LOCAL MILLENIUM ECOSYSTEM ASSESSMENT:

CONDITION AND TREND OF THE GREATER JAKARTA BAY ECOSYSTEM

Report Submitted to

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This report is a result of local millennium assessment with a case study of Greater Jakarta Bay Ecosystem (GJBE). This exercise is mainly based on secondary data provided by several stakeholders in GJBE area.

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I. BACKGROUND

Jakarta Bay and *Kepulauan Seribu* (Thousand islands) essentially form a large coastal ecosystem with relatively different characteristics. The whole ecosystem, which is called Greater Jakarta Bay Ecosystem (GJBE) stretches from 106^{o} 20' and 107^{o} 03' east longitude, and from 5^{o} 10' to 6^{o} 10' south latitude, and is administratively within three provinces, i.e., Banten Province, the Capital City Special Region of Jakarta, and West Java province (Fig. 1). The Jakarta bay bound by the capes of Tanjung Pasir to the west and Tanjung Karawang to the east is mainly influenced by land-based activities. The bay is exposed to high pollution load transported in from up-land region by 13 rivers i.e., Angke, Bekasi, Cakung, Cidurian, Ciliwung, Cikarang, Cimancuri, Ciranjang, Cisadane, Citarum, Karawang Krukut and Sunter. On the other hand, *Kepulauan Seribu* that forms a chain stretching some 80 km in a northwest to southeast line is a coastal ecosystem dominated by 110 small islands. The total land area of the islands is estimated 864,59 ha, with 45% of the islands has an area lest than 5 ha, 25% of them has size 5 – 10 ha, and 30% of the islands has size larger than 10 ha (BAPEKAB *Kepulauan Seribu*, 2002).

As any large coastal ecosystems, the Greater Jakarta Bay Ecosystem (GJBE) provides at least four major functions to the existence of human well-being and economic development i.e., life-support services, supply natural resources, recreational services, and waste regulating services. Major types of system (mangroves, seagrass beds and coral reefs) support the existence of both marine life and local communities. In *Kepulauan Seribu* ecosystem, fishing and aquaculture activities as well as tourist industries become source of income for local communities. While in mainland area of GJBE, there are about 50 industries ranging from transportations, dockyards, and dairy products to recreation industries. With rapid development of the Jakarta Metropolitan Area (JMA), Jabotabek, in the last 20 years, the coastal waters of GJBE has increasingly affected by combination of human and natural impacts, which include natural ecosystem transformation, non-sustainable practices on resource exploitation, and pollution.

Figure 1. Greater Jakarta Bay Ecosystem that consist of two coastal ecosystems, that is Jakarta Bay and Thousand islands (*Kepulauan Seribu*) or Pulau Seribu Complex (source: Williams et. al., 2000).

It is likely that the threat from anthropogenic sources is greater than that of natural sources; hence the human activities will continue to dominate the fate of GJBE in the next few decades. These human impacts may cause habitat loss, habitat degradation and resource depletion. Moreover, the cascading impact will likely decrease the functional role of ecosystem and its services to human well-being, if the management interventions do not take place.

The paper, which provides a synthesis on the condition and trend of GJBE based on available secondary data, is divided into four sections (Appendix 1). First, the ecosystem services explain the sub-systems that currently exist. Second, the driver change of ecosystem describes several factors that play on shaping the ecosystem. Third, indicators of ecosystem services explain the current stage of local communities benefited from the GJBE services. Finally, the management interventions that human should be directed to maintain integrity of the GJBE.

The result of assessment hopefully could assist the local governments to better understanding about the ecosystem and subsequently could help them in managing the ecosystem for the benefit of current and future generation.

II. CONDITION AND TREND OF ECOSYSTEM SERVICES

1.1. Major types of sub-system

The GJBE consists of three major sub-systems i.e., mangrove forests, coral reefs and seagrass beds. These three sub-systems play significant role in providing services through their interaction processes in nutrient cycling, organic particles and migrations of fauna as well as impact of human activities. For examples, when one sub-system is under disturbance such as, a destruction of large area of mangrove forest, this likely increase export of suspended sediment to seagrass beds system. Chronic supply of high-suspended sediments will affect a process of photosynthesis of seagrass bed, thereby reduces the ability of seagrass bed system to grow and reproduce. As a result the ecological services of the seagrass bed as nursery ground of fish communities may disturb. The following paragraph will describe the services and current condition of each sub-system.

Mangrove forest: Mangrove forest provides services through interaction between biotic (flora and fauna) and abiotic components (water, light, soil). The vegetation within the ecosystem physically provides services as 1) protection of coastal area from erosion by wind and waves; 2) protection from saltwater intrusion; and 3) filter of pollutant and waste from land-based source. Further more, mangrove vegetation biologically support coastal fishery resources by providing source of nutrients, and therefore provide an excellent area for spawning and nursery for certain species of fishes, crabs and shrimps in continuing their life cycles.

Based on forest inventory in 1997, an area of mangrove forest was estimated about 23.358,00 ha (Table 1), and only half of it was forest area (12.284, 61 ha). This estimated forest area maybe overestimated from actual condition. For example, in 1997 total mangrove in Bekasi district was estimated about 13.191,81 ha, but in the year of 2000, Mr. Darmawidjaja, a head of Bekasi district, stated that the mangrove forest in his jurisdiction was approximately only 9.746,25 ha, distributed in Muara Gembong Sub-district (9.045,77 ha), Babelan Sub-district (404,39 ha), Cabangbungin Sub-district (158,10 ha) and Tarumajaya Sub-district (132,19).

Table 1. Mangrove forest along the coast of Tangerang, North Jakarta and Bekasi districts and Kepulauan Seribu (source: data from Institute of Mangrove Research and Development, 2002abc).

District	Forest area (ha)	Non-forest area [a)] (ha)	Total Mangrove area (ha)
Kepulauan Seribu	126,13	-	126,13 [b)]
North Jakarta	177,40	158,10	335,50 [c)]
Tangerang	726,99	8.977,57	9.704,56 [d)]
Bekasi	11.096,00	2.095,81	13.191,81 [d)]
Total area	12.284,62	11.231,48	23.358,00

Note: [a)]non-forest area is a mangrove area where agriculture, fish-pond, water-sport areas exist.
[b)]Coral Reef Information and Training Center (2004)
[c)]Ministry of Forestry Decree No. 097/Kpts-II/1988
[d)]Survey data by PT Insan Mandiri Consultant (1997). Results of inventory of degraded mangrove forest in West Java Province.

At present mangrove forest in North Jakarta can be found in the western part of Jakarta Bay, i.e., Muara Angke and forest reserve of Angke Kapuk, Kemayoran and surrounding Cilincing-Marunda. Mangrove forest in *Kepulauan Seribu* is estimated only 126,12 ha and distributes in Rambut island, Bokor isl., Untung Jawa isl., Lancang Besar isl., Peteloran Barat isl., Penjaliran Barat and Penjaliran Timur isl. (BPLHD – DKI, 2003, Appendix 2). Destruction of mangrove forest can interrupt the ecological interaction processes among the three sub-systems and cause not only to reduce flora and fauna in the mangrove system but also in the long run may decrease productivity in both seagrass and reef sub-systems.

Coral reefs: Coral reefs are among the most productive, diverse, aesthetically pleasing of all biotic communities. The system can prosper nutrient-poor waters because of water flow and a large investment in mutualism (Odum, 1997). In *Kepulauan Seribu*, coral reefs that cover of about 19.430 ha (Winardi, CRITC, pers. com.) are essential as a source of the livelihood for subsistence fishers, and the main source of protein in time of worst season (e.g., during west monsoon where the wave is very violence). Coral reefs serve various ecologically and economically functions such as, a natural barrier against wave erosion, hence protecting coastal communities, aquacultures (*tambak*) and tourist areas. The reefs are also a potential source of local government revenue from tourist's activities.

