

## **PART FIVE:**

### **CONCLUSION AND RECOMMENDATION**

In the previous chapters, we worked through both microscopic analysis through field survey, and macroscopic analysis through satellite image and GIS, which were combined to obtain the total evaluation of impact of sea level rise on coastal cities in Indonesia. Even though there are still many rooms for improvement, especially from viewpoint of accuracy. However, logical sequence from basic original data until final macro evaluation seems to be already established.

In the end of every fiscal year, results from two different approaches were reported together in the seminars and workshops held in Bandung. The seminars and workshops were participated by resource persons and related central and local governmental officials. Finally strategies for adaptation were discussed.

Furthermore, based on these recommendations, the team (NILIM & PUSKIM) will launch another research project for discussion of future urban shape in 2004-2006, funded by Ministry of Environment.

In this part, conclusion on impact of inundations and recommendations on countermeasures against sea level rise.

## **5.1. Conclusions**

### **5.1.1. Loss Measurement**

- (1) Neglecting some constraints in the analysis, the result finding has a figure that among the surveyed cities the biggest lost asset whether lost investment or loss function occurs in Semarang, which have the percentage 31% and 23% in average. While the lowest loss occurred in Denpasar is 0.2 % and nil.
- (2) The result findings, unfortunately, have no relevance to the occurrence of inundation as our earlier assumption that the loss asset should be enhanced if the height and the frequency of the inundation increase. Such figure of the intensity of inundation, the worst condition occurs in Jakarta and Mataram where the inundation reaches nearly 100 cm in height with it's duration up to 12 hours.
- (3) Even though of 2. Looking more detail into the results, the last asset is more influenced by both geology characteristic of the site and quality of building construction. The geology characteristics in Semarang often happens rob condition in which the buildings will always settle year by year, while in Denpasar, the geology of the soil consists of the thick sand layer. The next, the lost is also influenced by the quality of the buildings, that is the better quality, the less damage. The damage of majority of the building is in non-engineering building parts because in Semarang it was well designed, while in Denpasar it was well prepared regarding environmental condition.
- (4) When the loss measurement is identified based on the building type, the lowest loss occurs on the platform system houses with the percentage of loss investment is almost 7% and lost function approximately 3%. For landed houses, the loss approximately reaches 18% up to 20%. The difference can be understood easely, because the platform houses usually have already anticipated to the occurrence of the inundation or the height of tidewater.

### **5.1.2. Impact of Socio-economy**

- (1) In fact, inundation in each city has significantly influenced and disrupted daily activities of the residents although in defferent level of disturbance. Among 7 cities of the survey areas, residents in Semarang get the most adaptation to inundation, that is; it almost affects all of the daily activities and takes a lot of time to protect their houses against inundation.
- (2) Finacially, regular inundation has not only affected badly daily activities and loss of productive time, but given in the worse conditions and the residents have to spend a lot of money since they have to improve their dwelling units accordingly.
- (3) Reffering to standard of living, residential areas should not be constructed in inundated area caused by uprising sea level. The fact that most people construct their houses and live in such areas is most likely to psychologically and physically bring them insecure living. Living in such conditions is a stressor or threat for their further life.

Thus in social perspective, loss measurement is not only considered on time spent against inundation matters, but also financially they spend a lot of money for elevating and improving their dwelling units.

### **5.1.3. Influences of SLR in each area**

#### **(1) Jakarta**

As part of the capital of Republic of Indonesia, North Jakarta has accommodated many activities as well as very dense population. According to the current land use, the main facilities provided in North Jakarta are to accommodate housing, port, industry and resort. In North Jakarta many areas are also located on lowland and under the highest tide. With regard to the circumstances, it is predicted that sea level rise will give very big negative impact on the area. One of the facts that support this misgivings is that the inundated area in North Jakarta is affected also easily sea tide fluctuation. When the highest tide happens, much more areas will be inundated, for example. Such inundations become worse if we see the current conditions of drainage and sedimentation. Since the condition of drainage is very bad and proceeding of sedimentation enlarged continuously inundated areas because water cannot flow well.

#### **(2) Semarang**

In the study area located in North Semarang District has two problems related to sea level rises. The problems are land subsidence and flooding (in the area called Rob). Because of these problems, housing areas, for instance, tend to be limited. Moreover, in some area the growth of household is minus. In Tanjung Mas sub-district as a detail area of the study, land subsidence enlarged inundated areas especially in rainy season and high tide. The dominant activity in Tanjung Mas which be disrupted by SLR is domestic ones in their houses.

#### **(3) Surabaya**

Because most coastal areas in Surabaya City is located on lowland and also under the influence of highest tide, sea level rise will badly influence the area. Besides lowland area, the impact of sea level rise will be more serious in some areas where wastes and irregular buildings stand by the rivers, because of poor drainage system. The influence of sea level rise can be indicated by some activities that cannot run well anymore. In general, sea level rise will disrupt some activities on coastal areas. In Rungkut District the possibly disrupted activities are those in industrial estates, new housing areas, and commercial areas. The disruptions of these activities will also give negative impact to the development of Surabaya City in general. The negative impact on industrial estate reduces job opportunities and government revenue. That means one of the mainstay of the activities cannot function well. The negative impact on new housing areas and some vacant land indicates these areas are not suitable for new housing development. This is, these vacant areas cannot meet the needs of rapid population growth of Surabaya City.

