Studying Spatial Plan in Coastal Urban Environment – facing global threat and adapting to local condition

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Key words: spatial planning, coastal urban environment, disaster risk reduction

SUMMARY

Spatial planning is a process involving projection on future usage of space. It requires input from different sectors and stakeholders. Nowadays planners are also confronted with the increasing number of disasters in highly populated and economically important areas. There is a growing needs and awareness to incorporate disaster risk information in the spatial planning. One of the particular areas vulnerable to disaster is coastal urban environment. It is facing global threat from the impact of climate change and local-driven natural hazards.

The paper firstly reviews literature on coastal urban cities and its characteristic. It also presents their function and importance to the society in terms of economic development and environmental sustainability. It then followed by a review on recent studies on global warming and natural hazards confronted by coastal cities as well as a conceptual framework to reduce them. Spatial plan was proposed as a long term framework to facilitate disaster risk reduction. The paper took a case study approach using a medium size city of Semarang in Indonesia as an illustration. Three aspects were evaluated, how the spatial plan linked to the idea of disaster risk reduction, how the spatial plan address the issue of disaster risk reduction and how the spatial plan map represent disaster risk reduction effort.

The findings indicate that the recent spatial planning documents in the case study area have made considerable progresses in addressing coastal disaster risk issues. The number of disaster related issues discussed in the Spatial Planning documents of 2010 to 2030 is much higher than those of 2000 to 2010. Guidance on what types of land use appropriate for hazard prone area and plans on hazard modification was provided. General directions for development restriction in hazard prone areas were also provided. Overall the city of Semarang has made considerable progress in addressing the numerous types of locally driven natural hazards, although with little reference to global threat from climate change.

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1. INTRODUCTION

Large number of the world's biggest cities is located in coastal environment. All of them are having important position in economic, culture and social function. However, they are facing a potentially serious threat from various sources of disasters whether it is natural, human-induced or human-accelerated disaster. Global warming will highly likely increase the frequency and magnitude of natural disasters, especially in the coastal urban environment. On the other hand local-driven disasters will be highly likely to increase. Rapid population growth and urbanization will put more pressure to coastal cities. Limitedly available space forced less fortunate inhabitant to occupy marginal land usually located in disaster-prone area.

There is an immediate need for a better plan to prepare for and lessen the adverse impact of disasters. With the recent threat of different types of hazards confronting by coastal cities, the predicted extend and magnitude of hazards should be formally incorporated in spatial plan. Spatial planning can help to achieve sustainable development objectives through multifunctional use of space. Spatial planning consists of activities to allocate space for a number of uses based on envisioned future requirement within its carrying capacity. This process incorporate multiple factors such as population growth, economic forecast, estimated transportation development and available space.

This paper addresses the conceptual analysis of how spatial planning can facilitate disaster risk reduction effort. It aims to presents an evaluation of spatial plan in a coastal city in developing country in response to global warming and local-driven natural hazards. A case study approach was employed using a medium size coastal city of Semarang in Indonesia. Three aspects were evaluated, how the spatial plan linked to the idea of disaster risk reduction, how the spatial plan address the issue of disaster risk reduction and how the spatial plan map represent disaster risk reduction effort. General spatial plan (Rencana Tata Ruang Wilayah: RTRW) and Detailed Spatial Plan (Rencana Detil Tata Ruang Kota: RDTRK) were evaluated, complemented with in depth discussion with city planners.

2. COASTAL URBAN ENVIRONMENT

Coastal zone is a transition area between land and sea, and possesses characteristics of both elements. It receives influence from physical process and human activities (Fletcher & Smith, 2007), both from landward and seaward, with different function and scale of effects (Tissier, et.al., 2004). The interaction between physical process and human activities in coastal zone determine the characteristic of coastal environment. Many coastal zones are located in a delta region or alluvial plain with dense population. It is estimated that around 38% of the world population is living in area not more than 100 km from shoreline (Cohen et.al., 1997; Kay and Alder, 2005), with more than 50% of Asian population living in this area (Mimura, 2008). 14

out of 25 the world biggest cities are located in the coastal environment, including Tokyo, Mumbai, New York, Manila, Los Angeles, Shanghai, Osaka, Karachi, Guangzhou, Jakarta, Buenos Aires, Istanbul, Rio de Janeiro and Lagos (Brinkhoff, 2008). The coastal environment is economically important, environmentally sensitive to many affecting factors, and physically vulnerable to many types of natural, man-made and man-enhanced hazards.

