Research on Tsunami Hazard and Its Effects on Indonesia Coastal Region

(3 YEARS COOPERATION RESEACH WITH JICA-JAPAN)

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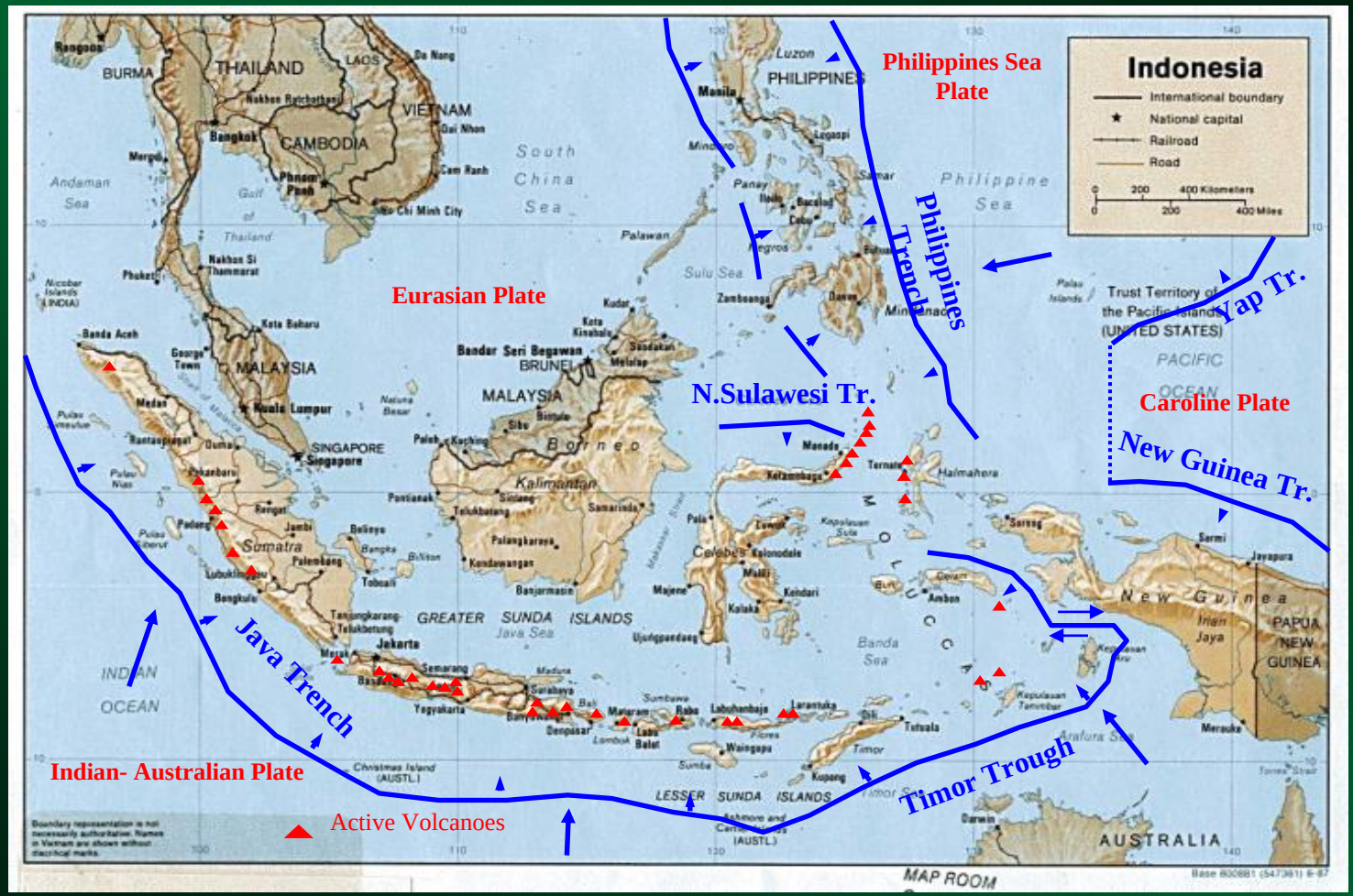


INDONESIA TECTONIC & PLATE BOUNDARIES

- Mangrove is heavily vegetated in South East Asian countries. 40% mangrove in the world is growing in this area
- Mangrove has important role as a habitat of marine ecology
- Previous studies concluded mangrove as a greenbelt protecting coastal area is effective to reduce tsunami energy

PICTURES OF MANGROVES *(RHIZOPHORA SP.* *are courtesy pictures from several sources)*




OVERALL GOAL:

Reduction of tsunami hazard (in Indonesia)

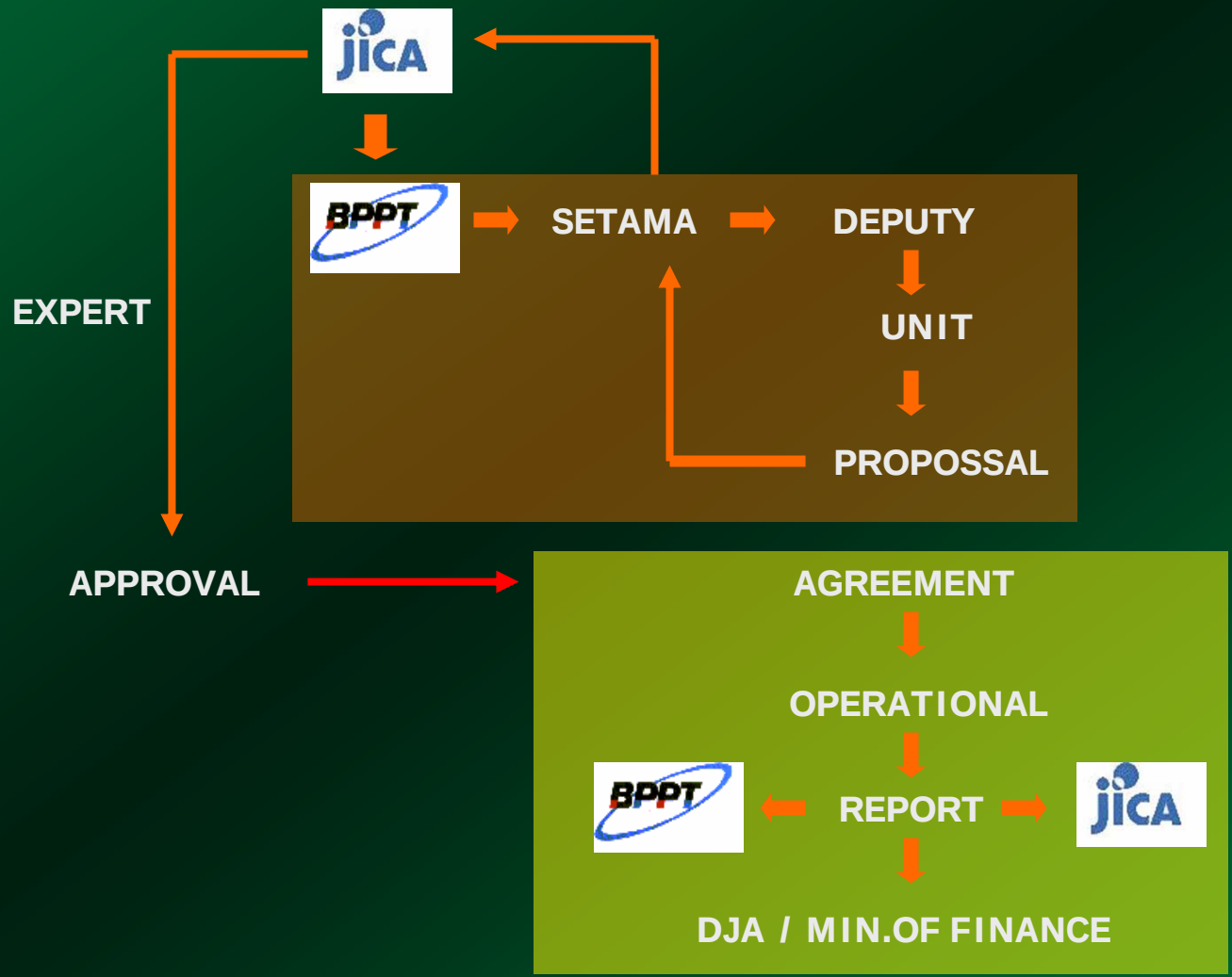
PROJECT PURPOSE:

