

Local adaptive capacity as an alternative approach in dealing with hydrometeorological risk at Depok Peri-Urban City

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Abstract. Located in a tropical area, cities in Indonesia are vulnerable to hydrometeorological risks such as flood and landslide and thus become prone to the climate change effects. Moreover, peri-urban cities had double burden as the consequences of main city spill over and also lack of urban facilities in overcoming the disaster. In another perspective, the city has many alternative resources to recover, so its create urban resiliency. Depok city becomes a case study of this research regarding with its development following the impact of Jakarta growth. This research purposes to capture how the local city dwellers could anticipate and adaptive with flood and landslide with their own mitigation version. Through mix method and spatial analysis using GIS techniques, it derives the two comparison approach, the normative and alternative that had been done by the city dwellers. It uses a spatial analysis to have a big picture of Depok and its environmental changing. It also divided into 4 local group of communities as a representative of city dwellers regarding the characteristic of a settlement with their level of risk. The result found type or characteristic of settlement which influenced the local adaptive capacity, from the establishment of infrastructure, health fulfillment and social livelihood with different kind of methods.

1. Introduction

Cities as a melting pot of population and innovation growth become a place where the frequency of disasters are escalated and have been exposed to several kinds of environment risk [1]. City and urbanization are two inseparable incidents as it becomes a base for urban development. Rapid unplanned urbanization, population pressure with unstable and unclear policies makes urban areas at great risk [2]. Meanwhile, since 2011, Indonesia has entered a period of development, called urban millennia, a situation where the number of urban residents is greater than in rural areas. Major cities in Indonesia have a strategic role in regional development as a service, collection and distribution node, which has a backward relationship with its small and hinterland cities as well as forward relationships with other big cities [3]. Unfortunately, the growth rate of cities in Indonesia is relatively uneven and uncontrolled. Examples such as development in some cities, it is not likely to see the characteristics of the city itself consequently the physical burden that must be borne by the city even further increases. If the situation is not immediately addressed, then the magnitude of potential disasters and weak growth process will slow the pace of development of cities in Indonesia.

In other side, cities in Indonesian archipelagic have many challenging issues regarding the environmental depletion because of its location. Regarding the tropical area, it seems very common with dynamic climate and environmental change. Environmental changing at the archipelagic and tropical area is different with the mainland at others continental. As the consequences, 62 % of 497 cities in Indonesia have a high-risk level of disaster [4].



Moreover, besides the negative effects from the urban growth, the city also become “one-stop solution” which are ideas and technology grow in cities become a solution for disaster mitigation. At the national level, the government takes a major role in coping the disaster at-risk area. It includes how to mainstreaming disaster issues at provincial, city and municipalities levels. However, government past paradigm was a top-down approach which is a service provider and distribution of development outcomes. Especially at the provincial level, since there is regional autonomy so province government takes a lead for the local program. This kind of participation seldom encountered problems that causing project-oriented, passive benefits and increasing inequality [5].

In order to reduce disaster risk, we couldn't only stand to a government program, meanwhile local capacity at society or community level already adaptive with the risks itself with their version. The focus of this research is to figure out how the local group of communities could identify their own capacity as local adaptive dealing with environmental risk surround their neighborhood. Focusing on hydro-meteorological risks determined with 2 kinds of hazards such as flood and landslide. As a study case, Depok is a peri-urban received pressure of Jakarta growth and development. Since 2007, Depok experienced a devastating flood disaster that resulted in huge losses. Flood disaster in Depok is caused by several factors such as heavy rain that can cause river water flows, piles of garbage along the river and the depths of which have started shallow and filled with garbage. By knowing the local adaptive, its aims to understand there are alternative approach from communities as city dwellers in coping with flood and landslide risks. So it can't depend on government action only, but also gathering the local community's participation.

