

# Ecosystem Approach Studying Development of North Coast Jakarta

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**Abstract.** The Inhabitant population of the city of Jakarta continues to increase, the extent of land is limited, and the increasing demand for housing and support facilities, to encourage the conversion of land in Jakarta, for example, the conversion of mangrove forests and reclamation on the north coast of Jakarta in a bid to increase the area of land for the construction of housing and business and commercial centre. Changes in land cover caused by changes in the ecosystem affect the North Beach neighbourhood of Jakarta. The purpose of this paper examines the impact of changes in land cover and environmental development of coastal areas of Jakarta. The qualitative research approach used. Analysis of changes in land uses the space, temporal analysis instruments, to study the change of land use in 1995, 2000, 2005, 2010, 2015. The scope of the study is limited to environmental issues, which include the natural and built environment of the Environment. The study results get, the development of the north coast city of Jakarta ignores ecosystems, such as coastal ecosystems, open green spaces, river ecosystems, resulting in a puddle of water at high tide.

## 1. Introduction

Jakarta has a diverse role as the capital of the State, business and commerce, and municipal services, promote economic growth, increased more than in the other cities in Indonesia and drivers of migration, resulting in increased population. According to National Statistic Bureau In 1980 the population of the town amounted to 6.503 million inhabitants and a population census in 2010 increased to 9.607 million. The Jakarta Capital City has a land area of 661.52 km<sup>2</sup> and sea area of 6977.5 km<sup>2</sup> and recorded  $\pm$  110 islands scattered in the Thousand Islands, with the growing population, and breadth of the land is limited encourage the conversion of mangroves and swamps (wetlands) for settlement and region business and commerce, as well as the reclamation along the coast to add to the breadth of the land. Waters of Jakarta Bay with a long coastline reaches 50.5 km and reached 39,238.5 ha of water area[1]. The addition of the land area of Jakarta town reclamation area includes the addition of breadth Taman Impian Jaya Ancol and Pantai Mutiara carried out by private companies, while the conversion of mangrove forests and wetlands (swamps) occurs in Kapuk area become residential areas, business, and recreation. The addition of the land area of the town of



Jakarta is reclaimed to create artificial islands. With the pattern follows the river which empties into the Bay of Jakarta. With the 13 estuaries, then at least will form 17 islands reclaimed.

According to Law No. 1 of 2014 on the amendment of Law No. 27, article 1, paragraph (2) of Coastal is the transition between terrestrial and marine ecosystems are affected by changes in land and sea, whereas in paragraph (21) controls the coastal border, mainland along the banks of a width proportional to the shape and physical condition of the beach, a minimum of one hundred (100) meters from the highest tide landward.

Climate change can be caused by processes internally or external strength, or the presence of anthropogenic changes that are constantly in the composition of the atmosphere due to land use, [2]. The definition of climate change at the top shows how the climate system change, adaptation is the adjustment effort lifestyle and ingredients to climate change, while mitigation is basically mitigation efforts to prevent climate change is getting worse. Mitigation can also be interpreted as a variety of active measures to prevent / slow down climate change.

According to Macintosh and Ashton (2004), "Mangrove greenbelts can provide significant coastal protection from erosion and should be established along erosion-prone coastlines and riverbanks and in areas which experience significant damage from typhoons, tidal surges, cyclones, and geomorphic erosion (Macintosh and Ashton 2004). Greenbelts should be a minimum of 100 m, but preferably up to 500 m or 1 km (advocated in Mekong Delta, which is subject to typhoons) at the open coast and 30-50 m along riverbanks and lagoons, and >10 m on islands, creeks, and channels (Macintosh and Ashton 2002; Macintosh and Ashton 2004). In the Red River Delta in Vietnam, engineers estimate that an earthen sea dyke with rock facing will last about five years before it requires repair from wave damage, whereas the same sea dyke with a 100 m wide protective mangrove belt will last up to 50 years! [3]

