International SYMPOSIUM

18 - 20 May 2009

Effects of Climate Change On Coastal Zone Management

Launching of **Expert Capacity Data Base**

IndonesianCoastalHUB

Bandung , Indonesia
Hotel Jayakarta

CBA2008-08NSY-Andonowati
Integrating Indonesian Capacity for Coastal Zone Management

Organized by

Lectures with abstracts

Monday 18 May 2009		
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Jamaluddin Jompa		*Climate Change, Potential Impacts on Coral Reefs, and Management Challenges*
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Y.R.A. Lumingkewas, R. Poerbandono and K. Prijatna		*Recent adaptation measures and the progressing regional environmental settings in Seribu Islands, Java sea, Indonesia*
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ABSTRACTS

INVITED LECTURES

THE SOCIAL-ECOLOGICAL SYSTEM APPROACH IN THE CONTEXT OF INTEGRATED COASTAL MANAGEMENT AND GOVERNANCE

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Coastal zone is widely known as the most complex systems, both in terms of ecosystem and human system so that the need of integrated approach is considerably very important for enhancing efforts to achieve sustainable development objectives of such ecosystems. One of important approach in governing the coastal complex system is social-ecological system approach (SES approach). Anderies, et.al (2004) define social-ecological system as an ecosystem/biological unit intricately linked with and affected by one or more social systems. In this regards, Daly's full and empty world theory would be relevant to identify the relations among social actors in the complex ecosystems or between social actors and complex ecosystem. In this lecture, principle of SES management and governance would be emphasized with some relevant case studies.

CLIMATE CHANGE, POTENTIAL IMPACTS ON CORAL REEFS, AND MANAGEMENT CHALLENGES

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Climate change is not a mere prediction anymore, it has happened, and it will continue in the future. The warming sea surface temperature has caused a serious coral bleaching since 1998 and it seemed to be worsening in the following years. Coral bleaching involves the rejection of microalgal symbiotic zooxanthellae from the coral tissues, in response to stress, such as from an extreme seawater temperature (~2 ^{0}C warmer than average temperature). In the absence of these symbiotic microalgae, the reef builder Scleractinian corals may not be existent and dominate the reef any longer. The increasing CO_2 emission in fact not only trigger global warming and cause the reef to die from bleaching, but also affect ocean acidification that eventually make coral to grow slower. Furthermore, due to the global growing economy and development in the past century, coastal communities have put even bigger pressures to the coral reef ecosystem through destructive fishing, coral mining, sedimentation, and pollution. Then, are we going to lose our valuable coral reefs? Indonesia as the center of the Coral Triangle, of course rely so much on these resource, so we need to find the best solution urgently. The fate of our coral reefs seem to be gloomy, they face multi stressors, these indeed huge management challenges if we are going to save our coral reefs for future generation.

CLIMATE CHANGE AND GLOBAL WARMING: IMPLICATION TO COASTAL ZONE AND SMALL ISLANDS, AND STRATEGIC PERSPECTIVE OF ADAPTATION

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Indonesia that consists of more than 17.000 islands and 95.181 km of coastlines, makes it the biggest archipelagic state in the world and a host to rich and essential coastal and marine goods and services to society. Some 60% of the total Indonesia's population live on the coastal and small islands areas, and these areas become more crowded every year.

Coastal and marine environment are strongly linked to climate in many ways. The potential consequences of climate change are not yet being considered in Indonesia's coastal and small islands management. It is urgent to begin adaptation now with regard to development of coastal and small islands uses.

In coastal and small islands areas where beaches or wetlands must migrate inland to survive, implementing protection or retreat strategies for coastal and small islands developments can reduce the economic impacts of inundation and shoreline movement.

Key words: *coastal zone, small islands, climate change, global warming, adaptation*

RAMIFICATION OF SEA LEVEL RISE ON SEA-BORDER BETWEEN NEIGHBOURING COUNTRIES

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The direct effect of climate change is the increase of surface air temperature causing warming of the Artic and Antartic regions, melting glacier ice, and in turn raising the global sea level. This eustatic change in sea level will conspicuously reduce the land areas of all coastal states of the world.

Furthermore, the global sea level rise is bound to have considerable legal ramifications on sea-borders between neighbouring states. Whether the existing sea-boundary requires adjustment or not depends on a number of factors, such as the bathymetric condition between the respective countries. When such adjustments took place the prevailing geopolitical condition need to be reshaped, and this could provoke political tensions, economical disputes, and conflicts between the relevant states.

