SEAWATCH BUOY MONITORING AND ZONING FOR MONITORING IN COASTAL AREA DEVELOPMENT PLAN

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Abstract

Indonesia is the "Marine Continent", encompasses a total area of 5.8 million km^2 of which 75% is sea water and the remaining area is divided between 17.805 islands, having an overall coastline of more than 81.000 km. The location of research at regency of Jepara, Central Java. This area very potential for developing the coastal area into an area with conserved environment and productive. The ecosystem in the coastal zone are important for biological and economic productivity, storm protection and erosion control. Reefs, mangrove, wetlands, and tide lands are vital breeding, nursery and feeding areas for marine species.

The purpose of this research analysis of appropriate area use to shrimp pond, fish pond, sea grass, tourism and mangrove system. A preliminary model for a decision making tool has been developed by using Geographical Information System. The methods used is land evaluation which includes clarification of land's capability, evaluation suitability and monitoring an environmental quality of marine and coastal area from SEAWATCH Buoy by collecting the near real time data. SEAWATCH Buoy is possible to know the dynamic of Indonesia water which can be integrated with other data, for used decision making process.

I.   INTRODUCTION

Indonesia is the "Marine Continent", encompasses a total area of 5.8 million km^2 of which 75% is sea water and the remaining area is divided between 17.805 islands, having an overall coastline of more than 81.000 km. Marine aspect in the scope of living area for Indonesia has a great role to support the human basic needs especially for food, energy, transportation, industrial activities and security area.

The location of research at regency of Jepara, Central Java. This area very potential for developing the coastal area into an area with conserved environment and productive. The ecosystem in the coastal zone are important for biological and economic productivity, storm protection and erosion control. Reefs, mangrove, wetlands, and tide lands are vital breeding, nursery and feeding areas for marine species.

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The coastal zone where land meets sea and where fresh and salt waters mix contain many of the Earth's most complex, diverse and productive ecological systems. It functions as a protective buffer and filter between the land and the sea, and is increasingly valued for recreational and aesthetic purposes

The purpose of this research analysis of appropriate area use to shrimp pond, fish pond, sea grass, coral reef, tourism and mangrove system. A preliminary model for a decision making tool has been developed by using Geographical Information System. Overlay mapping is a valuable technique for the organization and analysis of diverse spatial information. The activities begin with data input, compile base data spatial and attribute, analysis, output and evaluation. Method that will be used is by interpolating into point-point of sample observation. Information derived from remote sensing or aerial photography is often extremely valuable in the initial stages of planning, particularly where existing data are sparse and human and financial resource are limited.

II.   MARINE CONSERVATION ZONES

Directorate General Forest Protection and Nature Conservation (PHPA) has direct responsibility for the development of management plans for conservation areas. In time, all these areas will fall within the extended provincial marine coastal management planning area. For those marine conservation areas that have been gazette, they are recognized by their legal status and their boundaries are established by regulation and cannot easily be altered. It is intended to recognize the boundaries of existing and proposed conservation areas and these areas will be indicated on the zoning maps to be developed as part of the zonation process.

a.   **Marine National Parks**

National Marine Parks are areas that have been designated or proposed by PHPA. The designated areas have legal status while the proposed areas are those that are still waiting to be gazette but in many cases are already recognized on official maps or plans. The primary function of Marine National Parks is to conserve areas of outstanding natural value of national, regional or global significant which must be large enough for recreational and educational use without decreasing conservation value.

b.   **Marine Wildlife/Strict Nature Reserves**

Marine Wildlife Reserves and Marine Strict Nature Reserve are also areas which have been nationally designated or proposed by PHPA. Similar to National Parks, the designated areas have legal status while the proposed areas are those that are still waiting to be gazette but are already identified on official maps. Marine Wildlife Reserves and Marine Strict Nature Reserves are small or large areas which function as: - strict protection which may require some manipulation of species or habitat as a part of management; their use being limited for research, monitoring and education; and respectively, - strict protection with use limited to non-manipulative research and monitoring

c.   **Marine Tourism Parks**

Marine Tourism Parks are areas which have been designated or proposed by PHPA. Similar to National Parks, Wildlife Reserves, and Strict Nature Reserves, the designated areas have legal status while the proposed areas are those that are still waiting to be gazette but are already identified on official maps. Marine Tourism Parks are small or large areas which exhibit natural beauty and recreational potential and may have low value for conservation.

d.   **Marine Conservation Zone**

These areas may be newly proposed for conservation and habitat protection. The areas that are identified include the most sensitive and fragile coastal zone environments. Justification for setting aside new conservation areas is in line with the Indonesian government's proposal to expand the areas under conservation from 2.5 million hectares to 30 million hectares or 5% of the total marine area (Sloan, 1993, Dahuri, 1996). The capability and nature of existing coastal and marine habitat is a valuable resource and its conservation benefits should be discussed in consultation with other sectors particularly in light of present use and future development plans.

III.   COASTAL DEVELOPMENT ZONES

In view of Indonesia primary goal of economic development, it has been recommended that specific coastal and marine areas be set aside for development purposes. The proposed marine zones include a General Use Zone, Special Use Zone, and General Use Subzones (fisheries, mining, tourism, industry, transport and communication)

a.   Marine General Use Zone

A Marine General Use Zone (MGUZ) will in most instances dominate the zoning picture. The MGUZ is essentially a multipurpose economic development zone where communities and commercial enterprises are free to pursue a variety of development activities such as traditional and commercial fisheries, coastal shipping and other related activities which do not fall into a specific sub-zone. These will normally be large extensive areas. Depending upon location, the MGUZ will potentially extend out from the shoreline to the 12 nautical mile limit of provincial authority and is not otherwise zoned for any particular specific use.

b.   Marine Special Use Zone

The Marine Special Use Zone (MSUZ) is based on the principle that the area is nationally designated and its development is given priority'. This includes important specially designated shipping lanes utilized for oil tanker traffic, military restricted areas, and marine areas set-aside for economic development.