The coral reefs of Jakarta Bay ecosystem were first described in detailed in the early 1920s by Dutch scientist who noted that coral systems to be in generally good condition (De Vantier, 1998). In recent years coral reefs have shown signs of stress that may be an early warning of global warming and chronic land-based pollution. Five main threats leading to coral reefs deterioration, are as follows, poison fishing, blast fishing, coral mining, pollution and overfishing. Monitoring studies showed that the trend of maximum depth of living coral reef is declining rapidly (Fig. 2). In the last 20 years, about 65 – 80 % of living coral were destroyed by both land-based and sea-based pollution sources. The latest survey by the Taman Nasional *Kepulauan Seribu* (2001) showed that coral reefs status at bad to medium condition with living coral cover ranged from 13.0% to 36.0%. This condition reflects declining services of coral reef ecosystem to human well being. Suharsono (2004) stated that the coral reefs of Jakarta Bay are functionally dead system.

In relation to economic valuation of coral reefs closed to tourist center such as *Kepulauan Seribu*, blast fishing was estimated to yield net benefit to individual fishers of US$ 15.000 per km^2 of reefs, while causing net losses to community of US$86.000 in fishery values, US$193.000 in coastal protection, and US$ 482.000 in tourism (Cesar, 1996). Moreover, he stated that, although not as destructive as blast fishing, cyanide fishing could cause economic looses to society about US$46 millions, but if sustainable use was being practiced such as hook and line fishing, the net benefit to society was about US$ 321,8 millions.

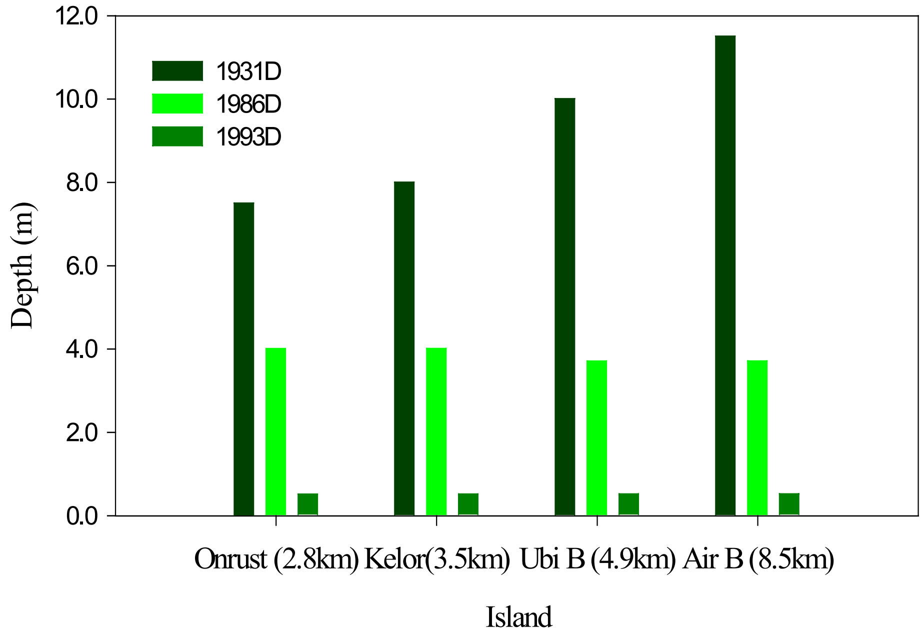

Figure 2. Temporal and spatial comparison of maximum depth of living coral reef for four islands in Jakarta Bay (source: raw data from Tomascik et. al., 1993).

Seagrass beds: Seagrasses are often characteristic features of soft-bottom habitat extending from the intertidal to subtidal (Tomascik et.al., 1997). Seagrass bed in *Kepulauan Seribu* ecosystem is estimated about 13.110 ha (Winardi, CRITC, pers. com.). The most common seagrass association in *Kepulauan Seribu* reef flat is that of *Enhalus acoroides* and *Thalassia hemprichii*. Less common are *E. acoroides, T. hemprichii* and *Syringodium isotifolium* (Azkab, 1991). Moosa et al. (1999) stated that about 78 species of fish associated with seagrass beds were found in the *Kepulauan Seribu* complex.

The services of seagrass bed in stabilization of coastal sediments by their extensive root network have been recognized for some times (Tomascik et al., 1997). In fact, artificial seagrasses are now being manufactured to protect economically valuable beachfront properties where pollution has destroyed natural seagrass beds. The seagrass beds also serve as habitat, feeding and nursery ground for invertebrates, fishes, turtle and dugong. For examples, commercially valuable fishes and penaeid shrimps are dependent on seagrass communities for food and protections during at least one stage of their life cycles. Even though seagrass beds are believed to be a key pathway of nutrient to many coastal invertebrates, fishes and shore birds, there are very few studies on the economic value of this system in Indonesia.

2.2. Greater Jakarta Bay Ecosystem Services

Greater Jakarta Bay ecosystem (GJBE) provides myriad services to local communities ranging from source of food (protein and fibers), fishery, industry, transportation, tourism to waste's regulator. In addition, potency of oil production is estimated about 588 milliard barrels and currently the production is 75 million barrels, whereas the potency of offshore gas is estimated 1.767 milliard barrels, with current production 192.288.670 barrels (BAPEKAP – *Kepulauan Seribu*, 2002).

Biological diversity*:* Marine biological diversity is an important component of ecosystem services. Products of biodiversity include many of the services produced by ecosystems (food and genetic resources). Changes in biodiversity can influence all the other services (Alcamo and Bennet, 2003). Marine species diversity found in coastal waters of Jakarta Bay and *Kepulauan Seribu* is presented in Table 2. Biological diversity especially in the National Marine Park of *Kepulauan Seribu* is relatively high. It is estimated about 183 species of stony corals, 113 – 166 species of fishes, 101 species of seaweeds, 6 species of seagrasses and 4 species of mangroves (Anonymous, 1999).

In Northern Pari island (*Kepulauan Seribu*), for example, recorded 47 species fishes associated with mangrove forest area (Hutomo and Djamali, 1984) These species are resident of coral reef fishes. Suharsono et. al. (1998) also recorded 166 species of reef fishes under 16 families from 22 islands of *Kepulauan Seribu*. The number of species and fish abundance increase as the living coral cover increases (Hutomo and Adrim, 1985, Suharsono et. al., 1998).

Species diversity associated with mangrove areas in mainland of GJBE is presented in Appendix 3. Among three districts of terrestrial coastal area of GJBE, coastal area of North Jakarta has high diversity of flora compare to Bekasi district, but highest diversity of bird is recorded in Bekasi district.

Table 2. Diversity of marine species in coastal waters of Greater Jakarta Bay Ecosystem

Taxa	Jakarta Bay	*Kepulauan Seribu*	Source
Mangrove	-	9	Pramudji, pers. com.
Seaweeds	-	101	Moosa et. al, (1980)
Seagrasses	-	6	Moosa et. al. (1980)
Stony corals	-	183	Moll and Suharsono, (1986) *in* Tomascik et. al. (1997)
Echinoderms	12	89	Aziz (1981, 1997)
Mollusks	329	392	Moosa et. al.,(1980)
Stomatopods	-	8	Erdman and Sisovann. 1998
Fishes	362	166	Suharsono et. al. (1998)

Source of food: Food production of GJBE can be divided into two categories, i.e., food production from aquaculture and from capture fishery. Capture fishery plays a significant role in contributing to economic activity and a major income for coastal communities. However, the trend of fish production from capture fishery tended to decline during the last six years (Fig. 3). Fish catch decrease annually at an average of 11 percent, while the value of fish production was relatively constant during the period of 1997 – 2002, except in 1999 the value of fish production reached a maximum point (Rp. 95 million). Recent study on fishery stock indicated that the GJBE was under over-fished condition (DP2K – DKI Jakarta, 2003).