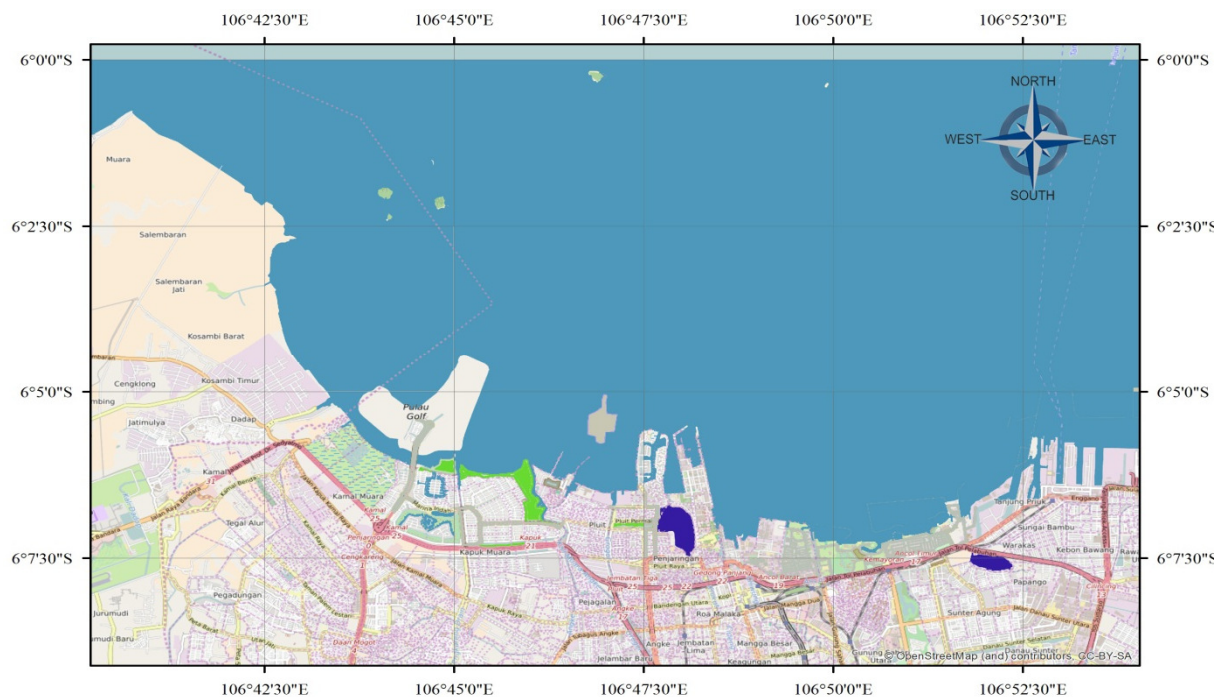
"Strategies for adaptation to sea level rise, there are three main categories: retreat, accommodate and protect. In the Pacific islands, this could mean leaving low-area islands or, if available, on the same island, leaving the area of low and move to higher ground. Accommodation suggests changes in land use when the water level rises, such as improving the building or changing to crops that are more tolerant to salt. According to Nicholls and Leatherman (1996) often use a protection embankment built to keep the sea from the shoreline could use hard structures such as seawalls and breakwaters, while Watson et al. (1996) chose the use of vegetation to stabilize the beach. Adding sand and rocks to the beach there or raise the height of the coastal village location may be useful in some places (Nicholls and Leatherman, 1996), according to Watson et al (1996) the precautionary approach, including enforcement of land use regulations and building regulations, increases the range of buildings on the beach [4]

According to the researchers the United States, "the best thing to protect the property from sea level rise is a sand dune, or swamp mangroves, or coral reefs, or seagrass [5] and Bruttomesso (2001) "Identifies three types of activity to waterfronts, normally require: 1) 'recomposition': giving a common unitary sense to the different parts, both physical and functional, of the waterfront; 2) 'regeneration': revitalizing urban areas which can be of considerable size and often centrally located; and 3) 'recovery': the restructuring and restoration of existing buildings and structures. Typically, these are linked to initiatives aiming to 're-join' the city and the waterfront physically and functionally [6].

