Satellite Monitoring of Fishing Vessels as A Tool to Localize and Estimate The Fishing Activity

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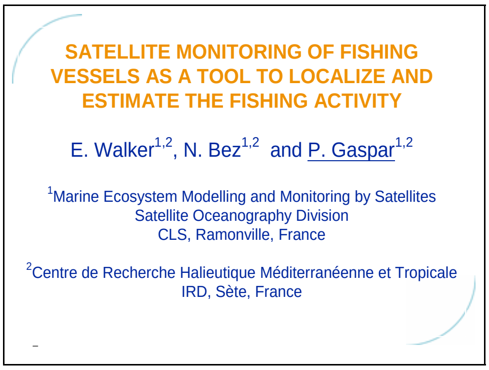
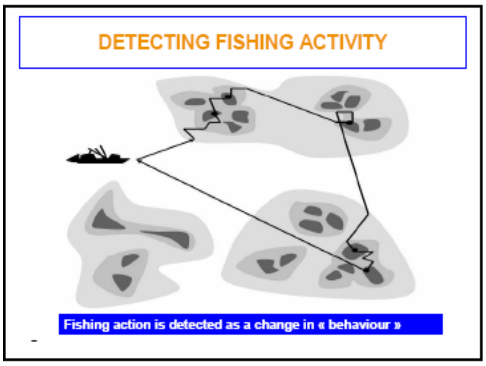
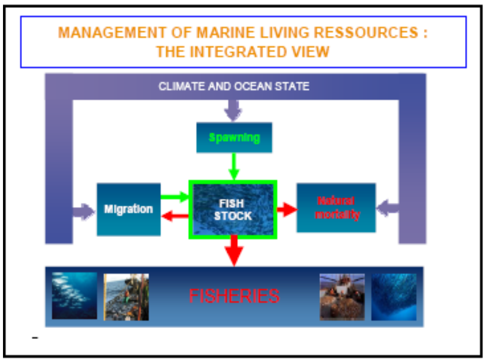
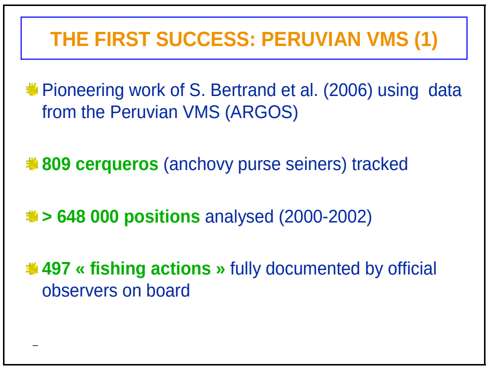
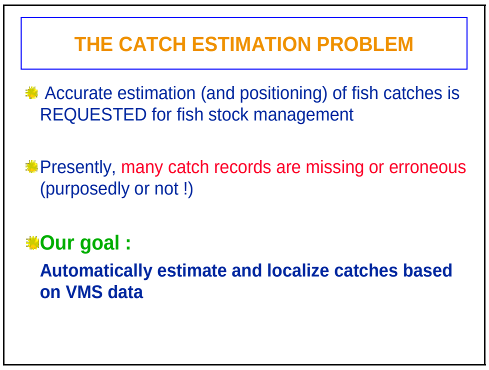
[2]*Centre de Recherche Halieutique Méditerranéenne et Tropicale, IRD, Sète, France*

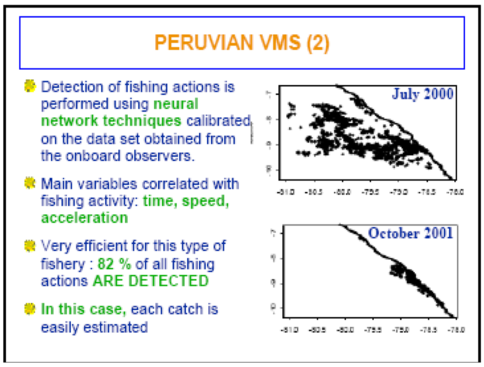


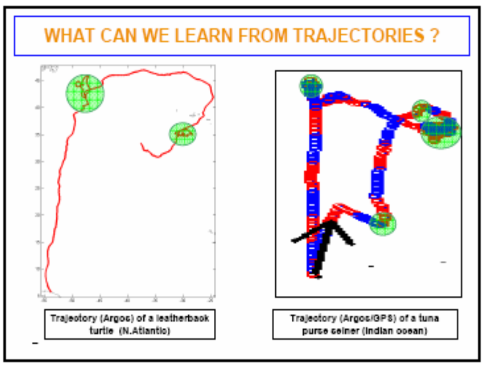


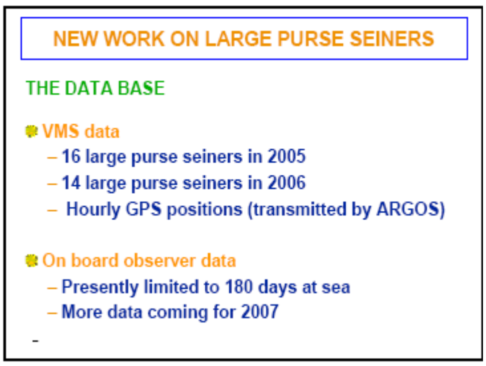






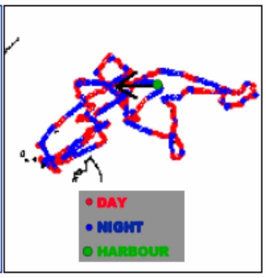




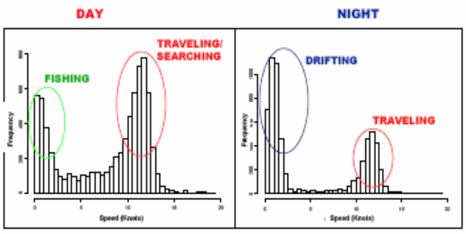


DATA BASE ORGANISATION

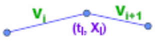
- BY FISHING TRIP
  - Begins when the vessel is > 15 miles from harbour and stops at 15 miles from the next harbour stop
- DAY/NIGHT
  - Day positions = one hour before sunrise to sunset



ANALYSIS OF SPEEDS



A SIMPLISTIC ALGORITHM FOR DETECTING FISHING



If [(vessel not in harbour)

and (t_i during DAY)

and (V_i and V_{i+1} > 1.3 knots)]

Then (t_i,X_i) = time/position of fishing action

Results for 7 fishing trips on 4 vessels

TRIP N°	VESSEL N°	% of detection
1	1	63 %
2	1	80 %
3	2	74 %
4	3	83 %
5	3	30 %
6	4	0 %
7	4	7 %

PRELIMINARY CONCLUSIONS

FOR LARGE PURSE SEINERS

- In « usual » conditions, high detections rates (~ 75 %) can be obtained with very simple algorithms.
- Detection rate drops rapidly in « unusual » weather conditions as the vessel movements become atypical.
- Detection rate is even worse (close to 0) when VMS data are missing (vessel 4 with >30 % of missing hourly positions).

NEXT STEPS

ON GOING EFFORTS TO

- Identify « unusual » weather conditions by adding weather forecasts to the list of explanatory variables
- Precisely analyze the effects of missing VMS data on the detection rate
- Obtain better detection rates with more elaborate algorithms (neural network)

FUTURE WORK

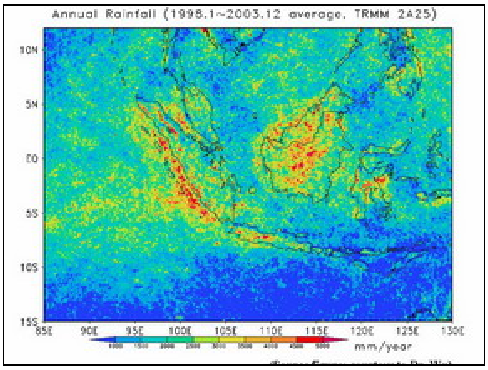
- Develop algorithms to estimate catches based on VMS tracking data
- Work on other fishing gears (trawlers, long line)

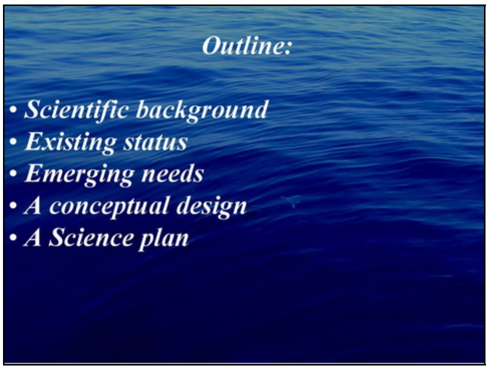
OPERATIONAL SUCCESS CRITICALLY DEPENDS ON

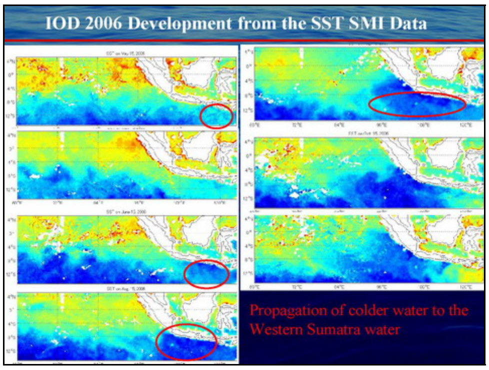
- ✓ Availability of high-quality observer data set
- ✓ Continuous day to day monitoring of the state of the fleet and the VMS

