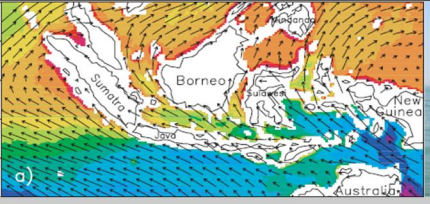



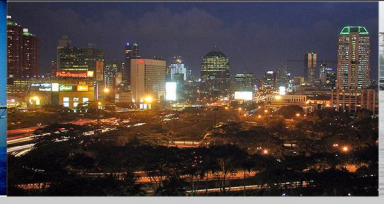


INTRODUCTION TO JAVA SEA

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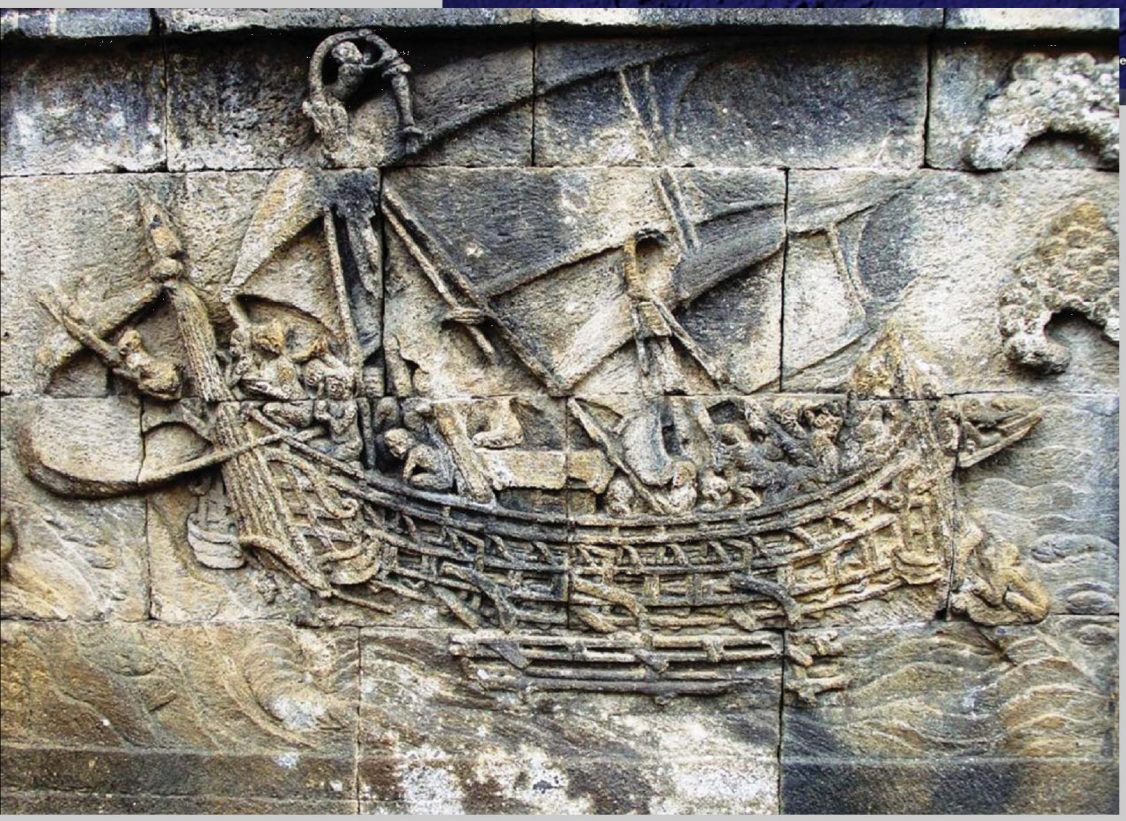

Genia Atma Nagara — Nugroho Adi Sasongko — Olugbenga Johnson Olakunle





Abstract

Java Sea is one of the most important seas in Indonesia since it lies on the north of the main Island of Indonesia, Java. Being part of Sunda shelf, it can be classified as shallow water with average depth 40m. As an introduction to Java Sea, we will discuss four main points in Java Sea, those are: physical oceanography condition of Java Sea, the natural resources, transportation and environmental problems in Java Sea.

Similar to other Indonesian waters, the oceanography condition of Java Sea mainly influenced by monsoon climate, that is, a semi-annual reversal wind condition. This monsoon condition will govern the currents and water mass variation during the year. Besides, the existence of two big oceans, Pacific and Indian Ocean and also the other seas that adjacent to it will give some contributions to the water mass condition and tidal condition. The condition of water mass surely will influence the biological resources in Java Sea such as the types, distribution and also the primary productivity. In this section also, there will be discussed about the fisheries activity and how it actively increased because of the population and economic growth. Being proven of having oil and gas basins, the offshore oil and are also important resources of Java Sea. All of them will be discussed on the part of natural resources. As a part of the largest archipelago in the world, Indonesia, sea transportation is another important activity in Java Sea, especially because it connects the main island, Java, to other islands. Today, the increasing of offshore oil and gas industry that increase the presence of oil tankers, floating vessels and other marine activities have add the players to the transportation in Java Sea.

The population and economic growth in Indonesia, especially in Java Island have led to the increasing fisheries, petroleum industry and transportation activities in Java Sea. These conditions, in turn, will give pressure to the sea environment. As a result, many environmental problems become the issue, such as pollution from the household and industry that carried trough the rivers and also ecosystem degradation such as coral reefs. Therefore, the comprehensive study of the environmental condition must be seriously performed in the future, since today there is not so much information about the comprehensive and detailed information of the environmental status of Java Sea.