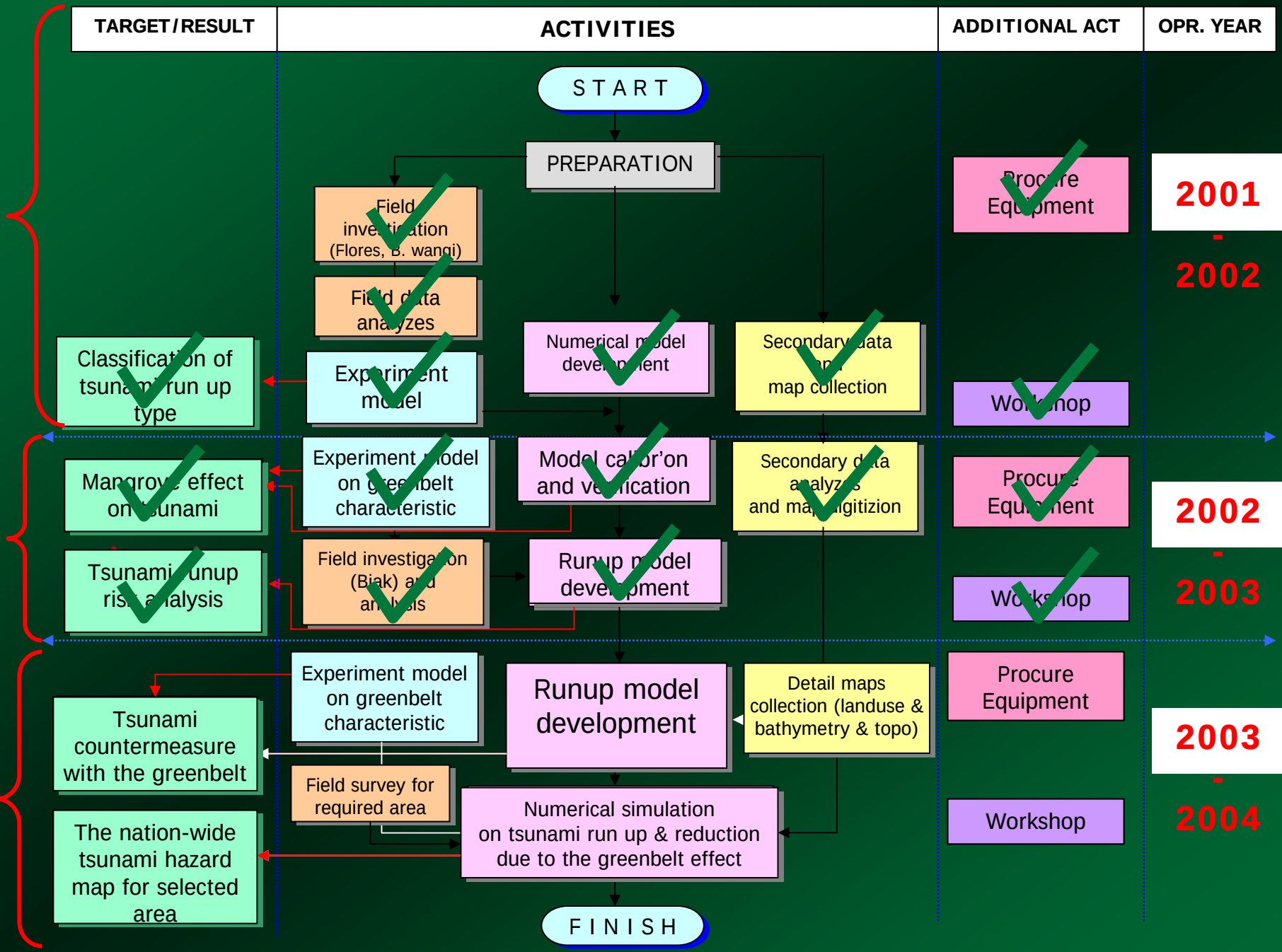
1. To make a nation-wide risk map of Tsunami hazard
2. To make an effective countermeasure for Tsunami disaster (in laboratory scale)

OUTPUTS:

1. Numerical Model of Tsunami run-up
2. Nation-wide risk map of Tsunami hazard
3. Experiment results on the effectiveness coastal protection against Tsunami

GRANT SCHEME FLOW CHART




TARGET/RESULT
ACTIVITIES
ADDITIONAL ACT
OPR. YEAR
START
PREPARATION
Field investigation (Flores, B. wangi)
Field data analyzes
Experiment model
Numerical model development
Secondary data and map collection
Classification of tsunami run up type
Procure Equipment
Workshop
2001 - 2002
Experiment model on greenbelt characteristic
Model calibr'on and verification
Secondary data analyzes and map digitizion
Mangrove effect on tsunami
Procure Equipment
Field investigation (Biak) and analysis
Runup model development
Tsunami runup risk analysis
Workshop
2002 - 2003
Experiment model on greenbelt characteristic
Runup model development
Detail maps collection (landuse & bathymetry & topo)
Procure Equipment
Tsunami countermeasure with the greenbelt
Field survey for required area
Numerical simulation on tsunami run up & reduction due to the greenbelt effect
Workshop
The nation-wide tsunami hazard map for selected area
2003 - 2004
FINISH