IV.   **MARINE GENERAL USE SUB-ZONES**

a.   Fisheries

The fisheries sub-zone is designed to accommodate and guarantee continued access to fish resources for those who maintain permanent or semi-permanent fish tarps and mariculture structure. Coastal fish/shrimp ponds are treated as a land zone given their previous use as mangrove forest. Fishing grounds for pelagic or demersal are not treated as a zone given the migratory and seasonal nature of this type of fisheries.

b.   Mining

Marine oil/gas exploitation sites and pipeline installations may cover significant area. These are normally permanent sites and the right to utilize is through a permit to exploit the oil and gas resource and is issued from national, provincial or district level government. Marine based mineral exploitation falls under a similar right to use and is also by permit. The function of these areas requires that other activities not directly connected with the oil and gas or mining industries be limited. The location also acts as local point for the concentration of management resources aimed at minimizing or avoiding environmental impacts.

c.   Tourism

These are areas whose primary function is to serve the tourism industry. They are officially recognized as tourism areas and currently function predominately as commercial marine tourism centers or are designated for commercial marine tourism development or use. For terrestrially based designated tourist areas that rely on direct access to the sea and therefore require a coastal location, a marine buffer of 500 metres should be applied in order to ensure that conflicting activities do not occur along the inshore areas of the tourist development.

d.   Industry

The function of coastal industrial areas limits the uses to which the adjacent areas can be used for. In order to reduce potential conflicts between different uses, these areas require specific recognition. Coastal industrial areas may be designated and currently regulated by government agencies or private industry. The areas may include facilities for cold storage, shipyards, shrimp processing and fish cannery or any other coastal industrial activity, particularly heavy industry which tends to locate in coastal areas as they are dependent on relatively inexpensive transport which seaways can offer. For terrestrial based coastal industrial areas that rely on direct marine assess, a 500 metres inshore buffer is recommended.

e.   Transport and Communications

In order to resolve or minimize conflicts, corridor of the coastal and marine environment must be reserved for specific transportation and communication needs. Related right of way and infrastructure developments including designated domestic shipping lanes, shipyards, permanently moored facilities, anchorage and navigational aids, and fish port/landing fall into this sub-zone. Specific recognition must be given to heavy tanker traffic, which are

required to transit through Indonesian sea lanes on route to other international destinations.

V.   REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM

A GIS is a computer-based system of storage and manipulation of data that is organized by area or allocation. Areas can be identified by a grid of cells (cell-based or raster systems), or information can be stored by means of the boundaries of mapped areas. A GIS enables different kinds of information to be recalled and combined; for example, areas that are both suitable for coastal tourism and within a specified distance of all-weather road could be overlain and mapped.

Most kinds of data processing undertaken on a GIS can also be done manually, by overlay of transparent maps, comparison and calculation. For small areas and few mapping units, this is the quickest way to do it. A GIS becomes efficient where there are numerous mapping units and many combinations of data are needed.

A GIS can offer valuable facilities to coastal zone planners. First, disaggregated data can be stored and retrieved by location. For example, reef fish catch may have been collected in order to calculate a financial measure of performance like the gross margin; these data can be stored and subsequently retrieved and used again for other purpose. Point data can be stored as such, rather than being lost by incorporation into mapping units. Thus, in a survey of coastal ecosystem, data such soil depth and texture in mangrove areas, gathered for individual locations in the field, can be stored and retrieved for use in land evaluation. A further facility is to undertake complex and manually tedious calculations using any combination of the data in store. In this ways, tables and maps of interpreted information can be produced very quickly. More important, the data can be updated or corrected and the methods of calculation revised by changing the computer macro so that new maps and tables can be produced rapidly.

Processing data will be done with image processing (digital analysis) into Landsat Image TM using software ILWIS version 1.4. A preliminary model for a decision making tool has been developed by using Arc/Info software version 7.0.4. Overlay mapping is a valuable technique for the organization and analysis of diverse spatial information. Geographic Information System (GIS) provide a particularly flexible approach to the manipulation of spatial data. The methods used is land evaluation which includes clarification of land's capability, evaluation suitability and monitoring an environmental quality of marine and coastal area from SEAWATCH Buoy by collecting the near real time data. SEAWATCH Buoy is possible to know the dynamic of Indonesia water which can be integrated with other data, for used decision making process.

The data acquisition module is mainly based on a network of SEAWATCH oceanographic data collection buoys. The SEAWATCH buoy is a vertical stabilized automatic buoy. The buoy is presently equipped to collect the following parameter: air pressure, air temperature, wind speed and direction, sea current and direction, wave height, oxygen saturation, and nutrient content. The collecting data are internally

processed, stored and hence transmitted to shore by use of satellite communication satellite, enabling near real time data evaluation

Due to the complexity of human activities, natural systems and owner ships in the coastal zone, an integrated management scheme is needed to allocate coastal resources efficiently and minimize environmental degradation. Planning for sustainable resources management is based on weighing priorities. Zoning is the most important part in managing the coastal area and maritime in unity. With a zoning, a person can describe the area easily and clear on purpose of planning.

The following successive steps are presented:
- Inventory the secondary data, digital data and literature
- Analyzing the secondary data and digital data
- Take premier data (field)
- Formatting and structuring data into a GIS
- Analyzing the field data and buoy data
- Processing the spatial data
- Analyzing the result

VI.   SEAWATCH BUOY CONTRIBUTION

Seawatch Buoy contribution management of mangrove, coral reef, sea grass and marine biodiversity. The relevant data are:
- Current speed and direction
- Sea temperature and salinity (in depth profile)
- Waves height and period
- Turbidity (sedimentation)
- Nutrient (phosphate)
- Dissolved oxygen

a. Coastal Management, EIA Studies

In both these areas time series of environmental data are important to describe the status of the environment. SEAWATCH will provide relevant data.
- Sea Temperature and Salinity
- Current speed and direction
- Nutrient
- Turbidity and algae
- Wave height
- Dissolves oxygen