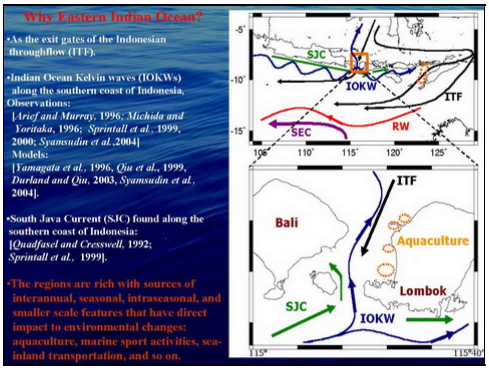
A Conceptual Design of Operational Oceanography in The Eastern Indian Ocean

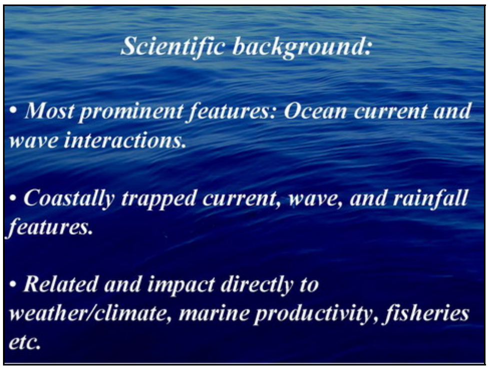
Dr. Fadli Syamsudin
Agency for the assessment and application of technology (BPPT)
and Indian ocean panel(10P) member



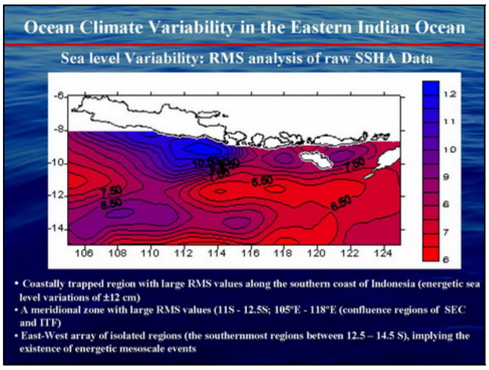


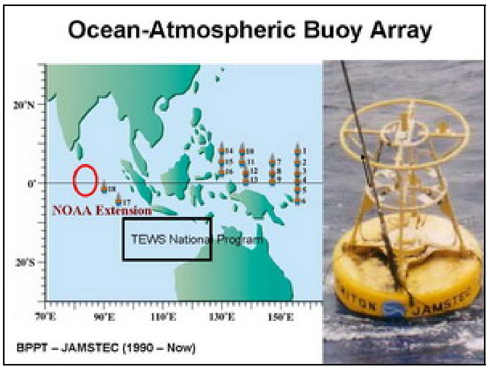


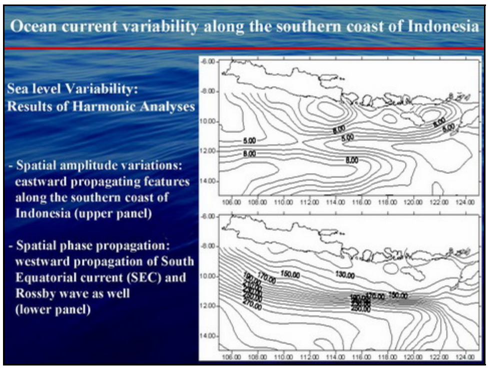


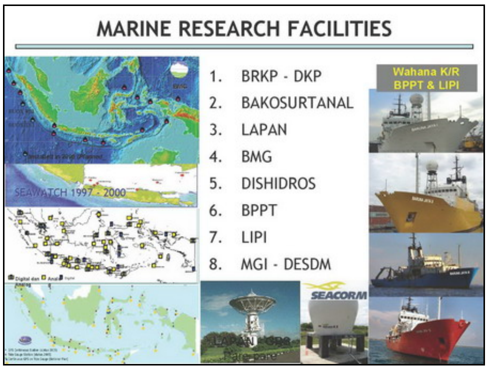


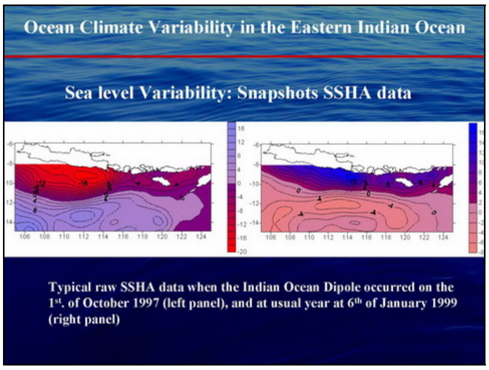

Existing Status


Ocean Climate Variability in the Eastern Indian Ocean
Sea level Variability: RMS analysis of raw SSHA Data
• Coastally trapped region with large RMS values along the southern coast of Indonesia (energetic sea level variations of ±12 cm)
• A meridional zone with large RMS values (11S - 12.5S; 105°E - 118°E (confluence regions of SEC and ITF)
• East-West array of isolated regions (the southernmost regions between 12.5 – 14.5 S), implying the existence of energetic mesoscale events

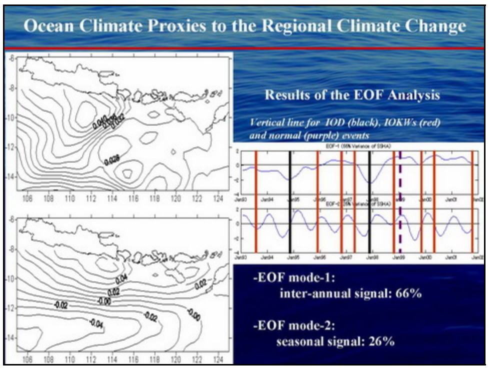

Ocean-Atmospheric Buoy Array
NOAA Extension
TEWS National Program
BPPT – JAMSTEC (1990 – Now)

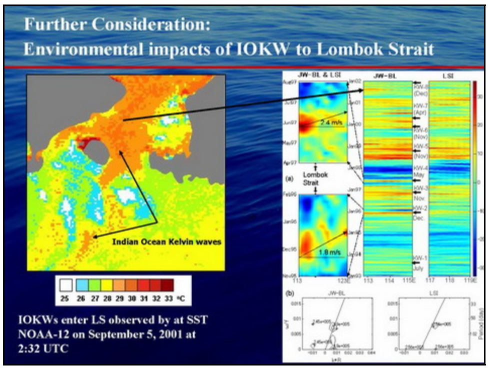

Ocean current variability along the southern coast of Indonesia
Sea level Variability:
Results of Harmonic Analyses
- Spatial amplitude variations: eastward propagating features along the southern coast of Indonesia (upper panel)
- Spatial phase propagation: westward propagation of South Equatorial current (SEC) and Rossby wave as well (lower panel)

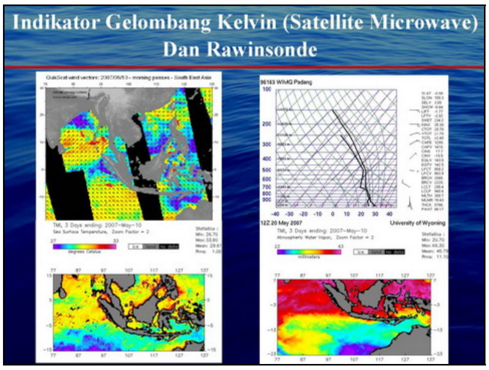

MARINE RESEARCH FACILITIES
1. BRKP - DKP
2. BAKOSURTANAL
3. LAPAN
4. BMG
5. DISHIDROS
6. BPPT
7. LIPI
8. MGI - DESDM
Wahana K/R
BPPT & LIPI
SEAWATCH 1997 - 2000
SEACORM

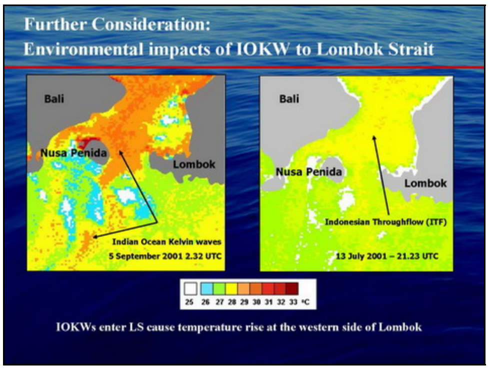

Ocean Climate Variability in the Eastern Indian Ocean
Sea level Variability: Snapshots SSHA data
Typical raw SSHA data when the Indian Ocean Dipole occurred on the 1st. of October 1997 (left panel), and at usual year at 6th of January 1999 (right panel)