Stakeholders

I. Ministry of Marine and Fisheries
II. Meteorology and Geophysics Agency
III. Ministry of Settlement and Area Infrastructure
IV. Agency of National Survey and Mapping Coordination
V. Universities
VI. Local Government

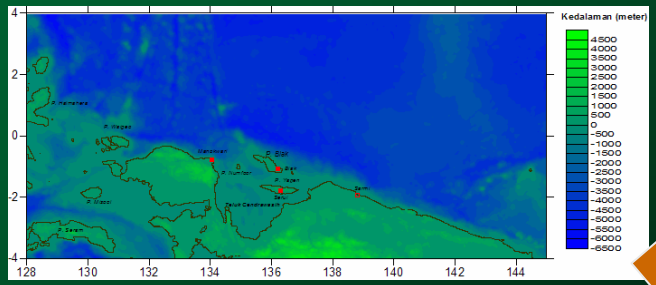
Activities Results

Field Investigation and Data Collection :

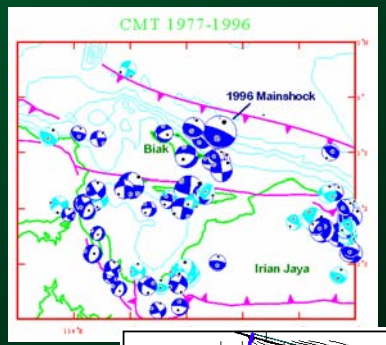
Relocation of residents to secure areas inside the land is usually ineffective due to the following reasons:

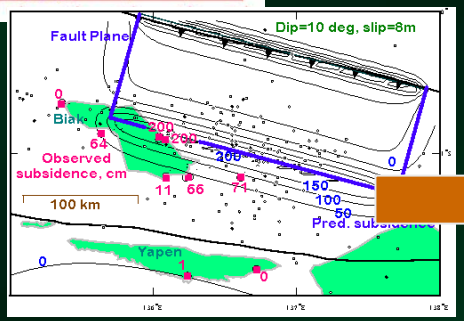
- The residents have been quite familiar only with fisheries livelihood.
- There is no land to cultivate in the relocation area, and is not easy to find a job inside the land.
- They believe that tsunami will not come in the near future.
- In general, they are willing to move the living area some distance from the beach, but with additional condition of secure facilities for anchoring the boats and fast access to this facility from living area.

NUMERICAL MODEL OF TSUNAMI



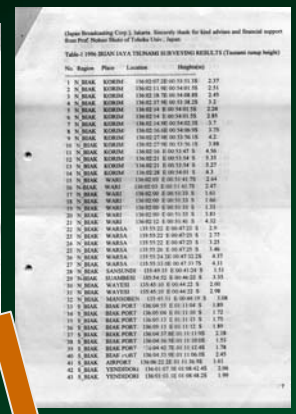
1. Bathymetric map (ETOPO2)





2. Tsunami source (Harvard CMT)

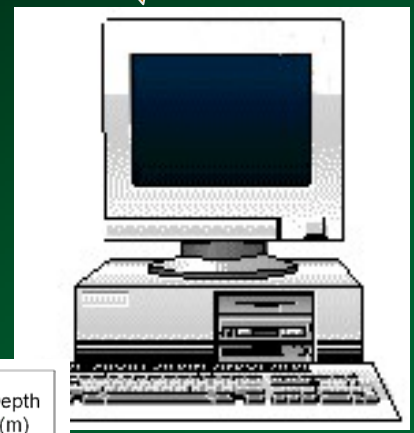
3. Field Investigation (ITST)



Verification

Model Design of Biak Tsunami 1996

Batas Model	Utara Selatan Barat Timur	: 4º : -4º : 128º : 145º
Jumlah grid	511 x 241	
Ukuran Grid (dx = dy)	3700 meter	
Langkah Waktu (dt)	3 detik	
Lama simulasi	5 jam	



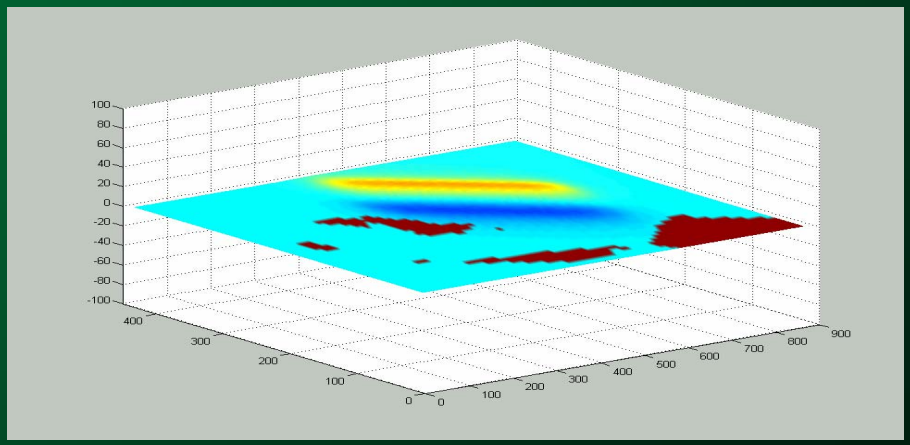
Simulation

Fault Parameter of Tsunami Biak 1996

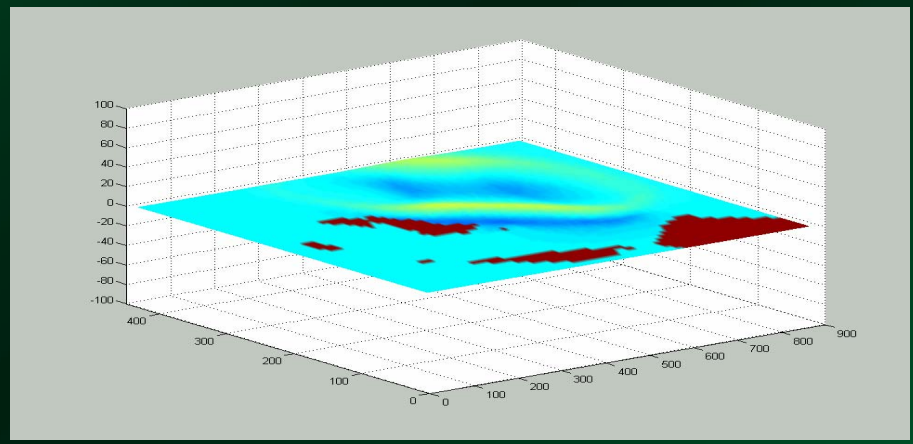
No	Referensi	M_w	Fault Length (m)	Fault Width (m)	Strike (°)	Dip (°)	Slip (°)	Dislocation (m)	Depth (m)
1	Harvard quick CMT	8.2	18×10^4	50×10^3	27	60	99	11.217	15×10^3