b. Tourism Industry

Maintaining clean and healthy waters are the highest priority by the tourism industry. Data giving the status for water quality, harmful algae and means for coping with pollution incidents give the basis for a strong tourist industry. The SEAWATCH system for handling crises reduce the risk for damage to important tourist resorts. The relevant data are:
- Turbidity and algae
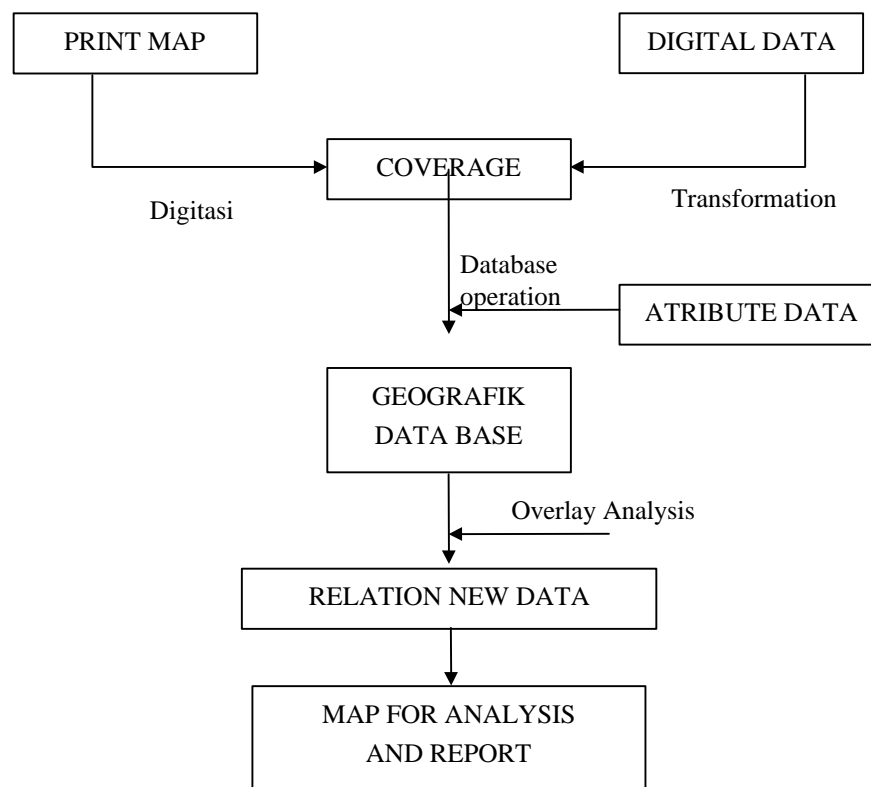
- Dissolved oxygen
- Nutrients
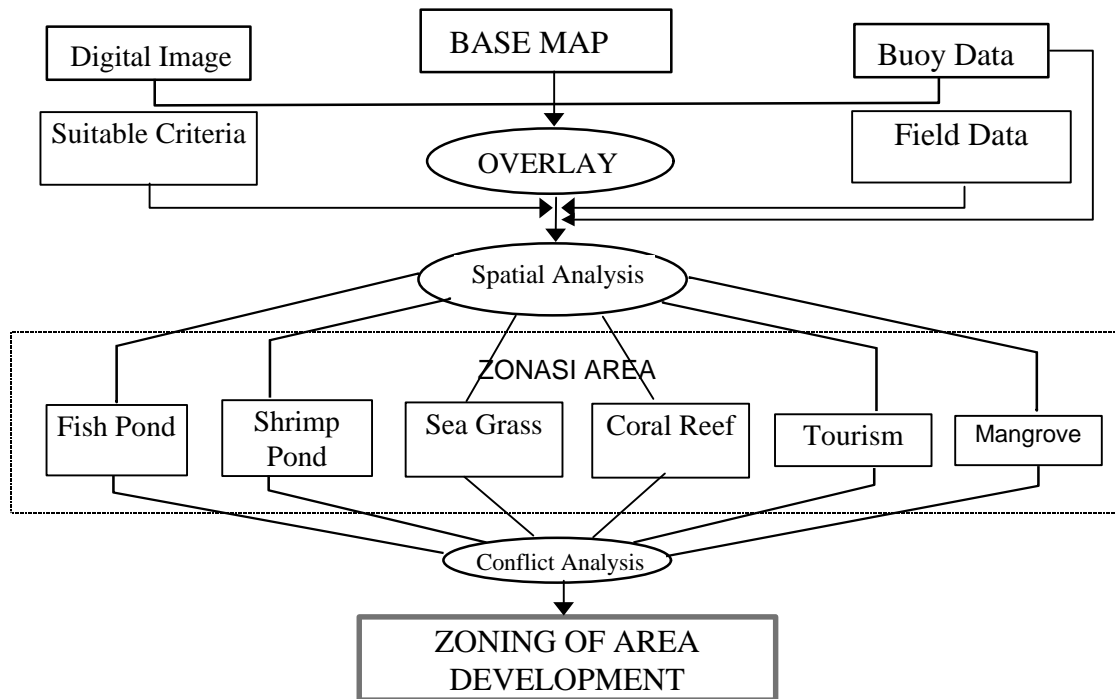
Picture 1. Flowchart activity
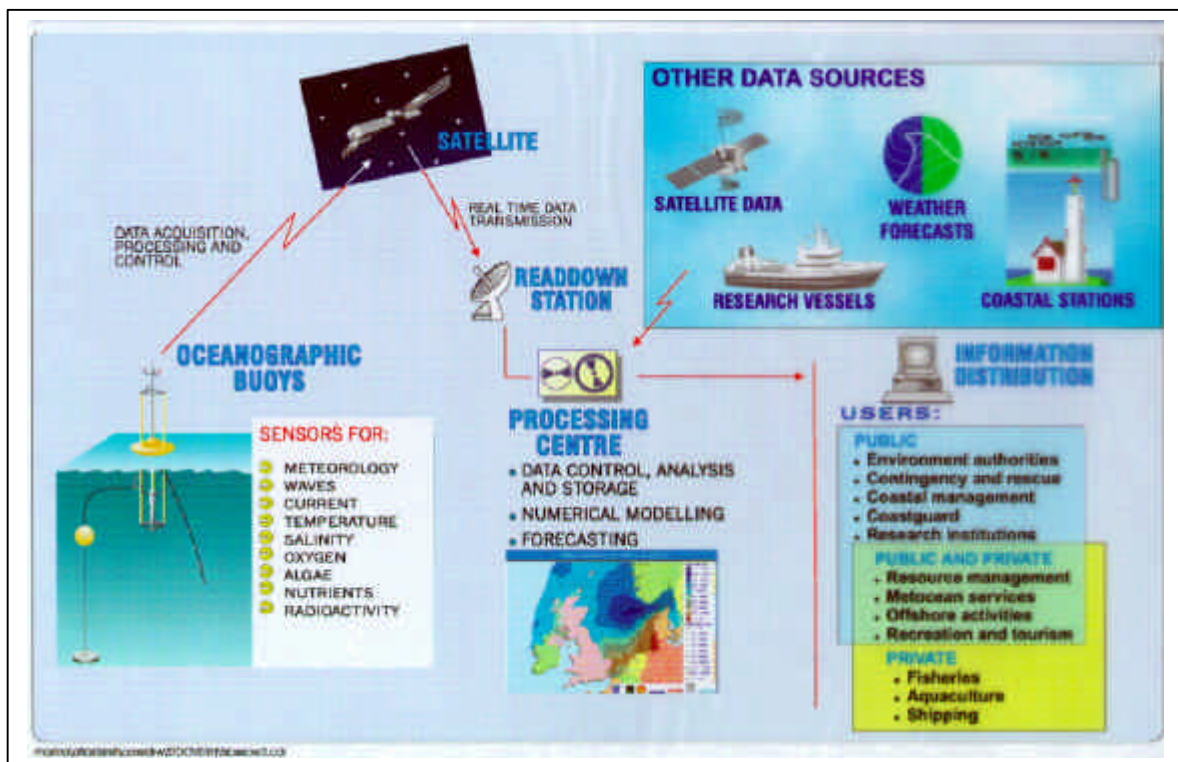
Picture 2. Seawatch System

VII. DATA ANALYSIS

Have a two GIS in data analysis has been gathered become database, that is overlay analysis and attribute processing data with scoring method. Execute for overlay analysis before take a field data with purpose for get to unit waters sea area, use for take a sample. Overlay will be use concerning map has been already spatial digital data. After get a field data in unit area, data will be enter to computer became database as a attribute data for detailed processing. Processing attribute data be based on suitable area criteria for certain use. Attribute data will be scoring for determine land suitable level. High score indicate for suitable, low score indicate for not suitable.