Procurement of materials to improve the land by creating artificial islands and reclaimed northern coast of Jakarta City posed a problem, especially when the need to dredge the seabed. This will lead to the occurrence of landslides in the area of the seabed around the location of the backfill and threatened sinking small islands around the dredging. Reclamation can have adverse effects on the marine environment, especially coastal ecosystems, such as coral reefs, mangroves, and biota including humans. The purpose of this study examines the development of the northern coast of Jakarta City with the ecosystem approach. The scope of this study is limited to environmental issues, which include the natural environment and the built environment

## 2. Methods

The research method uses a qualitative approach, analytical instruments using descriptive methods, to assess the changes in land use analysis of space, temporal, using satellite imagery data from 1995, 2000, 2005, 2010, 2015. Data was collected using a purposive sampling method to interesting phenomena and influence the research by conducting field observations. This research took place at 6° 07 'South latitude until 6°12' and 106°72 'East longitude to 106°82'. An administrative research site located in the Penjaringan District and Pademangan District, the area explained in the picture.



**Figures 1.** Research Location

Source: ArcGIS 10.2

## 3. Result

### 3.1 Natural Environment

Northern coastal ecosystem of Jakarta, among others: 13 rivers flowing through Jakarta is Kali Mookekart (on the side of Jalan Daan, mostly across the West of Jakarta), Kali Angke (across the South And West of Jakarta), Pesangrahan (across the south and west), and Grogol (South And West), Krukut (South, Central), Kali Baru Barat (Jakarta of Center), Ciliwung (South, East, And Central), Kali Baru Timur (Central, South and East), Cipinang (East and Middle), Sunter (Middle East), Buaran (East), Jati Kramat (East), and Kali Cakung (East). Kali or the rivers that eventually empties into the Bay of Jakarta. There is a direct way to the sea, there is also a need to connect with the West Flood Canal, the East Flood Canal, Cengkareng Drain, and Cakung Drain.

Angke Kapuk Forest Preserve is a formal conservation area owned by Jakarta in the mainland, is Penjaringan subdistrict, North Jakarta, extending from Angke river estuary in the east to the border of Jakarta to Banten in the west. Based on the Decree of the Directorate General of Forest Inventory and Land Use. No.08 / KPPS / VII 4/94 protected forest has an area of 44.76 ha and designated as a conservation area, with Mangrove trees as dominant vegetation.

The existence of the types of wildlife is intimately associated with the type of vegetation in the region. An area of the beach with mangrove vegetation types and special habitat types, so that wildlife that is found in protected forests are species of mammals and aves. In addition to the type of long-tailed macaque (*Macaca fascicularis*) discovered the protected species legislation or migratory, among

others: kingfisher blue (*Alcedo coerulescens*), Pecuk snake asia (*Anhinga melanogaster*), herons small (*Egretta garzetta*) ibis rokoroko (*Plegadis falcinellus*) and turns mustache (*Chilidonias hybridus*). Angke Kapuk protected forest as well as a conservation area is one potential object for the purpose of travel / ecotourism. In order to improve the development of tourism sector in Indonesia is also supporting education and research system.

Muara Angke Wildlife Reserve set in 1998 by the Government through the Minister of Forestry and Plantations No. 097 / kept-II / 1998 as a Muara Angke Wildlife Reserve with a total area of 25.02 ha., This area includes the Village of Kapuk Muara, Penjaringan, North Jakarta. The area is adjacent to the Housing Muara Karang and fishing settlement Muara Angke Angke restricted. On the north side, the Angke-Kapuk protected the forest that is within the authority of the Department of Forestry in Jakarta. Vegetation in Muara Angke Wildlife Reserve is a mangrove forest, with a fairly high species diversity. Found the swamp overgrown with grass, reed (*Saccharum spontaneum*) and water hyacinth (*Eichhornia crassipes*), while the fauna encountered in the form of lizards, monkeys, and various species of birds. Overall the mangrove forests around Pantai Indah Kapuk, among others: the protected forest (mangrove) 49.25 ha, Muara Angke Nature Reserve (Mangrove) 21,45 ha, 91.37 ha Forest Tourism, Forestry nursery 10.47 ha, 29.05 ha Cengkareng Drain, Transmission Line PLN 29.99 ha. Sedyatmo toll road and green track 91,37ha (Hadi Alokodra, 1996).