Activities Results

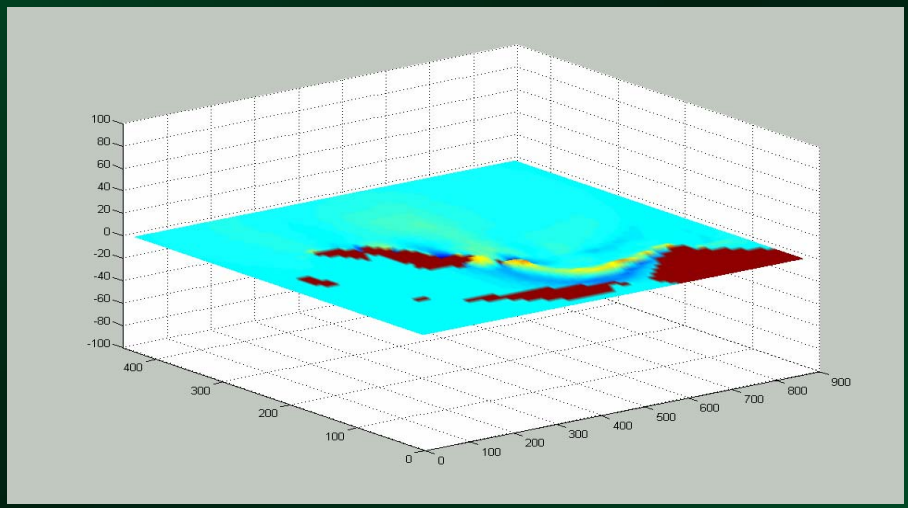
Numerical simulation :



Biak tsunami - wave propagation at t = 0



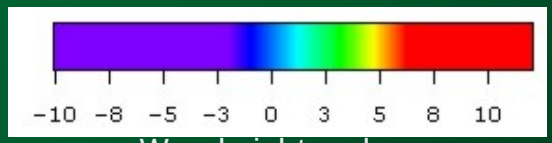
Biak tsunami - wave propagation at t = 5 min



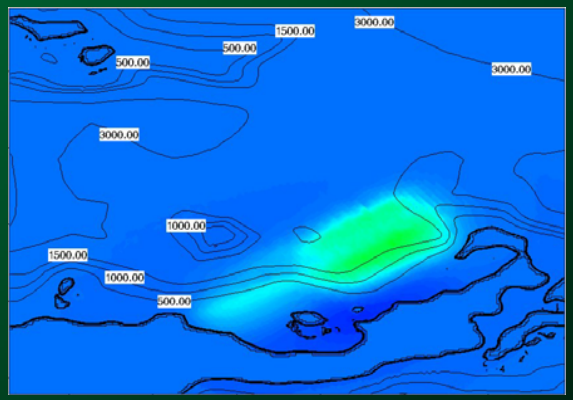
Biak tsunami - wave propagation at t = 20 min

Activities Results

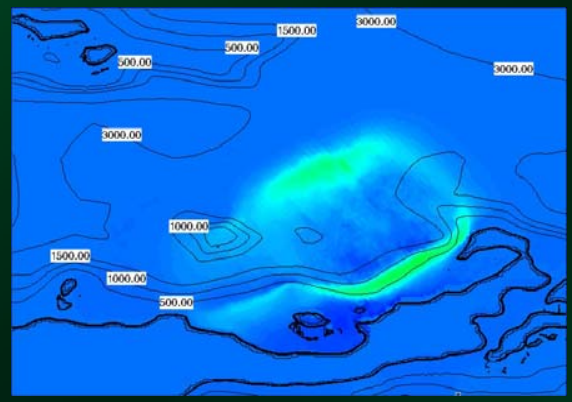
Numerical simulation :