Keywords : Java Sea, Environment, Monsoon Climate, Oceanography, Resources, Transportation

Introduction to Java Sea

I. Introduction

The Java Sea (Indonesian: *Laut Jawa*) is a large (310,000 km²) shallow sea on the Sunda Shelf. It was formed as sea levels rose at the end of the last ice age. The Java Sea lies between the Indonesian islands of Borneo to the north, Java to the south; Sumatra to the west, and Sulawesi to the east. Karimata Strait to its northwest, links it to the South China Sea.

Figure 1. Java Sea (source: http://encarta.msn.com/map_701513467/Java_Sea.html)

II. PHYSICAL OCEANOGRAPHY OF JAVA SEA

1. Wind and Surface Currents

Just like any other part of Indonesia, Java Sea is strongly governed by monsoon climate. Monsoon could be defined as semi-annual reversal wind. The Northwest monsoon reaches it's peak in December to February and it is usually characterized with frequent rainfall and windy period (or Indonesian just called it rainy season). On the other hand, the Southeast monsoon reaches it's peak on June to August and it usually characterized with low rainfall (dry season). From **Figure 2**, we can see that on Java Sea, the wind blows nearly parallel with the axis of the channel from east to west during south east monsoon. It reverses during the northwest monsoon.

Because of the high constancy of the monsoons and of their regular appearance, the ocean currents show the same characteristics (Writky, 1961). Hence the surface currents in Java tend to follow the direction of the prevailing winds which change along the year. From May to September the water flows to the west and from November to March to the east (see **Figure 3 and 4**). In April and October the direction of the flow changes and

eddies occur. Normally in these months a current towards the east prevails off the coast of Java and a current towards the west off the coast of Borneo.

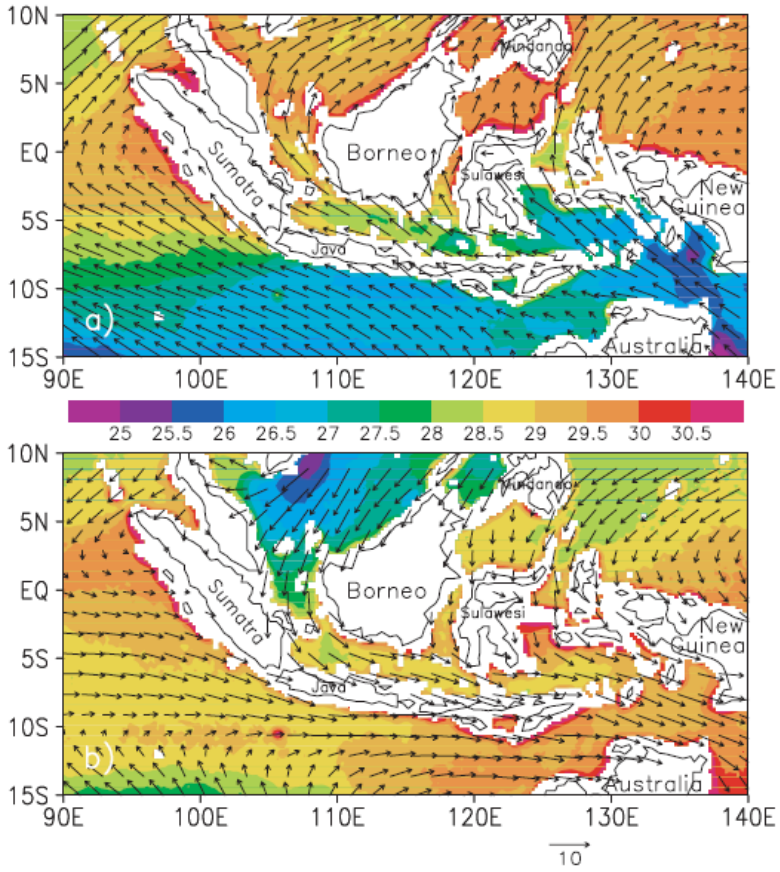

Figure 2. Wind circulation on Indonesian waters, a) during southeast monsoon, b) during northwest monsoon. (source: Qu, T. et.al.,2005)

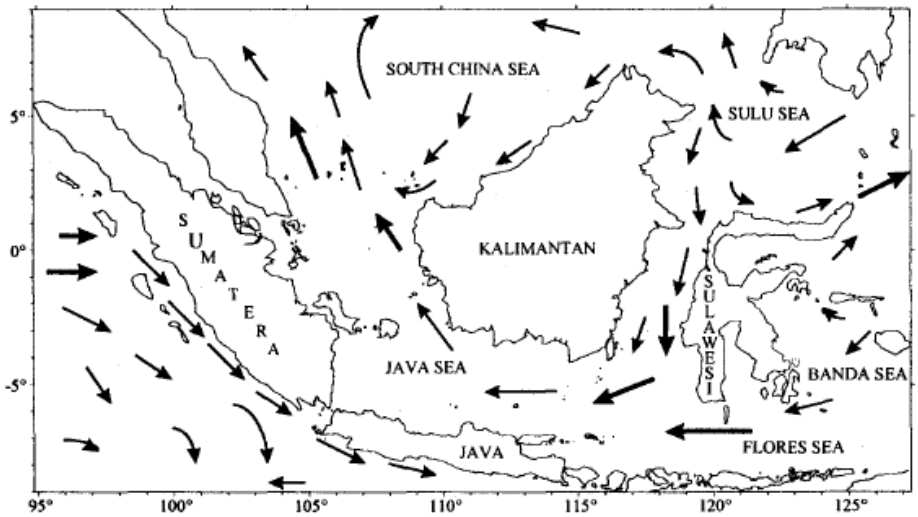

Figure 3. Average surface current during South east Monsoon (Source: Wyrtki, 1961)