Location PIK originally inhabited mangrove forest fauna, among other things: monkeys, snakes, crocodiles. Coastal marsh as a puddle, converted as residential and business district (an area of 831 ha), is estimated as the cause of the flood that caused the motorway Sedyatmo as well as the surrounding residential areas submerged when it rains (<http://www.menlh.go.id>).

Taman Impian Jaya Ancol and inaugurated on June 25, 1967, was opened to the public. Widely used initially only 137 ha land area of 552 ha available. Taman Impian Jaya Ancol is situated between the international port of Tanjung Priok and between domestic ports, Sunda Kelapa. Built of swamp and scrub, marshy ground in 1960 is still full of bushes. Through PP 5111960, Ancol belongs to the central government and will be used as an industrial area (Ancol Barat), housing (Ancol West and East), and the designation as the East Ancol recreational area (<http://www.jakarta.go.id/encyclopedia>)

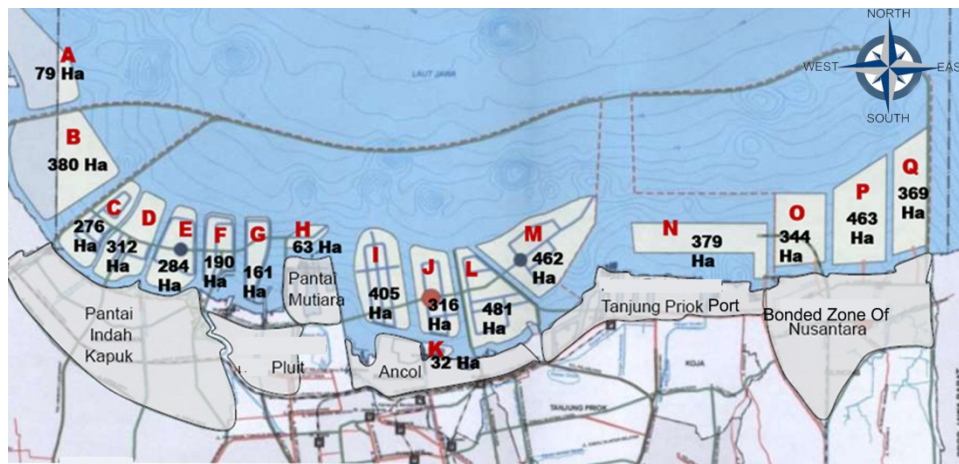
### 3.2 Built Environment



**Figure 2.** Spatial Planning of Northern Jakarta City

Source: Angraeni, 2012





**Figure 3.** Reclamation Plan Region Pantai Indah Kapuk

Source: Pemprov DKI, 2014

Reclamation construction of North Coast Jakarta, Pantai Mutiara conducted since 1985, this development until 1999. First the reclamation in Jakarta with a total area of 110 ha. PT Pembangunan Jaya Ancol reclamation of the north side of the industrial area and recreation around the year 1981. Ten years later, turn Pantai Indah Kapuk conversion of mangrove forests, swamps, ponds for the luxury residential area which is now known as Pantai Indah Kapuk. In 1995, after the reclamation is used for industry, namely Bonded Marunda <http://nationalgeographic.co.id/> 15:09, 12 September 2016).

After converting the coastal region Acol, extensive additions Beach Ancol Dreamland carried back by reclaiming the beach. As the expansion of recreational areas as well as for industrial and apartments, this is also done at the Mutiara Beach neighborhood and Pluit.