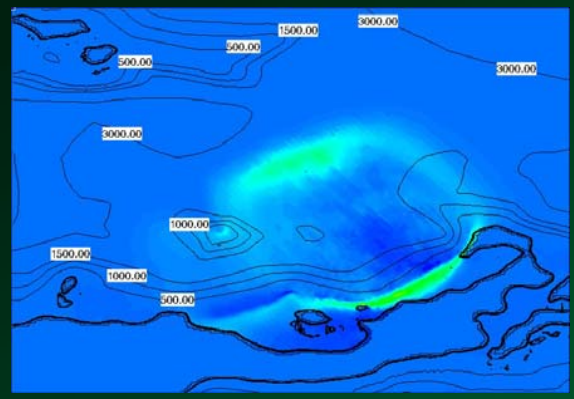
Waveheight scale



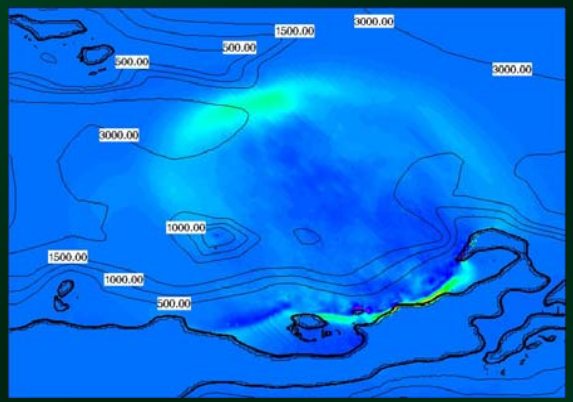
1 min



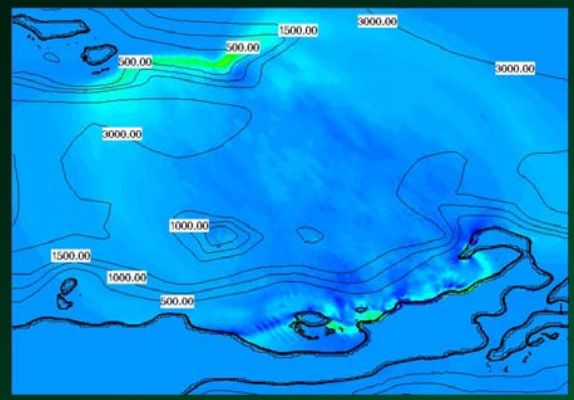
4 min



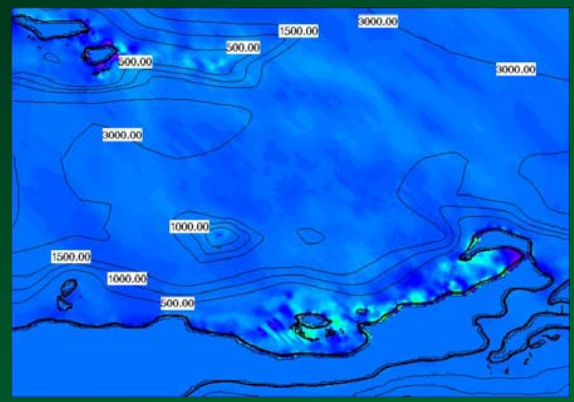
6 min



10 min



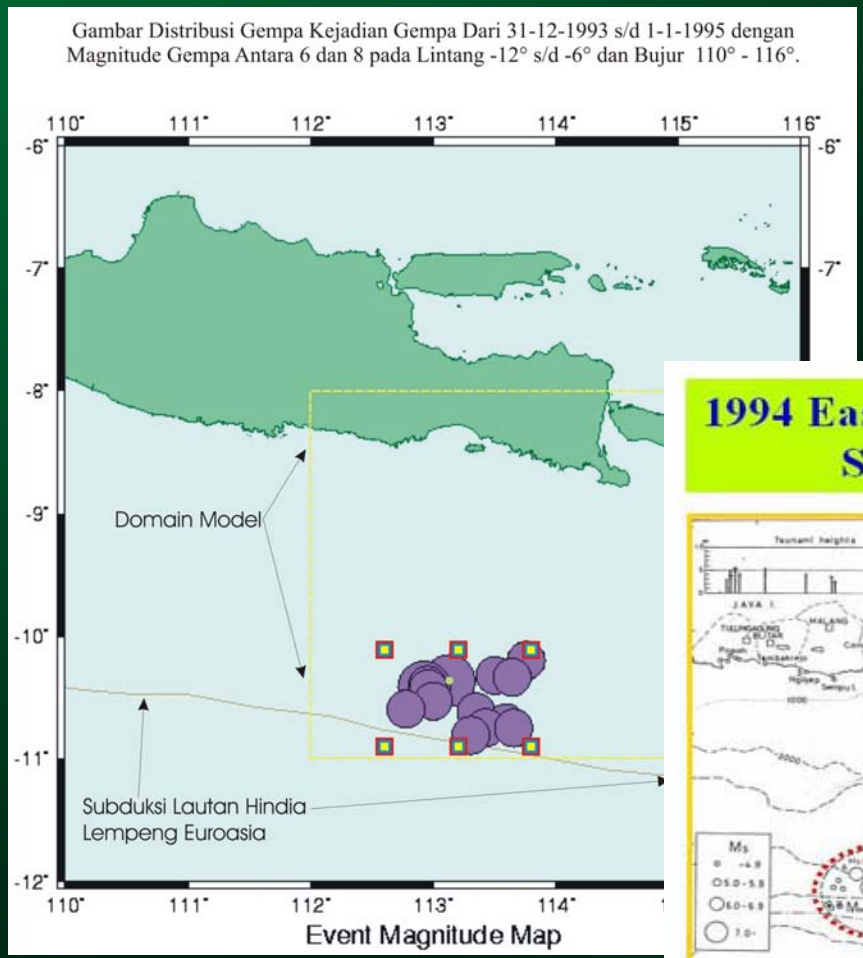
15 min

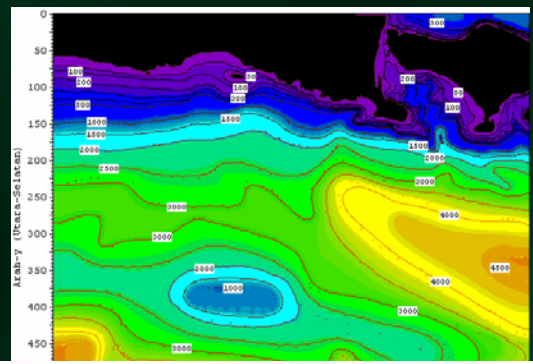


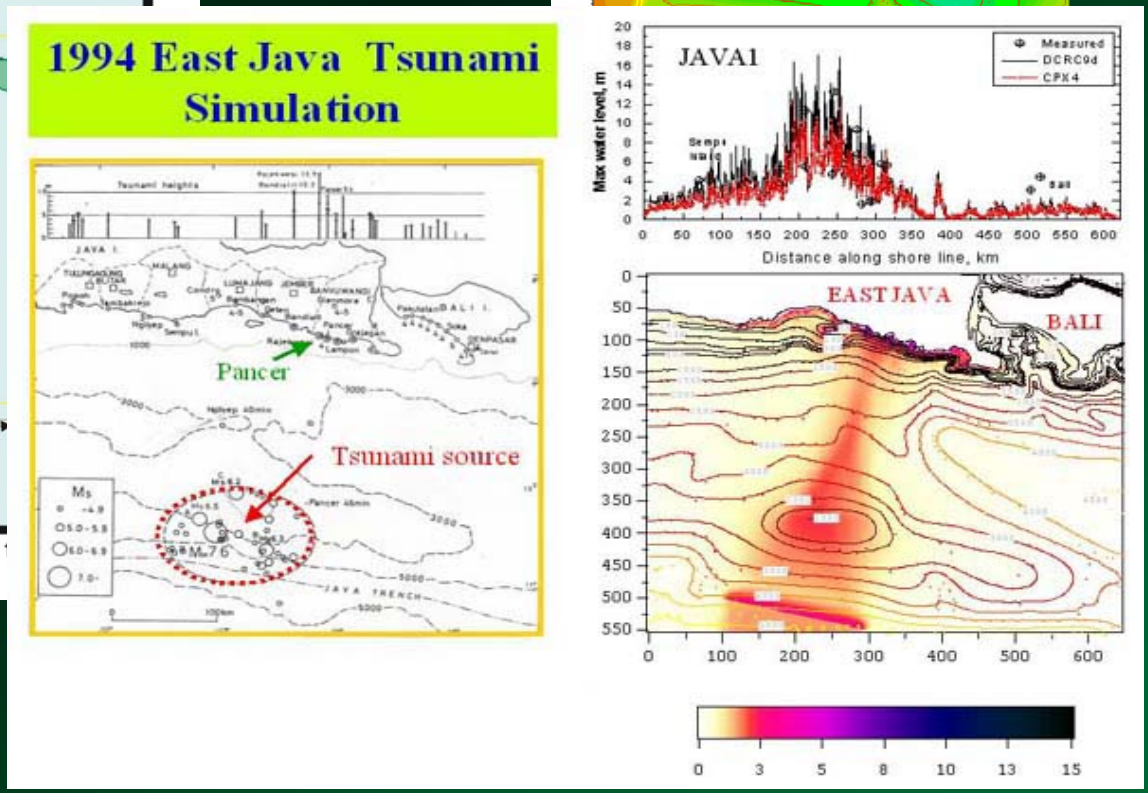
50 min

Activities Results

JAWA TIMUR (1994)