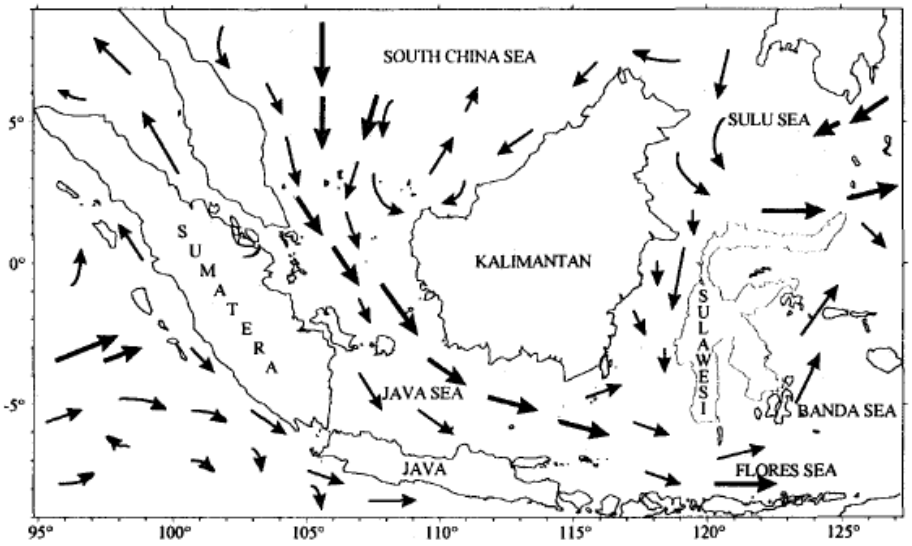

Figure 4. Average surface current during Northwest Monsoon (Source: Wyrtki, 1961)

2. Water Mass (Salinity and Temperature)

Java Sea is relatively shallow water with average depth about 40m. It will result in good mixing of water mass creating homogenous layer from the surface to the bottom. Hence, the surface condition of the water mass properties in this area will give adequate information about the characteristic of the water mass in Java Sea.

Generally, sea surface temperature in tropical area such as Indonesia is warm and has small variation during the year. The average annual variation of temperature is smaller than 2°C in the equatorial regions, slightly higher values of 3° to 4°C, occur in the Banda, Arafura and Timor Seas as well as south of Java (Wrytki, 1961).

Unlike the temperature, the salinity in Java Sea shows more variation. In the western part of the Java Sea, the salinity is relatively low due to run off from many rivers in Sumatra, Java and Kalimantan. While in the eastern part, the salinity is higher due to oceanic water mass that dissipated to that area.

As a consequence of the semi-annual climate that discussed on the previous subchapter above, the water mass in Java Sea will have seasonal movement related to its adjacent waters such as South China Sea, Karimata Strait and Flores Sea. Figure 5 shows that during the Southeast monsoon, the currents from the east bring more saline and lower temperature water from Flores Sea. The saline water gradually penetrates the Java Sea and the current does not totally replace the lower salinity water. Hence, it will result in higher density of water mass penetrating to Java Sea during this period. These phenomena will be reversed during the Northwest monsoon, where the currents bring the less saline water from the west Java Sea to the east. This condition will cause the salinity in Java Sea relatively smaller and the density will also decrease.