Mari-cultures especially green mussel and seaweed cultures are important source of protein and fibers from Greater Jakarta Bay Ecosystem. The total potential area for mariculture is estimated 2.975,75 ha for seaweed culture and 53,00 ha for fish culture (BAPEKAP *Kepulauan Seribu*, 2002). Of these potential areas, it is estimated that effective mariculture business is about 50 percent of its potential area. At current condition fishers, in *Kepulauan Seribu*, involve in various mariculture industries, such as seaweeds (1.487 person), sea bass (63 person), milkfish (11 person), sea cucumber (23person) and shrimp (11 person). Meanwhile, around Jakarta Bay area there are currently about 3000-fisher families practice on green mussel culture, and the average production approximately 20 – 25 ton per day. For examples, in Kamal Muara village as one of the fisher village in adjacent of Jakarta Bay, there are about 397 fishers with 1000 unit of mussel's rafts (Litasari, 2002). The mussels were sold in Jakarta

Metropolitan Area and several cities in West Java (Cianjur, Banten and Cirebon). Average income for fisher family is estimated Rp. 4.500.000 per season per raft (Litasari, 2002).

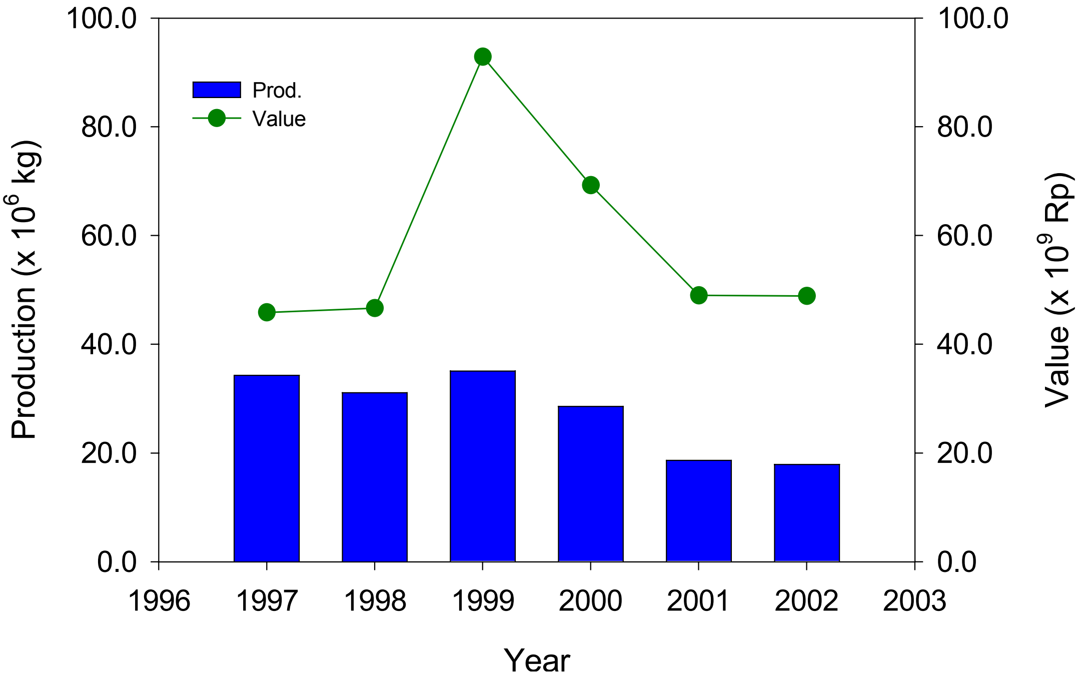

Figure 3. Fish production from local capture fishery landed in Location of Fish Auction (source: raw data from Dinas Peternakan,Perikanan dan Kelautan – DKI Jakarta, 2003. Data Perikanan Tahun 1992 – 2002).

***Recreation*:** Tourist activities have become one of the leading sectors for coastal economic development in GJBE. The number of public and private resort (Appendix 4 and 5) is growing in *Kepulauan Seribu.* There are 505 cottages tourist accommodations in 2002, and about 286 people working directly with this activity as well as several thousands who indirectly involved. The number of domestic tourists was increasing during early and mid 1990-s; the number then decreased during Indonesian economic crisis in 1997/98 (Fig. 4). In contrast, the number of foreign tourists was relatively constant (20.000 tourists) during the last 15 years. Tourism activities could economically bring benefits not only to the local government but also to local communities. However, the number of tourists may need to be controlled as the increase in number of diving and other tourist related activities on the islands (including coastal development to support tourism) can have a negative impact on the condition of ecosystems surrounding tourist areas.

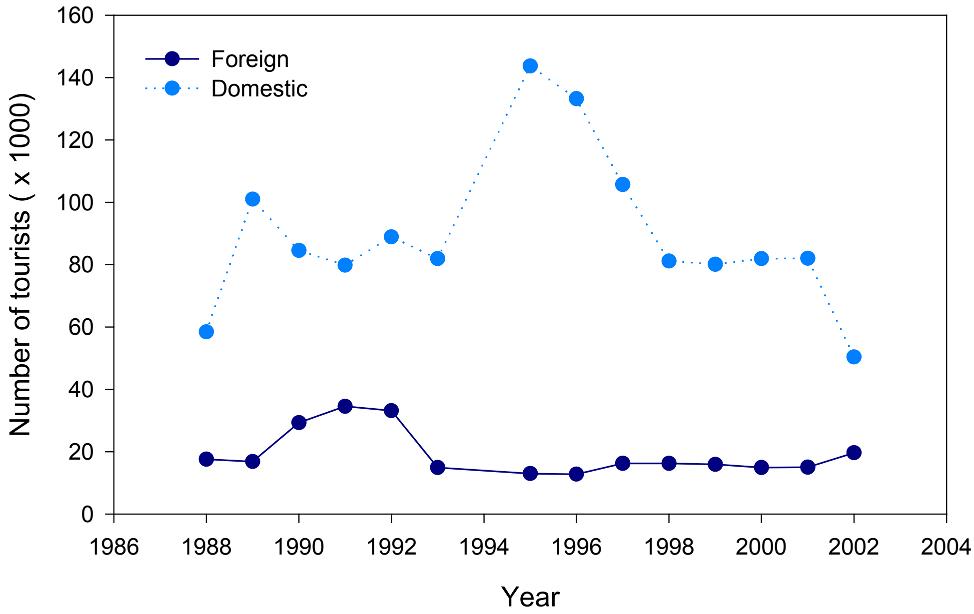

Figure 4. Number of tourist (domestic and foreigner) visited *Kepulauan Seribu*. (source: *Kepulauan Seribu* dalam Angka, 2002. Tourist number in 2002 was recorded from period of Jan to Sept.

***Pollutant regulator**:* The Jakarta Bay ecosystem not only provides a bounty of food sources, but also becomes a giant pollutant receptor from both marine areas (such as, shipping, dockyards, oil and gas industries) and inland area (such as, industries, households, and agricultures). The inland area is considered as the primary source of waste and pollutants because almost all untreated wastewater from household (20 million people) and 2050 industries (BPLHD-DKI, 2003), end up in the Jakarta Bay. The 13 rivers that flow through the JMA pick up approximately 1.400 m^3 per day of solid waste. Of this total solid waste, 1.100 m^3 flows directly into the bay. Survey on the extent of solid waste pollution on 24 islands of *Kepulauan Seribu* in 1985 and 1995 indicated that the total litter onshore had increased twofold during the last ten years and had reached the islands located 60 km from the shoreline of Jakarta Bay (UNESCO, 2002). Similarly, inorganic wastes from industrial activities have been increasing since 1980s, especially for lead (Pb) and copper (Cu), (Fig. 5). Compared to 20 years ago, on average Pb and Cu concentrations in sediment of Jakarta Bay increased 5 and 9 times, respectively. Recent study showed that spatial distributions of Pb and Cu in sediment were highest in the west and middle areas of Jakarta Bay where human activities concentrated in those areas (Fig. 6 and 7).