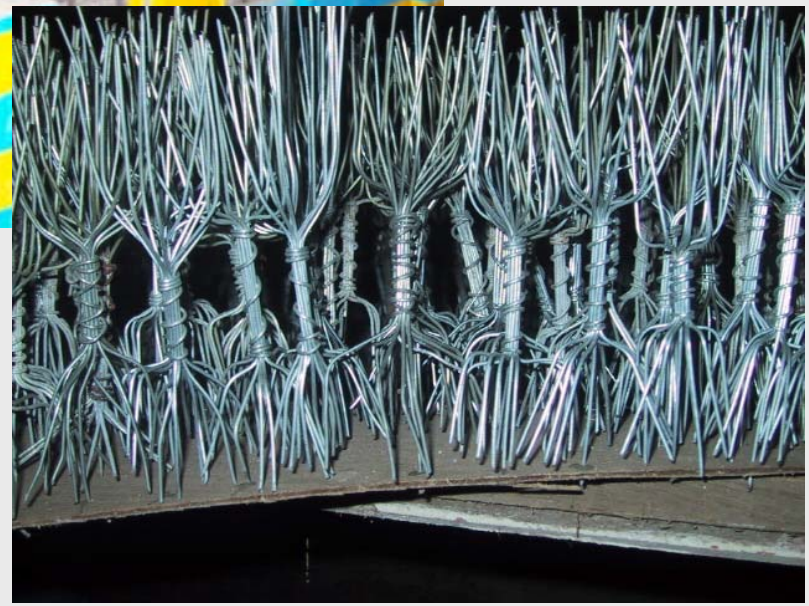


Activities Results

Physical Modeling

OBJECTIVES:

1. Investigate tsunami runup characteristics in regard with typical coastline shapes.
2. Investigate effects of mangrove damper on tsunami runup
3. Collect data for calibration of numerical model on tsunami runup on the beach