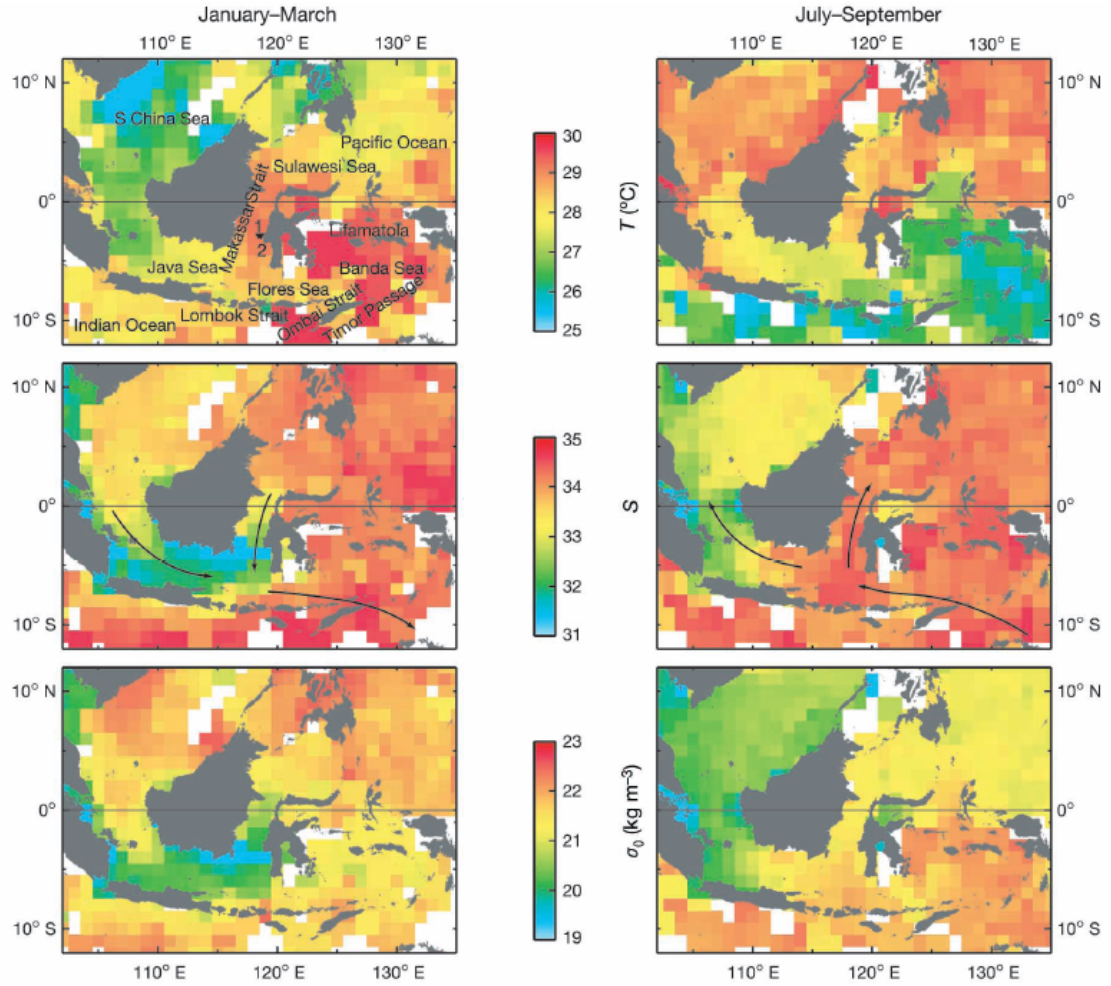

Figure 5. Surface Temperature, Salinity and Density Distribution. The left side: during Northwest monsoon, right hand side: during southeast monsoon. The data taken from World Ocean Atlas. (source: Gordon et.al, 2003)

3. Tides

Because of its position, the tides in Indonesian waters are strongly influenced by the tides from the Pacific and Indian Ocean. The tides within the Southeast Asian Waters are co-oscillating tides of the Pacific and the Indian Oceans, and because of the extremely strong subdivision of this region the pattern is manifold and in each basin a different oscillation is primarily stimulated (Wrytki, 1961).

In the Indian ocean, the semidiurnal type is very dominant and forms mixed tide, prevailing semidiurnal. It governs Timor Sea, Banda Sea and Sahul Shelf. While in the Pacific Ocean, especially in the western part of it, the tides are mixed with prevailing diurnal and govern the China Sea, Philippine waters and Celebes Sea, while Java Sea with Malaka and Makassar Straits are the boundary regions.

Since the Java Sea is more open to the China Sea, we can say the influence from the western Pacific Ocean is greater, then, the type of tides in Java Sea are mixed tides with prevailing diurnal (**Figure 6**). It means that there will be 2 high waters and 2 low waters in one day, which very much differ in high and sometimes there only be 1 high water

and 1 low water. We can also observe that there is some area that has pure diurnal type, that might be caused by its local condition.

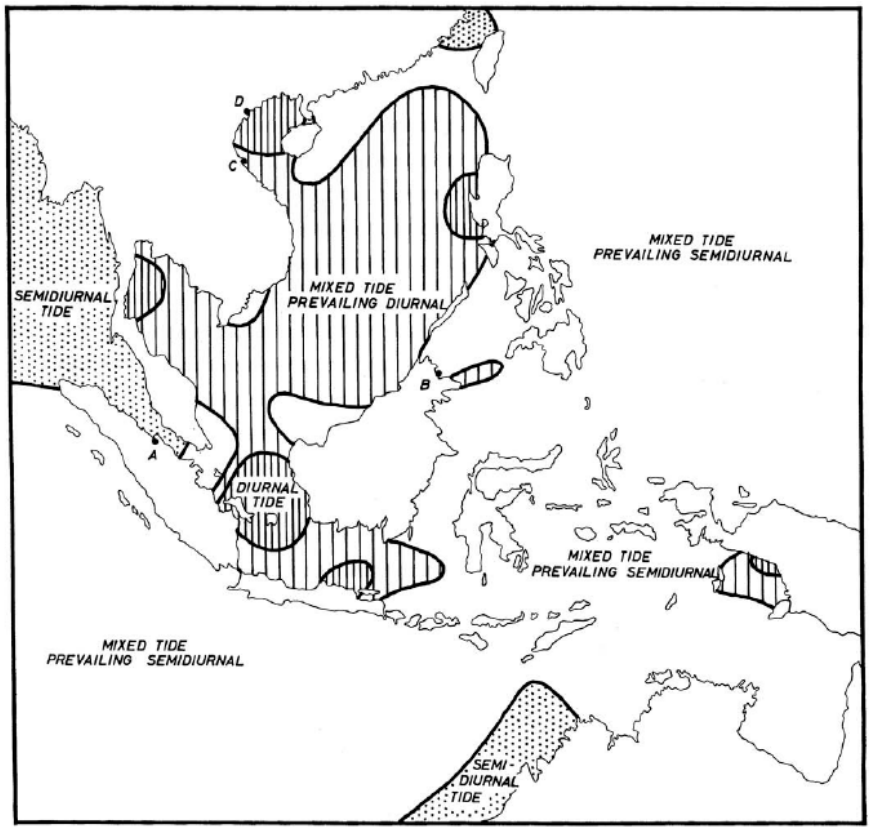

Figure 6. The type of tides in Indonesian waters. (source: Wyrtki, 1961)

4. Java sea bottom sediments

The most part of bottom substratum of the Java Sea is constituted by silt and formed by highly dense mud layer, with large muddy bed in the North-East and central area which are mixed with coral and shell debris (Boely ***et al.***; Emery ***et al.*** in Sadhatomo, 2003). Sandy mud is frequently observed in the South part of Kalimantan, North of Madura and near the coast; rocky outcrops associated with coral formations are observed.