The development of coastal urban environment brought in more stakeholders which creates higher complexity in governance. Involvement of a wide range of stakeholders and interest groups are increasing and lead to more complex requirements in governance to guarantee physical and socio economic sustainability (Milliman and O'Riordan, 2007). More stakeholders' interests mean more competing uses of space which need to be addressed appropriately. Industrial sector need to build plants or warehouses in strategic location close to ports and road network. Real estate developers look for superb location with interesting view to build residential areas. Both sector even willing to invest large sum of money to reclaim land in the coastal zone to obtained space for development. Government need to invest and build public infrastructures and utilities. Environmentalist advocate for sustainability of the protected areas usually needed for development. All of these needs requires space which becoming more scarce and expensive. On the other hand, external pressures and hazard threats are increasing.

3. GLOBAL THREAT AND LOCAL NATURAL HAZARDS

In terms of location, hazards can be categorized as local, regional and global. Local hazard affect limitedly spatial coverage with small number of population, for example landslide stroke isolated village in remote area. Regional hazard covers wider area with more people affected, such as flooding that inundated several municipalities of states. Global hazard affect the whole earth surface with large number population affected. Global warming which subsequently followed by sea level rise is an example of global hazard. Global warming was triggered by the increase of a number of green house gases, such as CO_2 and CH_4.

Arrhenius in 1896 published his research that stated the temperature effect of CO_2 if the concentration of that gas were to increase (Nielsen, 1989). Evidence from coral reef, oxygen isotopes and other records leaves little doubt that there are globally coherent connections between sea level and climate (Warrick, 1993). Global warming can lead to change the sea level mainly through thermal expansion of the ocean and by changing the net mass balance of glaciers and ice sheets (Raper, et.al., 1996; Titus, 1990; Warrick, 1993). Inter-governmental Panel on Climate Change (Bindoft, et.al., 2007), the most authoritative institution in climate change study, confirm that in the 20th century the average rate of sea level rise was 1.7 ± 0.5 mm/year. The rate in recent decades seems to be higher that the previous time which can be interpreted as a sign of accelerated sea level rise. The rate of sea level in the period 1993 to 2003 as estimated from satellite altimetry observation was 3.1 ± 0.7 mm/year. Sea level rise affect global environment particularly coastal zones. The direct and indirect impact will varied depend on the shape of coastal zones, bathymetric setting and geological formation.

The direct consequences will be inundation of low elevation areas in coastal zone and increase in coastal erosion. Frequent and continuous inundation will slow down economic activities, affect residential areas, lower environmental health and decrease land value. They can reduce the capacity of the local government in delivering other important development activities since they have to allocate budget to overcome the direct impact. In many local cases the magnitude of sea level rise is relatively low compare to land subsidence. Nonetheless, their combined impact, known as relative sea level rise, will significantly enhance the impact. In recognition of the importance of coastal urban environment, the consequences of this disaster will be severe in terms of economic loss, population affected, and damaged infrastructures.

Land use conversion in coastal cities is very high to accommodate the need for housing, industrial, and business uses. It will create multiple effects such as the disappearance of protected area and conflict in use of available space. Scarcity of affordable land forced some low income earner people to work or live in marginal land. Marginal land is usually located along the river bank, close to swampy area or on the steep hills slope. Those areas are more vulnerable to disaster compare to prime locations. Hill slopes are very vulnerable to landslide, especially during rainy seasons. Low elevation areas are very vulnerable to water related disaster. River flooding and tidal surge are common to many coastal cities. In recent years, the impact of inundation coming from tidal surge in coastal areas is receiving a lot of attention in Indonesia. Approximately 41 million people in Indonesia live in areas of 10 m or less from the mean sea level (PEACE, 2007). Many coastal cities are experiencing increase in extend and magnitude of tidal surge. This includes Jakarta, Semarang, Surabaya and many other smaller cities. These increases indicate the likely possibility of impact of sea level rise or land subsidence or the combination of both factors.