Like other ecosystems, the Jakarta Bay naturally has capability to absorb and reduce various contaminants. However, it is possible that this absorption capacity has been exceeded. The pollution load of zinc, phosphate and nitrate has exceeded the assimilative capacity of Jakarta Bay both during dry and rainy seasons (Anna, 1999). In the mean time, pollution load of chemical oxygen demand (COD) exceeded the assimilative capacity during the dry season. Furthermore, evaluation on the impacts of land-based contaminants on the coral and green mussel, Rees et al. (1999) suggested that the concentration of metals in waters was the primary route for metal uptake by the coral and mussel tissues. They also found that coral cover and coral colony numbers decreased toward near-shore. Recent study showed that the diversity of fishes caught by beach-seine declined from 45 species in 1974 to only 20 species in 2003 (Arifin et. al., 2003). Similarly the trend was also observed for biological diversity of fishes caught with bottom trawl.

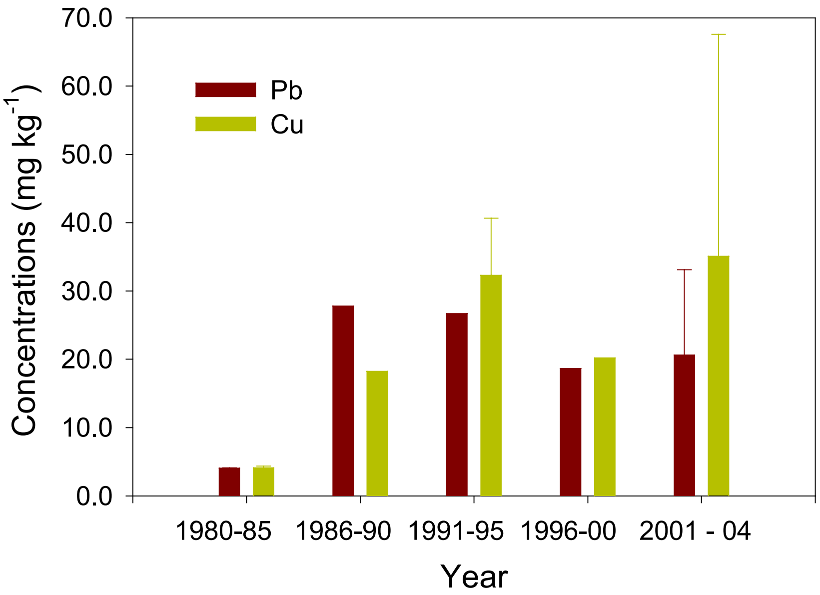

Figure 5. Lead (Pb) and Copper (Cu) concentrations in sediment of Jakarta Bay (bar = standard deviation, unit in mg per kg sediment dry weight).

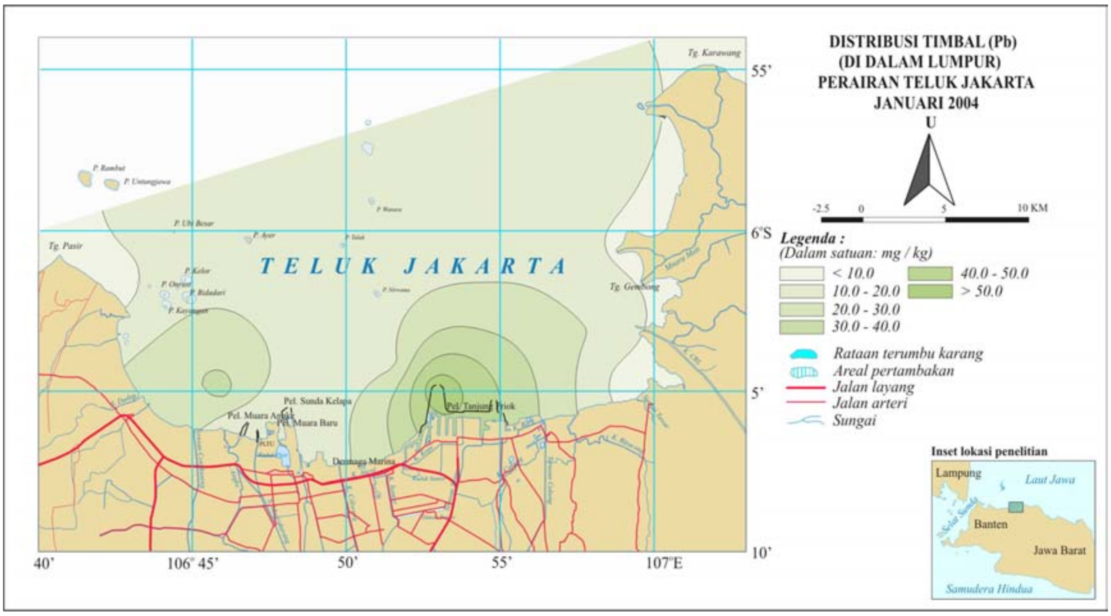

Figure 6. Spatial distribution of Pb (mg kg^{-1}) in sediment of Jakarta Bay during east monsoon (source: Arifin, 2004).

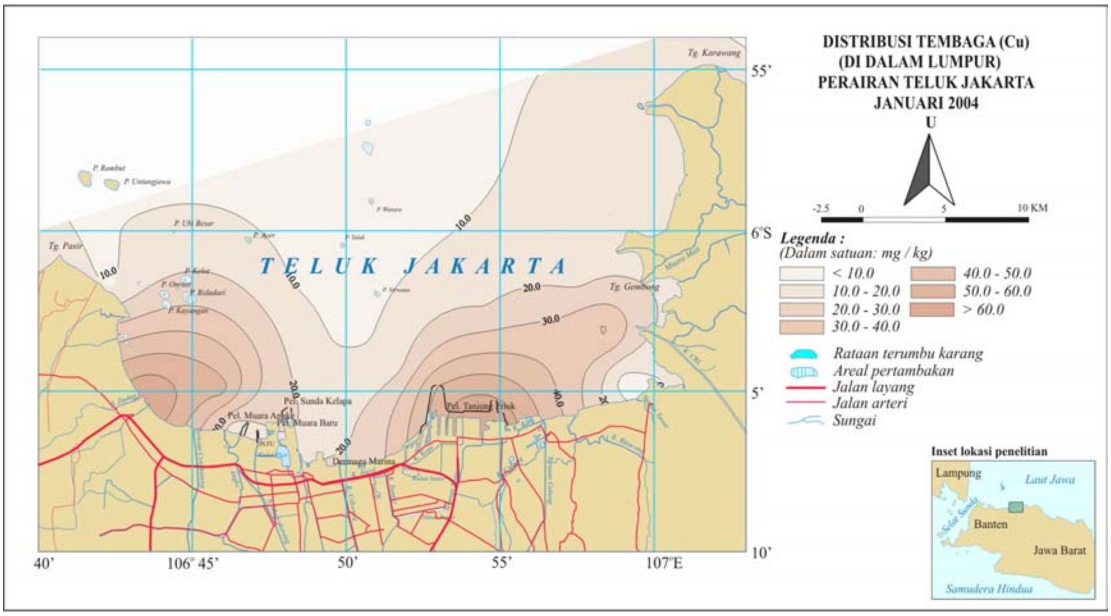

Figure 7. Spatial distribution of Cu (mg kg^{-1}) in sediment of Jakarta Bay during east monsoon (source: Arifin, 2004).

III. DRIVERS OF ECOSYSTEM CHANGE

Natural resources, both living and non-living resources, are an asset that provides flow of goods and services for human being (communities) for unlimited time if they are wisely managed. Ecosystem degradation may be drove by natural factors such as, El Nino episodes and tsunami, or human-induced factors such as, pollution and overfishing. Both factors will disturb the flow of good and services, and finally will reduce the value of resources that are impacted. This section will discuss some of the direct and indirect of drivers of change in Jakarta Bay ecosystem that can lead to habitat loss, habitat degradation and resources depletion (Table 3). Indirect drivers of change in the ecosystem namely, demographic, socioeconomic, and technology factors; whereas direct driver of change includes among others land-used change, marine resource harvest, and nutrient load.