A line extending from east to west through the Java Sea roughly divides the bottom sediments of the region into two distinct groups:

- Those to the north are largely derived from the non-igneous formations of Borneo,
- while those to the south were derived from the volcanic rocks of Java, Coarse quartz sand is found in the vicinity of the several entrances to the sea, but the great central basin is for the most part composed of soft mud that are rich in calcium carbonate in the vicinity of coral reefs.

Java Sea, in the longitudinal (East-West) axis, the bathymetric profile tends to slope with the deepest part lying in the East and ending in the continental slope. Many coral reefs

and islands lie in the Java Sea and extent from the West to the North-East, which traditionally correspond to fishing grounds of pelagic fishery.

III. NATURAL RESOURCES OF JAVA SEA

1. Biological Production

The Benthic research, that carried out in 1984 along a west-east axis in the Java Sea and in the Strait of Madura, shows relatively poor benthic communities. The average densities of macro faunal organisms (> 1 mm) did not exceed 250 specimens·m^{-2}; the total biomass was below 1 g AFDW·m^{-2}; small polychaetes and crustaceans were the dominant groups. A number of larger organisms have developed very remarkable adaptations to the muddy environment. Meiofaunal organisms (nematodes being the dominant group) numbered $0.06 \cdot 10^6$ to $0.46 \cdot 10^6$ specimens.m^{-2}. In general there is a trend from west to east towards somewhat richer communities. The actual carbon demand of the benthic ecosystem in the area investigated is tentatively estimated at an average of 38 g C·$m^{-2} \cdot y^{-1}$, which amounts to about 40% of the primary production. Both the very soft fluid-mud bottoms in the central Java Sea and in Strait Madura, and the relatively low amount of energy available for growth, probably prevent the establishment of well developed benthic communities (de Wilde et. al., 1989).

Figure 7. Seribu Islands coral reef
(source : http://farm1.static.flickr.com/18/24180432_fa86776f81.jpg)

2. Importance of the marine organism

Indonesia's aquatic ecosystem is not any different from other aquatic ecosystems in the world, but consists of more tropical fish species that are not found anywhere else. Like other aquatic ecosystems, food webs within the Java Sea involve many species that are inter-dependent on each other. There are microscopic single-cell planktonic algae that are in the first tropic level. There are small invertebrates called zooplankton and some smaller fish that feed on the algae, which form the second tropic level. These herbivores are fed on some bigger fish and other invertebrates; they form the third tropic level. On top of these, some larger fish and marine mammals, such as killer whales, feed on the predatory fish and they stand on top of all tropic levels, as well as being the "keystone species" in their ecosystem.

There are, at least, two types of population groups in the Java Sea. The first one is the group of resident species that spend their whole life in the Java Sea and depend on the functioning of coastal waters. The species of this group are included in the coastal population group. The second one is the visitor species group, which, at the time being, plays the major part in pelagic fishery. These species stay in the Java Sea for a part of their life span, in the young age only, meaning that adult stages and their reproduction mainly take place outside Java Sea, in the eastern Seas of Indonesia.

3. Economic Importance of fishing industry

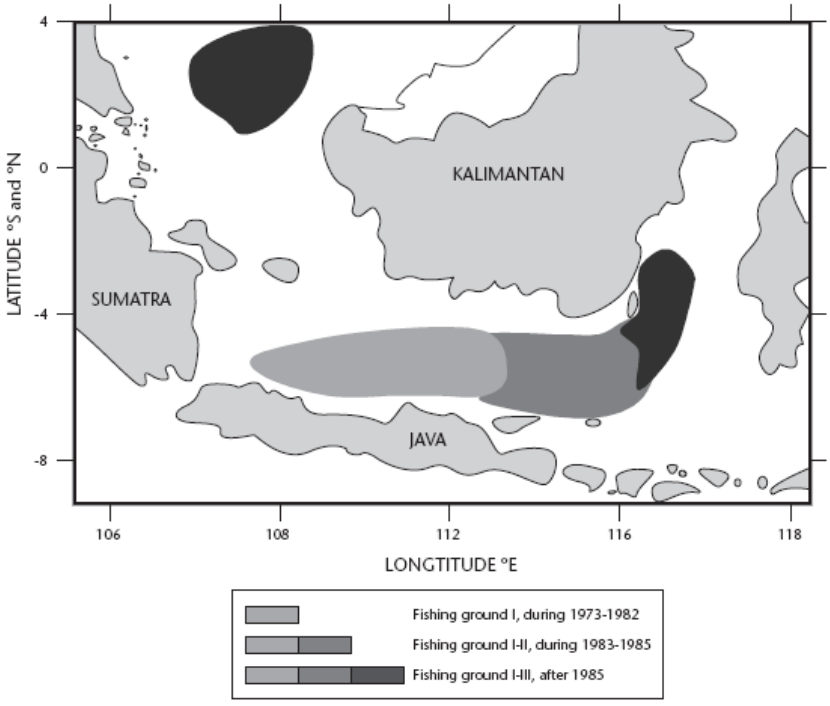

Figure 8. Area of fishing ground in Java Sea (source : Purwanto, 2003)