The underlying geological structure of alluvial plains that are the foundation of many coastal cities is subject to land subsidence. The clay layer that supports coastal cities is very sensitive to water concentration. Extensive groundwater extraction and reduction of water infiltration in the recharge areas in water basin may lead to compaction of the clay layer. This process is followed by lower the elevation of the land relative to a certain datum which is named as land subsidence (Sutanta, et al, 2005). Based on time of occurrence, land subsidence can be classified as slow onset disaster. It did not produce any noticeable signs in short period of time and can only be observed after several years. Similarly, its impact can be obviously felt by the community after several years. With many severe disasters threaten coastal cities, an integrated approach in disaster risk reduction is required.

4. DISASTER RISK REDUCTION

Disaster is a result of exposure of element at risk to hazards and the lack of capability of **a** community to tackle the situation (Misonali and McEntire, 2008; UNISDR, 2009). Statistics from the EM-DAT database shows that there is an increase in disaster casualties and economic loses in recent years. This condition can be attributed to the increasing exposure of people to hazards due to rapid urbanization (Sanderson, 2000) and climate change (Resurreccion, et al, 2008). The latter was thought to be the factor in increasing frequencies and magnitude for climate-related disaster. Urbanization lead to the need of space to live in already limited space and some people are forced to live in disaster-prone areas. To minimize casualties, economic losses and ensure sustainable of development, a number of policy and efforts should be implemented in reducing disaster risk. Any policy issued should consider the types of disaster to be faced. Disaster can be classified into rapid and slow onset. Rapid onset disaster, such as earthquake and landslide, occurs suddenly in very short time without any sign to be noticed by people in the area struck. Slow onset disasters give noticeable early warning sign so that people can see how the hazards develop into, and prepared for, catastrophic event. Efforts in reducing disaster risk should take into account the predictability and other characteristics of hazards. However, it is difficult to accurately predict when and where most hazards will occur.

UN-ISDR defines disaster risk reduction as "the concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adv erse events" (UNISDR, 2009). According to this definition, there is a requirement for a systematic action which usually involving many government institution, NGOs and communities, having multidisciplinary nature. Organizational management and participation method between these parties need to be carried out systematically, and not in an ad-hoc basis, to sustain its effectiveness.

As disaster occurs in a certain geographic location, spatial information is vital in disaster risk reduction. The locations at risk to a certain types of disaster are predictable, at least in part. It is therefore argued that map, as a visualization of spatial data, is a prerequisite for successful efforts in disaster mitigation (NRC, 2007). Spatial data plays important role in all phases of disaster management, starting from preparation, emergency response, recovery and mitigation. Among other functionalities, it can be used to create thematic maps on population and infrastructures as well as underlying hazards in a certain areas. These thematic maps are necessary input in developing elements at risk maps. Elements at risk include people, building, agriculture field, economic activities, industrial complexes, road and railway, and bridges. The objective of elements at risk mapping is to identify which elements of the society are at risk if confronted with certain of types of natural and man-made hazards at any given time and magnitude. The process of mapping elements at risk usually involving large scale map of infrastructure and utilities combined with small-to-medium scale hazard maps. Current practices show that a multi-hazards approach is more frequently implemented.

One of the key elements in disaster risk reduction is conducted by effectively managing land uses, and it is one of the efforts listed in The Hyogo Framework for Action 2005–2015 (HFA, 2005). The framework also requested that risk assessment be incorporated in urban and rural land use planning, especially in mountainous and coastal flood plain area. It has also been advocated to integrate disaster risk reduction in land use planning (Burby, et.al, 1999; Sengezer & Koc, 2005). Spatial planning is a common method in land use allocation and is important in improving disaster risk reduction effort. The lack of attention within spatial planning to disaster mitigation has been addressed by Sanderson (2000). Fortunately recent research has indicated that the use of land use planning for risk prevention has been implemented in some places, such as in France and Italy (Menoni, 2004).