2. Materials and method

2.1. Materials

Rising urban populations will have implications for increased urban activity and space needs. The increasing need for urban space faced with land constraints leads people to place unsuitable areas for their activities and settle. Poor people tend to make settlement enclaves in restricted locations for housing because they're economically less affordable, for example on riverbanks. Slums are scattered in several parts of the city. Studies show that vulnerable populations inhabited slums due to proximity to urban economic opportunities, despite disregarding the safety of disasters and the environment [6].

In addition to the emergence of slum settlements, environmental degradation is also a consequence of urban development. Increasing the number of people imbalanced with the availability of space to live and doing activities makes vulnerable groups occupy areas prone to disaster. Bad habits and lack of basic infrastructure services for housing, food, water, sanitation and energy cause environmental problems, such as littering, using rivers for bathing, washing, cooking, and others. Many found the river to be a garbage dump for residents living on the banks of the river [3].

The disaster threats experienced by middle cities in Indonesia are hydro-meteorological disasters (i.e floods, landslides, droughts and heat waves), rather than the geophysical disasters (i. e., earthquakes and volcanic eruptions), that has been trending upwards in recent decades. This rising trend of climate-related hazards suggests a possible connection between these hazards and in turn disasters on the one side and climate change on the other [7].

Hydrometeorological disaster risk reduction is not only done with the construction and management of facilities and infrastructures, in accordance with National Law Nu. 26, 2007 on Spatial Planning, Republic of Indonesia if it located in disaster-prone areas requires spatial planning based on disaster mitigation as an effort to improve the safety and comfort of life and preserve the environment [8]. Floods are indirectly related to so massive land use changes. Land use will be given for making land use monitoring system [9]. It is understood that floods occur because of the unplanned rapid urbanization, change in land use and poor watershed management mainly in floodplains become important issues for consideration as the flood causes [10].

Based on the identification of potential disaster variables and historical data related to the hydro-meteorological disaster that threat Depok is flood and landslide [11]. The increasing number of

impervious land surfaces from Depok urban development, as well as the increasing utilization of Depok's water resources, put significant pressure on water resources and hydrological systems in Depok city. Assuming it will be including increased overland flow, erosive flow, instability increment river morphology, and changes in river biodiversity [12]. The pressure on this hydrological system is exacerbated by weather and climate trends worsening due to climate change. The impact of this phenomenon is a very high variability in terms of availability from time to time and spread unevenly perceived as floods and droughts. Intensive anthropogenic activities in Depok City and inadequate infrastructure management have consequences that exacerbate the above impacts, water pollution and landslide disaster.

Another consequence that is sometimes not in the spotlight when a hydro-meteorological disaster occurs is how well prepared the community. One way to look at it can be through the level of social vulnerability of Depok society. Based on previous research [11], areas in Depok with low social vulnerability are located in some districts located in the suburbs. In addition, in the region in some indicators also shows are in low grade. Broadly speaking, it can be said that the more towards the center of the city, the level of social vulnerability is increasing.

2.2. Research method

The method used in this research is mixed-method. Quantitative methods used are a statistical analysis of tabular data and spatial data with the help of geographic information system software (GIS). Qualitative method used is an interview with respondent, Shared learning dialogue (SLD) through focus group discussion (FGD) with the related institution and social element.

Data collection in this study is divided into three, according to categories of data to be collected. Secondary data were obtained by literature study and data from related institutions. Primary data will be obtained by field survey including in-depth observation and observation, ground check for secondary data validation, and interviews with respondents and shared learning dialogue (SLD). In the following data classification table, data collection is classified based on three types of data, including health data, basic infrastructure data and social data.

Communities were divided into 4 local group as a representative of city dwellers regarding the characteristic of settlement: 1) slum with high risk, 2) slum with low risk, 3) formal residential with high risk and 4) formal residential with low risk. Each local group is spread 2 different questionnaires. 1 questionnaire intended for ordinary resident and other questionnaires for stakeholder's/community leaders/ RT/ RW heads. The number of questionnaires distributed was 30 in each local group. The questionnaire consists of several closed questions (with options) and the rest is an open question. Questionnaires were processed and analyzed statistically.