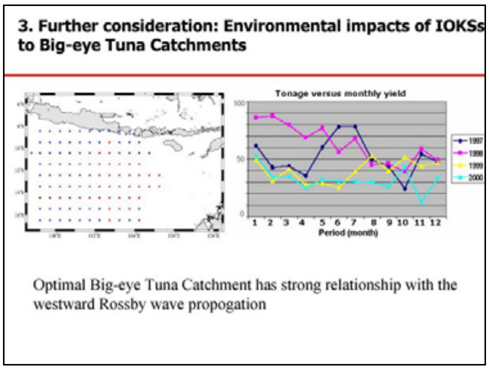

Emerging Needs

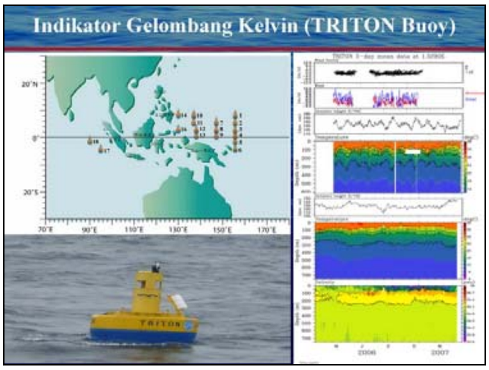

Ocean Climate Proxies to the Regional Climate Change
Results of the EOF Analysis
Vertical line for IOD (black), IOKWs (red) and normal (purple) events
-EOF mode-1:
inter-annual signal: 66%
-EOF mode-2:
seasonal signal: 26%


Further Consideration:
Environmental impacts of IOKW to Lombok Strait
Indian Ocean Kelvin waves
25 26 27 28 29 30 31 32 33 °C
IOKWs enter LS observed by at SST NOAA-12 on September 5, 2001 at 2:32 UTC

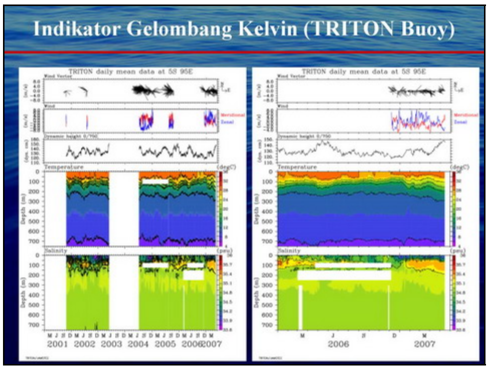

Indikator Gelombang Kelvin (Satellite Microwave)
Dan Rawinsonde

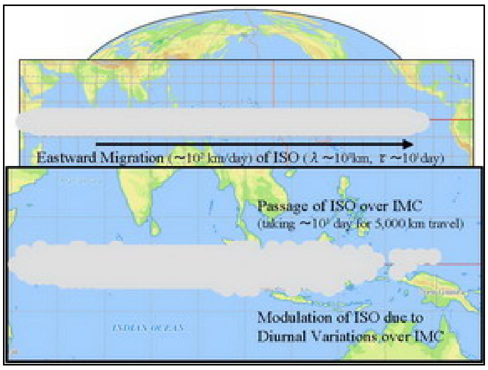

Further Consideration:
Environmental impacts of IOKW to Lombok Strait
Bali
Nusa Penida
Lombok
Indian Ocean Kelvin waves
5 September 2001 2.32 UTC
Bali
Nusa Penida
Lombok
Indonesian Throughflow (ITF)
13 July 2001 – 21.23 UTC
25 26 27 28 29 30 31 32 33 °C
IOKWs enter LS cause temperature rise at the western side of Lombok

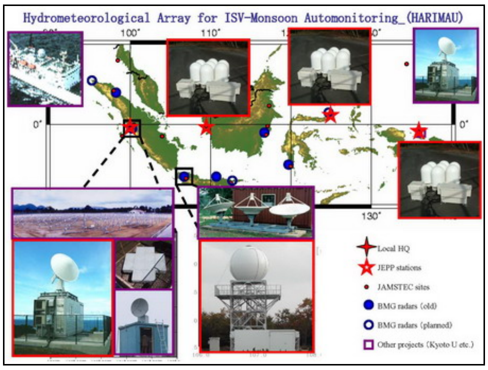

3. Further consideration: Environmental impacts of IOKSs to Big-eye Tuna Catchments
Tonage versus monthly yield
Period (month)
Optimal Big-eye Tuna Catchment has strong relationship with the westward Rossby wave propogation


Indikator Gelombang Kelvin (TRITON Buoy)


A Conceptual Design

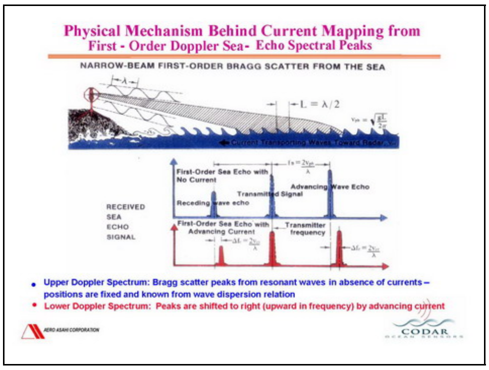

Indikator Gelombang Kelvin (TRITON Buoy)
TRITON daily mean data at 5S 95E
TRITON daily mean data at 5S 95E


Eastward Migration of ISO
Passage of ISO over IMC
Modulation of ISO due to Diurnal Variations over IMC



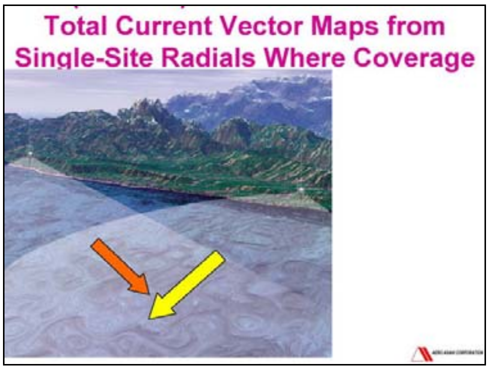
A Conceptual Ideas:

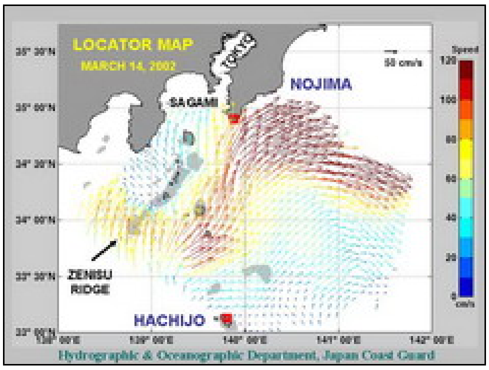
- to make use of satellite altimetry, SAR, etc. to deal with most dominant features in the sea surface (forex: monitoring eddies for the proxy to climate change, marine productivity, etc
- installment of atmospheric radar along the equatorial IMC to catch up MJO variation
- HF and CATS for cost effective monitoring technology



A Science Plan:

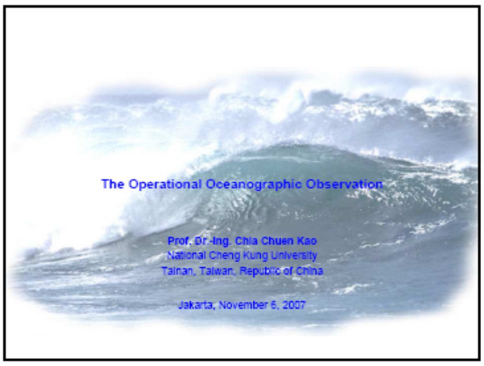
- Understanding how MJO affects on diurnal, fortnight and intra-seasonal variation of current, wave, and weather/climate.
- How eddies impact to climate, productivity and fisheries
- Understanding South Java Current, Indian Ocean Kelvin and Rossby Waves, internal waves and so on.

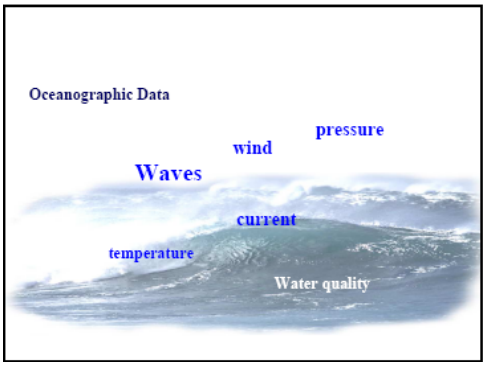


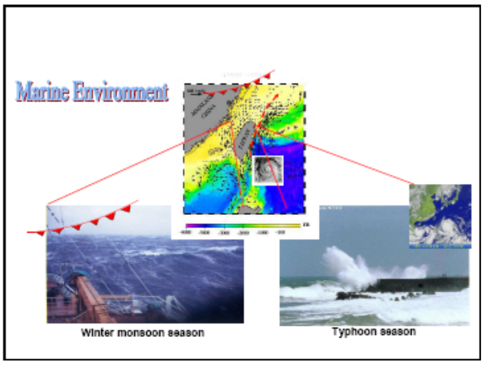


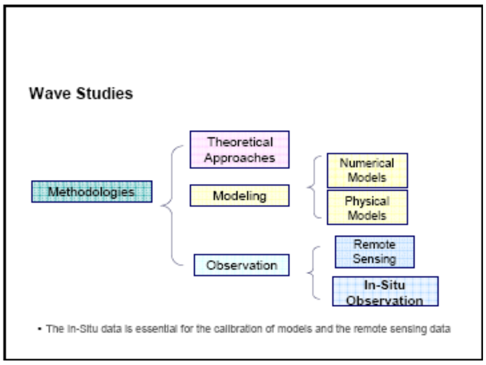
The Operational Oceanographic Observation