COASTLINE MODEL AND MANGROVE MODEL

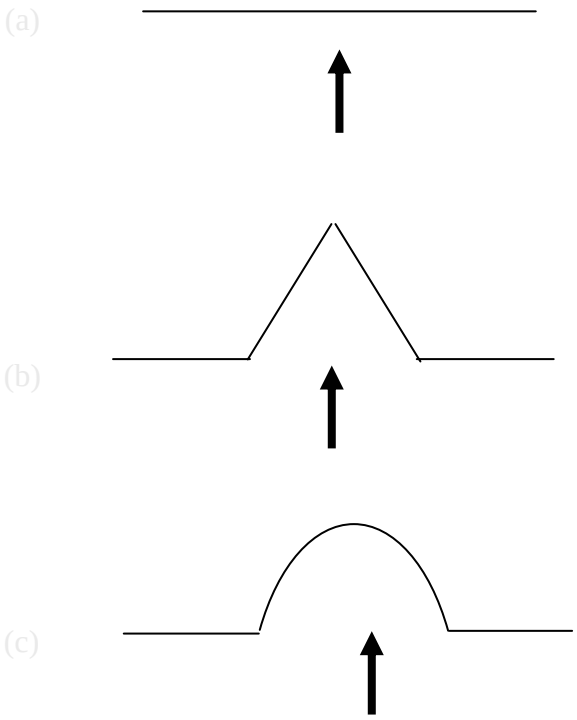


Fig-1. Typical shape of coastline model

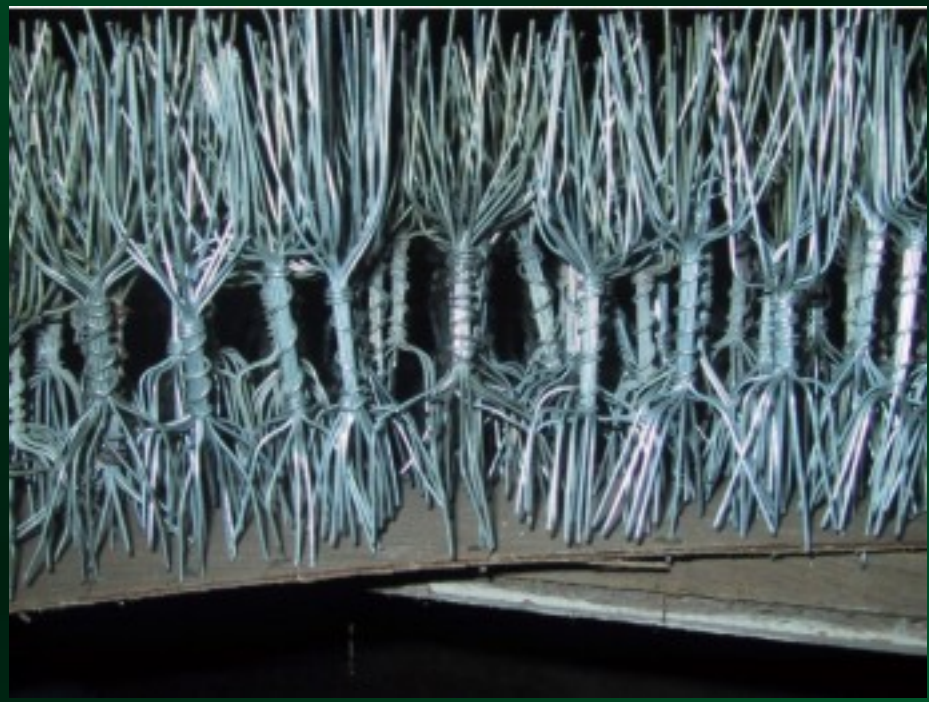
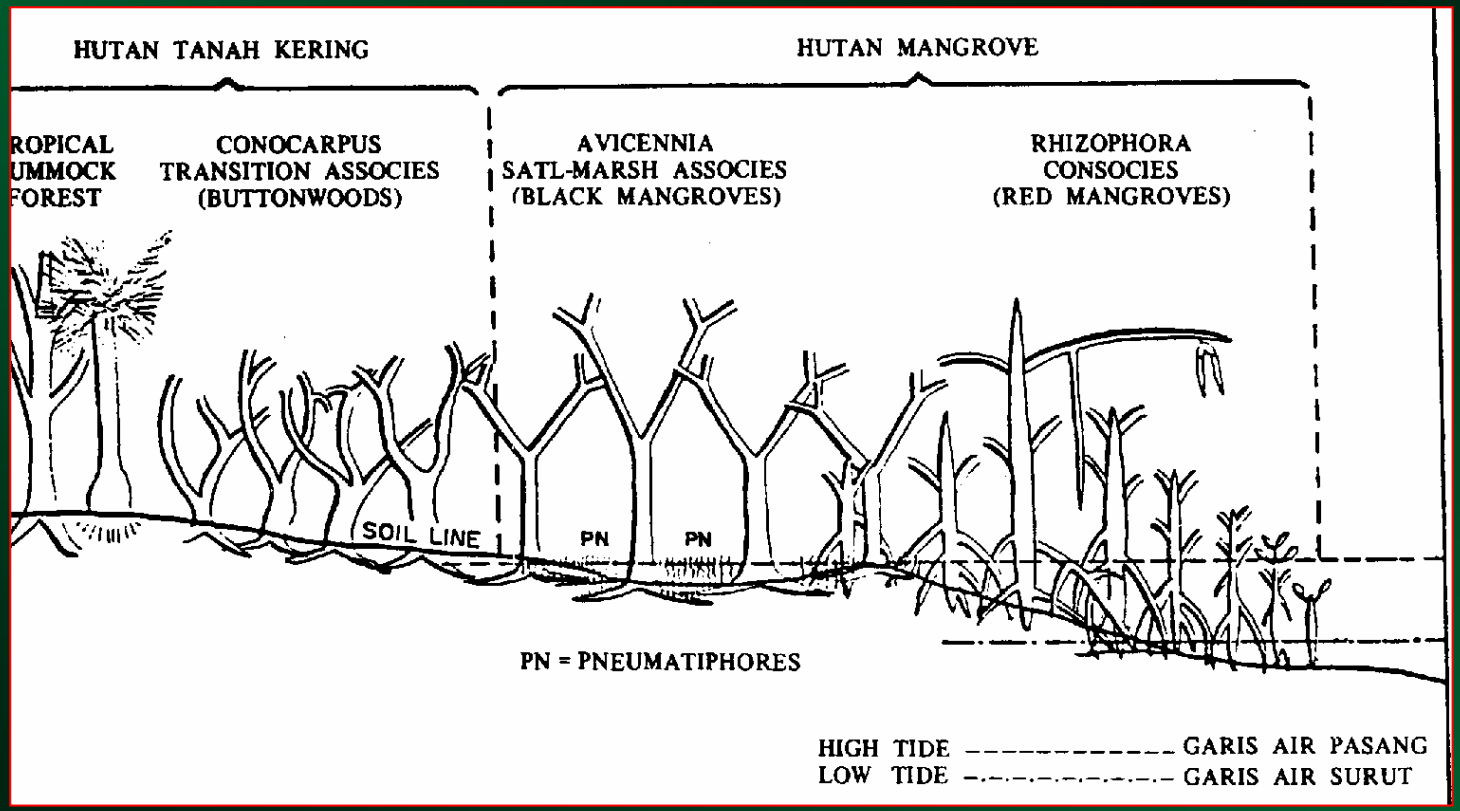
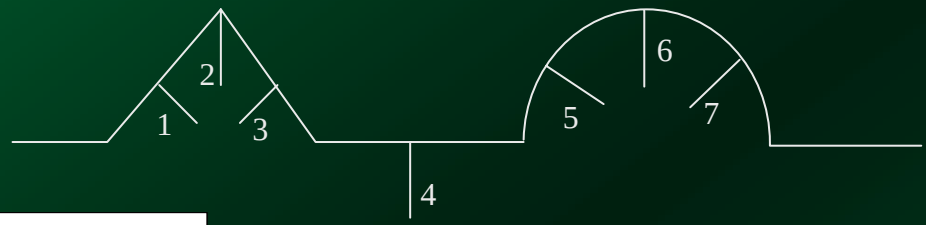