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│  PRINT MAP  │                    │ DIGITAL DATA│
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                   │ MAP FOR ANALYSIS│
                   │   AND REPORT    │
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Picture 3. GIS Process and Analysis Scheme

VIII. DATA COLLECTION

To use GIS effectively, it is a key factor to collect appropriate, useful, and accurate data. In other words, the framework of analyzing by GIS, or the effectiveness of the analytical result depends on the contents of a database developed for a project.

- Maps, the data of maps, which were collected for the research, include a topography map of Jepara area at scale of 1:250,000 provided by BAKOSURTANAL (National Coordinate Agency For Surveys And Mapping, Indonesia). Thematic maps at the scale of 1:250.000, such as Land Use, Rainfall, Slope, Elevation, Land Status, Environment Protection, Development Hazard, Drinking Water Facility, were also provided by BPN (National Land Agency, Indonesia).
- Statistical data, collected for supporting spatial information include

population, hotels, restaurant, etc. These data were collected from the relevant statistics books published by BPS (Central Statistics Bureau, Indonesia) and BAPPEDA TK II Jepara.

- Satellite data, satellite data of LANDSAT, were provided by US

IX. CONCLUSION

1. Zoning is the most important part in managing the coastal area and marine in unity, a person can describe the area easily and clear on purpose of planning. With a advanced computer technology, zoning activity can be implementation very fast and accurate. SEAWATCH Indonesia is a system that using telemetry technology for marine and coastal environment and can be collecting the near real time data for modeling and forecasting environmental sea. Geographical Information System (GIS) is a system for processing data on a digital for produce spatial information in zoning activity.

2. Unification use between buoy SEAWATCH data, GIS and digital image processing, become a system able to produce recommendation for made decision solution problems for integrated coastal environment management and have a environment conception.

REFERENCE

1. Uktolseya Henk, 1996. **SEAWATCH – A Solution to ICZM**, Workshop on Making Efficient use of Technology Application on Marine Environmental Monitoring for Supporting Sustainable Development.

2. Dahuri Rokhmin, 1996, **Integrated Sustainable Use in Coastal and Sea Area**.

3. Lillesand, Thomas M. & Kiefer, Ralph W., 1979, **Remote Sensing and Image Interpretation**, John Wiley & Sons, Inc.

4. Suwedi Nawa, 1994, **Technology in Environmental Management Optimizing**, Workshop on Technology Application on Marine Environmental Monitoring, Forecasting and Information System.

The Criteria of Suitable Use

Parameter	Suitable Level	
	Suitable	Not Suitable
1. Soil Conditions Soil Texture	Silt and Mud	Sand

2. Water Conditions
    a. Salinity (ppm)
    b. Temperature (^{o}C)
    c. Tide cyclone (m)
	5 – 25
	> 20
	1 – 4
		<5 or > 25
		< 20
		> 4

3. Rainfall per year (mm)	> 1000	< 1000
4. Potential square (m)	130 x Tide local cyclone or more	< 50 x local tide

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Table 1. Suitable criteria for Mangrove

PARAMETER	Suitable Level		
	Very Suitable	Suitable	Not Suitable
Current Speed (cm/second)			
Salinity (ppm)	25 – 35	20 - 24 and 36 – 40	< 25 and > 40
pH	7,5 - 8,5	7 - 7,5 and 8,5 – 8	< 7 and > 8
Temperature	21 – 27	15 - 20 and 28 – 33	< 15 and > 33
Wave	< 0,25 m	0,25 - 0,7 m	> 0,7 m
Bottom Sea (m)	< 15 m	15 - 45 m	> 45 m
Submarine Sediment	Sand, Gravel	Gravelly Muddy Sand	Mud, Silt

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Table 2. Suitable Criteria for Coral Reef

PARAMETER	Suitable Level		
	Very Suitable	Suitable	Not Suitable
Current Speed (cm/second)	20 - 30	10 - 20 and 30 – 40	< 10 and > 40
Water Purify (m)	> 5	5 - 2,5	< 2,5
Salinity (ppm)	30 - 32	28 - 30 and 32 – 34	< 28 and > 34
pH	7,5 - 8,5	7 - 7,5 and 8,5 – 8	< 7 and > 8
Temperature	22-26	20 - 22 and 26 – 28	< 20 and > 28
Bottom Sea (m)	0 - 2,5	2,5 – 5	> 5
Submarine Sediment	Sand, Gravel	Gravelly Muddy Sand	Mud, Silt

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Table 3. Suitable Criteria for Seaweed

Parameter	Suitable Level			
	Very Suitable	Suitable	Moderate	Not Suitable
1. Land Form	Alluvial Plain	Beach, Coral Reef Terrace	Denudasional Erosion	Denudasional Erosion
2. Land Cover	Land available	Agriculture / Plantation	Land Processing	Forest
3. Water Quantity (l/second)	> 50	30 – 50	10 – 30	< 10
4. Angle of Slope (%)	0 - 7	8 – 15	16 – 25	26 - 45
5. Surface Material	Gravel	Sand	Silt and Dust	Organic Soil, Stone
6. Surface Drainage	very good	Good	Moderate	Bad
7. Easy Access for Vehicle	None	Few problem	Moderate problem	Strong problem
8. Sea Water Quality	clear water, free pollution	rather turbid, none risk health	turbid, none risk health	a lot of pollution
9. Risk	no current, wave. <0,25 m	no current, wave.0,25 - 0,7 m	Current, wave.0,7 - 1.5 m	hard current, wave <1.5 m

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Table 4. Suitable Criteria for Tourism

Parameter	Suitable Level	
	Suitable	Not Suitable
1. Slope (%)	0 – 5	> 5
2. Land Conditions a. Soil Texture	Silt, Mud, Slightly Gravelly Mud	Gravel, Sand

b. Organic Matter(%)
    c. pH
    d. Organic Availability substance
	9 – 15 %
	6 – 7
	Moderate - High
		< 9 or > 15
		<6,5 or >7,5
		Low

3.   Water Conditions
    a.   pH
    b.   Salinity (ppm)
    c.   Temperature (oC)
    d.   Turbidity
	
	6 – 7
	15 - 25
	29 - 30
	Clear Water
		
		<6 or >7
		<15 or >25
		<29 or >30
		Turbid

4. Drainage	Bad	Good

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Table 5. Suitable Criteria for Fish Pond