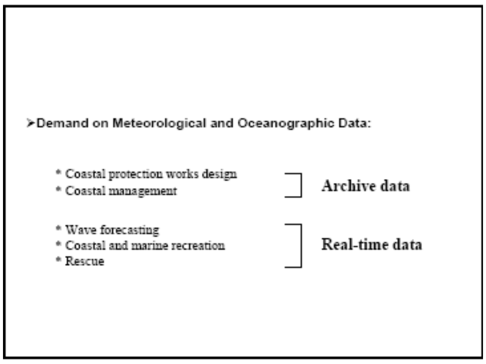
Prof. Dr.-Ing. Chia Chuen Kao
National Cheng Kung University
Tainan, Taiwan, Republic of China

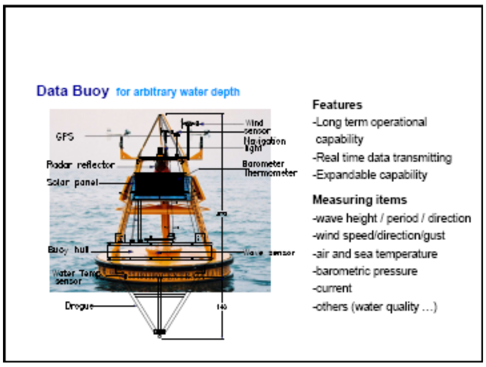


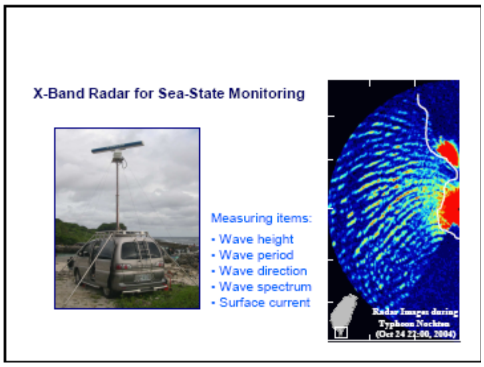


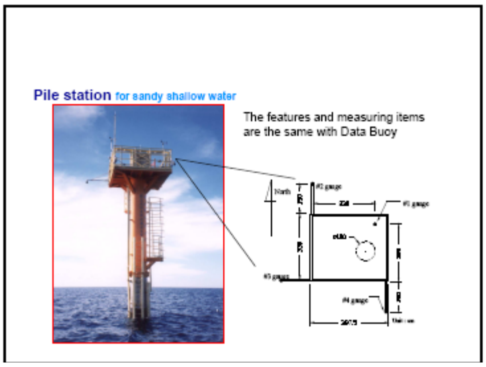


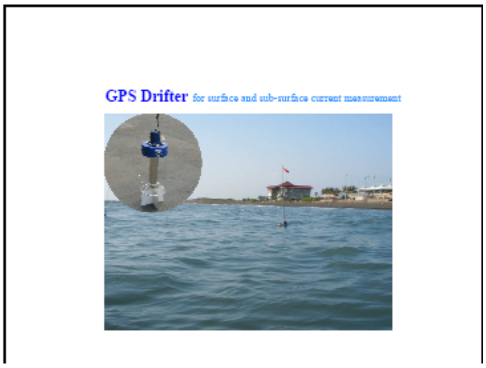


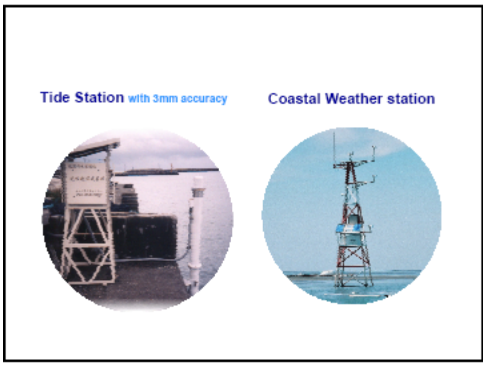


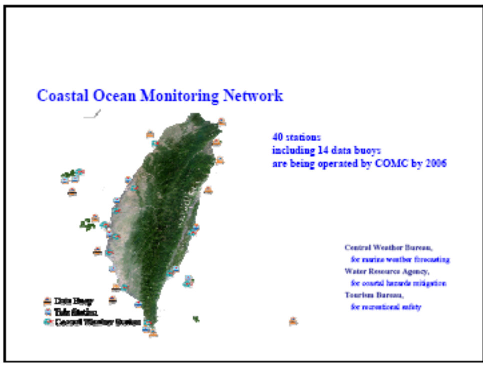

Data Buoy for arbitrary water depth
GPS
Radar reflector
Solar panel
Buoy hull
Drogue
Wind sensor
Navigation light
Barometer
Thermometer
Features
-Long term operational capability
-Real time data transmitting
-Expandable capability
Measuring items
-wave height / period / direction
-wind speed/direction/gust
-air and sea temperature
-barometric pressure
-current
-others (water quality ...)

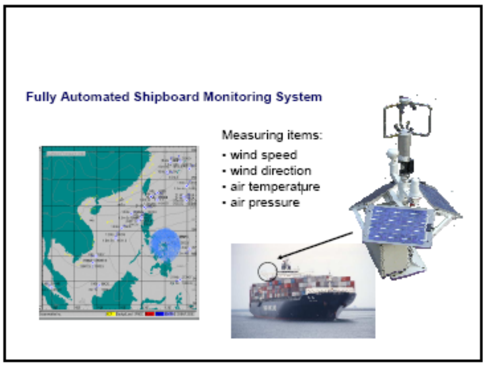

X-Band Radar for Sea-State Monitoring
Measuring items:
• Wave height
• Wave period
• Wave direction
• Wave spectrum
• Surface current
Radar Images during Typhoon Nockten (Oct 24 22:00, 2004)

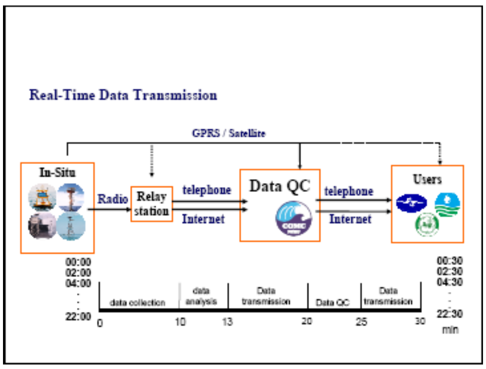

Pile station for sandy shallow water
The features and measuring items are the same with Data Buoy

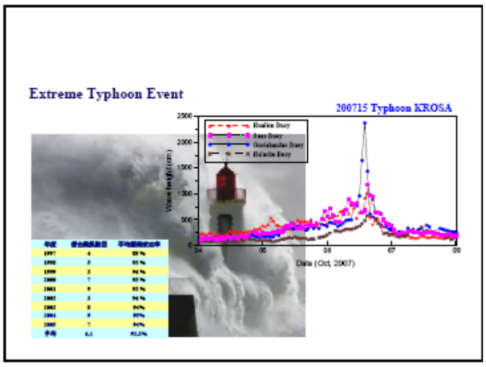

GPS Drifter for surface and sub-surface current measurement

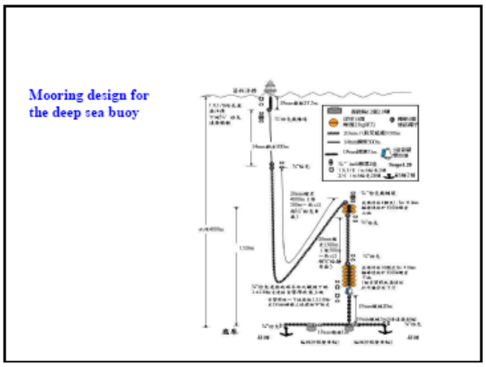

Tide Station with 3mm accuracy
Coastal Weather station

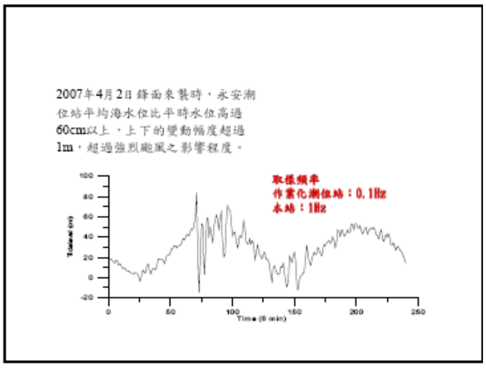

Coastal Ocean Monitoring Network
40 stations
including 14 data buoys
are being operated by COMC by 2006
Central Weather Bureau,
for marine weather forecasting
Water Resource Agency,
for coastal hazards mitigation
Tourism Bureau,
for recreational safety
Data Buoy
Tide Station
Coastal Weather Station