The effect of sea level rise on Indonesian sea-border is discussed in this paper, since Indonesia has sea-borders with ten (10) neighbouring countries, and some of them need to be ratified.

WAVE MODELLING IN A TIDAL INLET SYSTEM

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The Netherlands is a low-lying country protected by an elaborate system of dikes. Without these dikes about 40% of the Netherlands would be flooded. The safety of these dikes is a major concern for the coastal authorities. By law, these dikes must be monitored every five years (2001, 2006, 2011, etc.) to assess the required level of protection. This check is based on Hydraulic Boundary Conditions (HBC) that are derived every five years. In this way, the latest developments in statistical analysis, climate change, modelling techniques and strength of coastal structures can be accounted for. The HBC consist of near-shore water levels and wave conditions.

Presently, a long-term investigation is taking place in the Netherlands to determine these HBC for the Wadden Sea. This is a shallow sea situated in the north of the Netherlands and partly sheltered from the North Sea by a number of barrier islands. The Wadden Sea is connected to the North Sea via a number of tidal inlets. The water depth in the Wadden Sea varies from about 25 m in the tidal channels up to +1 m above mean sea level on the tidal flats. In addition, a set of 10 wave buoys is deployed to measure the wave conditions in the tidal inlets and interior of the Wadden Sea.

The wave conditions in the Wadden Sea are determined by transforming North Sea wave conditions into the Wadden Sea using the spectral wind wave model SWAN. This model is driven by storm winds. Wave boundary conditions are obtained from wave buoys located in the North Sea. Water level and current fields are provided by numerical flow models. The wave buoys are used to assess the reliability of the wave model in storm conditions.

The wave model computations show that the tidal inlets act as an effective filter for the North Sea waves, such that the wave conditions are mainly locally determined. Since the Wadden Sea is rather shallow, the wave height becomes depth-limited. The role of the various physical processes acting on the waves will be illustrated. This includes the role of the processes of generation and dissipation of the waves, as well as the role of propagation effects. A weak point in the present modelling is the penetration of low-frequency wind waves (waves with periods larger than 10 s) through a complicated bathymetry.

Sensitivity analyses were performed to assess the effect of climate change on the wave conditions in the interior of the Wadden Sea and along the dikes of the Netherlands. These changes include a sea level rise and increased storm conditions on the North Sea. The results of studies were used identify weak points in the coastal protection and in the modelling of wind waves under extreme conditions.

Indonesian Water Balance and Footprint

YAB Labmath

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In this lecture we motivate the use of modelling and simulation tools to study the effect of Climate Change on environmental water, i.e. rainwater. With as extreme example the important current problems of peatlands, it is argued that also more generally knowledge about the groundwater level is of much urgent interest, in view of increasing scarcity of water for human consumption and agricultural use. The main effects of CC for groundwater are the increase of wind speed and higher temperature, both resulting in higher evapotranspiration. Together with the fact that more intensified rain (at constant total rain) will lead to more run-off, the groundwater storage can be expected to decrease from simple balance law arguments.

Local variations may increase or reduce these effects; these variations can result from human interactions, such as changing land use (changing crop cultivation), urbanization, etc.

One measure to calculate the amount of water that is actually already 'virtually' assumed by the inhabitants is to use the concept of virtual water: the water needed to produce (grow) a specific crop, given the climatological circumstances and the way of producing (lan use and yield). We report about research performed at LabMath-Indonesia by Rik Bulsink and Meese Beeker from Utwente Netherlands in 2008, who estimated the total waterfootprint to be 1092 m^3/cap/year on average for Indonesia, with large differences between the main islands.

INDONESIAN COASTAL HUB www.IndonesianCoastalHUB.org

Andonowati

LabMath-Indonesia, Bandung

In many research areas in Indonesia, when discussing about who are doing what and where, we often have difficult to see even a global picture. What are past and current projects, where are their locations, which agencies are responsible, who are involved in the executions, where the funding comes from. A Map of researches and projects can answer those questions and thus can give direction for the future planning. In this article, we focus on the special topic that is Coastal Zone Management. Direction of a future plan & development in the Indonesian Coastal Zone is crucial particularly because of the impacts of the global climate change.