Parameter	Suitable Level		
	Very Suitable	Suitable	Not Suitable
Water Quantity 1. Wet Season (Month) 2. Average rainfall (mm/year) 3. Tide (mm)	 1- 3 2000 – 3000 1 – 3	 0,5 - < 1 1000 – 2000 0,5 - <1 >3 - 3,5	 < 0.5 < 1000, > 3000 <0.5 >3,5
Land Parameter 1. Soil Teksture	Clay, Sandy Silt	Slightly Gravelly Mud, Silt and Dust	Organic Sand
2. pH Soil	7 – 8	6,5 - 7,4 8,4 - 8,5	<6,5 >8,5

3. Substance hara
   a. Organic (%)
   b. Nitrogen (N) (%)
   c. Fosfor (P) (ppm)
   d. Calium (K) (ppm)
   e. Calcium (ppm)
   f. Mg (ppm)
	
	16 - 3,5
	>0,20
	>46
	>500
	>1200
		
		1,6 - 3,5
		0,16 - 0,20
		36 – 46
		350 – 500
		700 – 1200
			
			<1,5
			<0,16
			<36
			<350
			<700

4. Free Polluted	>600	300 – 600	<300

a. NH3 (mg/l)			
b. NO2 (mg/l)	0	<1,0	>1
c. H2S (mg/l)	0	<0,25	>0,25
5. Free Flood	0	<0,001	>0,001
	None	Moderate	High
Water Conditions			
1. Salinity (ppm)	27 – 28	25 – 26 ; 29 – 30	< 25 ; > 30
2. Temperature (°C)	12 – 13	<10 ; > 15	
3. Water Purify (cm)	35 – 50	10 - 11 ; 14 – 15	< 25 ; > 60
4. pH	7,8 - 8,2	25 - 34 ; 51 – 60	< 7,5 ; > 8,5
5. Oksigen (mg/l)	5 – 8	7,5-7,7 ; 8,3-8,5	< 3 ; > 10
		3 - 4 ; 9 - 10	

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Table 6. Suitable Criteria for Shrimp Pond

The result of this analysis. The level of area divided into three classes, that can be defined as:

SS (Very Suitable) : Very Suitable area that does not have boundary parameter to be develop a certain use

S (Suitable) : Suitable area that has boundary parameter, but can be excelled with certain treatment

N (Not Suitable) : Not Suitable area that has a permanent boundary parameter, that cover the possibility to excel it with certain treatment

| MARINE ZONES	SELECTION CRITERIA	DATA SOURCE
National Marine Park	Designated by PHPA	- PHPA Status maps - RTRW(P) - RePPProT
Marine Wildlife and Strict Protection Park	Designated by PHPA	- PHPA Status maps - RTRW(P) - RePPProT
Marine Tourism Park	Designated by PHPA	- PHPA Status maps - RTRW(P) - RePPProT
Marine Conservation Zone (Proposed)	- Areas proposed for conservation and habitat protection; - Inter-tidal areas covered by mangrove & nipa; - Estuary & coastal wetlands - Coral reefs - Sea grass - Turtle nesting beaches	- PHPA Status maps or RTRW(P) - Land use/cover maps (BPN) - Ecosystem thematic maps PPPO, PHPA and CRIFI
Marine General Use Zone	- From the shore line to the 12 nautical mile limit of provincial authority not otherwise zoned for specific use	- Mapped areas outside other zoned areas on LPI and nautical charts
Fisheries (Subzones)	- Marine fish traps and mariculture structures covering a acontiguous area of at least 25 hectares in size (unless represented schematically) including: - Fish aggregating device (FAD, Liftnets) Pearl Farms	- Fishing techniques (CRIFI) - Provincial Fishery Division - BPN
Mining (Subzones)	- Marine oil/gas exploitation sites & pipeline installations - Mineral exploitation - Exploitation permit issued from national, provincial or district level government	- Ministry of Energy and Mines - PERTAMINA - National Hydrographic Map Series

|		
	- Sites must cover a contiguous area > 25 ha	
Tourism (Subzones)	Designated as Tourism Areas and includes: - Areas which currently function predominately as commercial marine tourism centers or are designated for commercial marine tourism development or use; - Marine areas adjacent to terrestrial toursim area (500 m marine biffer)	- RTRW(P) - Ministry of Tourism - BPN - Approved private sector development plans
Industry	- Designated coastal areas currently regulated by goverment agencies or private industry: - 500 m buffer on the marine side	- Ministry of Industry - BPN - Approved private sector development plans
Transport & Communications	- Coastal/marine related infrastructure developments which covers including (schematically represented): - Shipping lanes - Permanently moored facilities - Anchorage and navigational aids	- Sea Trnasport and Communication - RTRW(P) - National Hydrographic Map Series