3.1. Indirect drivers of change

***Demographic factor*:** The number of population of Jakarta Metropolitan Area steadily increased in the last 20 years (Table 4). Based on the census of population in 1980, population of the Capital City Special Region (commonly referred to as DKI Jakarta) is about 6,48 million. The population increased at average of 2.7 % per year during the period of 1980 – 1995 (Table 4). However, the result of the census in 2000 showed that the population dropped to 8,38 million. This result might reflect the combination of out-migration to the surrounding commuted-shed towns of JMA and a decline of in-migration from the provinces. In contrast to the population of DKI Jakarta, the population of the vicinity districts of DKI Jakarta i.e., Tangerang, Banten and Bekasi districts significantly increased during the last two decades; the highest growth of population was Bekasi district. The number of population in Bekasi for the year 2000 is triple than the number in the year 1980.

Based on the population census in the year of 2000, DKI Jakarta had the highest population density (12.788 person/km^2), followed by Tangerang district (2.910 person/km^2), Bekasi district (2.196 person/km^2), and *Kepulauan Seribu* district (0.24 person/km^2). Growth rate of population number has implication on the use of land around Jakarta Metropolitan Area. For example, from 1992 to 2001, it was estimated that about 10 percent increased in the use of land for housing. At the same period, about 16 percent of conservation area reduced its area from previous condition (Dirjen Penataan Ruang, Dep. Kimpraswil, 2004).

Table 3. Drivers of change and their threats to the Greater Jakarta Bay Ecosystem

Indirect driver	Direct driver	Threats
	Habitat loss	
Demographic	*population growth, urbanization*, **land-use change**	Coastal developments, housing demands, industrial sites, ports
Socioeconomics	*demand for live fish aquaria fish*	Destructive fishing (dynamite, cyanides, muro-ami, bottom trawl) Aquaculture-related habitat conversion (shrimp ponds)
Technology	*Lack of emission control*	Global warming (increase sea level rise)
Sociopolitics	*Poor developed policy at local or national level*	Coastal deforestation (mangrove deforestation) Mining (sand and coral mining)
	Habitat degradation	
Technology	*Demand of clean water (industries, hotels, recreation centres)*	Saltwater intrusion (deep water wells, uncontrolled population growth in Seribu islands)
	Lack of sewage treatments, **nutrient load**	Eutrophication (nutrients)
Sociopolitics	*Lack of regulations*	- Alien species invasions (shipping industries, ballast water discharge); - Uncontrolled tourism activities
	Lack of law enforcement	Land-based pollution: trace metals, Sea- based pollution: oil spill
	Resource depletion	
Socioeconomics	*Strong economic demand,* **marine resource harvest**	Overexploitation of high value resources
Sociopolitics	*Lack of empowering local communities*	Direct take of low value of species
	Lack of alternative income generating	Intensive extraction of resources

Note: drivers that are discussed are as follows, indirect driver (demographic, socioeconomic and technology), and direct driver (land-use change, marine resource harvest and nutrient load)

Table 4. Total Population in the Jakarta Metropolitan Area, 1980 - 2000 and its neighboring districts bordering Jakarta Bay and *Kepulauan Seribu* (*source*: *Cybriwsky and Ford, 2001; BPS – Statistics Indonesia, 2002).*

Population	1980	1990	1995	2000
DKI Jakarta	6.480.654	8.254.035	9.112.652	8.384.853
Tangerang district	1.533.791	2.764.988	3.589.318	4.058.963
Bekasi district	1.143.463	2.104.392	2.757.376	3.259.690
Bogor district	2.728.671	4.007.941	4.700.309	4.606.349
JMA Total	11.886.579	17.131.356	20.159.655	20.309.855

Note: Jakarta Metropolitan Area (JMA) = Jabotabek – (Jakarta, Bogor, Tangerang, and Bekasi).

Socioeconomic factor: Socioeconomic factor is one of the drivers of change on ecosystem services. The rapid growth of industries has occurred without due regards to the environment in the last 20 years. In mainland of GJBE, there is approximately 2050 industries consist of 147 medium and large industries and 1.633 small industries (BPLHD – DKI, 2003). Most of these industries especially small industries did not have proper waste treatment plants. This factors strongly affect the state of water quality of surface waters (river and lakes) and finally to the quality of GJBE. In coastal area, the economic development is droved by shipping industry, oil industry and fishery.

Number of fisher communities in GJBE is gradually increasing especially for seasonal migrant fishers (Fig. 8). In 1990 number of fisher migrants was 5.631 individuals and within 10 years the fishers was double (11.552 individuals). The migrant fishers come from other areas such as, Central Java, West Java and Madura island. These migrant fishers, for example in Cilincing sub-district, have been caused social problem by staying illegally at the riverbanks. The fisher communities will keep growing as a result of influx of fishers from other regions. Subsequently, this condition will cause pressure to coastal environment.

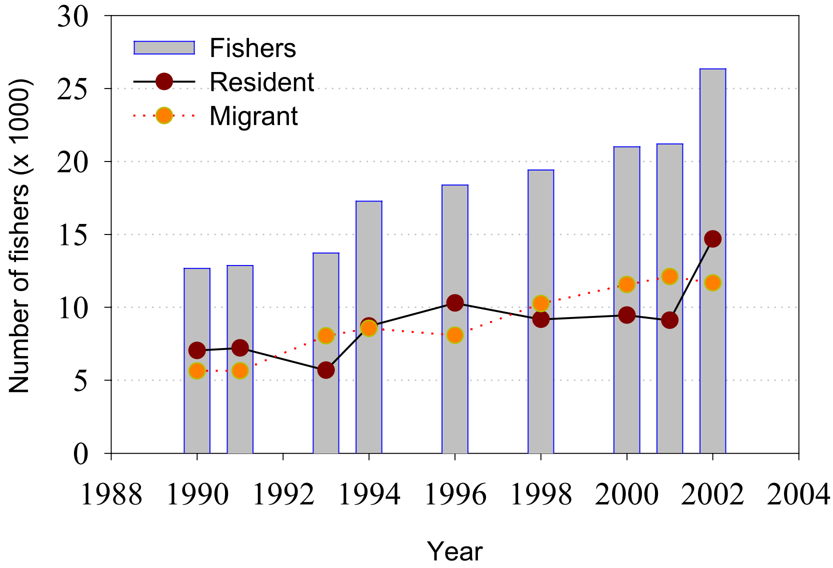

Figure 8. Number of fishers in Northern Jakarta Region including *Kepulauan Seribu* (source: Anna, 2003, DP2K-DKI,2003d).

Technology factor: Fishing technology used by fishers around the Greater Jakarta Bay Ecosystem can be divided into two categories. First, fishers who catch fish closed to coastal waters used fish-pod (*bubu*), lift-net (*bagan*) and hand-line (*pancing*). Second, fishers operate boats with engine and non-engine. It is estimated about 20 types of fishing gear operated in GJBE (DP2K-DKI, 2003a), but the most dominant is fish-pod (bubu), bottom line (*pancing dasar*), lift-net (*bagan*), rampus net (*jaring rampus*) and gillnet (*jaring insang*) (Table 5). Most of the fishing methods do not selective to specific resources, which mean they catch all type and size of fishery resources. This condition most likely causes strong pressure to the resources as regulation on mesh-size of nets and minimum size allowable catch seems not exist. Recent study showed that catch per unit effort in coastal waters of Jakarta Bay had been over maximum sustainable yield (DP2K-DKI, 2003b).

Blast fishing was one the most widespread destructive fishing technique in 1985, but now it seems uncommon practices in Kepulauan Seribu. It seems likely that blast fishing is economically unviable today (Nur et; al., 2001), or other possible explanation is that the fisher communities has realized the negative impacts of their practices on their marine resources.

Table 5. Five types of dominant fishing gears operated in GJBE

No.	Fishing gears	Number unit
1	Fish-pod	5517
2	Bottom-line	4731
3	Lift-net (fish)	811
4	Rampus-net	388
5	Gill-net	310

Mariculture technology is mostly in the form of extensive technology. There are about 3.410 mussels rafts distributed in eastern and western part of Jakarta Bay and in several islands in Kepulauan Seribu such as, Lancang besar isl., Lancang kecil isl., Laki isl., Damar isl., and Nirwana isl. (DP2K-DKI, 2003c). Several mussel rafts have become a problem for shipping as they are located in area of ship lane and some of the rafts also located in protected areas.