Preceded by several in-depth studies that included visits, observations and intensive dialogues with research groups in several Indonesian research institutions, it is clear that there are several research groups with very promising research capacities as well as excellent innovative ideas. Yet, many of those researchers are not connected to each other and often have no collaborations. Some time even same projects are redundantly executed by different groups. Thus, the first step toward having a research map in Coastal Zone Management is to create a structured and standardized expert inventory in the area. This idea was the basic of our application to APN-Capable project. The proposal entitled *Integrating Indonesian Capacity for Coastal Zone Management* was granted last year (2008) under Project Reference CBA2008-08NSY-Andonowati.

The design of the expert data base, and the collection of data, started in September 2008. A questionnaire was designed and made online available on the APN-project website www.labmath-indonesia.or.id/apn. During the course of the project, however, the idea of creating this inventory has been developed. The main concern is how the data base can grow, dynamically updated, and become a point of interest to the participants. For this, we have been trying to study some scientific communities and how the members of these communities interact. We conclude that we want to make a virtual meeting point that is called Indonesian Coastal HUB. The Hub in-fact also become a nucleus for a Virtual (Thematic) Research Park.

From the main page (Home) of the Hub, recent information that is entered by members and collected can be accessed through buttons related to Files, Events, Links and Questions.

Members can also upload their simulation tools, research papers, teaching material, and their networks in the area of Coastal Zone Management.

The Hub will accommodate the core expertise as its members. These members then are listed alphabetically and can be shorted as well as searched by names, institutions, keyword (associated with his/her research areas). New members can be added based on the invitations of the current members. In the application form for the new member, a login name and password will be requested which, when the membership is approved, can be used to login to the web. The core members will have access to information from the main page.

The Hub will also accommodate memberships from larger coastal management Community such as consulting companies, policy makers, etc.

We brought up the idea and showed the model of an Indonesian Coastal Indonesian Hub in the second APN meeting held on 20-21 March 2009. This second meeting was attended by 20 senior researchers from Universities such as Institut Teknologi Bandung, Institut Pertanian Bogor, Universitas Gajah Mada as well as Government Agencies such as Indonesian Institute of Sciences, Agency for Assessment and Applications of Technology as well as senior representatives from the ministries. It was opened with a presentation of Prof. Syafwan Hadi entitled “Policies on Indonesian Coastal Management” followed with a presentation on the model of Indonesian Coastal Hub. All participants were very positive with the idea of Indonesian Coastal HUB. The following suggestions were made regarding the Hub & expertise.

- The data security of the expertise needs to be addressed
- Expertise and projects can be shown and accessed on the Indonesian Coastal Map
- Additional tools to help the user in updating their profile or inviting their colleagues
- The Hub will be hosted as an independent website.
- Maintenance and administration of the Hub are the responsibility of LabMath Indonesia.
- Meeting of the core experts will be conducted yearly at different institutes/agencies/ministries.

During this presentation the official launching of the website will take place.

DISTRICT LEVEL PREDICTION FOR ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE ON COASTAL MANAGEMENT

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Climate change, as implication of global warming, which caused by increasing of green house gasses, has consequence on two main case at boundary layer, that is fluctuation of rainfall and temperature. This implication happens to several district region on Indonesia Island.

In this study, it is performed a prediction of distric's rainfall . HyBMG model can be used to build this prediction on spatial map. The result is focused to Malang area regarding to the research area to provide climate information which it appropriates with the farmer and policy maker needs. Malang is a unique district which locates in East Java, has a mountainous area and some part of Malang is urban area. Furthermore, this is a national program was initiated to develop a climate information system which is intended largely to provide high resolution climate information to support climate-related decision making processes at regency/district scales. The result of climate information in the newly implemented system in Indonesia is basically a high resolution climate forecasting based on dynamical and statistical downscaling in combination with some 'classical' and advanced statistical techniques.

The applications of the district level prediction has been usefull to support many activities of climate change particularly on coastal and agricultural management.

Keyword: *climate change, coastal management, district level prediction*

VARIATIONAL BOUSSINESQ SIMULATIONS OF HARBOUR WAVES

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Essential principles of fluid dynamics for surface water waves are the basis of the Variational Boussinesq Model (VBM) that is in development in collaboration between LabMath-Indonesia and the University of Twente. This model has exact energy conservation, incorporates approximate dispersion properties and can deal with steep bottom variations, with calculations that can be restricted to the horizontal directions only.

In this lecture we present some results of simulations performed with a numerical Finite Element implementation on an unstructured grid of the VBM. Geo-physical problems are characterized by the presence of length and time scales that can be orders of magnitude different, which creates specific need for attention for reliable simulations.