In the last 40 years, there was evolution on how disaster risks reduction efforts have been studied or implemented, specifically related to land use and spatial planning. Hazard zoning and land use control to protect people from hurricane has been implemented in the USA since

1970s (Baker, 1977). In the Central America, Centre for Prevention of National Disaster in Central America (CEPREDENAC) developed vulnerability-based land use planning which make use information derived from multiple hazards analysis (Montoya, 2002). Disaster occurs when a certain types of hazards exceeding the capability of community to overcome the situation. Frequently, the scope of disaster is on local scale, affecting local population and infrastructures. The American Planning Association (Burby, et.al, 1999) proposed that local planning should address different types of natural hazards. During the period of 1990-2000, there was a growing concern on how to reduce disaster risks and was institutionalized through an UN-sponsored of International Decade for Disaster Risk Reduction. The follow up program in 2000 was the formation of UN-International Strategy for Disaster Reduction. After the year of 2000 there were a number of new strategies such as increase community participation and collaborative efforts, looking for the better way to disseminate information and engage in multidisciplinary approaches. There was also greater interest in incorporating multi hazards information in regional and land use planning, such as the application in Stockholm and Gdansk (Schmidt-Thome, et.al, 2005) and the incorporation of land subsidence, sea level rise and flooding information in land use policy for the European Union countries (Greiving, et.al., 2005).

Local government is the first to respond the disaster occurred in their area. They have responsibility for their local environment, know better local situation than others, and most importantly receive mandate to govern and protect local community. It is important that effort in disaster risk reduction should be focused in local government without neglecting global threat. Incheon declaration (2009) on disaster risk reduction highlighted the need for capacity building on local governments in disaster risk reduction and adaptation to climate change. The term local governments in the declaration consists of different level and size of administrative categories from regional, provincial, cities, districts, municipalities and villages. Furthermore, the declaration implied that it is necessary condition to be successful in disaster risk reduction that good local government practice be implemented with special emphasize on policy development and enforcement of spatial planning. The relation and functionalities of spatial planning in disaster risk reduction will be explored further.

5. SPATIAL PLANNING AND DISASTER RISK REDUCTION

Spatial planning involves the process of allocation, forming, sizing, and harmonizing space or land for multifunction uses (Albrechts, 2006). It is a task usually conducted by a planning agency with input from many disciplines such as a planners, economist, transport analyst, and geo-information specialist. Based on the area under consideration, spatial planning can be classified into national, provincial (state), regional (district level) and detailed spatial planning. The classification is based on the extent of the planning and how detail the spatial plan is. District level spatial planning provides general guidelines on how space is utilized, zoned, and controlled. Detailed spatial planning have legally binding status, covers the whole city area or small part of it , and the output spatial plans map produced at large scale map of 1:500 to 1:5,000 or larger. Some planning scenarios require less detailed information, and therefore very detailed is might not be needed or not available. For example, geological and hazards map usually not available in large scale.

Spatial planning deals with the development of a particular spatial area within which disaster may occur. Information on multi types of hazards in that particular area is indispensable, and should be formally incorporated, in spatial planning. However, although this topic was discussed quite some time, the practical implementation was still limited. Greiving et.al. (2006), in his study on the role of spatial planning in natural hazards risk management in some European countries, found some interesting results. They concluded that the role of spatial planning in risk management was low as it mainly used to, e.g. restrict development in hazards-prone area. In most cases, multi-hazards approaches do not exist because there are many organizations dealing with different types of hazards working independently. They also found a lack of coordinated activities among different actors involved. Different countries have different ways of integrating risk related information in land use planning. Risk related can be incorporated in preparatory land use planning or in detailed land use planning.