Post harvest technology used is generally using low technology (Fig. 9). Various fishery products are produced as shrimp paste, dried shrimp, dried fish, cooked mussel.

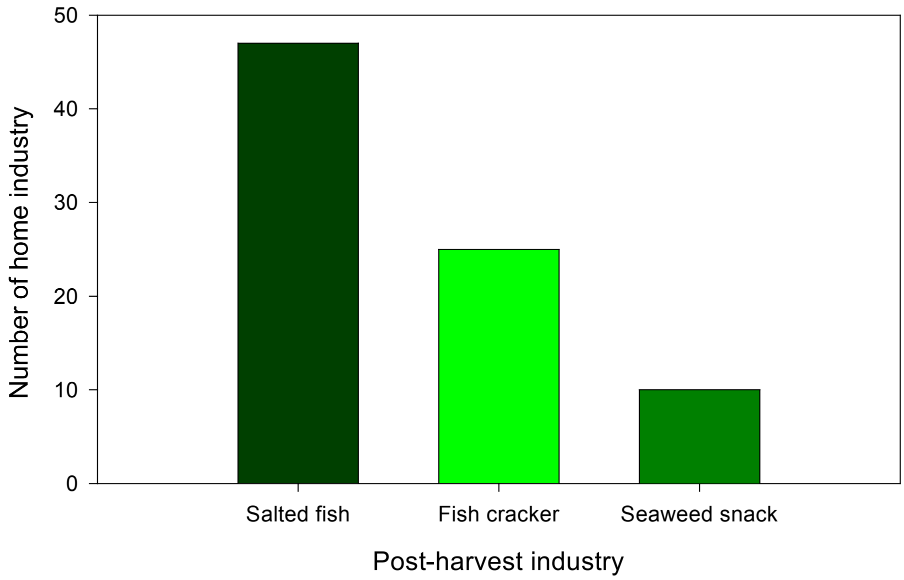

Figure 9. Post-harvest technologies to produce marine products.
(Source: BAPEKAB *Kepulauan Seribu*, 2002)

3.2. Direct drivers of change

***Land-use change**:* An enormous land-use change is envisaged along the coastline of GJBE both housing and business projects (commercial and industrial zones). Housing and business projects in North Jakarta (e.g., Pantai Indah Kapuk Housing) in late 1980s have had greatest impact on mangrove areas. The next mega project will also be conducted, such as reclamation and revitalization of the north coast of Jakarta as a waterfront city (Kompas, 2 June 2003). Moreover, a development plan to extent a run-away strip for airplane in Panjang island is currently initiated by governmental district of *Kepulauan Seribu.* These reclamation projects should ideally not marginalize local fisher communities, but hopefully it will increase their welfare. Therefore, comprehensive study should be carried out before the activities are realized.

Beside reclamation activities, coral and sand mining in North Jakarta and *Kepulauan Seribu* have caused ecosystem degradation and disappearance of islands. Willoughby et. al. (1998) reported that three islands disappeared below sea level between 1985 and 1995. Ubi Kecil and Air Kecil islands have now disappeared as a result of coral reefs extractions, similarly Ubi Besar island is currently eroding rapidly as the reef around the island was dredged.

Marine resource harvest: Fishery activities in Jakarta Bay can be categorized into aquaculture and capture fishery. Capture fishery directly and indirectly influences ecosystem condition. Direct impacts include habitat damage due to destructive fishing practices such the use of cyanide and blast fishing. While indirect impacts may result from intensive extraction of important components of the ecosystem such as carnivore and herbivore fishes. Beside capture fishery, mariculture (e.g., milkfish, shrimps, seaweeds and green mussels) plays a significant role for fisher communities along the coastline of GJBE who involve in various stages of fishery industry.

Number of raft is estimated 1000 unit for green mussel culture from about 397 fishers. The production of green mussel culture in 2000 was estimated about 10.000 ton and decreased compared to previous years (Litasari, 2002). The mussel production both in term of quantity and quality decreased in the last two years. The duration of culture was also longer compared to previous years; in early 1999 the duration of culture between was 6 – 7 months, but now is 8 – 11 months. More over the production declined to 50%, from 15 – 20 ton per unit raft to about 10 ton per unit raft (Litasari, 2002).

Nutrient load: Nutrient (phosphate and nitrate) concentrations have significantly been increasing for the last 20 years. Phosphate (*ortho*-P) was increased 10 times higher than that of two decades ago. Similar trend was also observed for nitrate with lesser magnitude. Nutrient concentrations were generally higher at location of < 5 km from coastal line than that of > 10 km from the coastal line. The nitrogen and phosphate input from land base source was generally higher during west monsoon where heavy rainfalls and maximum of river discharged occurred. While high nutrient concentrations are important as indicator of productivity of ecosystem, but an excessive of the nutrients also becomes boomerang to the life of communities at high organization levels such as, fish and shellfish communities.

During period of 1975 – 1979, for example, both phosphate and nitrate concentrations reached 2.90 μM and 6.90 μM, respectively (Fig. 10). Enrichment at about 0.10-μM phosphate above natural concentrations could cause blooming of micro-algal population (Lapinte et. al., 1993 *in* Suharsono, 2004). Recent monitoring showed that both concentrations were even higher during east monsoon (Fig. 11), phosphate concentration ranged between 0.90 and 14.57 μM, while nitrate ranged between 1.13 and 3.50 μM (Arifin et. al., 2003). These high nutrient concentrations caused a regular micro-algae blooming. *Dinophysis caudata* blooming occurred in 1978 and 1986, followed by *Noctiluca* blooming in 1993 that caused massive fish-kill. The micro-algal bloom that causes a reduction of water transparency, and chronic oxygen depletion in water column will likely change diversity of coastal fishery resource that may lead to reduce fishery productivity.

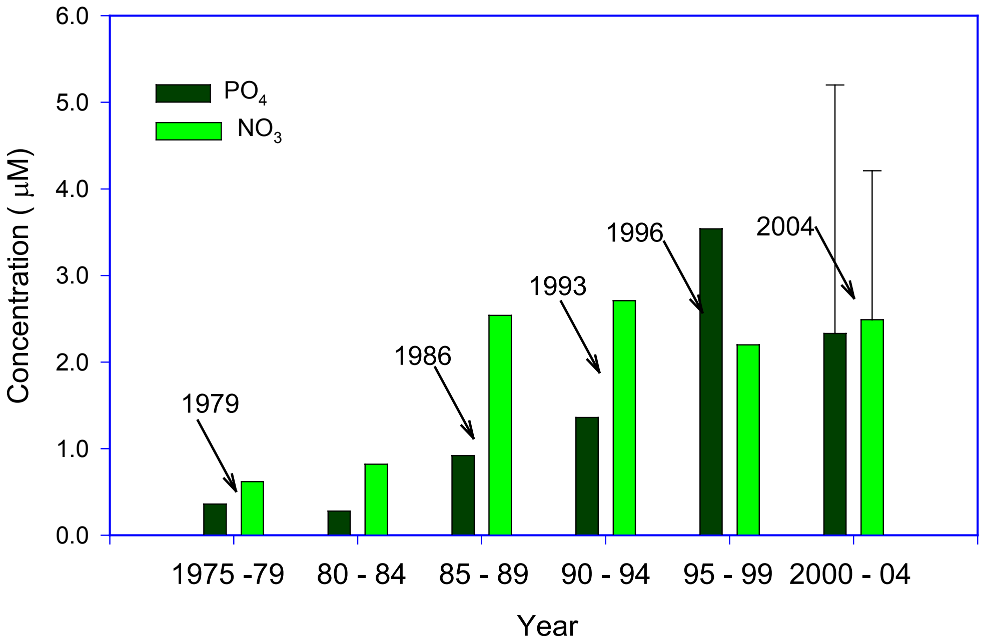

Figure 10. Nitrate and Phosphate concentrations (µM) in JakartaBay; arrow's sign: microalgal bloom occured(source: 1975/78 data from Ilahudeand Liasaputra (1980),1990/94 data from Siswanto (1990), Arifin (2004)).

