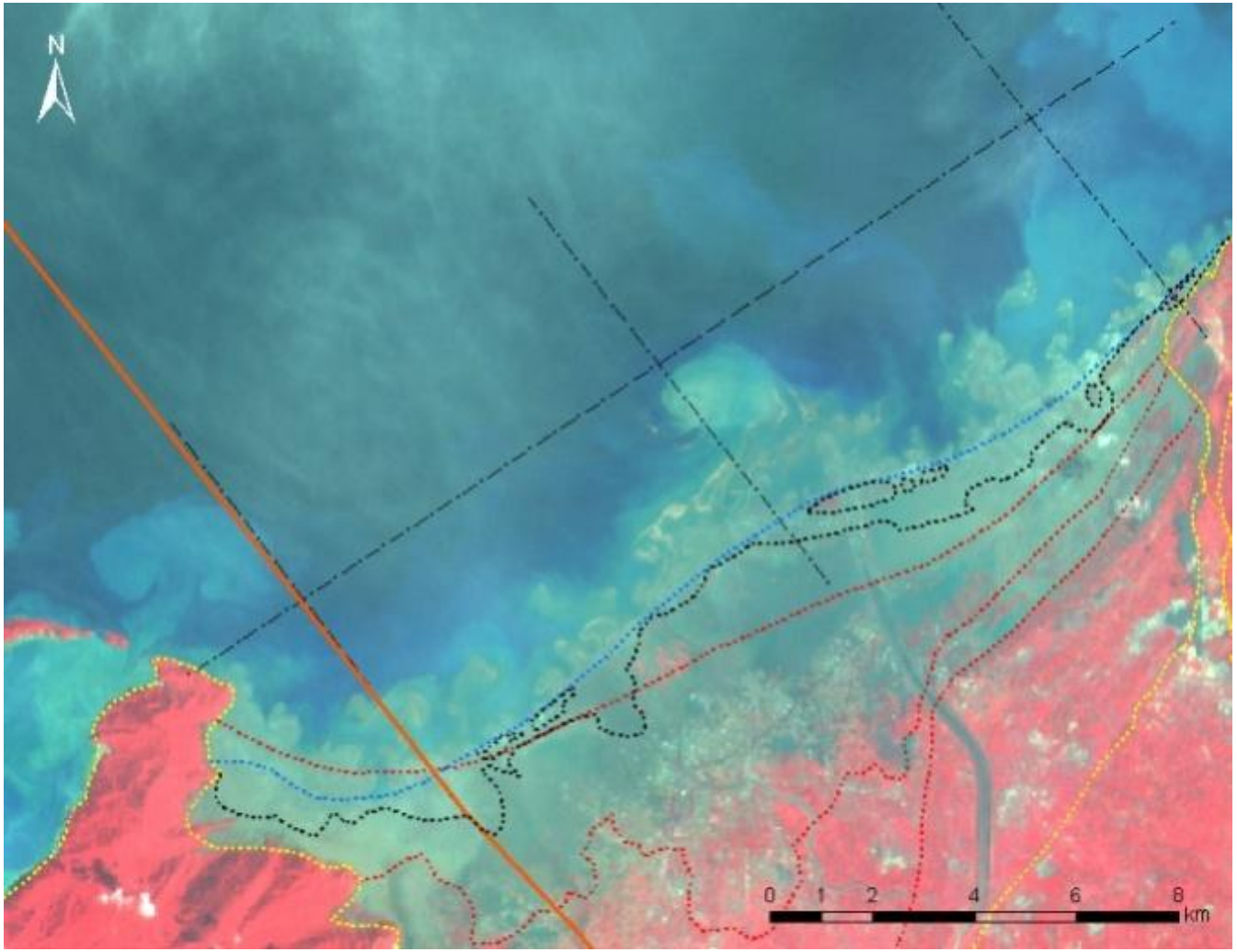








Recent 110 years Ujong Pancu Coastal line dynamic



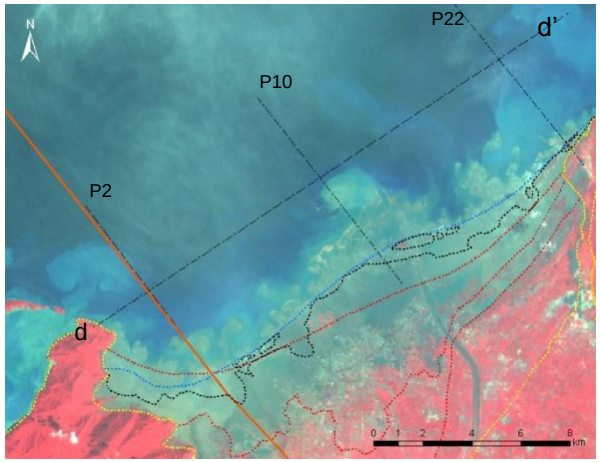
Fault zone

Holocene shorelines

Pre-tsunami shoreline

Post-tsunami shoreline

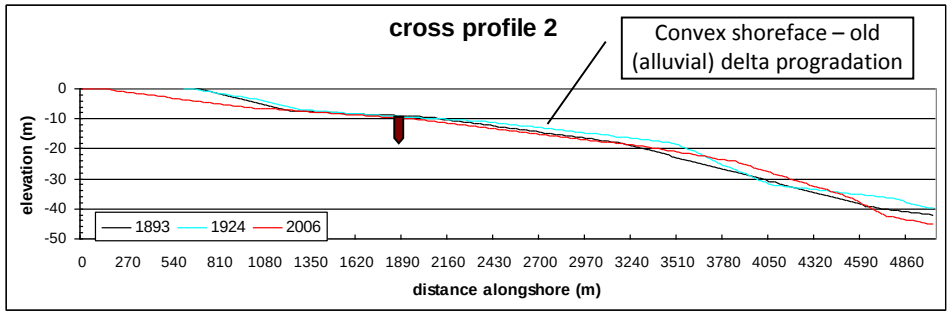