We present results for coastal waves, in particular waves entering the harbour of Cilacap on the coast of South Jawa. The very detailed wave interactions that are seen in the simulations can lead to numerically observable resonance phenomena in the relatively small inner harbour, for a specific value of the period of the waves entering the harbour from the ocean.

Comparison of the dispersive simulations with non-dispersive simulations (the shallow water limit) show good agreement for the waves outside the harbour, but at the same time essential differences inside the harbour.

Remarkably, although incoming waves have periods of the order of 10 seconds, the total numerical ‘loading time’ for the (initially still water) harbour is much longer, of the order of one thousand periods; for reliable simulations one has to accept this additional computer time since in most cases no suitable initial wave field will be available.

CARBON NUTRIENT COASTAL FLUXES OVER JAVA AND THE POSSIBLE IMPACTS TO GLOBAL CLIMATIC CHANGES

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ABSTRACTS

CONTRIBUTED PAPERS

THE ROLE OF PRECIPITATION, TEMPERATURE, AND LAND COVER IN CONTROLLING RUN-OFF OF THE NORTHWEST OF JAVA COASTAL ZONES: A CLIMATE CHANGE PERSPECTIVE

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This paper discusses the role of land cover and climate represented by precipitation and temperature in controlling run-off of the northwest of Java coastal zones focusing in Ciujung, Cisadane, Ciliwung, Citarum, and Cimanuk watersheds. Changes of land cover in terms of conversion of forest into agricultural and residential areas, as well as increasing of temperature are known. It is the intention of this study to investigate how both parameters control run-off.

Run-off is simulated using Spatial Tools for River Basins and Environment and Analysis of Management Options (STREAM) [1]. STREAM has already been calibrated [2]. Climate represented by 10'×10' spatio-temporal maps of precipitation and temperature are of among the inputs of this spatial tool [3]. In this simulation, temporal land cover data are generated from available historical maps and forest cover. Land cover is converted to water holding capacity (WHC) [4]. WHC is used to estimate amount of infiltration. Model of drainage network is derived from Shuttle RADAR Topographic Mission and presented as 1km×1km resolution digital elevation model [2].

Figure 1 shows the simulation result in decadal average of discharges. Citarum and Cimanuk are the most contributor of freshwater to Java Sea. It can be seen that there has been increasing discharge during the last decade in all catchments. Total annual discharge is shown in Figure 2. Increasing trend of discharges is shown clearly in the latest 20-year. In order to examine the effect of climate and land cover changes to the computed discharge, separate simulations are carried out. Increasing of discharge correlate well with decreasing of WHC. Changes of land cover are thought to contribute to decreasing of water resident time in the watersheds studied here.