Ocean Ecopark is located in Taman Impian Jaya Ancol has a land area of nearly 34 hectares of the area of the resulting from the conversion Golf Course Ancol Become recreational facilities with the values of education (edutainment) and (adventure) approaches adventure for green lifestyle, into an open space with a composition of open space green and blue. Blue open space is a channel with a linear curve shape (organic) with a length of 400 meters with +/- 6 meters wide and the middle forming ring-shaped island, the which is used as a place of educational tours <http://swa.co.id/swa/trends/>

Toll Road Airport (Prof Sedyatmo) on adding lanes to the elevation of the road surface is higher in comparison with the toll lanes other existing, this is done to facilitate the flow of traffic, because the toll lanes have never experienced submerged due to heavy rain, elevation of the face is done also on local roads area of Pantai Indah Kapuk and Pluit. "The volume of rainwater in a measuring Salama 24 hours (starting clock 0700 GMT until at 0600 GMT, in the Territory of Jakarta, North Jakarta area, is the location with the largest volume of water that occurs on the 9-10 February 2015, with a total volume of water in North Jakarta on February 10, 2015 reached 36,670,726 m<sup>3</sup>, with a range of 100-400 mm rainfall / day (Kadarsah, et al). "Penjaringan and Pademangan sub-district is an area that is often experienced as a result of the floods and waterlogging caused by rain runoff. Cause ponding of water is partly due to the extent of land-proofed compared with green open spaces. This is due to the widespread development of residential and business district and trade. From 2010 Until 2030 the vast puddles on Penjaringan and district Pademangan will reach 1045 ha (settlements) and 463 ha (Industry), this condition occurs when not in use change in both these districts [7].

Currently in North Jakarta area, there are 26 locations prone to tidal flooding, among others: Penjaringan, Pluit, Kamal estuary, Kapuk estuary, Tanjung Priok, Kalibaru, Ancol, Pademangan, Marunda, Koja, Lagoa, Sunter Karya South, Papanggo, Sunter Agung, Warakas, Kebon Bawang,

Sungai Bambu, Jampea, Kramat Jaya, Kelapa Gading, KBN Cakung, Sunter Jaya, and Yos Sudarso (<http://bnpb.go.id/berita>).

#### 4. Discussion

In the reclamation plan and manufacture, the artificial island would require the formation material that could reach millions m<sup>3</sup>. Large volumes needed considering the plan of the artificial island will reach an area of 2700 ha. With this comprehensive revitalization of artificial islands and the northern coastal city of Jakarta will form a new town requires infrastructure support Supplies electrical energy, water, waste management, transport, road network, green open spaces and public facilities, and social.

To expand the land in the northern coastal city of Jakarta to reclamation by using materials obtained from the surrounding waters of Jakarta Bay by way of dredging the seabed, seabed mining for the purpose of hoarding with a large area can damage coral reefs in the Gulf of Jakarta and surrounding areas, and can submerge small islands at the mine site as a result of the loss of coral reefs and landslides on the seabed in the dredger, because "the coral reefs in addition to beauty is also a convenient place for marine life and have the physical capability reduces the pressure waves of the sea [5].

Artificial islands reclaimed should be able to produce an ecologically built environment, the development of new islands as a city should be in accordance with its carrying capacity. "The carrying capacity is defined as the maximum continuous load that can be imposed by humans on the environment. (The Independent Commission on Population and Quality of Life, 2000)."

Of the seven urban ecosystems on an artificial island, just agricultural land cannot be implemented, while six other ecosystems can be applied.

Urban ecosystems consist of several subsystems interrelated, each representing a complex system and interplay with each other at the level of structure and function differently. This the ecosystem can be understood and studied in various sizes. Is it a pond, river, lake, or a piece of the pond, forest, or landscape. Even the laboratory is a unit of the ecosystem can be observed. As long as the essential components and interact to form a partnership to achieve a functional stability, even if only a short time, the force can be considered as an ecosystem. Urban ecosystems are clearly different from natural ecosystems, in particular on the features that contain a variety of artificial facilities.

Urban Ecosystem consists of seven elements identified as 1) street trees; 2) lawn & garden 3) the urban forest 4) agricultural land 5) wetlands 6) lake / sea, and 7) rivers (Bolund and Sven 1999). Of the seven urban ecosystems on an artificial island, just agricultural land cannot be implemented, while six other ecosystems can be applied. At 17 artificial islands being developed will generate 13 channels which is a continuation of the 13 rivers in Jakarta and upstream Jakarta Bay, otherwise it will form a channel with a channel width of 200 meters that separates the coastal plain north of the city of Jakarta with 17 artificial islands. Around the edge of the canal, the author of the category as a wetland of arable Mangrove. Mangrove planters can also be done on an artificial island beach overlooking the open sea. Mangrove plants around the artificial island will form a green belt that has a function as a barrier waves and attempt to restore the coastal ecosystem strengthen the structure of the artificial islands and barrier of wave, in addition to Mangrove also must cultivate coral reefs, the breeding of coral reefs, in addition, to withstand waves can also serve as a residence of marine life, area of land which formed naturally, slowly but surely made island will have the same ecosystem with the urban ecosystem