Recent 110 years coastal profile

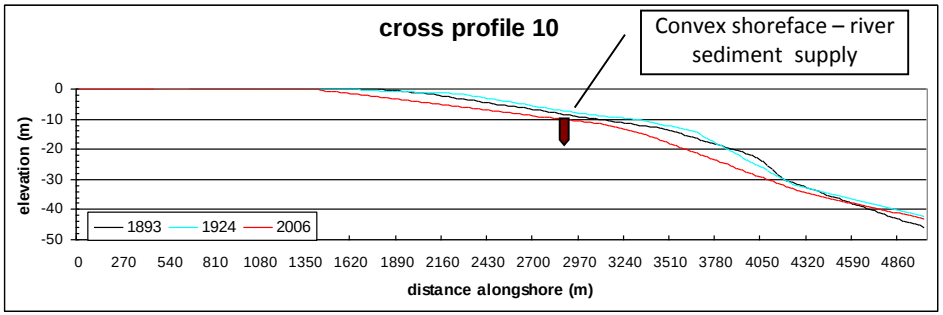


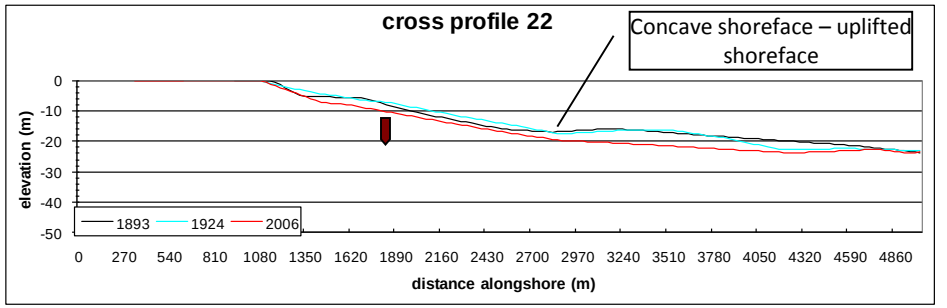
SPOT5©26-12-2004

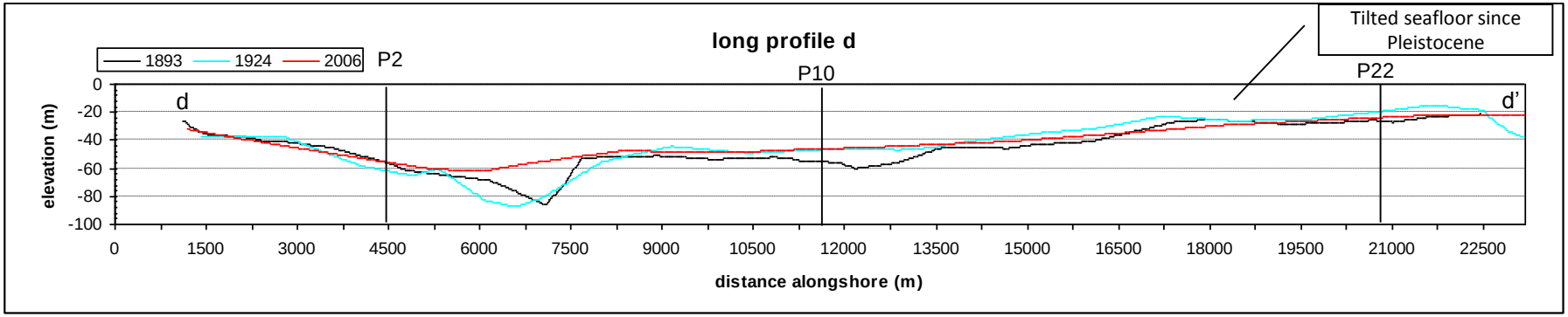
- *Fault zone*
- *Holocene shorelines*
- *Pre-tsunami shoreline*
- *Post-tsunami shoreline*