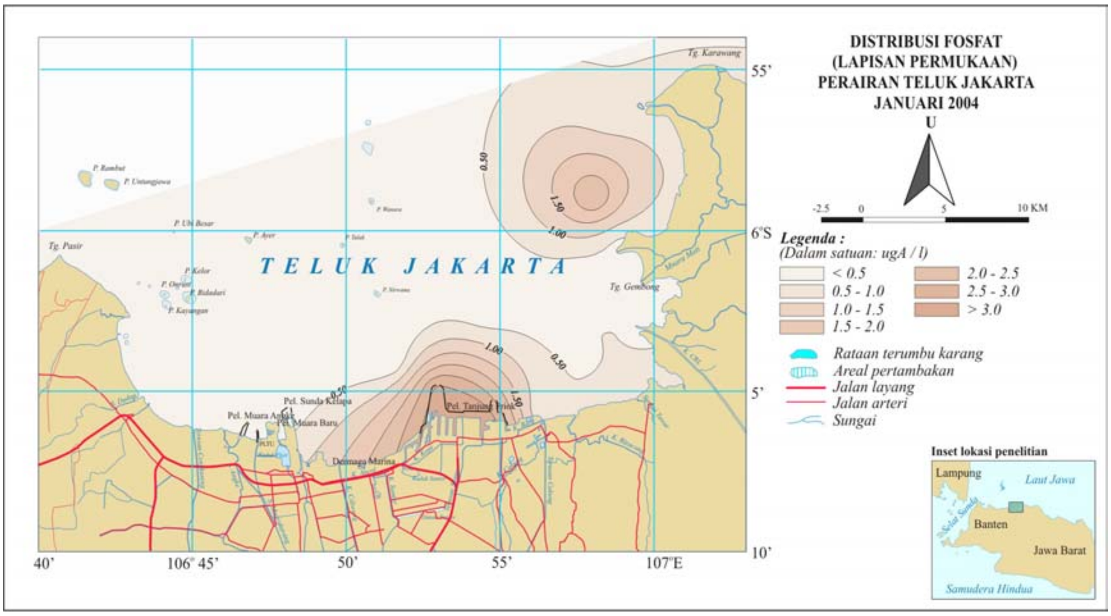

Figure 11. Spatial distribution of phosphate during east-monsoon (January) (source: Arifin, 2004). 1.0 µg A $l^{-1} \approx 1.0$ µM

IV. INDICATORS OF CONDITION OF ECOSYSTEM SERVICES

4.1. Marine Production

Production of capture fishery sector decreased in the last five years. Fish production was continuously declining from 35.008,0 ton in 1999 to 28.525,6 ton in 2000, and finally to 17.828,7 ton in 2002 (DP2K-DKI, 2003b). This trend showed that the GJBE is possibly under stresses from both intensive fishing, and degraded water quality due to pollution from both land and marine sources. The area of brackish water fish-pond in North Jakarta also decreased since 1992 and no brackish-water fish pond operated after the year of 1996. This is because the quality of water was increasingly not favorable for shrimp and fish pond-industries (DP2K-DKI, 2003d).

4.2. Access to Clean Water

Population census in the year of 2000 showed that DKI Jakarta had the highest population density (12.788 person/km^2), followed by Tangerang district (2.910 person/km^2), Bekasi district (2.196 person/km^2), and *Kepulauan Seribu* district (0.24 person/km^2). High density of population demands great quantity of water for their daily life. However, local coastal communities around GJBE have lower access to clean water (Fig. 12). Population who has access to clean water is only 25 to 35 percent of the total population, and the rest of communities do not have access to clean water.

4.3. Income and Education Levels

Most coastal communities especially Kapuk Muara and Kamal Muara (North Jakarta district), Kronjo (Tangerang district) live below the poverty line due to their limited capital and skills (UNESCO, 2000). About one third of communities have elementary education or lower. Most people are fishers (65%), others work in factories (20%) or in informal sectors such as vendors or traders.

Table 6 shows several factors of indicator of poverty condition in district of Bekasi, Tangerang and North Jakarta. In general, an average age of communities in these three areas can reach over 40 years with less than 6 % is illiterate. Lack of access to clean water and malnutrition of infant are among the chronic condition in three districts (Fig. 12).

Human poverty index (HPI) for Bekasi, North Jakarta and Tangerang districts were 20.8%, 23% and 25.1 %, respectively which are above HPI of Jakarta Province, 15.5% (BPS, Bappenas and UNDP, 2001). The index indicated that the communities living in these three districts are at low-medium category of poverty condition.

Table 6. Human Poverty Index (HPI) within three districts based on population census in 1998.

Municipality/ District	Population does not reach age of 40 years (%)	Adult illiterate (%)	Population without access to clean water (%)	Population without access to health care (%)	Mal-nutrition of infant (%)	HPI
Tangerang	13.6	5.7	67.8	20.0	18.5	25.1
Bekasi	14.3	2.9	74.9	0.0	11.6	20.8
North Jkt	7.9	2.3	72.7	0.8	26.2	23.1
Jakarta Province	***7.9***	***2.2***	***40.2***	***2.0***	***23.7***	***15.5***

Note: *Kepulauan seribu* was a part of North Jakarta District before 1999 (regional autonomy decree No. 22/1999).

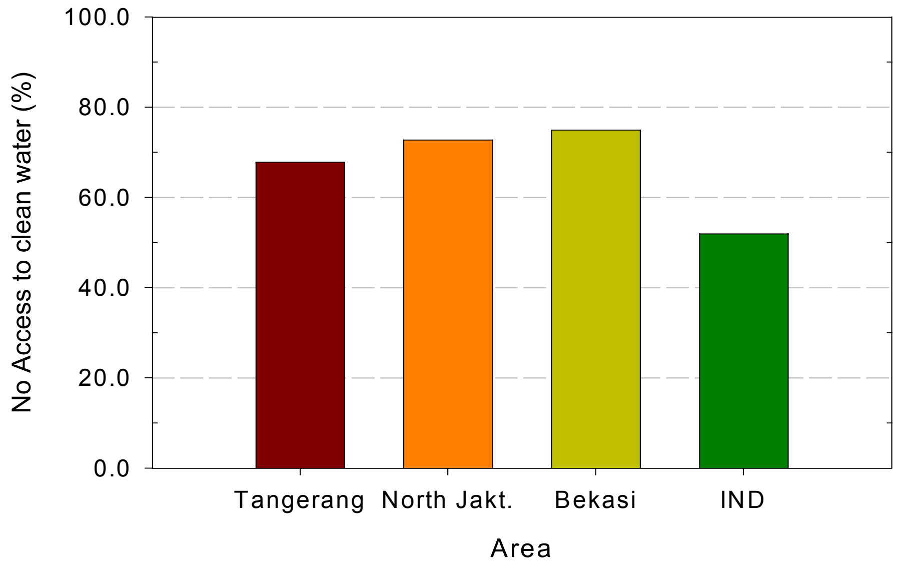

Figure 12. Population without access to clean water in three areas of mainland GJBE (BPS, Bappenas and UNDP, 2001). IND - Indonesia

V. MANAGEMENT INTERVENTIONS

It is obvious that much can be done to improve the condition of Greater Jakarta Bay Ecosystem, if the will is present among stakeholders. To improve the current condition of the GJBE, there is a need to expand management interventions through dissemination of information on condition of GJBE and empowering island residents as well as to improve awareness of stakeholders and the public.

Two approaches in management interventions were needed in order to reduce pressure on GJBE. At public domain, there is a need to improve JMA's waste management and recycling in order to reduce the waste that flows from the city to the coastal sea. Moreover, the socioeconomic sustainable development of the local communities living on the islands and along GJBE must be strengthened through development of fish and seaweed culture, as well as tourism. At government domain, the implementation of good developed policy at local and national level, strong law enforcement and regulation, as well as development an integrated waste treatment for small scale industries in district of Tangerang, Bekasi and Jakarta.