#### **(4) Denpasar**

Denpasar has been known as a tourism city because dominant activities here are tourism and its supporting facilities. Compare to other cities in this study, Denpasar is relative better in terms of inundations. Based on our investigation, the last flooding in this area

happened four years ago, and now almost no area is inundated. Regarding sea level rise, some areas in Denpasar are vulnerable to flooding. This is because there areas are located in low and flat area. As has been explained before, the activities in such areas are almost all related to tourism. Therefore the disruptions by sea level rise will also negative impact to tourism activities. Specifically based on investigation in Serangan Sub District, the impact of sea level rise will disrupt the newly reclaimed areas. The areas are categorized as flat and low land compared to other areas. And a dominant activity possibly disrupted by sea level rise.

(5) Mataram

Similar with other coastal cities in this study, the area of Mataram is categorized as lowland and flat area and some of them are below the highest tide. Therefore, many areas in Mataram City are also very vulnerable to disruption by sea level rise. The side influences of sea are abrasion and flooding at the highest tide. Based on investigation in the coastal area the damages of building depends on the distance to the beach. The closer to the beach the worse damages happen. As a way to reduce damages of abrasion and tide, government as well as community built dikes and cleaned drainages together. Continuous sea level rise as predicted by IPCC will make much more damages on the coastal area in Mataram City.

(6) Banjarmasin

Most of the areas in Banjarmasin are located 0.16 meter below sea level, so sea level rises will give serious big negative impact. That is; most of the areas will be inundated permanently. According to present activities in the area of study (Kuin Vilage) like floating market, existence of archeologically precious sites, etc, sea level rises will cause many activities of the community cannot be run anymore. The floating market, for instance, will be damaged and the community should arrange some supporting facilities such as new quay. The disrupted of the precious sites as one of the tourism destination cannot run well.

(7) Makassar

Regarding the impact of sea level rises, the area of study has some problems such as flooding, intrusion, abrasion, and sedimentation. According to the activities, the predicted impact of sea level rise, will make such problems worse, which has an seriously negative impact on housing. Which is dominant activity there.

## **5.2. Recommendation**

### **5.2.1. Further development on loss measurements**

To achieve more accurately the results of our loss measurement, the method most likely to be developed is the approach that should be based on the following consideration:

- To classify house types
- To modify the hazard to address a specific site
- To make detail resistance model of structures and their content
- To exploit sources of information such as local meteorological records, local building codes, expert opinions on local design
- To indicate the related uncertainty

In short, the end product of the analysis depends heavily on effort, time and budget for implementing the study results.

Obtaining the result of the measurement of lost assets due to the uprising sea level at the macro level, depends upon the availability of data of housing growth, density and the detail of future housing distribution. This impact of SLR can be quantified and predicted only insofar as factor of “vulnerable system”. This factor is difficult to describe because of two reasons. First, sufficient detailed digital maps elevation and housing types are not available. Second, the future dynamic of the response of coast, coastal human activities and population are largely unpredictable. As of the future impact we will not estimate what the impacted system will be like, because the coastal landscape and buildings and infrastructure will adapt gradually in response to the changing environment and the socio-economic condition. Therefore, a main weaknesses in the estimation of loss measurement in housing due to sea level rise, are the sea level rise prediction and the interaction with human activities.

### **5.2.2. Policies in view of socio-economic points**

Living in inundated areas could generate a view of living in an unhealthy environment. Living in such area may be the only alternative for low income people who have limited ability to provide appropriate places. Our data reveal that socially and physically gradual adaptation to inundation has been a natural manner of the inhabitants to keep living in this area. Yearly raise of house floor small dike construction and building repairs to avoid suffer from inundation, are the types of self-defensive adaptation done by the residents.

In contrast, the supply of housing areas for the better income bracket is most likely due to their comfort urban facilities. The bracket has no financial difficulty to adapt themselves to the unpleasant condition through some efforts such as filling in the wetland prior to site construction, providing of the standardized neighbourhood facilities and houses and even setting up the suction pump in the Semarang survey area.

In the long term, both adaptations are costly. Nowadays the local authority has less ability enough to newly develop better residential areas, therefore the authority is likely to maintain the current residential areas for low income bracket with basic neighborhood infrastructure. In a wider scale, the authority has to provide advanced city services. Such example done by the local authority in Semarang are lifting-up all main roads, and construct overpassing roads to support transportation in and or out of harbor operation all the times and to keep all days distribution goods and services all days. At the same time, the inhabitants close to the road have also done the same things, that is; they elevate their dwelling units and resist inundation.

To prevent inundation from getting worse, following recommendations can be proposed:

- (1) The local authority has to make evaluation on the cost and the benefits to sustain inundated areas as residential or even as industrial uses.
- (2) The local authority has also to make explanation or clarification to inhabitants concerning the sea level rise inundation and its impact on dwelling units. It is necessary for inhabitants to make any choices and decision concerning location for their living.