Scale of sample thickness : = 1 meter deep

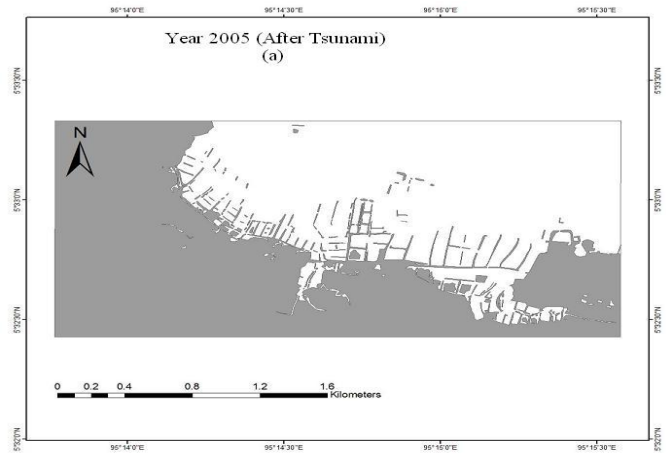


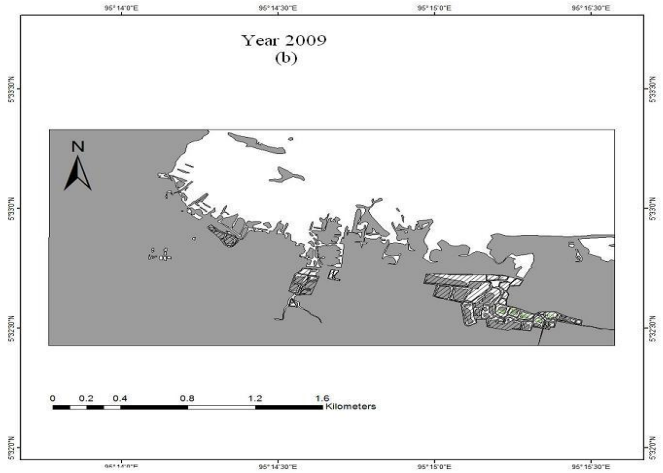


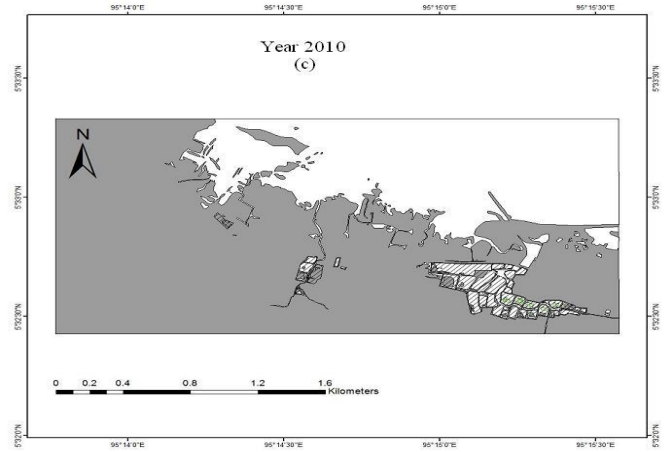


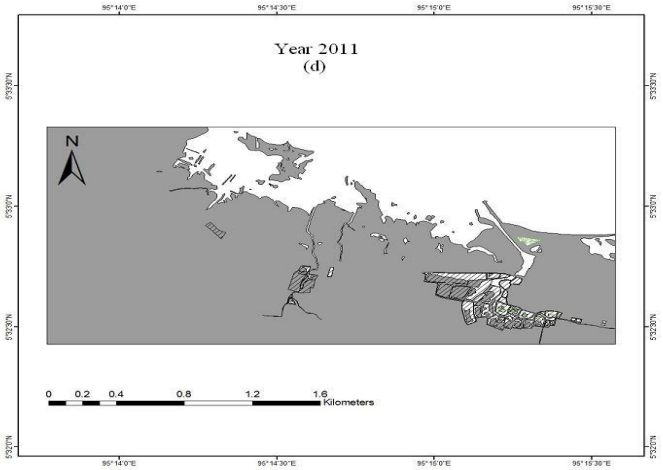


Recovery of Ujong Pancu coast after the 2004 tsunami





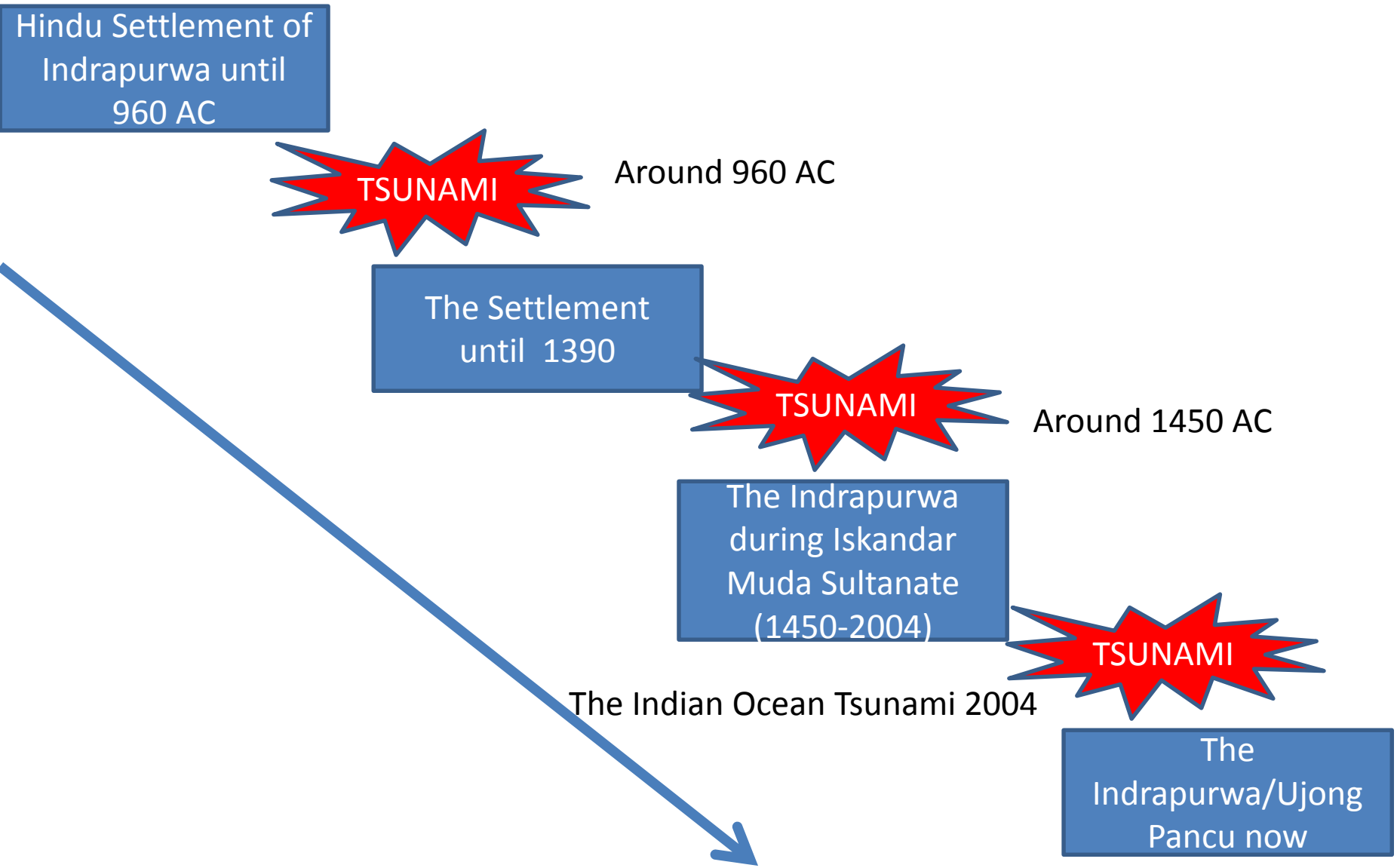




The Coastal Morphology Features	Area (km^2) for Year of Image			
	2005	2009	2010	2011
Land	2.86	3.39	3.60	3.76
Water in the lagoon	2.71	2.17	1.95	1.81
Ponds	0.00	0.23	0.23	0.21
Vegetation (Casuarina sp./Rhizopora sp.)	0.00	0.01	0.01	0.01

The History of the Indrapurwa Settlement

(tentative findings)



Conclusion

- The Indrapurwa/Ujong Pancu area is a sediment rich area. After tsunami, the coast can be recovered through the natural coastal processes.

- The recovered coastal land was kept to attract the community to return to the area. However, on the other hand, the lessons learned from previous tsunami did not pass to the next generation. This caused a large number of human casualties in the Indian Ocean Tsunami in 2004.

Thank you