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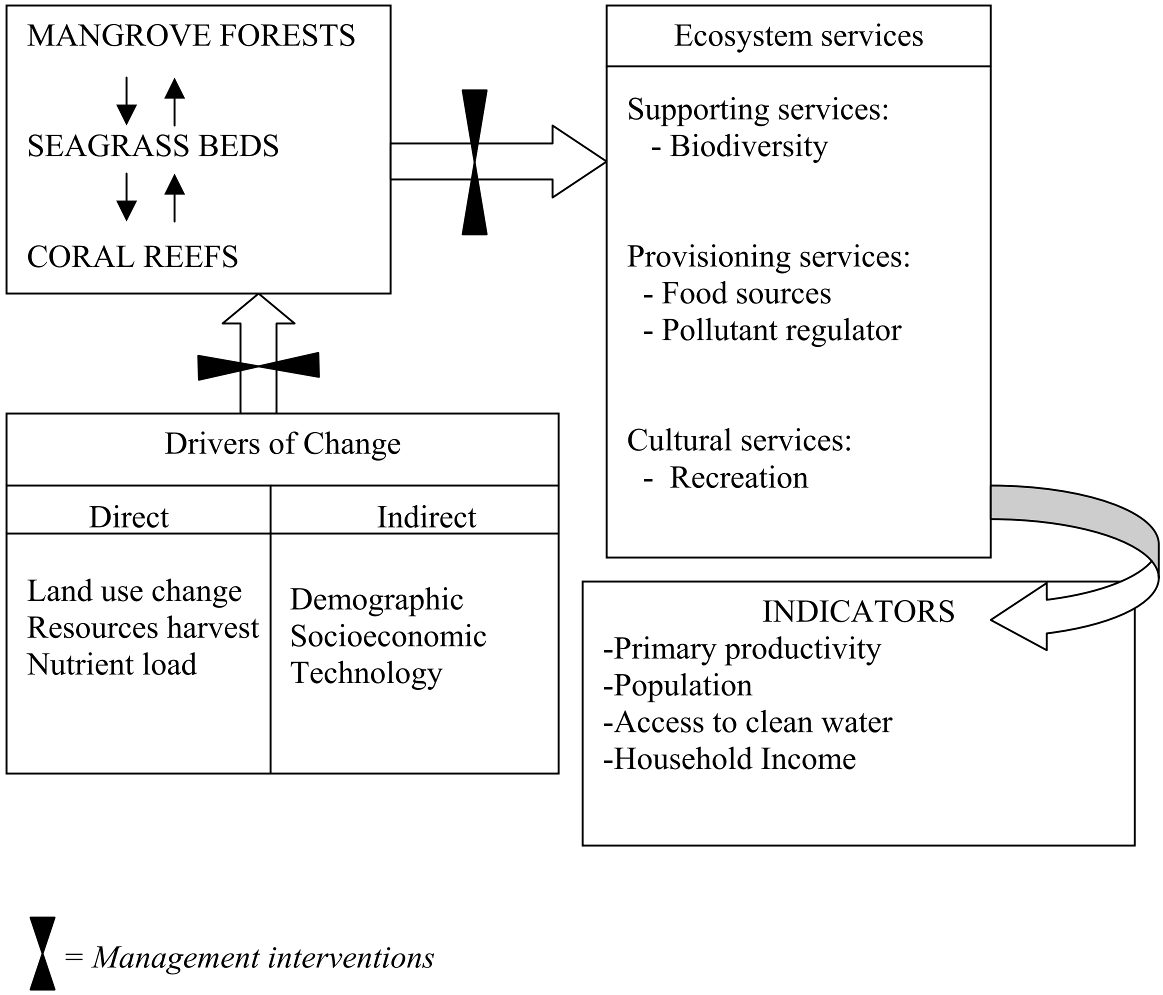
Appendix 1. Flowchart of assessing condition and trends of Greater Jakarta Bay Ecosystem



Appendix 2. Mangrove vegetation in Marine Protected Area of Kepulauan Seribu

No	Island	Area (Ha)	Number of species	Species
1.	Suaka Margasatwa P. Rambut	27,00	9	*R. stylosa, R. mucronata, S. alba, B. gymnorhiza, A. marina,I. racemosa, C .tagal, E. agllocha, A. granatum.*
2.	Bokor Isl. (protected area)	25,23	2	*R. mucronata, S. alba*
3.	Untung Jawa Isl.	31,00	2	*R. mucronata, A. alba*
4.	Lancang Besar Isl.	16,50	3	*R. mucronata, S. alba, A. alba*
5.	Peteloran Barat isl. (protected area)	11,30	3	*R. mucronata, C. tagal, A. marina*
6.	Penjaliran Barat isl. (protected area)	8,30	4	*R. stylosa,C.tagal, S.alba, A.marina*
7.	Penjaliran Timur isl.(protected area)	6,80	4	*R. stylosa,C.tagal, S.alba, A.marina*
Total		**126,13**		

Source: Lembaga Pengkajian Pengembangan Mangrove ***in*** BPLHD - DKI Jakarta (2003)

Appendix 3. Species diversity associated with mangrove forest in GJBE

Organism	Species diversity		
	Tangerang district	North Jakarta district	Bekasi district
Flora	20	26	9
Mammalian	22	4	7
Bird	11	-	32
Reptile	14	7	8
Fish	2	11	4
Crustacean	2	12	10
Gastropod	22	27	5
Bivalve	16	13	nd

Source: Institute of Mangrove Research and Development – UNEP (2002abc)

Appendix 4. Public resort islands in Kepulauan Seribu

No	**Island**	**Management**
1	Ayer Sarotama	Prima Perkasa
2	Bidadari	Seabreez
3	Bira Besar	Pulau Seribu Paradise
4	Hantu Barat	Pantara
5	Hantu Timur	Pantara
6	Kotok Besar	Kotok Wisata Indah / Palem Putra Harmoni
7	Laki (sudah tidak beroperasi)	Faden Gema Scorpio
8	Macan Besar (Matahari)	Matahari Impian Indah
9	Putri	Buana Bintang Samudra
10	Tondan Besar (Pelangi)	Pulau Seribu Paradise
11	Sepa Besar	Sepa Permai
12	Onrust	Dinas Pariwisata
13	Cipir	Dinas Pariwisata

Source: Tim Pengawasan dan Pengendalian Pembangunan Fisik Kepulauan Seribu, Jakarta Utara (Januari 1997) ***in*** Utami (2004)

Appendix 5. Private resort islands

No	Island	Management/Owner
1	Air	Siti Tanjung/Ponco Sutowo
2	Bira Kecil	Asriland/Bambang Trihatmojo
3	Bulat	Wono Madu/Indra Rukmana
4	Bundar	Data Script/Yusuf Kamdani
5	Burung	Bumiraya/Herman Susilo
6	Genteng Besar	Nings Ass/Ismail Ning
7	Genteng Kecil	Nings Ass/Ismail Ning
8	Kaliage Besar	Yys.Arafah S/Surya Paloh
9	Karang Beras	Tristar Bineka U/Jefri Baso
10	Karang Kudus	Central Pondok S/Joni Wijaya
11	Lancang Kecil	Faden Gema Scorpio/Evelin F
12	Lipan	Unitras U/Edward Soeryajaya
13	Melinjo	Sanjaya/O.Sanjaya
14	Melintang Besar	Kaliraya Sari/Gunawan
15	Opak Besar	Indowisata Citra/Bambang K
16	Panjang Bawah	Mulia Grup/Handoko W
17	Pemagaran	Mercubuana/Probosutedjo
18	Satu	Wisata Ekatama/R. Suprapto
19	Semut Besar	Reputasi Sejahtera/Setiadi K
20	Semut Kecil	KG-Marine/Joni Wijaya
21	Tengah	Seabreez/Ciputra
22	Tidung Kecil	Frans Seda
23	Tongkeng	Multisedco M/Setiawan Djodi

Source: Warta pariwisata vol. 1V(3) ***in*** Utami (2004)