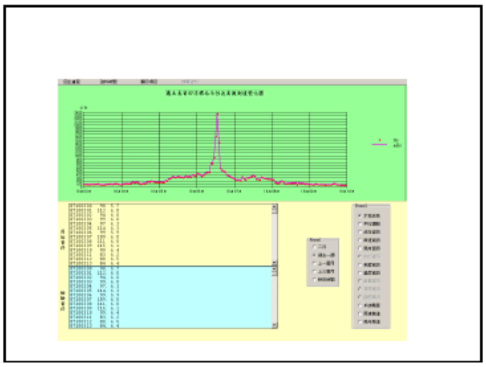

Fully Automated Shipboard Monitoring System
Measuring items:
• wind speed
• wind direction
• air temperature
• air pressure

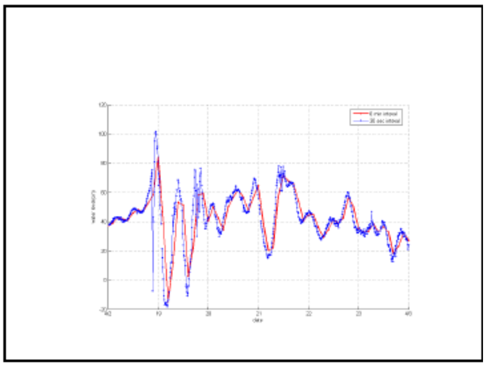

Real-Time Data Transmission
GPRS / Satellite
In-Situ
Radio
Relay station
telephone
Internet
Data QC
telephone
Internet
Users
00:00
02:00
04:00
22:00
00:30
02:30
04:30
22:30
data collection
data analysis
Data transmission
Data QC
Data transmission
0
10
13
20
25
30
min

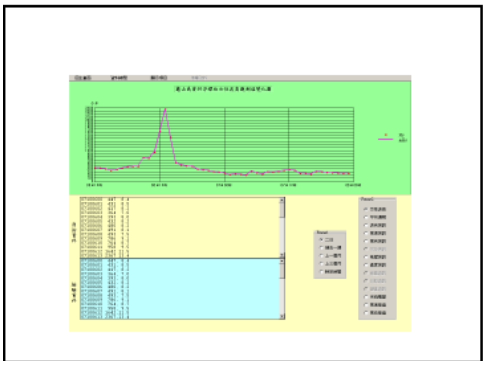

Extreme Typhoon Event
200715 Typhoon KROSA
Wave height (cm)
Date (Oct, 2007)

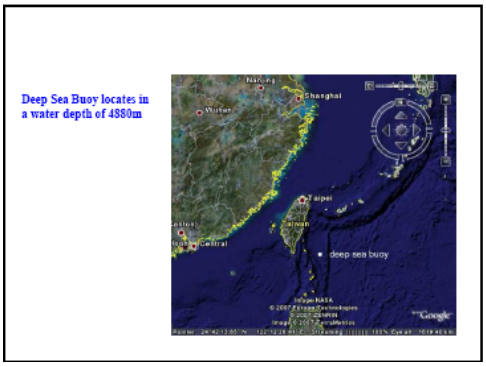

Mooring design for
the deep sea buoy

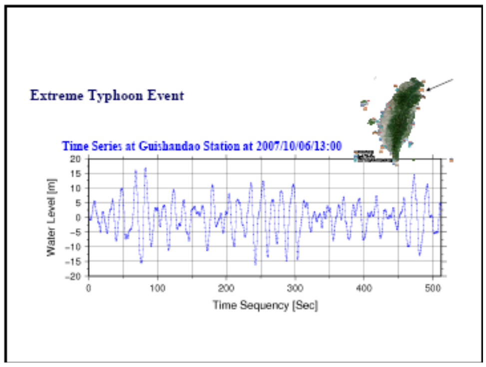

2007年4月2日鋒面來襲時，永安潮
位站平均海水位比平時水位高過
60cm以上，上下的變動幅度超過
1m，超過強烈颱風之影響程度。
取樣頻率
作業化潮位站：0.1Hz
本站：1Hz
Time (6 min)



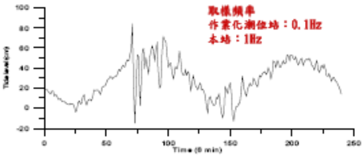


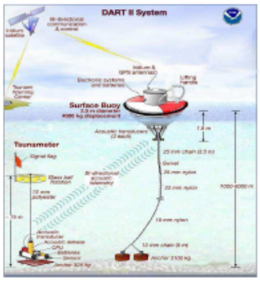


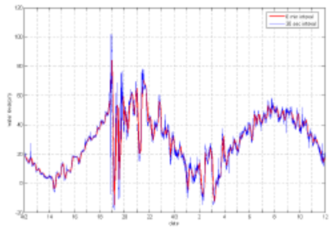

Deep Sea Buoy locates in
a water depth of 4880m
Shanghai
Taipei
deep sea buoy


Extreme Typhoon Event
Time Series at Guishandao Station at 2007/10/06/13:00
Water Level [m]
Time Sequency [Sec]

2007年4月2日鋒面來襲時，永安潮位站平均海水位比平時水位高過60cm以上，上下的變動幅度超過1m，超過強烈颱風之影響程度。





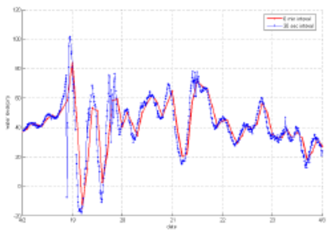


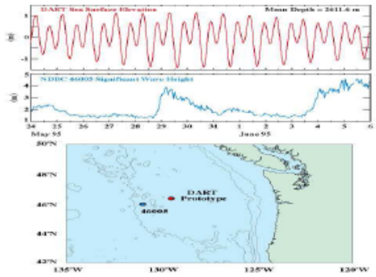
Deep-ocean Assessment and Reporting of Tsunamis (DART™)

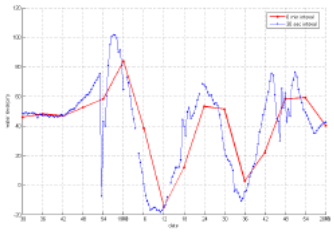
DART II PERFORMANCE CHARACTERISTIC / SPECIFICATION SUMMARY

Mandatory Characteristic	Specification
Measurement sensitivity	Less than 1 millimeter in 6000 meters; 2 * 10-7
Sampling interval, internal record	15 seconds
Sampling interval, event reports	15 and 60 seconds
Sampling interval, tidal reports	15 minutes
Tsunami data report trigger	Automatically by tsunami detection algorithm
Data flow, BPR to TWC	Less than 3 minutes after triggered event

Desired Characteristic	Specification
Reliability and data return ratio	Greater than 80%
Maximum deployment depth	6000 meters
Minimum deployment duration	1 year
Operating Conditions	Beaufort 9







http://nctr.pmel.noaa.gov/Mov/DART_04.swf

for an impressive movie

http://www.ndbc.noaa.gov/dart.shtml

for real time data

A Typhoon Swell Freak Wave Hindcast Example

Nai Kuang Liang

Institute of Oceanography
National Taiwan University
Chinese Taipei

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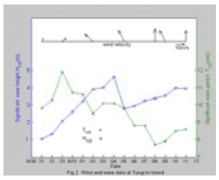
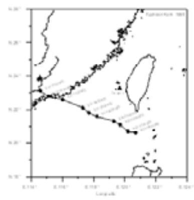




Introduction

- The typhoon or hurricane may generate huge waves within its domain. However, swells usually propagate faster than the typhoon itself and appear outside the typhoon.
- As a typhoon/hurricane approaches a location in the ocean quickly, the enhanced swell may be higher than those in the storm.

Introduction

- The typhoon can be regarded as a wave generator.
- As the typhoon is stationary, the situation is different from that approaching a station.
- As the typhoon approaches the observer, the travel time for the wave energy becomes shorter. This results in an increase in the wave energy flux.

Introduction

- If the typhoon approaching speed is close to the swell energy speed, i.e. the group velocity, a medium scale typhoon/hurricane may generate an extraordinary high swell.
- I named this wave height accumulation phenomenon as the typhoon swell Doppler effect.

Introduction

- If a typhoon is stationary, the swells appear within duration T_D. If the same typhoon is moving, the swell appearance time becomes T_D'.
- The total amount of energy passing through the cross section of a unit wave crest length is the same for the two cases.

$$\int_0^{T_D} (1/8)\rho g H^2 C_g dt = \int_0^{T_D'} (1/8)\rho g H'^2 C_g' dt$$

Introduction

- For $C_g = C_g'$
- Then $\int_0^{T_D} H^2 dt = \int_0^{T_D'} H'^2 dt$
- Assume that $H'/H = \lambda$, called the wave height modification factor and H is not a function of time t. Then

$$\lambda = (T_D / T_D')^{1/2}$$


中國時報

罕見巨浪狂飆 南方澳四漁船遭擊沉

瘋狗浪突襲

這麼大的海浪 四十年沒見過

Freak Wave

- Freak waves, so-called rogue waves or monster waves are known as a maritime myth, because they are nearly impossible according to traditional ocean wave theory.
- The freak wave has been explained by the focused current and nonlinear effects. According to some research, an unusual, unstable wave type may form a single wave that 'sucks' energy from other waves.
- However, the moving wind system is another reason.