In different environmental and political setting, Indonesia made some significant progresses. The development of laws and regulations related to disaster mitigation and spatial planning in Indonesia was started in 2005. It was after the devastating tsunami in Aceh which occurred on 26 December 2006 and killed more than 170.000 people that the need for law on disaster mitigation became very urgent. The political process was speed up after the earthquake in Yogyakarta on 27 May 2006, which killed more than 5.700 people. In 2007, three laws which contain disaster mitigation directives were enacted. They are Law on Disaster Mitigation (24/2007), Law on Spatial Planning (26/2007) and Law on Coastal Zones and Small Islands (27/2007). Law 24/2007 is the main reference on how disaster mitigation to be conducted. Similar type of law was never enacted before although Indonesia is located in the Pacific ring of fire with 127 active volcanoes, situated in plate tectonic margin with very frequent earthquake as well as many coastal lowland and small island vulnerable to inundation and tsunami. Law 26/27 is a revision of Law 24/1992 on Spatial Planning. The major progress of this revised law in relation to disaster mitigation is that it formally requires disaster risk information to be incorporated in spatial plan. Law 27/2007 recognizes the vulnerability of coastal zones and small islands to different types of land- and sea-borne hazards. In the section of Disaster Mitigation, it regulates that any development plan for coastal zones and/or small islands has to include a section on disaster mitigation.

In an effort to minimize impact of a certain disaster, mitigation is required. Mitigation means lessening adverse impact of hazards by implementing various strategy and actions (UN-ISDR, 2009). Some possibilities exist for the strategy and action such as do nothing, retreat, and adaptation. Do nothing is not an option at this moment since it was based on fatalistic view when people have limited capacity to tackle the problem. Retreat means moving away from the disaster area if the community cannot withstand the devastating consequences of disaster. Adaptation usually requires engineering approach to minimize the impact of disaster. The latter two strategies can be fitted ideally in spatial plan. There are four roles of spatial planning in disaster risk reduction (adapted from Fleischhauer et.al., 2005)

a. Restrict development on dangerous disaster-prone area. Spatial plan will be useful tool to keep infrastructures development out of disaster-prone area,
b. Allocate different land-use setting for disaster-prone area. Timber plantation may be allowed in steep slope but paddy field and residential area are forbidden.
c. Legally binding land-use plan or zoning. Detailed spatial plan may contain recommendation on e.g. building density and maximum elevation/storey which can be

useful in the event of earthquake.

d. Modify hazards intensity and frequency. Spatial plan can contribute to reduce disaster risk by, e.g. prohibited development in conservation area required for flood water retention.

To be able to develop effective spatial plan able to reduce disaster risk, information on disaster characteristics are required. Table 1 listed some requirements in disaster risk information on different level of spatial planning at the local/district level.

Table 1. Requirement of disaster risk information in spatial planning (modified from Fleischhauer et al., 2005)

Planning type and activities	Flooding	Landslide/ mass movement	Land subsidence	Sea level rise	earthquake	volcanic
Restrict development	Extent Depth Frequency	Extent Frequency	Extent Rate	Extent Rate	Extent Intensity	Extent Type of effects
Differentiated land-use setting	Extent Depth Duration Frequency	Extent Frequency	Extent Rate	Extent Rate	Extent Intensity	Extent Type of effects
Land-use plan or zoning	Extent Depth Frequency	Extent Frequency	Extent Rate	Extent Rate	Extent Intensity	Extent Type of effects
Modify hazards	Extent Depth Rate Sources	Extent Rate Trigger	Extent Rate Sources	Extent Rate	Type of effects Subsequent disaster	Extent Type of effects Subsequent disaster

6. GLOBAL CHALLENGE, LOCAL CASE: EVALUATING SPATIAL PLAN IN SEMARANG CITY, INDONESIA

Semarang is the capital of Central Java Indonesia, ranked number four biggest coastal city in Indonesia after Jakarta, Surabaya and Makassar. The city was chosen as a case study because it suffered from numerous types of disaster from the sea, hinterland area as well as the earth beneath the city itself. As a fast growing city with relatively better human resources and ICT infrastructures, it was assumed that the spatial planning had incorporated disaster risk reduction component.

6.1. Description of the case study area

Semarang city, Central Java, Indonesia (Figure 1) covers 373.7 km^2 with the population in 2006 was 1,434,025, distributed un-evenly in 16 sub-districts and concentrated in the middle-north of the lowland area. In the last four years the population grows by 1.5% per year. It is estimated that in 2030 the population of the city will be around 2,156,000. The current population density is 2,900 per square km, with the net population density reaches 10,200 people every square km (City of Semarang, 2007).