Ideally, the whole artificial islands are equipped with urban forests, to control the micro law that lowers the temperature of the air on artificial islands. The Urban forest is a collection of trees with different species of trees with dense plantings, around the entire city, with a continuous pattern and form connecting all the ecosystems on the artificial island. Besides reducing micro air temperature, the plant can reduce the kinetic energy of rainwater use, until the pressure of rainwater on the surface to be reduced, because the rainwater pressure eased after touching the trees and other vegetation. The rainwater that hits the ground is channelled into the ground through the trunk and the rest flowed on the surface soil. Besides works to increase the absorption of rainwater, and reduce the pressure on the

surface of the soil, vegetation has other functions, among others, can reduce air temperature due to the radiant heat of the sun, absorbed by trees and vegetation, trees can also reduce wind pressure, thus reducing the air temperature around the plant grows. The existence and preservation of vegetation in a place, then the quality of life in the neighbourhood of the vegetation is to be good. Vegetation has a role in the ecosystem, among others: As a patron, binding energy for the entire ecosystem, and as a source of mineral nutrients.

Vegetation actually the most crucial species in the ecosystem because it has a role as a producer in the food chain system. Breadth of green open space, vegetation density impacts the ability of the soil to absorb rainwater (permeability), thus increasing infiltration capacity, so as to control the flow of surface water (runoff), so that the process of the hydrological cycle can occur that result in groundwater levels swell, which in turn intrusion sea water is inhibited.

The layout of open green space in this artificial island could be centralized or spread across multiple locations. "Green open space is an elongated area / line and / or in groups as a place to grow crops, whether naturally grown or planted (Act No. 26 of 2007, Article 1)." Then in chapter 29, the green open spaces can be public open spaces and private spaces, (verse 1). Spacious green open space in the urban area of at least 30 (thirty) percent of the area of the town, (paragraph 2). Spacious green open spaces in urban public least 20 (twenty) percent of the total area of the town. The condition of at least 30% area RTH expected of artificial islands. Ecosystem-made island in the form of an urban forest or a body of water, such as lakes or ponds may be stabilizing, with the function of maintaining the balance of hydrology and the availability of clean air, lowering micro air temperature, and as a place of recreation that is accessible to the entire population of the town and surrounding areas, resulting in interaction between people who are on an artificial island and locals outside of the island. The function of the ecosystem is the earth's ability to sustain life for a long period of time [8], other than that of ecosystems, according to Sarukhan (2005), provide Four services provided by ecosystems (table 1)

**Table 1. Ecosystem Services**

Services	The benefits
<i>Provisioning</i>	Food ingredients
	Clean water supply
Culture	Recreation
	Education And Knowledge
	Spiritual
Regulation	Resisting Abrasion
	Withstand Wave
	Lowering The Temperature Of Micro Air
Supporting	Biodiversity
	Nutrient Cycling
	Strengthening The Structure Of The Soil

On the development of the town in this artificial island should not be any exclusive island with certain class citizens. As in the natural surroundings of biodiversity will be better in comparison with monocultures that are sensitive to external threats the species concerned. In social life, diversity in terms of ethnicity (ethnic), culture, and social class will provide beauty and harmony when it is going well. In environmental science, there are five interrelated elements, which is building a life and can be used on the social system, the five elements, diversity, harmony, the interaction, interdependence, and sustainability. By the very nature of life in the world of interdependence is something absolute, human beings need each other while running their lives.

Reclamation by creating an artificial island will result in settlement of fishermen in the estuary angle fish market and harbour of fishing vessels in the back, it should be planned well how out access fishing boats, and how to access the resident fishing settlement to a new island. This needs the attention of the local government should not be a gap in treatment between resident fishing settlement with town residents on an artificial island later.