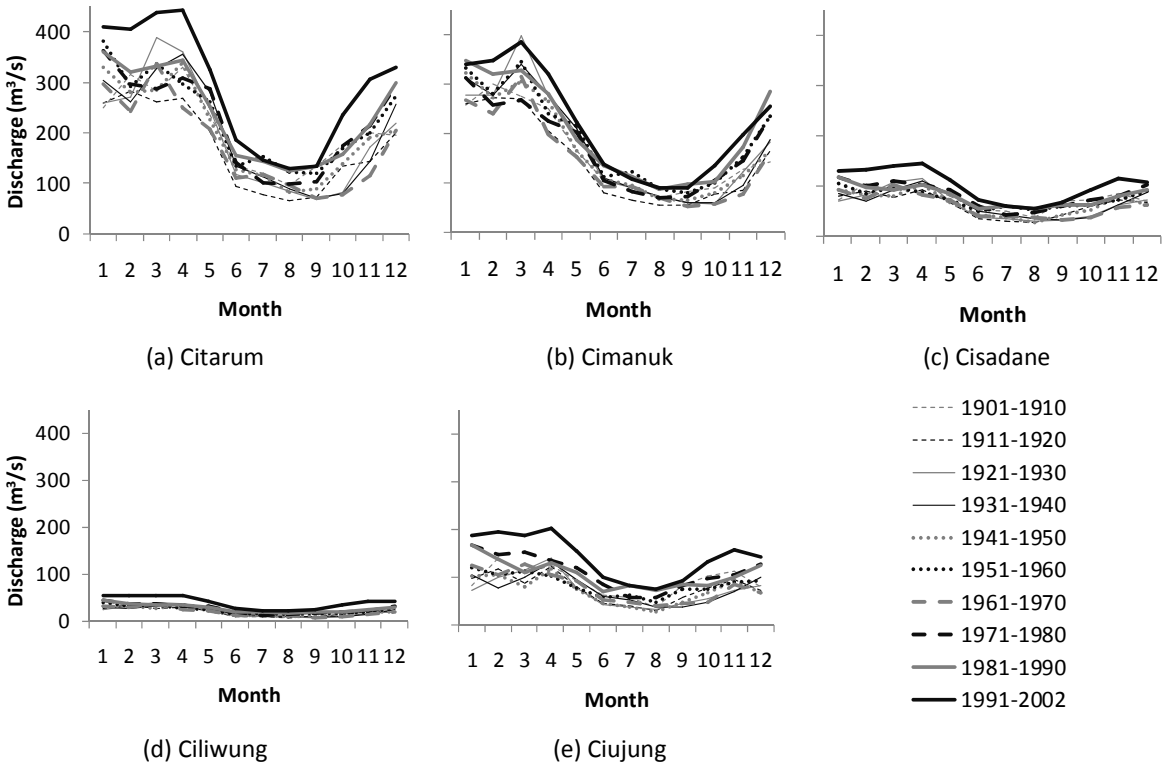

Figure 1. Decadal average discharge

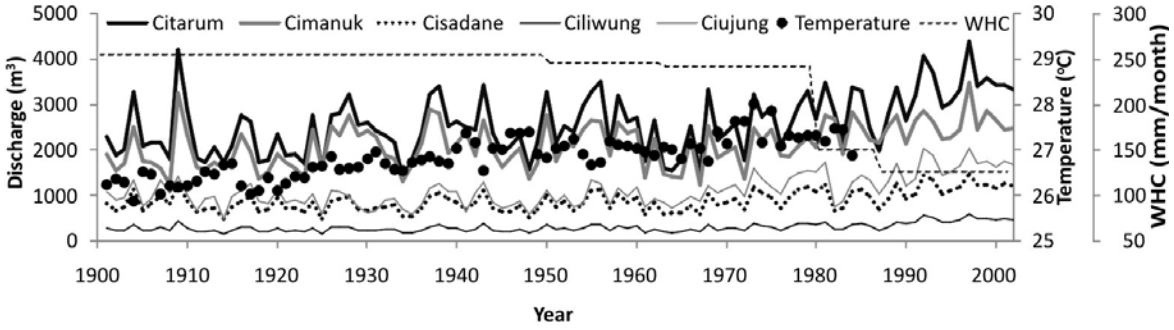

Figure 2. Total annual discharge, annual average temperature, and water holding capacity (WHC)

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PAST-DECADAL SIMULATIONS ON OCEAN WAVES, TIDES, CURRENTS AND SEA SURFACE TEMPERATURES ON THE NORTHERN COAST OF WEST JAVA

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West Java is an important province in Indonesia since it close to the capital city of Jakarta and plays an important role in the economical activities in the country. The province has two seas, the Java Sea on the northern part and the Indian Ocean on the southern part. Unlike the southern coast, the northern coast of West Java is characterized by the presence of broad deltaic plains built out into the relatively low-wave energy micro-tidal environment of the Java Sea by silt-laden rivers. These deltas are formed by mud, sand and other sediments resulting from siltation in the mouth of the rivers. The length of coastline on the northern coast is about 365 km and highly dynamic due to erosion process. It is important to study ocean and coastal characteristics to support our knowledge in the dynamic of coastal area, especially if it is referred to the climate changes. The characteristics can be analyzed through comprehensive studies covering measurements and numerical simulations of oceanographic parameters. Simulation on the oceanographic parameters (e.g. tides, currents, sea surface temperatures and waves) during the period of 1998 – 2008 on the Northern Coast of West Java Province, Indonesia was investigated in this paper. Simulation of flow was driven by the global tide model derived from sea level data observed by TOPEX-POSEIDON/JASON Satellite. Actual observed meteorological conditions (wind, temperature and rainfall) and river discharges were also imposed to the simulation. Any climate change represented by the meteorological conditions during the simulation period will be taken into account. The simulation was verified, calibrated and validated by some measurements data from any sources during the simulation period. Based on the verification and validation, the model presents a satisfy result and can simulate the past-decadal variations of tides, currents, waves and sea surface temperatures properly. The sea level and sea surface temperature rise within 10-years period of simulation are captured. Currents and waves were simulated and can be further analysed to calculate the erosion process.