It has an interesting topographical setting, with lowland area stretching approximately 3 km in the western part to 10 km in the eastern part from the coast. Area situated below 5m accounts for 34% of the total land area, with in many isolated area already situated below mean sea level. This lowland area is very vulnerable to flooding from the river as well as from tidal inundation. The southern part of the city has hilly and undulating terrain and has significance as an environmental buffer, for example as water recharge area. Landslide and mass movement occurs frequently in the hilly areas, especially during rainy season. 338 Ha of land are highly susceptible to landslide and mass movement (City of Semarang, 2007).

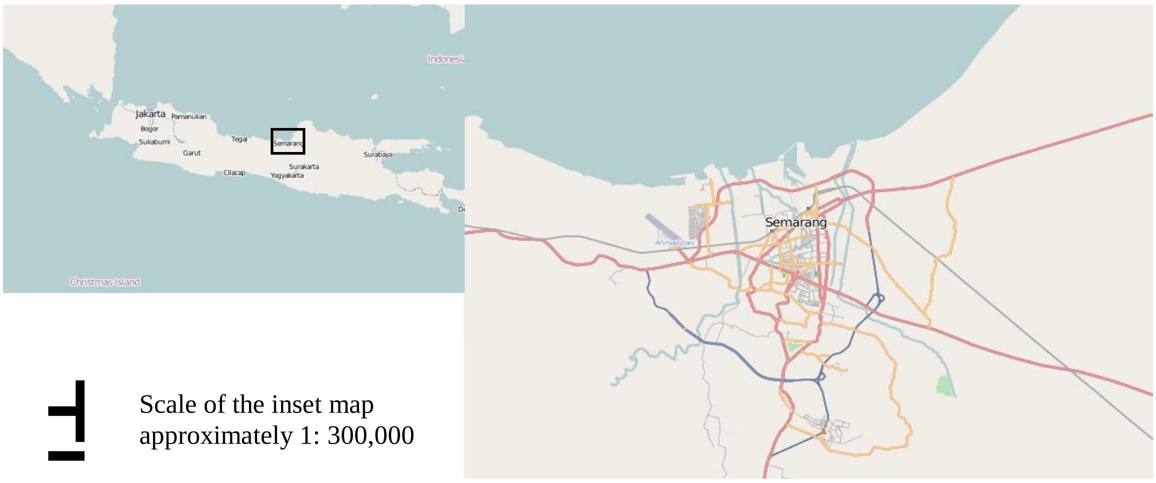

Figure 1. The case study area, Semarang City, Central Java, Indonesia
(Source: http://www.openstreetmap.org)

The city experiences several types of natural disaster, such as river flooding, tidal surge, land subsidence, mass movement and landslides. Some main rivers are becoming shallower and narrower because of the high erosion rate in the hilly area. This is the result of extensive land use change from forest and plantation into residential areas in the upper part of the city. In effect, magnitude and extend of flooding is increased. Land subsidence is another factor in increasing the flood risk. At present, 273 Ha of land in highly populated area are subject to land subsidence of 4cm/year or higher (Semarang city, 2007). The most obvious impact is abandoned houses, office building, industrial complexes and railway because of continuous inundation. Geodetic leveling measurement has been conducted in some parts of the city. At one of the vertical control points in the north-eastern part of the city, the land has subsided by 20.5 cm in three years (Basuki, 2000). The most recent study conducted by Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)-Germany and the Centre for Environmental Geology-Indonesia has found that the rate of land subsidence in the surrounding of Semarang port has reached more than 8 cm/year. They employed differential interferometric SAR method based on several hundreds permanent scatterer points obtained from multitemporal SAR images of ERS and Envisat (Kuehn, 2009).