Sea-level rise due to climate change in urban development in artificial islands must be taken into consideration in spatial planning. There are four roles of spatial planning in disaster risk reduction [9] as follows:

1. Limiting the development of disaster-prone areas are dangerous.
2. Allocate land use different settings for disaster-prone areas.
3. The land-use plan or zoning has legally binding.
4. Modify the intensity and frequency of hazards.

Based on the four roles of spatial land-use planning should allow the restriction of the use of space, especially in areas that are sensitive to the threat of sea level rise, especially on the beach, using the equivalent line the river, as a green corridor to minimize losses due to the brunt of the waves.

The development of artificial islands, with the level of 2700 hectares and the revitalization of the old beach area of 2500 hectares, will be a new town development held private parties, namely developers and involve more than one developer. Master Plan prepared by the developer must constitute a single entity, which is the result of a compromise between the developer and the government. The Master Plan is the result of a compromise is used as a reference in the development of the island, so there is no overlap, and as an instrument of coordination of actions in the field. "Urban areas that have major non-agricultural activities with the regulatory function of the area as a place of urban settlements, concentration and distribution of government services, social services, and economic activities (Law No. 26 of 2007, chapter 1, verse 25)." Based on the formulation of a new town as a whole should have a structure that can support the activities of its citizens as well as support all existing activities. "The structure is the arrangement of residential space and network infrastructure, and tools that support the social economy in a society that a hierarchical structure. (Law No. 26 of 2007, article 1, paragraph 3)." Thus, the development of new towns includes several aspects, among others: the number of houses being built, infrastructure that includes public facilities, social facilities, and access to green open space (RTH), transportation networks, water treatment plants and solid waste.

The development of new towns must maintain a harmonious environment, integrated planning and can protect the region has unique characteristics, and the culture that needs to be protected planning so that the spatial development of new cities should consider the uniqueness and potential of natural landscape or areas that have unique value and culture, it must be supported by the spatial patterns to safeguard and maintain the uniqueness in this region where the new town was developed, as mandated by Law No. 26 of 2007. "Spatial distribution pattern allocation is in an area that includes spatial allocation and protection function space allocation for the function of culture (Article 1, paragraph 4)", whereas, in article 1, paragraph 20, the region is the region whose main function is protection or cultivation. In the reclamation area in Penjaringan there Mangrove Forest Reserve area, and Wildlife must be protected.

Construction of a new town on an artificial island ideally has a large infiltration capacity, this condition can be achieved by building a low ratio ranged from 30% -40% so vast green open space larger than built-up areas, development of artificial islands covering an area of 2,700 ha, plus the revitalization of the old coast around the artificial islands makes the construction of an artificial island as a new town. With the ecosystem approach is expected to materialize an ecological town, a town that can repair and restore coastal ecosystems better, and the town that is friendly to citizens of the town.

## 5. Conclusion

Beaches in Jakarta Bay has a coastal ecosystem rich in marine life is diverse, reclamation to form artificial islands by bringing sand dredging the seabed may damage coastal ecosystems, among others: the damage and loss of marine organisms, such as coral reefs and cause abrasion finally submerge small islands on the location of the sand, other than that of mangrove forest ecosystems and wildlife in Muara Angke danger of being corrupted and can change the biota habitat is in it remembering the position of mangrove forests, and wildlife habitat change which was originally facing the sea into the



back of the artificial islands. The ecosystem approach to the development of the city on an artificial island and the revitalization of the northern coast of the city can be as an alternative to improve the ecosystem of the north coast City of Jakarta, with shape of planting Mangrove as a green belt on the island Artificial, the urban forest and body of water, such as lakes or ponds on the artificial island.

The new town on artificial islands and the revitalization of the North Jakarta coastal cities will be occupied by residents of all ethnic groups (tribes), and social class, so the development of the city in this artificial island to be able to open up access to all social classes, and do not build up area exclusively for groups and particular classes, thus generating the harmonization of social systems in the new town of artificial islands and in the coastal plain old.

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