### **5.2.3. Suitable policies for each area**

Development planning of such areas should always be based on characteristics of the area and its surrounding area. Development Plans of the area on one hand should support the inhabitants activities and also possible for activities development.

In this study, sea level rise is considered to generate negative impact of activity development on the 7 cases of coastal cities. In planning process of the areas, the submergence and disruption possible to occur should be precisely recognized. And then, new construction of facilities in the areas highly possible to inundation of sea level rise should be minimize. Whilst it is not easy to limit activities especially those that contribute to economic development of the city. Therefore, provision of appropriate infrastructure must be prepared to minimize the impact of sea level rise.

Survey data revealed that current inundation is generally due to inappropriate capacity and quality of drainage system; for instance no water pump for reducing back water from the sea and less improper dike to block the water. Therefore, such infrastructure should be improved and developed suitable for the proper geographical conditions.

## **5.3. Application to other region / cities**

### **5.3.1. Basic Units**

This research was undertaken as a sub-theme of “ “, headed by Geographical Survey Institute, Ministry of Land, Infrastructure and Transport, Japan. The final result will be integrated into a global (Asia-Pacific wide) digital map of “Vulnerability”.

In this context, the result of this study is hoped to be applied to other cities in Indonesia , and in Asia-Pacific countries.

From typological point of view, platform type houses observed in cities outside of Jawa island is more common to houses in other countries, and data obtained from 3 Jawanese cities with landed houses, will be applicable to many other large and middle scale Indonesian coastal cities located in Jawa island.

### **5.3.2. Methods**

If there is difficulties in obtaining directly through field survey, several data obtained from this study could be referred and applied from typological point of view.

If some original survey is applicable for the requested city, the method, manual and questionnaire reported here will also be useful.(Fig. Flow-chart).

### **5.3.3. Unit for Measurement**

When we will apply the data to other cities, with different economical level, then the price of buildings (initial construction, or cost for rehabilitation from damage) will be far different, regarding cost for local building materials and man-powers. Therefore, in this study, we tried to describe the loss and cost based on the direct measurement and description of man-power and amount of each material.

## **5.4. Setting up practical strategies for adaptation**

### **5.4.1. Financially best efficient solution**

As discussed in Chapter V, when SLR attacked a city, the people in the low-wet area will never be passive to suffer from it silently, but will choose some form of adaptation at small or large scale.

Therefore, in order to evaluate the net loss for a city caused by SLR will never be clear, without assuming the best way of adaptation discussed in Chapter V. In this context, the best way of adaptation will be that costs least and saves best..

#### **5.4.2. Socially feasible solution**

As mentioned before, the possible alternative adaptation will be in the form of re-settlement, reclamation, or change of building type, in the form of “project”. However, the project will be accompanied with change of life style of inhabitants, and needs social adaptation, that may include change of income source.

Field survey reports and following discussions in the workshop suggested the difficulty of changing life style in low-income groups. Even if “re-settlement” is the best efficient way of adaptation, they cannot choose it being afraid of losing job opportunity, or being inaccessible to initial capital for investment. They might remain in the current site and will continue to pay for expensive rehabilitation, staying at very low level of daily life, accompanied with frequent inundation. They have to buy new cheap furniture frequently. They will continue to pay for frequent repair of their houses. This kind of socio-economical constraint will lower the limit of the adaptation, or threshold of vulnerability of the city.

In the global relationship, assistance from countries causing the problem to the suffering countries will be the primary solution, as a kind of international compensation. However, loan may have another effect.

The World Bank is making effort for establishing small-scale loan system for low-income groups. If the desired kinds of system will be established in the vulnerable areas, and help low-income people to choose the rational solution, it will create another channel for international co-operation.

### **5.5. Designing future images of cities**

#### **5.5.1. Viewpoint of emission**

In this study, Global Climate Change in the field of Urban Development and Housing Construction was discussed as “an environmental” condition, which will affect the conditions for coastal cities through e.g. SLR.

However, on the contrary, housing construction and urban development also influence to the Global Climate Change, through e.g. CO<sub>2</sub> emission. Scrap and build of short life buildings, popularization of air conditioning, urban form based on the popular use of vehicles will result the rapid increase of emission, that will partially contribute to the total increase of emission.

In this context, to have long term scope of the future urban images will be valuable to guide the specific housing construction and urban development appropriately.

### **5.5.2. Longitudinal adaptation and future urban image**

Adaptation to the SLR will be longitudinal process, and we have to cope with in the long run, however, we have already recognized the vulnerable areas where we need some strategies since now. In addition, through discussing adaptation alternatives, e.g. re-location, or introduction of multi-story houses, we can also discuss about the aspect of emission at the same time.

In order to evaluate the urban scale sum of emission, we also need some typological approach to urban buildings, and areal macro analysis through utilizing satellite image and GIS. These methods are almost common to the approaches we have taken for SLR issues, even though the target cities will be more varied (including inland cities).