Case Study 1

- Two days ago, a medium scale typhoon Janis had been in the area around 19°N, 136°E and moved fast toward Taiwan.
- The data of typhoon Janis are shown in Table I. There was unfortunately no wave measurement.

Freak Wave

- On January 1st 1995 an extreme single wave of 26 meters was measured under the Draupner oil-platform in the North Sea.
- On December 12, 1978 the cargo ship Muenchen, a state-of-the art cargo ship, disappeared in the mid-Atlantic.
- In March, 2001, two reputable ships were crippled to the point of sinking. The Bremen and Caledonian Star were carrying hundreds of tourists across the South Atlantic. At 5am on 2 March the Caledonian Star's First Officer saw a 30m wave bearing down on them.

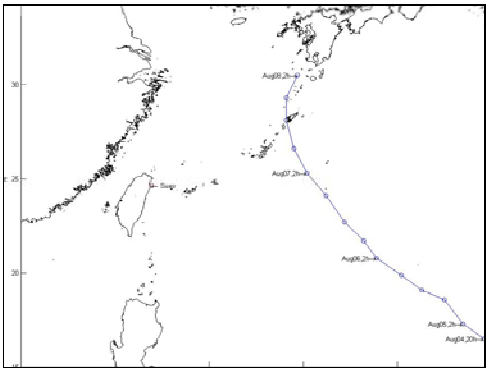
Case Study 1

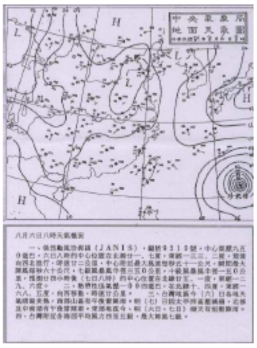
Table I Data of typhoon Janis

Month	Day	Time (local)	Latitude	Longitude	Central Pressure (hPa)	Radius of Beaufort Scale No.7 (km)	Note
8	4	20	16.5	139.6	990	150	
	5	2	17.3	138.5	990	150	
		8	18.6	137.5	980	200	
		14	19.1	136.3	970	200	
		17	19.5	135.75	962.5	250	interpolated
		19	19.77	135.38	957.5	283	interpolated
		20	19.9	135.2	955	300	
		21	20.05	134.98	954.2	300	interpolated
		23	20.35	134.55	952.5	300	interpolated
	6	2	20.8	133.9	950	300	
		8	21.7	133.2	950	350	
		14	22.7	132.2	950	350	
		20	24.1	131.2	945	350	

Case Study 1

- At about 4 a.m. on August 7, 1992, four fishing ships were totally destroyed by sudden huge waves in the vicinity of Suao Harbor(24.63°N, 121.93°E) at the east coast of Taiwan.
- One man died, two persons were missing and five fishermen were wounded. As the accident was close to the harbor, some wrecks were drifted to shore.
- One fisherman reminded that he has never confronted such big waves in his 40 years' fishing career.





Case Study 1

- No. 7 is the first datum which is not overrun and the wave height modification factor amounts to 19,85.
- The wave height 40.5m must be over-estimated. But the wave height must be huge. Because the wave height modification factor is sensitive to the typhoon data. The number ought not be emphasized.

Case Study 1

- Using my "typhoon swell prediction scheme" and assuming Kuroshio current being 2.5 knot, the hindcasted wave are shown in Table II.
- Ts is assumed to be 1.2Tp, where Tp is the peak wave period.

Case Study 2

- At about 2 p.m., October 23, 1987, regardless of the invasion of Typhoon Lynn, 304 teachers and pupils of Hydraulic Elementary School of Pingtung County came to Mau-Bi-Tou coast for a tour(near southern tip of Taiwan,21.91°N, 120.725°E).
- As the pupils walked one by one along aisle to the coral reef, suddenly huge waves attacked the coast and 9 pupils were drowned in the sea. The whole nation dropped in a great grief.
- At the meantime, the typhoon scale has transferred from "strong" to "medium" and its center was about 500 km away but has moved fast previously toward Mau-Bi-Tou. On the next day, the headline of United Daily News wrote: "Typhoon Far Away, Hazard Close to Eyes".

Case Study 1

Table II Hindcasted typhoon Janis swell

No.	Day	Time	H1/3 (Meter	TS (Sec.)	λ	DD (N.M.)	TD' (Hour)	Approaching Speed (knot)	Note
1	7	20.6	0.96	8.28	2.29	1026.8	1.15		
2		9.88	1.17	10.49	1.414	940.6	-10.7	14.36	overrun
3		7.85	1.53	11.66	1.414	886.1	-2.03	12.4	overrun
4		5.58	2.14	12.9	1.414	827.8	-2.26	12.77	overrun
5		4.73	2.59	13.64	1.414	802.1	-0.85	12.85	overrun
6		4.46	2.8	14.0	1.414	789.6	-0.27	12.5	overrun
7		4.73	40.5	14.05	19.85	774.7	0.0025	14.9	

颱風遠在天邊？災難近在眼前！

國小師生郊遊 變貓鼻頭

滔天巨浪拍岸 吞噬九學童

邱主席極表痛心 促查明校方責任

怪師長疏忽 哭喊打擊起 望海的母親 哀慟昏厥

傷心過度 老師癱瘓 應訊答辯 事出突

風狂浪急 未封閉步道 墾丁公園 任遊客涉險

明知琳恩來，郊遊未延期 學子逐波去，究竟誰之過

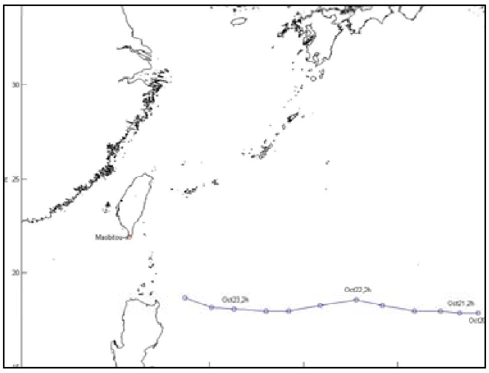
Case Study 1

- Due to the swiftly approaching speed around 14 knots and the quickly enhancing typhoon strength increasing from 970 hPa to 955 hPa in 6 hours, the data from No. 2 through No. 6 in Table II are always overrun.

Case Study 2

Table III Data of typhoon Lynn

Month	Day	Time (local)	Latitude	Longitude	Central Pressure (hPa)	Radius of Beaufort Scale No.7 (km)
10	20	20	17.9	139.3	920	300
	21	2	17.9	138.3	915	300
		8	18.0	137.3	910	300
		14	18.0	135.9	925	300
		20	18.3	134.2	925	300
	22	2	18.6	132.8	930	300
		8	18.3	130.9	945	350
		14	18.0	129.2	945	400
		20	18.0	128.0	945	400



Case Study 2

No.	Day	Time	H1/3	TS	λ	DD
1	23	12.3	5.03	15.7	1.41	522.5
2		12.9	5.06	15.7	1.40	512.5
3		13.5	5.1	15.7	1.40	502.5
4		14.1	5.14	15.7	1.40	492.5
5		14.7	5.18	15.7	1.39	482.7

＊ Assuming zero current speed

Case Study 2

Table IV Hindcasted typhoon Lynn swell

No.	Day	Time	H1/3 (Meter	TS (Sec.)	λ	DD (N.M.)	TD' (Hour)	Approaching Speed (knot)	Note
1	22	17.2	3.8	16.7	1.49	1020.3	2.7	10.0	
2		20.6	4.0	16.9	1.47	963.8	2.8	10.0	
3	23	1.3	3.0	16.1	1.16	887.5	4.44	14.0	
4		3.4	5.7	16.1	2.09	789.7	1.38	17.3	
5		6.7	4.1	15.8	1.47	708.3	2.76	14.3	
6		9.7	4.7	15.3	1.60	613.1	2.36	19.2	
7		11.7	7.6	15.7	2.15	532.6	1.29	17.3	
8		15.3	5.3	15.7	1.40	472.8	3.07	12.0	

Case Study 2

- If the longitude at 17h is perturbed from 128.6 to 128.7, the hindcasted swell at 14.1h, wave height is 7.1 meter.
- This is similar to that on the news paper!

Conclusion

- This hindcast can answer the reason of the accident. And It can be predicted.
- As a typhoon is approaching quickly
  or its strength increasing fast, somewhere hundreds nautical miles away from typhoon, freak wave may take place at sometime.

＊A little typhoon parameter perturbation may result to a freak wave.

Case Study 2

- The accident took place after 2 p.m..
- Interpolating typhoon data between14h～20h, Oct. 22 each hour linearly, only longitudes are changed:

Time	longitude
15	129
16	128.8
17	128.6
18	128.4
19	128.2

Thank You
for your Attention

Monitoring of Marine Resources in Indonesia's Small Outer Islands (Case: Manterawu Island, North Sulawesi)

Dendy Mahabror, Nicco P, Dedy Aan

ABSTRACT

In Indonesia archipelago, small outer islands are an important territorial base point. Monitoring for marine resources in these islands is important to know global warming phenomenon. Manterawu Island located in North Sulawesi is one of small outer island in Indonesia. This island have ± 750,66 Ha of land and surrounding by mangrove ± 1356,83 Ha and coral reef ± 494,77 Ha. Topography elevation of this island is about 3 meters. The interesting thing from this island is it has a potential sub surface sink. This study will assess an operational oceanography method to be implemented to the island. The goals of the method are to monitor sea level rise and coral bleaching affected by global warming. Some instruments will be installed in Manterawu Island such as tide gauge, meteorology and oceanography measurement station.