The Java Sea is a major fishing ground in Indonesia contributing 31% of the national marine fisheries production (Purwanto, 2003). Demersal and small pelagic fishery resources account for most production in the area. During the 1960s and 1970s, strong demand for fish, which in Indonesia resulted from both increased human population and

increased per capita fish consumption, stimulated the development of fishing in the Java Sea (**Figure 8**). This led to development of up-stream and down-stream industries, increases in employment opportunities, and increases in the number of fishers and fishing household.

4. Oil and Gas resources in Java Sea

Most oil and gas production comes from Tertiary basins onshore northern Sumatra, onshore and offshore Java, in the Natuna Sea, onshore and offshore east Kalimantan, onshore Papua (formerly Irian Jaya) and locally new prospects offshore Papua (**Figure 9**). Offshore oil production began in 1971 from the Cinta and Ardjuna fields in West Java Sea and this region is still the most important offshore producer, albeit in decline. Most of the rest comes from western Indonesia, over the well-explored shallow water shelf of the Java and South China Seas, geologically known as the Sunda shelf. The producing basins peter out offshore and, despite numerous exploration wells only a few fields have been developed in these waters in the shallow sea.

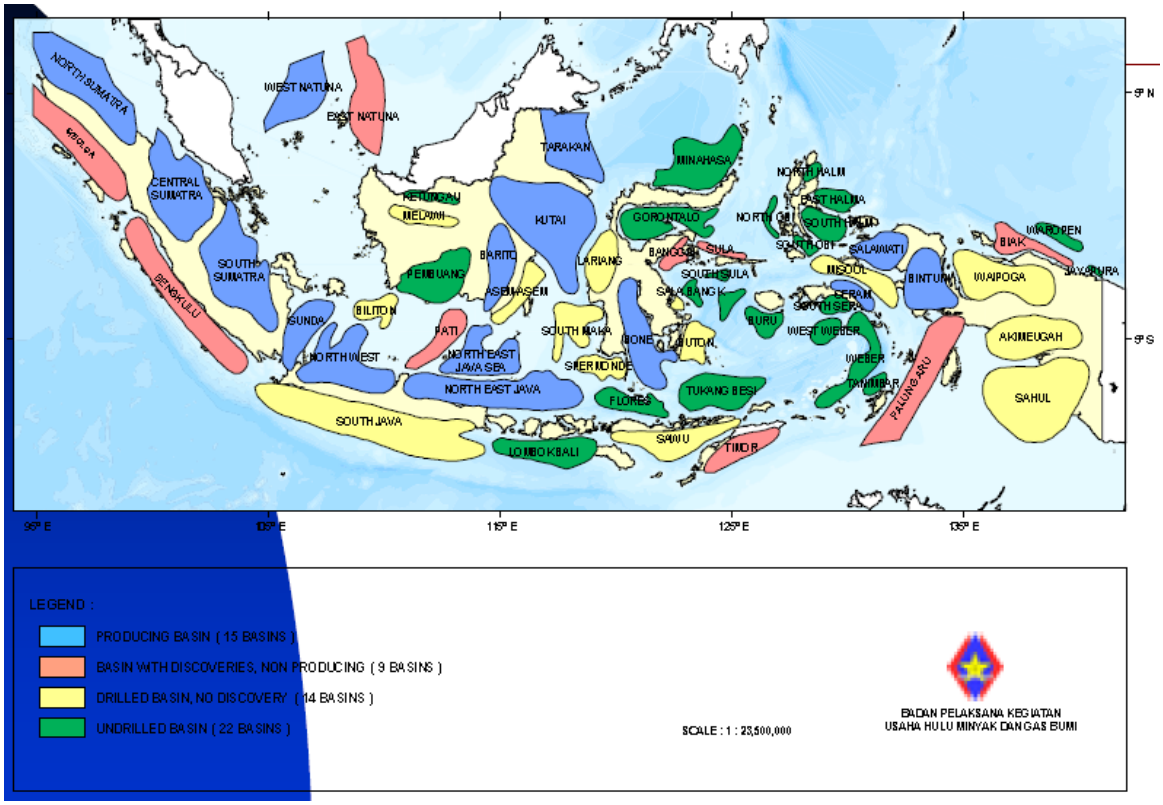

Figure 9. Indonesia Tertiary Sedimentary Basin
(source **:** www.ccop.or.th/ppm/document/CHWS3/**CHWS3DOC22**.pdf)

The greatest area of offshore oil production in Indonesia is off West Java, dating back to the offshore NW Java PSC signed by Arco in 1967 and the offshore SE Sumatra PSC signed by IIAPCO in 1968. Production began in 1971 and around 70 oil and gas fields and satellites produce from these two areas, the largest holding over a hundred mm Bbls (for example Intan, Indri, Widuri and Bima), the smallest only around 2 mm Bbls, developed with eight or fewer wells from caisson platforms. In 1993 a gas development project was completed delivering around 3.6 Bcm per year to power plants serving

Jakarta. However, production from West Java Sea continues to decline. In the East Java Sea Arco (now BP) began producing the 40 Bcm Pagerungan gas field in the Kangean block in 1993. Around 3.6 Bcm per year is delivered by pipeline to Surabaya. Other smaller gas fields west of Kangean Island, including Terang, Sirasun and Kangean West, can utilise Pagerungan facilities.