SPATIAL ASSESSMENT MODELING FOR THE IMPACT OF CLIMATE CHANGE ON COASTAL MANAGEMENT

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The phenomenon of climate change has numerous effects on coastal and marine environment. The earth's oceans will expand, sea level will be rose, coral reefs bleaching, algae bloom, lost of certain marine species, shoreline retreat etc. All of these factors will affect the human social economic activity and their welfare. Dealing with the coastal management, this study will indicate the impact of climate change on its. Sea level rise is one of the case that will study furtherly. *International Geographical Union's Commission On The Coastal Environment* reported that coastal recession has been occur in more than 70 % of the world coastal area. Sea level rise is believed to be the major issues that cause these problems. On the other hand, the pressure of economic need, supporting by the world demand in fisheries sectors, have given way to the exploitation of the coastal ecosystem. Both aspects can affect the sustainability of coastal ecosystem and the availability of social economic services. Dealing with this condition, a study to see the impact of sea level rise and social economic' use of coastal ecosystem was employed. A shoreline retreat model based on Geographical Information System (GIS) was developed to predict the future impact of sea level rise on coastal environment and its existincg land use management. Two small islands, one that has been degraded by human activities and another island that almost nature have been selected as the study area. The comparison of the impact of sea level rise cause by climate change indicated that the coastal ecocystem may give protection to the shoreline. Therefore, the coastal management have to consider the role of coastal ecosystem in its policy scenario in order to mitigate the impact of sea level rise.

IMPACT OF CLIMATE CHANGE ON PHYTOPLANKTON CHLOROPHYLL IN INDONESIAN WATERS

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More than ten years of global ocean color satellite data with records of chlorophyll-phytoplankton changing in Indonesian waters. Generally in Indonesian waters, the chlorophyll-phytoplankton declined in 10 years. Global warming caused the ocean temperatures warmed or nutrient depletion in ocean, so that any kinds of species of phytoplankton die. The decline in phytoplankton-chlorophyll has a direct effect on the world's carbon cycle and will reduce the food available to fish and other organisms, including marine birds and mammals. Therefore we need the grand scenario of the impact of global warming to anticipate the impact of global warming on marine living resources.

Key words: *phytoplankton, sensor, climate*

RECENT ADAPTATION MEASURES AND THE PROGRESSING REGIONAL ENVIRONMENTAL SETTINGS IN SERIBU ISLANDS, JAVA SEA, INDONESIA

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This paper presents documentation of recent regional environmental settings and discussion of current measures of local adaptation practices in Seribu islands, southwest of Java sea, Indonesia, focusing on Pramuka, Panggang, Karya and Semak Daun cays. Socio-economic profile of the studied site in terms of demography and Gross Domestic Product, as well as land use practices are also considered. The discussion is related to increasing risks of erosion and inundation. Recent regional environmental settings are represented by the prevailing regional wave climate and sea level according to available scientific reports. Changes of recent regional sea level are specifically obtained from Topex/Poseidon and Jason-1 data. Changes of land use are detected according to manual interpretation of remote sensing imagery. This comprises of aerial photo mosaic from 2004 and IKONOS image from 2008. Evidences of erosion and inundation are identified according to direct observation from several visits. Direct observations also provide qualitative measures of local adaptation practices.

In the investigated site, rate of changes of sea level of 0.015m per year during 1992 to 2005 is found. Conversion of vegetation into residential is found to be typical and thought to lead to retardation of stabilization of coral beaches. Constructions are found to be the typical solution to overtopping of water during high spring tide and erosion due to wave attack. Local inhabitants seem to possess sufficient awareness to the currently progressing environmental changes. It seems that their role as key player of subsistence economy prevents effective application of sustainable conservation strategy.

It is confirmed that even with successful achievement of local actions, regional controls in the forms of suitable development policy and natural governing factors are still considered the most contributors to the conservation and adaptation measures in Seribu islands. Still, local anthropogenic adaptation practices lead to the demotion of local natural environmental capability to cope with risks of erosion and inundation.

THE IMPACT OF CLIMATE CHANGE TO SEVERAL ASPECTS OF COASTAL SYSTEM

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Research on climate change impact to several aspects of coastal system was conducted at the coastal of Cirebon in 2008. Primary productivity, the dissolution of CO_2 in sea water, the land used altered and the vulnerability of inundation in coastal area were measured. The result showed that the dissolution of CO_2 had negative correlation with chlorophyll a. There are trend of increased on build land and decreased of vegetative area, and based on the measurement of low elevated area along the coastal of Cirebon pointed out that there are 10200,43 hectare of various land used would counted as vulnerability area of inundation if the sea level has rose 1 meter.