MREP Project

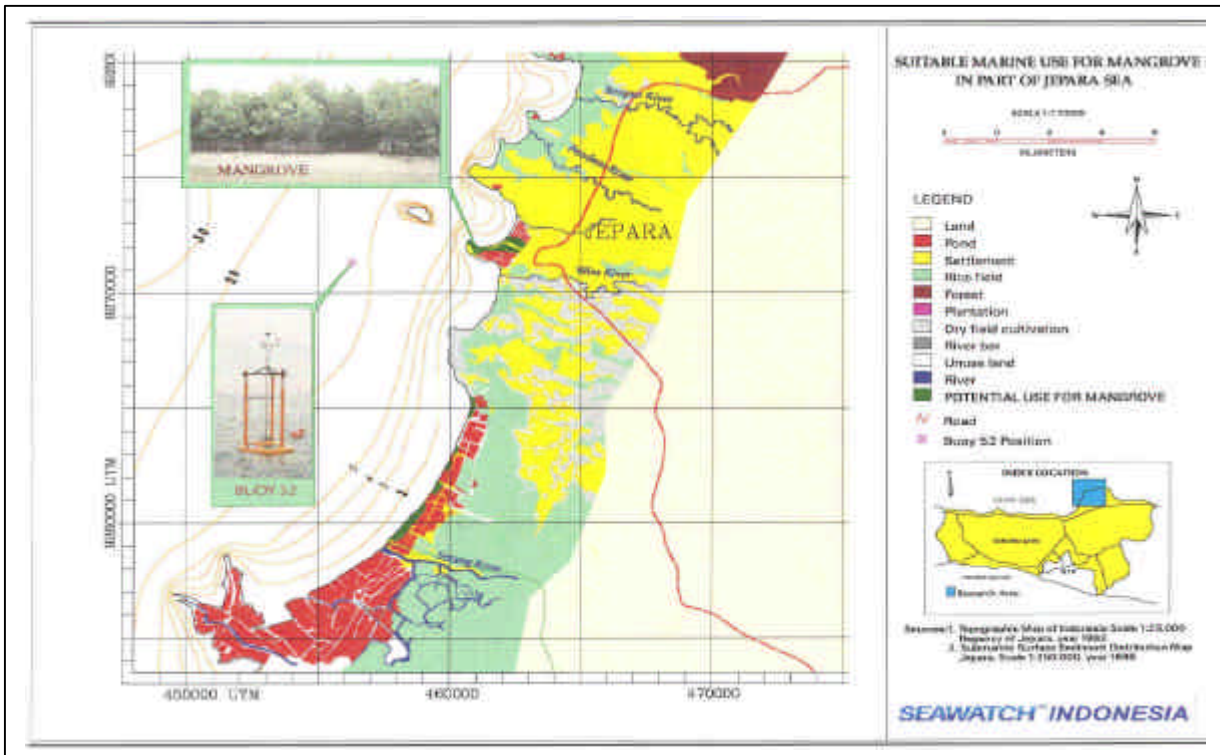Table 7. Zoning Criteria For Coastal Marine Areas
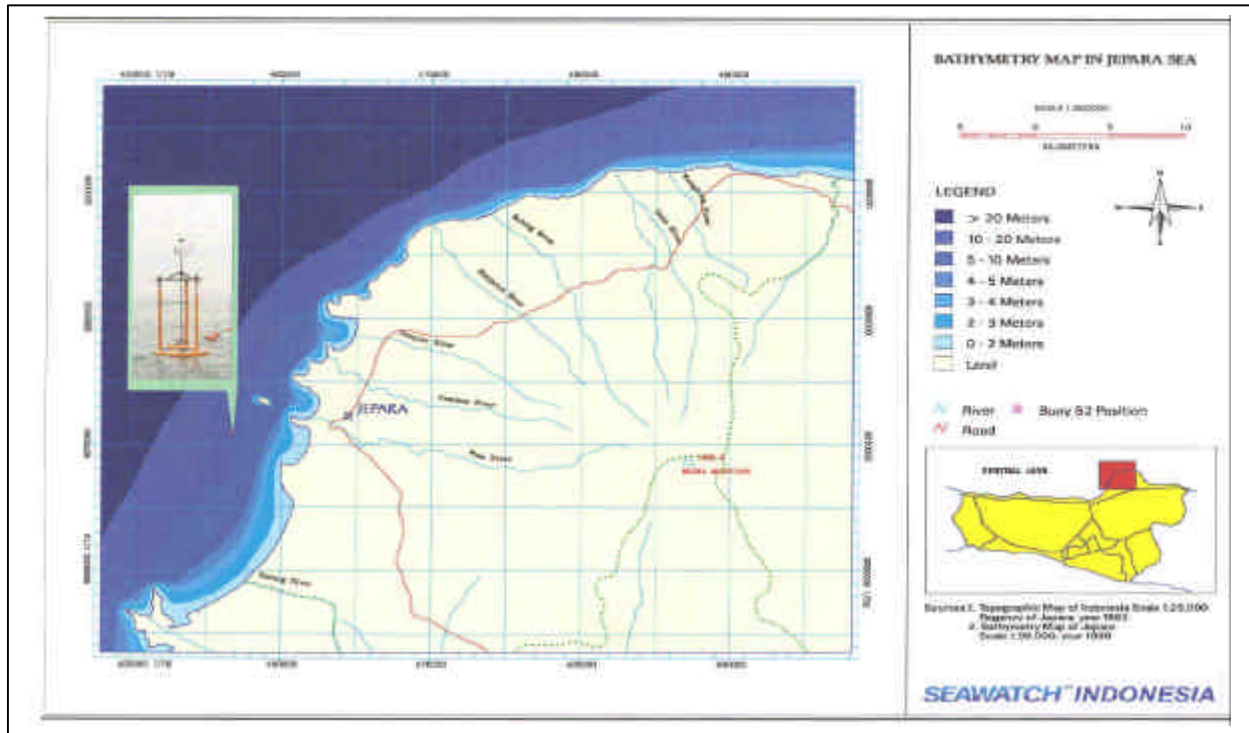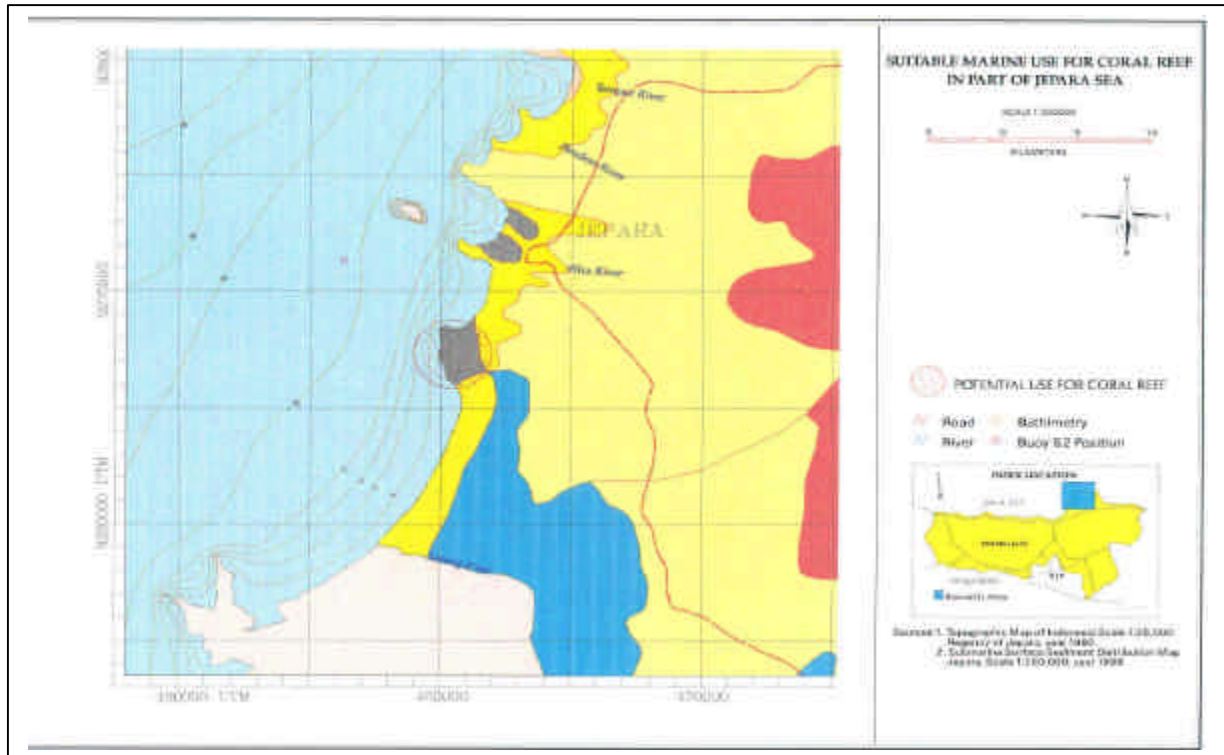
Picture 4. Bathymetry Map