There are also a series of small oil and gas fields northwest of Madura Island with fractured carbonate reservoirs and modest output. The first discovery in this region was in 1970, later developed as the Camar field in 1991 (Camar was suspended in 1994, then intermittently produced at around 2,000 Bbls per day). The Poleng field was discovered in 1972 and brought onstream in 1976, but abandoned in 1978. The KE2 field was discovered in 1978. A series of small finds were made in the 1980s and the KE5 gas field was brought onstream in 1993. Small discoveries with marginal commerciality have continued to the present day. Now, there are several oil companies become operator at java sea fields, such as Pertamina, BP, CNOOC, Petrochina, and Santos.

IV. TRANSPORTATION IN JAVA SEA

Indonesia's transport system has been shaped over time by the economic resource base of an archipelago with thousands of islands, and the distribution of its more than 200 million people highly concentrated on a single island which is Java. It remains a fact that Indonesia is the largest archipelago in the world consisting of 17,508 islands and covering a land area of 1.9 million sq. km as well as the waters area of 7.9 million sq.km. The population of Indonesia amounts 224,784,210, 98% of which occupying 5 main islands, namely 60% in Java, 20% in Sumatera, 7% in Sulawesi, 5% in Kalimantan, and 1% in West Papua. Geographically Indonesia lies in a strategic position, at the crossroad shipping routes from East to West and from North to South. Because Indonesia encompasses a sprawling archipelago, maritime shipping provides essential links between different parts of the country. Boats in common use include large container ships, a variety of ferries, passenger ships, sailing ships, and smaller motorized vessels. Frequent ferry services cross the straits between nearby islands, especially in the chain of islands stretching from Sumatra through Java to the Lesser Sunda Islands. On the busy crossings between Sumatra, Java, and Bali, multiple car ferries run frequently twenty-four hours per day. In the Figure 10, it shows dense of oil and gas vessel tanker across of Java Sea. There are 3 Refineries for oil located in the main island, Java. Crude oil which is extracted from Java Sea Basin and its surrounding, transported to Cirebon, Gresik and Cilacap processing plant facilities. After getting the fine product of oil, it will transported back to several terminals at several islands to distributed fulfilling energy which is consumer needed.

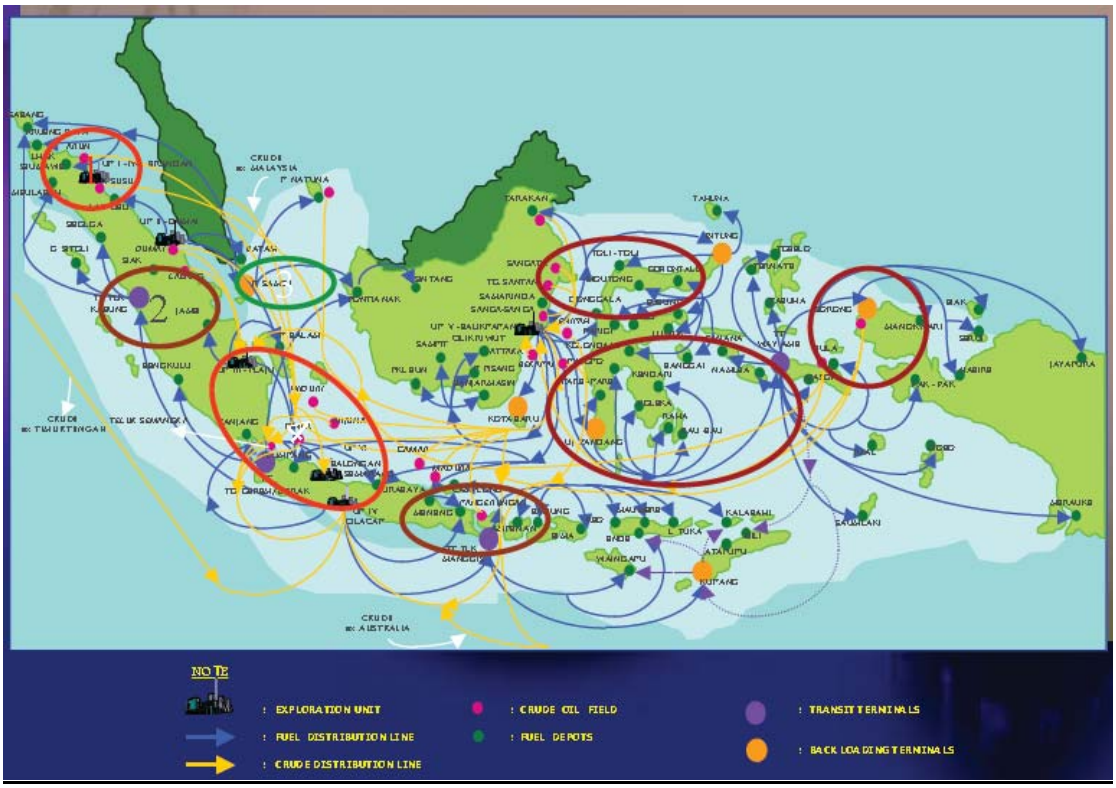

Figure 10. Supply and Distribution System of Crude Oil and Oil Product on water Transportation in Indonesia (Source : Bayu Satya BCS, 2007)

Consequently, sea transportation plays a vital role in nation-wide development. It serves as a means of transport both for mobility of people and cargo and of connecting among islands, as a means to promote national economic life, as a means to support other sectors, to increase and equalize people prosperity, to increase national product competitiveness, and to strengthen national integration and unity (Gunadi, 2004). In addition, the presence of offshore platforms in offshore Java Sea**,** the presence of oil tankers, floating vessels and other marine activities have increased thereby producing a multiplier effect on the economy and the people through employments and other benefits (**Figure 10**).