Pressure from population growth and limited available space has forced people to use marginal land on the hill slope and river bank for housing purpose. The risks of natural hazards are severe and need to be addressed appropriately. Figure 3 shows snapshots from the study area on the aspect of spatial plan, impact of disaster and current development activities.

a

b

c

d

Figure 3. A billboard with spatial plan map placed in various locations in the city (a), abandoned office because of continuous inundation from sea water as a result of land subsidence (b), a house in the formerly elite location is to be sold because of frequent flooding and inundation (c), land reclamation in importantly sensitive environment of mangrove forest (d). All photos were taken in July 2009.

Figure 3a shows the current practice of publishing the spatial plan to the community. Billboards were placed in various strategic locations in the city, enable people to inspect spatial plan. These billboards are complementing spatial plan maps posted in the city's official website. The next figure (3b) shows the severe impact of land subsidence. An office has to be abandoned because of its basement elevation is currently below mean sea level. Therefore, the sea water can never be drained out. This situation has been noticed since approximately 9 years ago. In figure 3c, a sale sign is put on the fence of unoccupied house. Similar sign were found in many houses in the formerly elite neighborhood. Market value of existing property decline sharply, while newly developed residential areas are difficult to enter the market. Finally, these impacts will affect the overall liveability of the city. However, despite the obvious impacts, it is shown in Figure 3d that a truck is unloading earth material to be used for reclamation in the former mangrove forest. The objective of the reclamation project was to develop a recreational park. The area is currently functioning as a water retention area to minimize river and sea water flooding.

6.2. Spatial planning and disaster risk reduction

Spatial plan of the city was formulated by a private consultant with close supervision from a governmental advisory team consisting officials from different agencies. The agencies involved are, among other, City Planning, Public Works, Local Land Administration, Environment, Mining, Investment Coordinating Agency, and Forestry. In fact the recent spatial plan formulation is a revision of the previous spatial plan. It consists of an evaluation on the implementation of the previous one, adjustment to the existing condition and development new planning scenarios. Public participation was encouraged by inviting some community and business organization to attend public meeting and focus group discussions. At the end, spatial planning policy requires approval from the local legislative body and was enacted as local government regulation.

In the city/district level, two types of spatial plan were developed that is RTRW (Rencana Tata Ruang Wilayah: General Spatial Plan) and RDTRK (Rencana Detil Tata Ruang Kota: Detailed City Spatial Plan). The latest RTRW and RDTRK are to be effectively implemented for 2010 to 2030. The development of them was based on Law 26/2007. However, there is a confusing situation in this case. Some government regulations required as a technical guideline were not yet issued. This includes government regulation on how spatial planning should be executed, how public participation be conducted and what are the map standard and specification. Therefore, provincial and district level government were forced to use new law but with old technical guidelines based on the previous law. With these circumstances, evaluated the RTRW 2010-2030, RDTRK 2000-2010 and RDTRTK 2010-2030 of the coastal city of Semarang were evaluated. The following aspects were analyzed: how the spatial plan linked to the idea of disaster risk reduction, how the spatial plan address the issue of disaster risk reduction and how the spatial plan map represent disaster risk reduction effort.

The process of revising RTRW was started in 2007, as the law on spatial planning ordered that the revision should be completed in 3 years after law was enacted. In the section of consideration, only one law related to disaster risk reduction was listed, law on spatial planning itself. Law on Disaster Mitigation was missing, although it was stated in it that disaster risk reduction should be incorporated in spatial plan. However, disaster risk is clearly having a part in the RTRW. There are some words related to disaster used in different sections of the spatial plan document. Landslide and mass movement were used 28 times, flooding and inundation were used 60 times, rob (local terminology for tidal flood) were used 14 times, land subsidence 7 times, sea water intrusion 1 time and disaster 20 times. This indicates that the planning agency recognize how vulnerable their city to numerous types of disasters. The following maps are part of the RTRW: mass movement, land subsidence, flooding, earthquake risk, and slope map. These maps are based on topographical map of scale 1:5000, but printed at the scale of1:95000.