Fig-2.
Model of magrove developed for the experiment

MANGROVE ZONE PROFILE



EXPERIMENT RESULT
WITHOUT MANGROVE



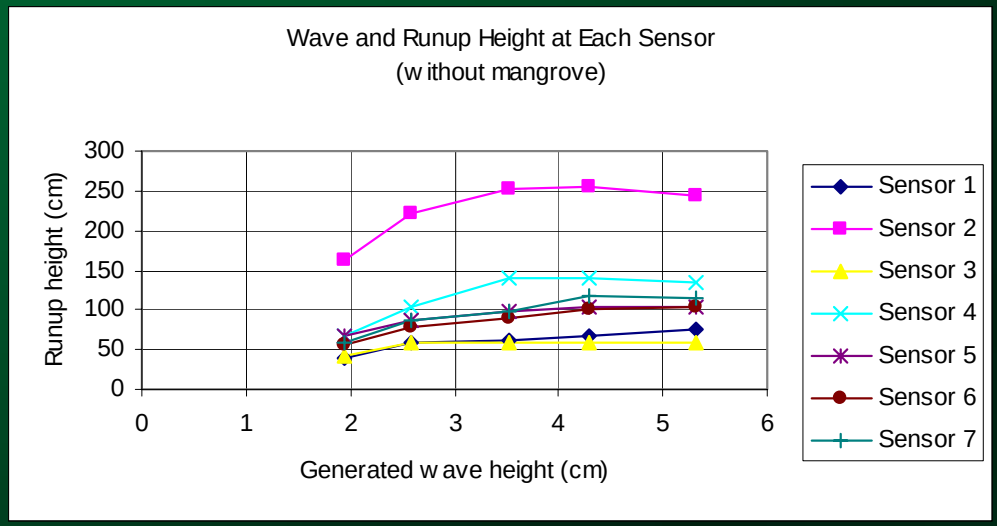


Fig-5. Runup – wave height relation, in case without mangrove

- The higher the wave height, the higher the run-up

The highest run-up recorded at sensor #2

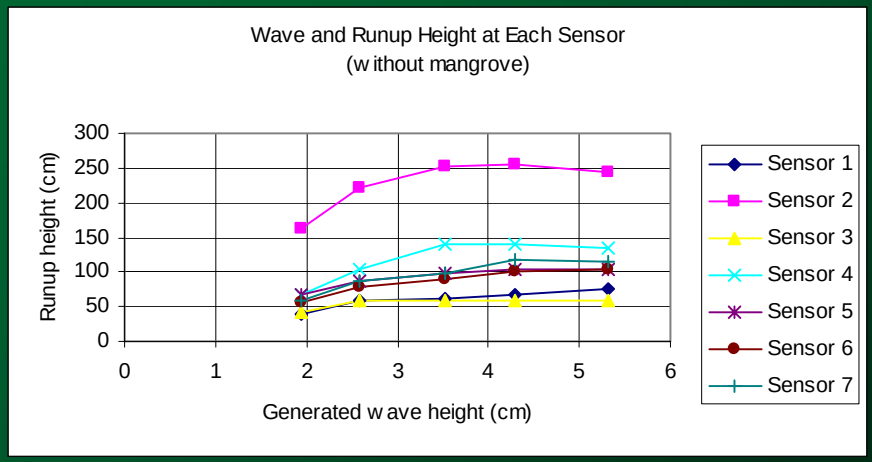
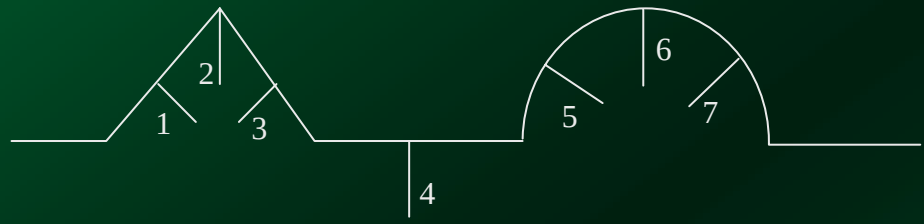


Fig-5. Runup – wave height relation, in case without mangrove



- 10 cm width reduces runup in average 2,3%
- 20 cm width reduces runup in average 5,1%

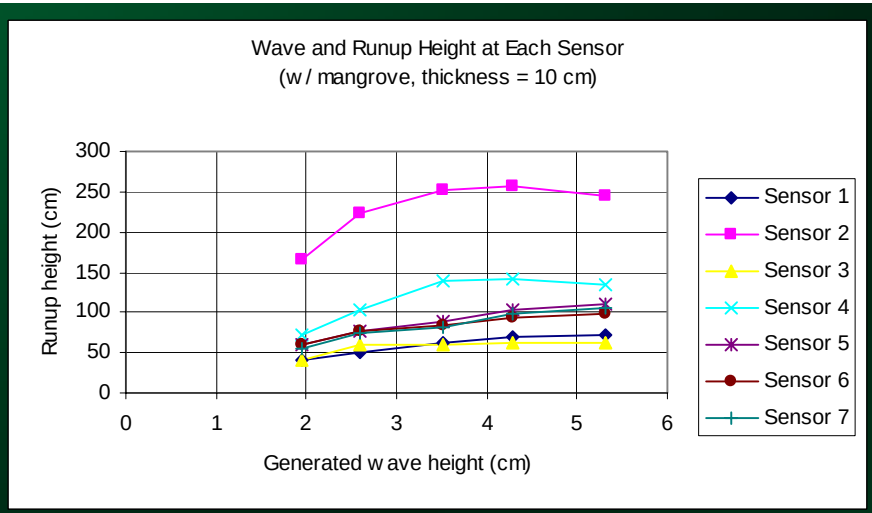


Fig-6. Runup – wave height relation, in case with mangrove of 10 cm width

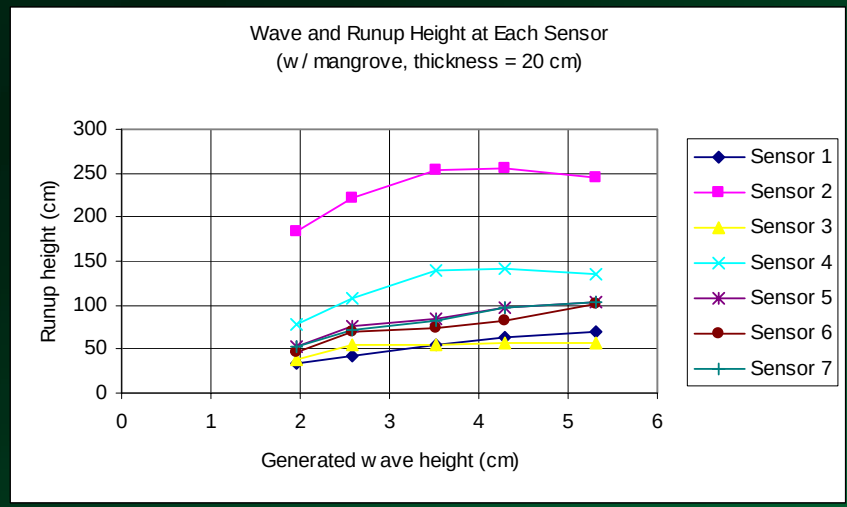
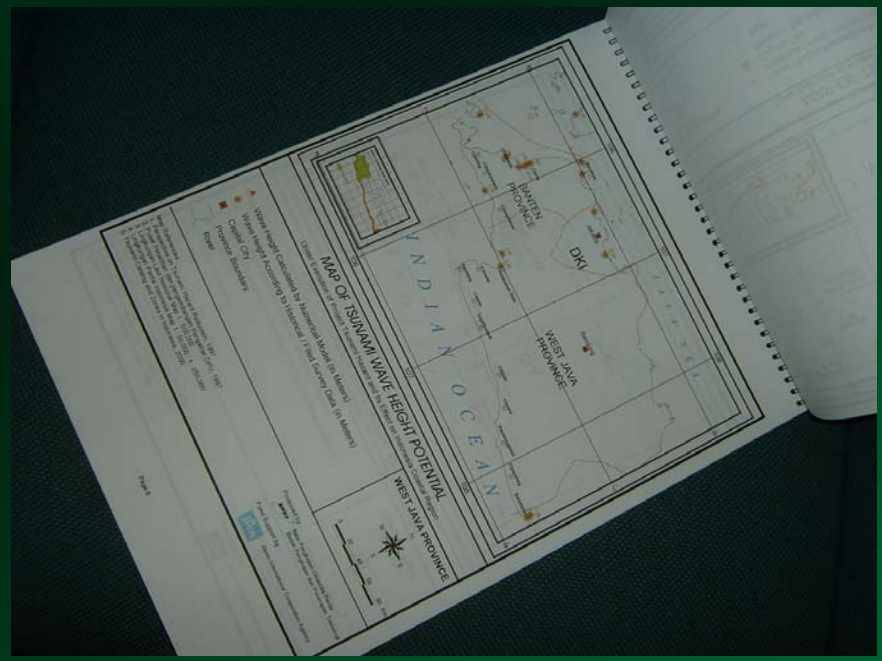


Fig-7. Runup – wave height relation, in case with mangrove of 20 cm width

1. Any typical coastline shape has specific effect on tsunami run-up on the beach
2. In general, the existence of mangrove at the beach reduce tsunami run-up
3. Mangrove elasticity had not been considered in the present research

Activities Results

Map of Tsunami Risk :



Next step

1. Develop tsunami run-up numerical model as well as physical model by including various vegetation and its characteristic
2. Make some recommendations & disseminations of the result to local government and related agencies
3. Develop national data base and network system for tsunami hazard and its mitigation