Keyword: small outer islands, global warming, manterawu islands, operational oceanography

1. INTRODUCTION

In Indonesia archipelago, outer islands has strategic value as base point from base islands of Indonesia on arrangement Indonesia territorial areas, Exclusive Economical Indonesian Zone, and Indonesia base continental, For exploit and resources management on outer islands, Indonesia issue to presidential degree in 2005 no 78 about small outer islands management.

The one of outer islands is Manterawu island or usually community called Mantehage. It's located in north Sulawesi in north Minahasa regency was bounded by Philippine. Manterawu island has big potential such as tour area, Conservation, and fisheries potential.

. Marine potential in Manterawu island not used yet optimally because it's geography position in outer Indonesia. The way of resources small outer islands on fisheries and marine are develop observation stations on marine and fisheries

Development of marine observation station have two benefit such the fist as to development marine observation station and nature laboratory for research and growing marine resources especially in potential areas. Second as medium to increasing control and safety small islands through to observation station for justification NKRI area.

2. PURPOSE

Marine resources potentials monitoring for small outer islands Indonesia.

3. BENEFIT

As one of monitoring system global warming effect to existence small outer islands.

4. METHODOLOGY

Method In this activity is accumulate primer data with survey mangrove plotting, coral reef and bathymetry will be compilation with ASTER Image data.

5. SURVEY RESULT

In 2007 have been doing Marine resources potential monitoring in Manterawu which one of small outer islands in north Sulawesi.

This island occupied by ± 2000 people which they are as farmer especially coconut farmer and rice farmer unirrigated agricultural field. Fisherman is the second profession in this island and they are use fishing gear traditional.

This island surrounded by mangrove woods especially rhizophora species and Bruguera, etc. It's function for wave detention and spawning ground, crustacea and other biotic.

This is result data spatial and data survey:

Result ASTER data process indicate to Manterawu Island have several dominant part as land, mangrove and coral reef. Beside that Manterawu island have characteristic oceanography such as drop off bathymetry as far as shoreline. Coverage of Coral reef is large and many variety. Mangrove forest is biggest part in Manterawu island, its founded as far as shoreline.

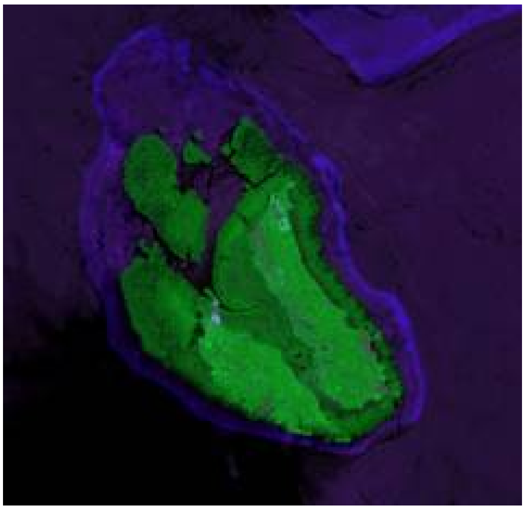


Figure 1: ASTER Citra Data Manterawu Island.

6. LANDS

Result ASTER data process indicate to Manterawu island have ± ***750,66 Ha***. Manterawu land is have 2 part, east land and west land. This island of consist Buhias, Tangkasi, Bango and Tinongko village.

Figure 2: Land Of Manterawu Island.

About 1/3 Main land of Manterawu island is critical land many of growing by shrubs. It's having an area of ± 220 Ha have potential to growing so that can increase economy local community. Jarak plant is long time to know by local community, but a little knowledge they have, now that plant not exploit anymore.

Exploit critical area give additional value for community area live. In this case *jarak* plant for ± 220 Ha area, its possible to produce 880 ton every harvest if assumed for 1 ha has plants 2500 trees with produced ± 2 kg per tree. Long time ago *jarak* produced torch fuel for lightning by local community.

Beside potential critical areas Manterawu land experience to treat for sink because of topography elevation oscillate 3 meters susceptible to increase surface sea. Local community called this island is sink of island because this island have a different with another island on there. Beside that land of island can not see from outside because other than only have topography elevation about 3 meter, its have land surrounding by mangrove forest.

Figure 3: Jarak Plant in Manterawu.

7. MANGROVE

Mangrove woods frequently called as bakau woods, bod woods or tidal woods, formed are devolution ecosystem between land and sea. Mangrove ecosystem have big gradient environment quality, so only kind have tolerant that environment condition such can survive and grow.

Manterawu island from processing ASTER data indicate have an area of mangrove forest about

± ***1356,83 Ha.*** Manterawu island domination by mangrove woods with Rhizopora type where that widely bigger than land coral reef. This woods consign 2 land in Manterau island. In around linecoast Manterawu island there are mangrove woods heavy enough so can categorical so it can help to protect coast and spawning ground.

Figure 4: Coverage of Mangrove in Manterawu.

Covered mangrove woods in this island extent enough, even though exceed that land. Mangrove growing in this island there are 18 type such as Acanthus ilicifolius, Bruguiera cylindrica, Ceriops decandra, Excoecaria agallocha, Heritiera littoralis, Nypa fruticans, Rhizophora apiculata, Sonneratia alba, Terminalia cattapa and Xylocarpus granatum.

8. CORAL REEFS

Coral Reefs is organism that alive at tropic sea bottom and formed to be sea biotic lime produce especially reef type and lime produce algae ($CaCO_3$) and formed of ecosystem strong enough to hold up to wave. Coral reef is ecosystem marine the most productive and highest biodiversity.

Figure 5: Coverage of Coral in Manterawu.

Result ASTER data process coral reef indicate to Manterawu island have an area of ± ***494,77 Ha***. Coral reef about ± 500m from shoreline and surrounding manterawu island. Mangrove and coral reef made ecosystem manterawu island will be guard and environment carrying capacity adequate enough. It can forming of the ocean park and this area is a part of Bunaken marine park.

Result Data survey by line transect method at north, south, east and west Manterawu island so can founded coral reef such as :

1. North Manterawu
   Domination coral reef Non-Acropora encrusting type, dead coral reef (16%). It indicate that hydrodynamic effect is big. This fact because of type and form coral reef alive in area have influence from wave and flow.
2. South Manterawu
   Domination coral reef Non-Acropora encrusting type, Non-Acropora Sub-Massive and dead coral reef (2%). It indicate that characteristic of environment in south manterawu waters influences by effluence intensity and big hydrodynamic compulsion (wave and flow) also at location exposure sub area.
3. East Manterawu
   Domination Acropora Branching type, Non acropora sub-massive and dead coral reef 5%. Emergent domination acropora branching equal with another type decide that characteristic of hydrodynamic in waters wave and flow and also have enough effluence intensity. Differences domination coral reef type in east manterawu between acropora branching and non acropora sub-massive decide that bathymetry in waters steep enough. And have difference location alive characteristic which Non Acropora Sub massive for shallow waters while Acropora Branching live in more deep waters.
4. West Manterawu
   Dominating coral reef are Acropora Branching and Non acropora sub-massive while dead coral 7%. Emergent domination acropora branching equal with another type decide that hydrodynamic characteristic in waters wave and flow and also have effluence intensity enough. Differences domination coral reef type in west manterawu between acropora branching and non acropora sub-massive decide that bathymetry in waters steep enough. And have difference location alive characteristic which

Non Acropora Sub massive for shallow waters while Acropora Branching live in more deep waters.

9. OCEANOGRAPHY

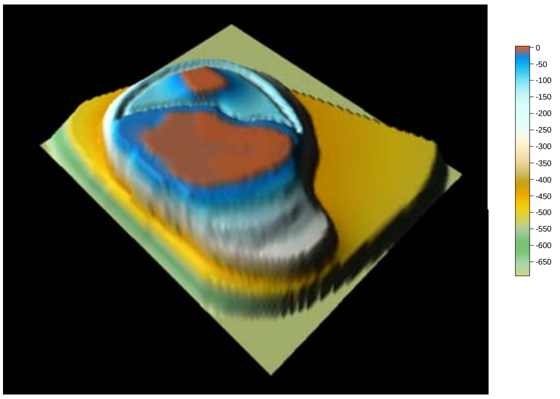


Figure 6: Bathymetry Simulation with Surfer Process.

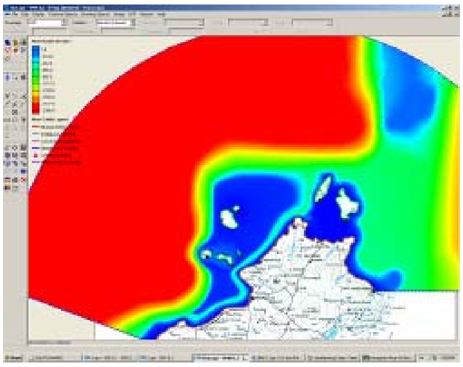


Figure 7: Bathymetry Simulation with SMS Process.