RDTRK 2000-2010 analyzed in this paper is a revised of the previous RDTRK issued in 1999 (City of Semarang, 2004). Every five years RTRW and RDTRK usually revised to keep up with recent development and adjusted to external and internal factors. In that time there was small number of frequent disaster with high number casualties in the country which in turn did not put disaster risk reduction in the mainstream issue. Law on Disaster Mitigation was even not yet prepared. Therefore, the consideration section did not list any law or government regulation directly related to disaster risk reduction. However, in the planning zones III, the RDTRK already identify three types of natural hazards, mass movement/landslide (mentioned 5 times), flooding (mentioned 8 times) and sea water intrusion (mentioned 3 times). There is no hazards map at all among 14 maps in the document. All of them were still manually drawn by draftsman without the use of any GIS software. They have no numerical scale and posses limited positional accuracy. During that period of time a lot of information on natural hazards have been produced by government agencies and universities but were not taken into account in the document.

The situation when RDTRK 2010-2030 formulated was quite different. Law on Spatial Planning and law on Coastal Zone Management and Small Islands were referred in the document, among other laws and government regulations. The word disaster was used 23 times, flooding and inundation were mentioned 42 times, rob 18 times, mass movement 3 times, earthquake 1 time, tsunami 2 times and hazard mapping 1 time (City of Semarang, 2008). It was the first time the terminology of disaster mitigation appears and map of flood control produced in the spatial plan document. Other progresses include the insertion of two separate sub-sections on flood control and disaster mitigation. The document also acknowledges that flooding and rob were destroyed transportation facilities and obstruct the development of the sea port, but did not provide clear and coherent statement on how to prevent from or reduce the impact of the disasters.

The RTRW and RDTRK list some guidance on what types of activities and land use appropriate for hazard prone area. These guidance covers area prone to landslide and flooding. Plans for hazard modification were also listed, such as development of polder to reduce flood water inundation. General directions for development restriction in hazard prone areas were also provided. However, it’s legally binding land status still not clear because its associated maps were in small scale and thus difficult to pin point the exact location. As disaster risks is time-dependent event, and some may have their frequency and magnitude increase over time, a projection on what would be the impact of certain disaster risk in the future is required. This modeling and projection was absent in the documents.

Based on the analysis of one RTRW and two RDTRKs for different time frame, evidently the most recent document progressed by recognized and incorporated disaster risk information in the spatial plan. Law on Disaster Mitigation was missing in the reference, which can be interpreted that these progressions were mostly referring the local conditions experienced by the planners and community. Global threat from climate change, which consequently can lead to rising sea water, was not mentioned in the documents. Land subsidence received little attention, mentioned seven times in RTRW and only two times in 4 planning zones documents. These four planning zones are located in the area suffering to land subsidence according to land subsidence map in RTRW document. RTRW discussed the issue in various parts as well as delivered one map on land subsidence, among other 26 maps. If we take the medium rate of subsidence of 5 cm/year, it will significantly increase the frequency and magnitude of flooding. Unfortunately, this issue has never been surfaced and subsequently comprehensive measures were not proposed. It is unclear why the detailed spatial plan did not take this matter into consideration. However, with all these drawbacks, the coastal city of Semarang has made considerable progress in facing numerous types of locally driven natural hazards.

7. Conclusion

Coastal cities are facing global threat from the rising sea level as a result from global warming and local natural hazards. Spatial planning is not directly responsible for disaster risk reduction, but can play important role in facilitating this effort. Four possible contribution of spatial planning are restrict development on dangerous disaster-prone area, allocate different land-use setting for disaster-prone area, legally binding land-use plan or zoning and in modify hazards intensity and frequency.

An evaluation on how a coastal city of Semarang in Indonesia responded to numerous hazards has been presented. Issues related to spatial planning and disaster risk have been addressed in since 2004, in the form descriptive presentation. They were visualized in some small scale thematic maps. Some deficiencies were found, for example no clear guidance on what measures should be taken to overcome the anticipated risk. Modeling and projection of the likely increase of frequency and magnitude of disaster risk in the future was missing in the documents. It might be related to the institutional capacity, awareness and political will of the local government. This situation might occur in other cities, especially if they have fewer resources in spatial planning and disaster risk reduction. Overall the city of Semarang has made considerable progress in addressing the numerous types of locally driven natural hazards, although with little reference to global threat from climate change.

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