V. ENVIRONMENTAL ISSUES IN JAVA SEA

If we sail The 600-mile though the Java Sea from Jakarta to Bali was challenging work. Oil rigs, fishing stakes, shipping traffic, floating debris, and countless fishing boats required that we keep a diligent watch. The increasing of activities at north seashore of java make increasing of Sedimentation and Pollution as a results of logging, erosion, untreated sewage and industrial discharges, which another and kill the corals.

Sedimentation, both from urban areas and from logging activities, smothers corals as it prevents them from capturing sunlight and plankton their primary sources of energy and nutrition. Pollution, from both agrochemicals and industrial discharges, can also kill corals. These problems are particularly acute close to estuaries of rivers and urban centers. For urban induced sedimentation, no economic costs have been calculated, typically they vary dramatically with the site, and reduction of discharges often has

many other economic benefits (such as sanitary improvements and disease control), making the cost to corals probably minor.

Based on data from BPLHD Jakarta, thirteen rivers flowing north to Jakarta Bay bring at least 14,000 cubic meters of mostly household garbage each day, or about half of the total of 28,435 cu m of garbage that pollutes the sea (**Figure 11**). Fifty-four percent of the floating garbage in Jakarta Bay is made up of plastics and the 13 rivers continue to transport a huge amount of trash. Domestic sewage, industrial effluent, and urban runoff from big cities in north part of Java threaten the southernmost portion of this area. Floating garbage is a problem, depending on prevailing winds. Ballast water discharges from boats result in tar being washed up on local beaches. Blast fishing, although outlawed nationally since 1920, still occurs as well as heavy ornamental fish collecting and major subsistence exploitation of marine resources.

Figure 11. Jakarta Bay Swamped by Trash
(Source : http://www.iran-daily.com/1386/2878/html/panorama.htm)

Indonesia is located at the center of the world's coral reefs diversity, and with some 75.000 square kilometers of coral, it holds approximately one – eight of the world's coral reefs. Coral reefs from the core of their livelihood for hundreds of thousands of Indonesia subsistence fishers, and are a sources of food security in times of agricultural hardship. They also provide a natural barrier against wave erosion. Despites this, the quality of coral reefs in Indonesia is declining rapidly. For example, coral cover on almost 40% of the reefs in the Seribu Islands is 'Poor', and only 5% have 'Excellent' coral cover. In this case percentage of coral cover can be used as indicator of reef health. The islands are under pressure from developers seeking more tourism and recreational facilities to service greater Jakarta. There is no strategy to promote environmentally and economically sound expansion of this industry. Boat anchoring and diving have already damaged coral reefs. Subsistence fishing pressures are very high and fish catches have declined with loss of coral cover, for example catches decreased from 1350 tones in 1973 to 100 tonnes in 1990. According to SUHARSONO (1998), percent cover of live coral at western part of Indonesia are : 3.93 % excellent, 19.10 % good, 28.09 % fair 48.88 % poor. Central part are : 7.09 % excellent, 22.70 % good, 33.33 % fair, 36.88

% poor. Eastern part are : 9.80 % excellent, 35.29 % good, 25.49 % fair and 29.42 % poor. All reefs near centres of population suffer from human impacts, and now there are many roving bands of fishermen who are damaging remote reefs by fishing using dynamite, cyanide, and muro-ami methods. Indonesia has started a massive Coral Reef Rehabilitation and Management Project (COREMAP) aimed at safeguarding the country's dwindling coral reefs, and slowing degradation. An economic analysis showed that the value of intact coral reefs to the Indonesian economy in tourism and sustainable fisheries was 50 times greater than the value obtained by using cyanide to collect fish, and mining coral rock and sand. Oil and gas explorations, taking place within kilometers of the park, could pose a potential future threat since they make any oil spill and hydrocarbon leakage.

I. CONCLUSION

Java Sea, located in tropical area, has unique characteristic that resembles the tropical seas. The water mass in Java Sea, just like any other seas in Indonesia, is governed by monsoon climate. Being shallow and warm, Java sea has high productivity, supports coral reefs ecosystem and has very rich demersal and small pelagic fishery resources. Therefore, Java Sea has become the major fishing ground in Indonesia, that supports 31% of national marine production. Beside fisheries, Java Sea also becomes one of Indonesian offshore production area since 1980s.

The population and economic growth in Indonesia, especially in Java Island have led to the increasing fisheries, petroleum industry and transportation activities in Java Sea. This condition, in turn, will give pressure to the sea environment. As a result, many environmental problems become the issue, such as pollution from the household and industry that carried trough the rivers and also ecosystem degradation such as coral reefs. Therefore, the comprehensive study of the environmental condition must be seriously performed in the future, since today there is not so much information about the comprehensive and detailed information of the environmental status of Java Sea.

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