Characteristic bathymetry of Mantehage island there are many drop off. High extreme is more than 500m. Manterawu island surrounding there are reef wall which as coast protection from wave.

On deep sea waters, wave movement be happen on upper ocean. Automatically not effect to underside close to sea bottom (because on deep sea, vertical distance from sea bottom to upper, so far). But depth bathymetry in this island is extreme enough which 5m until hundreds meters the distance only 100-200 m.

With this characteristic of bathymetry therefore wave movement from deep sea big enough but will be happen diffraction effect from large coral barrier in around this island. Beside that ocean flow in depth more than 25m is danger. Point flow strong enough is at mantehage side west this fact motivate characteristic of reef growing more domination reef branching exact is close by reef wall.

Under flow dashing reason forming of gua ceruk. At much gua ceruk there are potential fall if upper coral was brittle.

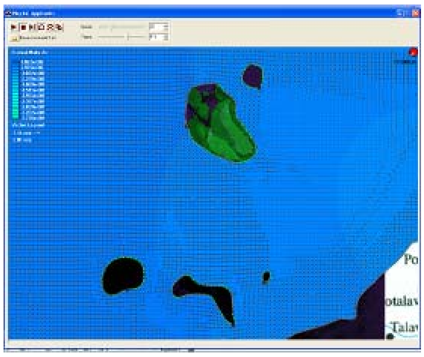


Figure 8: Current in Manterawu Island.

Characteristic this island are many kind, these island have most marine resources and low topography, but there are threat from global warming.

Global warming is the global average air temperature near the Earth's surface rise 0.74 ± 0.18 °C (1.33 ± 0.32 °F) during the last 100. This event could become more severe in the coming decades. The expected global warming from the greenhouse effect is likely to raise sea level a few feet in the next one hundred years and may increase the frequency of severe storms as well.

There are loss potential will be happened if nothing marine potential management resources and monitoring in small outer Indonesia island, such as:

a. Have been bleaching coral reef. Coral reef sometimes live at temperature oscillate 28^{o}-31^{o}C. If water sea temperature to go above 31^{o}C coral reef damage not be avoided anymore. This condition will be happen within less than 25 meter.

b. Coastal zone and small island has altitude under 2 meters lossing chance. If assumed increasing water sea level 1 meter at sloping 2% during 100 year is significant coastal zone, Including Indonesia small islands have sub surface sink about 4.050 Ha per year. Small island have potential sub surface sink ± 2000 islands.

Emergent global warming phenomenon like anomaly monsoon, water sea increasing and often breaker in this area which never happened before. Marine observation station in small outer island have potential suffer damage to global warming phenomenon effect. It is give input policy to management small island Indonesia.

The one of reason, why small outer island is need marine resources monitoring because of several years have been global warming phenomenon. It have effect especially for state formed by islands like Indonesia and whole small island in Indonesia have high land not more than 3m to sea surface and abundant marine resources.

The water that makes these islands desirable, however, also places them at risk. The beautiful homes with their oceanfront views are vulnerable both to storms, which can cause sub surface sink potential and erosion on shoreline.

Figure 7 provides a cross section of a barrier island washing over: the island erodes from the ocean side until it reaches a critical width, generally about 400-700 feet (Leatherman 1979), after which the erosive forces of storms tend more to push sand landward onto the bay side of the island. The net effect of the wash over process is similar to rolling up a rug; as the island rolls landward, it builds upward and remains above sea level.

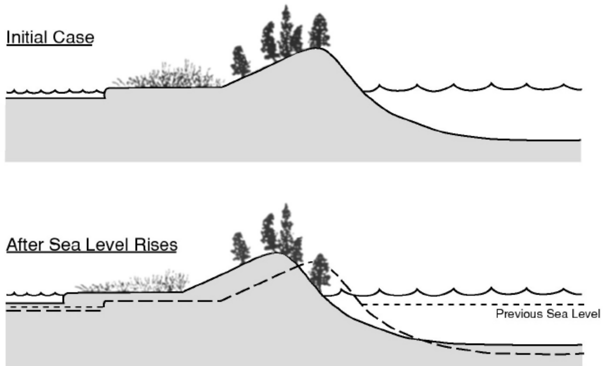


Figure 9: Natural Response Undeveloped Barrier Island to Sea Level Rise.

Base on IPCC (Intergovernmental Panel Climate Change) research between 1970-2004, In Indonesia have been increasing temperature average 0,2-1^{o}C. Global temperature increase on last 100 years, earth temperature increase about 0,7^{o}C, next since 1900 sea level increase 1-3 mm/years. If assumed every year have been increasing se level 3-5mm so next 100 years increasing 500mm.

Manterawu island have topography about 3m to mean sea water level (MSL). With that assume therefore in 500 possible these island will be sink.

Other effects of global warming may exacerbate these impacts. Warmer temperatures could increase the frequency and severity of hurricanes 50 percent (Emmanuel 1988), increasing both erosion and the salinity of estuaries and aquifers would increase, threatening water supplies and aquatic life.

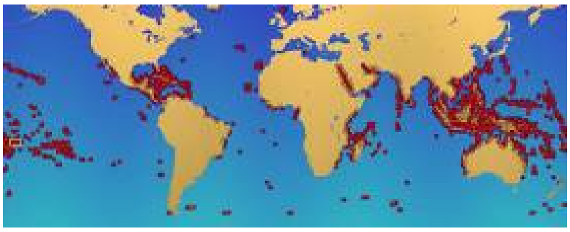


Figure 10: Distribution of Coral in The World.

Coral reef bleaching, the whitening of diverse invertebrate taxa. Of the causing stressors of coral reef bleaching, many are related to local environmental degradation and reef overexploitation. Of the stressors mentioned above, only sea water temperature and solar irradiance have possible global factors driving changes and extremes. Global warming, along with ENSO events, change sea water temperatures. Ozone depletion increases the amount of UVR reaching the Earth's surface, and possibly causing coral bleaching events.

Increased sea temperatures and solar radiation (especially UV radiation), either separately or in combination, have received consideration as plausible large-scale stressors. In most instances, wherever coral reef bleaching was reported, it occurred during the summer season or near the end of a protracted warming period.

Coral bleaching was reported to have occurred during periods of low wind velocity, clear skies, calm seas and low turbidity, when conditions favor localized heating and high penetration of short wave length (UV) radiation. Also less oxygen is held by water at higher temperatures. Potentially stressful high sea temperatures and UV radiation flux could conceivably cause coral reef bleaching on a global scale with suspected greenhouse warming and the thinning of the ozone layer.

As reef building corals live near their upper thermal tolerance limits, small increases in sea temperature (.5 –1.5 degrees C) over several weeks or large increases (3-4 degrees C) over a few days will lead to coral dysfunction and death.

In 1990, 1995, and 1998 is the hot years in 20 century. Increasing earth temperatures according Nature Journal happened:

1. Low: 0.8 - 1.7 °C as much as 9-13% species would be extinct with various level.
2. Middle: 1.8-2.0°C,. 15-20% would be extinct.
3. High: over 2.0 °C, 21-32% would be extinct.

Beside that increasing sea water temperatures about 2-3°C coral reef will be die because coral bleaching impact. This happening in Australia, Thailand, Filipina, Indonesia, Jamaica, Bahama, etc in 1997/1998 El Nino effect.

Marine and fisheries Department enounce, in two periods (2005-2007) Indonesia have been loss 24 small islands be sinking.

Much as 24 small islands include 3 islands in Nanggroe Aceh Darussalam, 3 islands in north Sumatera, 3 islands in Papua, 5 Islands in Riau, 2 islands in west Sumatra, 1 island in south Sulawesi, and 7 in Seribu island (NAW).

Figure 11: Marine Observation System.

This phenomenon so BROK (Balai Riset dan Observasi Kelautan) will be doing marine observation for small islands there have potential will be sink and marine resources damage. That monitoring is remote sensing method and in situ measurement. There are monitoring concept done for several next years such as:

10. CONCLUSION

This study “Monitoring of Marine Resources in Indonesia’s Small Outer Islands” have conclusion such as :

1. Topography elevation of this island is about 3 meters. The interesting thing from this island is it have a potential sub surface sink
2. This island have ± 750,66 Ha of land and surrounding by mangrove ± 1356,83 Ha and coral reef ± 494,77 Ha.
3. Characteristic bathymetry of Mantehage island there are many drop off. High extreme is more than 500m. Manterawu island surrounding there are reef wall which as coast protection from wave.
4. Some instruments will be installed in Manterawu Island such as tide gauge, meteorology and oceanography measurement station. This station have most Important to monitoring marine resources and existence small outer island.
5. Marine station observation most important for some forecast hydrodynamic in Indonesian sea such as :
   a. Weather Forecasting
   b. Reduce Loss of Life and Property from Disasters
   c. Protect and Monitor Our Ocean Resource
   d. Understand, Assess, Predict, Mitigate and Adapt to Climate Variability and Change
   e. Sustainable Agriculture and Land Degradation
   f. Protect and Monitor Water Resources
   g. Monitor and Manage Energy Resources