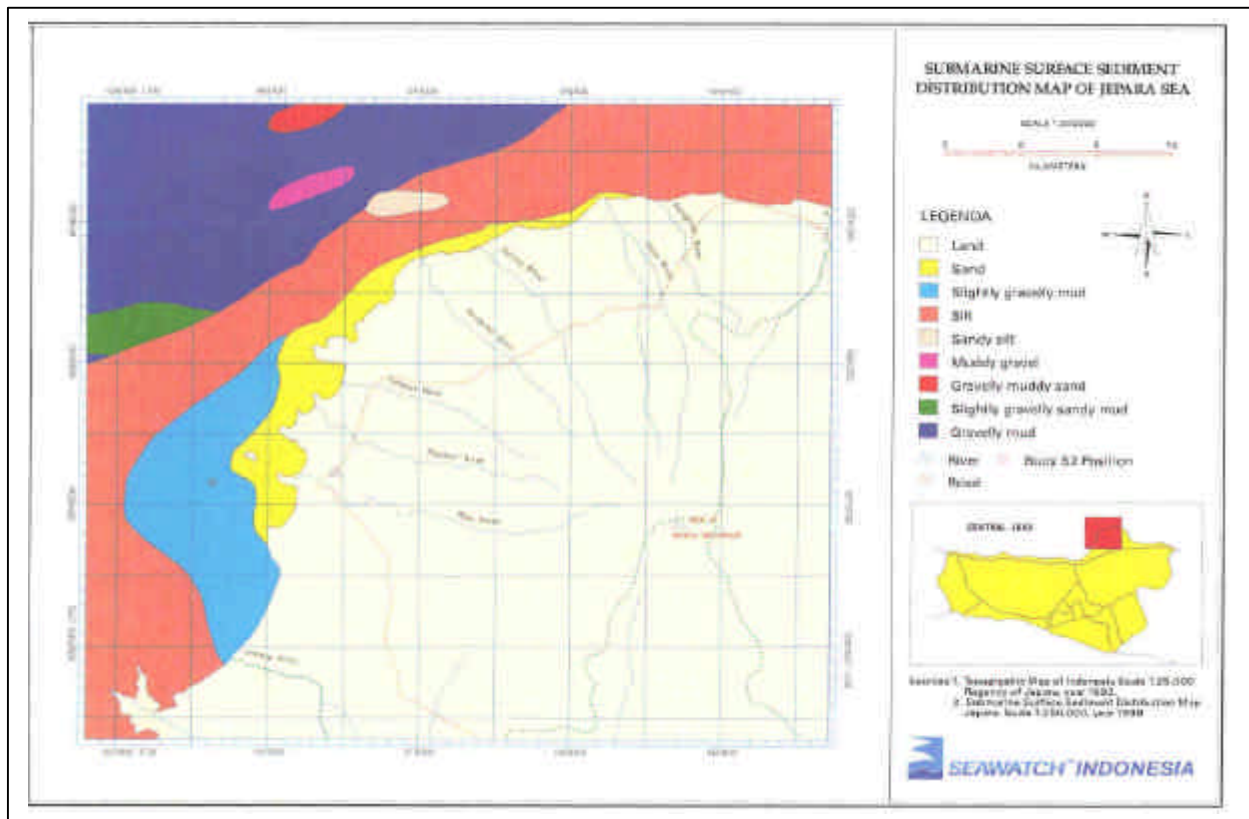
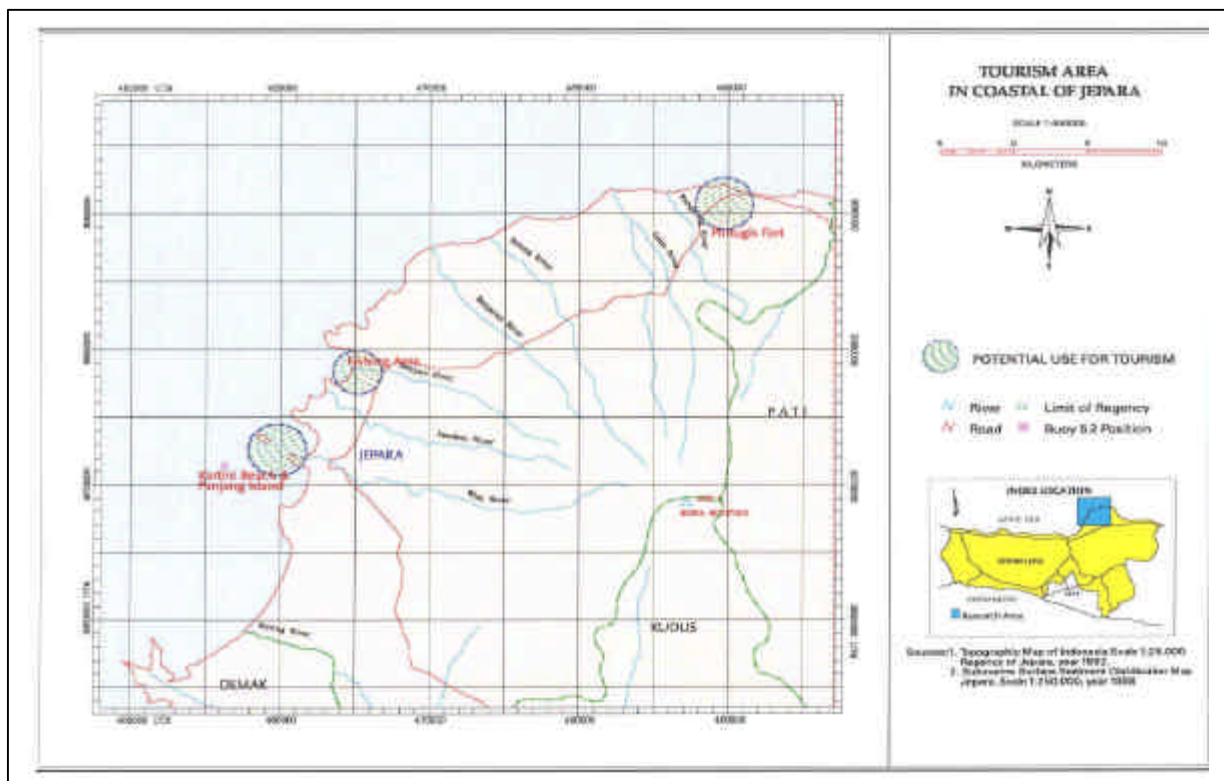
Picture 5. Submarine Surface Sediment Map
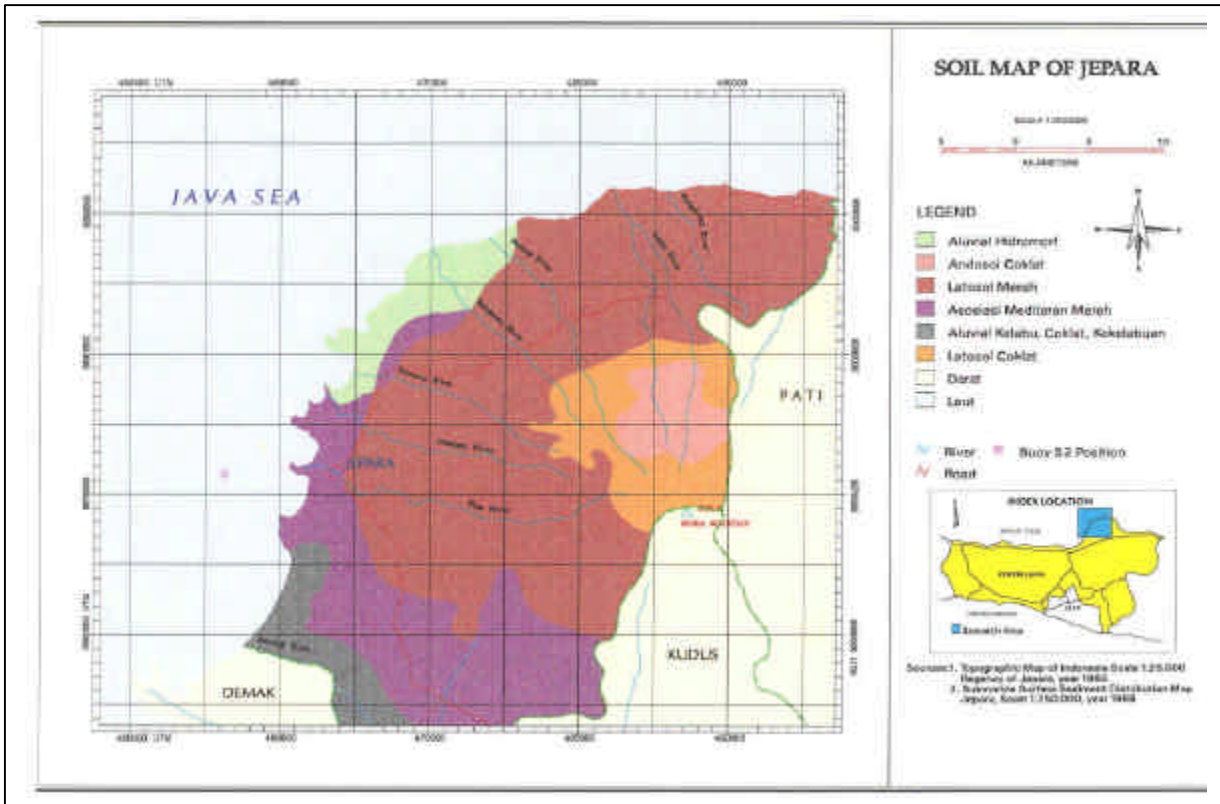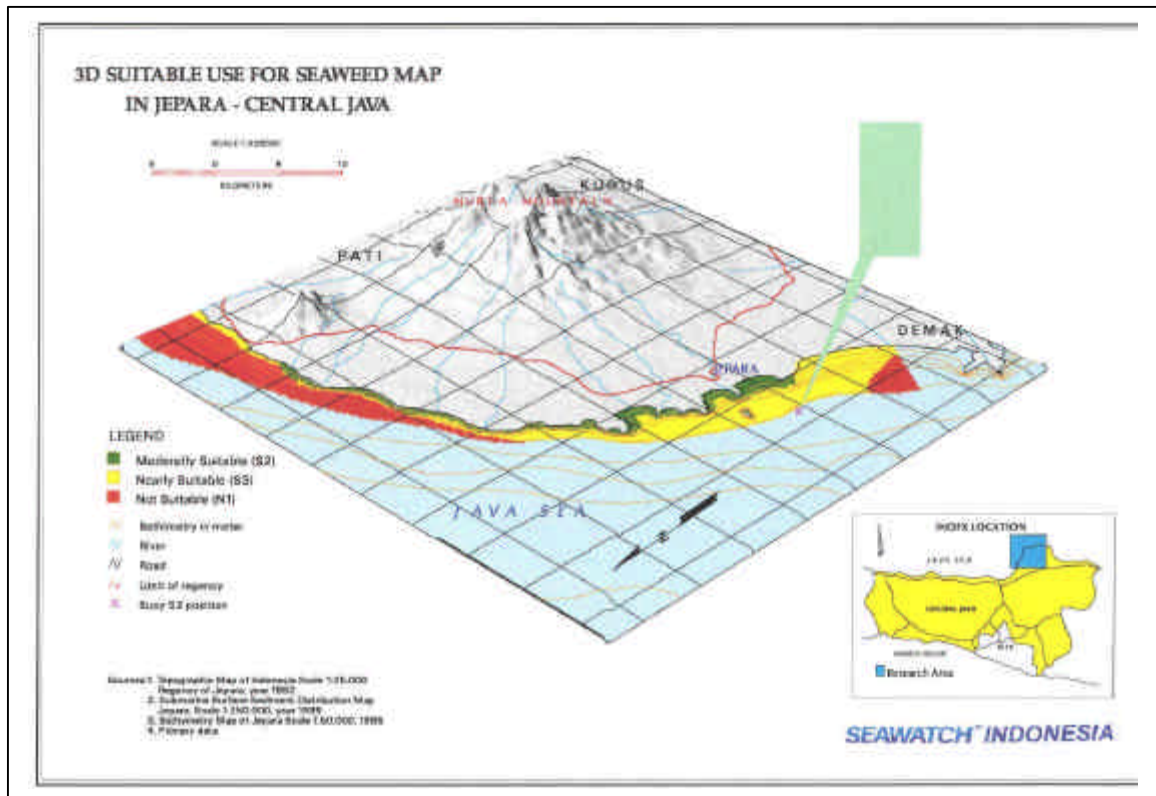
Picture 6. Soil Map

Picture 7. Suitable Map for Mangrove

Picture 8. Suitable Map for Coral Reef

Picture 9. Suitable Map for Tourism

Picture 10. Tree Dimensional Map for SeaWeed