3. Results and discussions

3.1. Hydrometeorological risk in Depok

Floods are overflow water that exceeds the capacity of rivers in their canals that are usually preceded by high rainfall or high flow water from upstream areas. Due to its vast territory, flood in different areas manifests themselves in different types and with various characteristics [13]. Flood and inundation problems are caused by high rainfall, modified or disturbed river morphological conditions, poor drainage systems, and other external factors such as high river sedimentation and landslides. One of the causes of high rainfall is impacted by the changing of climate surround.

The flooded districts spread throughout Depok City and are dominated in the east of the city, as shown in Figure 1. Some areas prone to flooding were passed by large streams such as Ciliwung and Pesangerahan River. Besides that, the absence of a lake is one of the factors that make the region prone to flooding. According to Figure 1, the flood-prone areas are 126.4 Hectares. Sukmajaya District became the most potentially affected by floods with an estimated total area of 32.8 Hectares. In addition, flood-prone areas in Depok City tend to be located at an altitude of fewer than 100 meters which includes a declivous area.

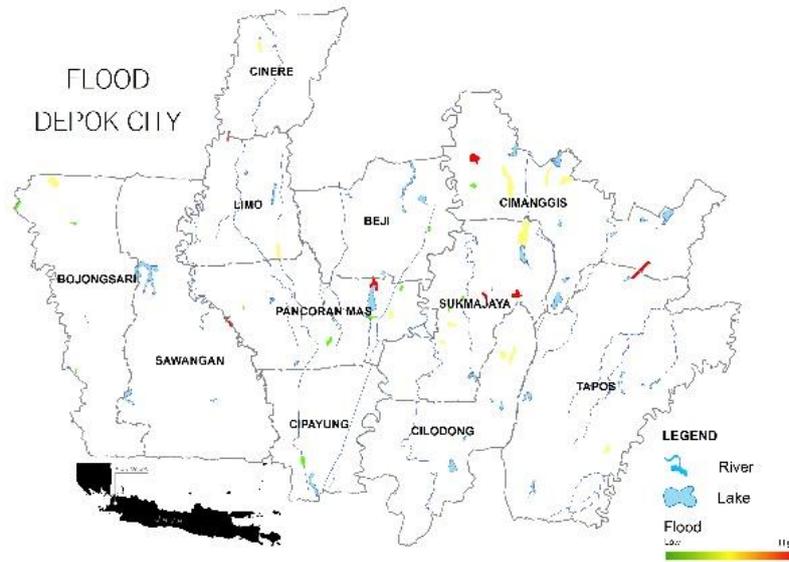


Figure 1. Flood area in Depok City in 2015 [11]

Landslide in Depok City occurs due to several factors from the physical condition, natural factors, and human activity. Factors caused by humans can be in the form of piles of garbage and the accumulation of material caused by the expansion of settlements so that piling up the soil around the valley leads to overloaded land, and farms activity on the slopes.

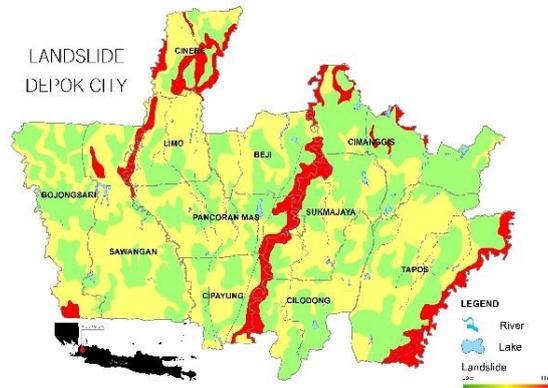


Figure 2. Depok City’s landslide area in 2015 [11].

The landslide-prone area in Depok City has a slope between 8-15% which means that the slope condition is quite steep and has a steep hill or valley. This region is often found along a large river flow that has a width of more than 10 m. Steeper the slope, the higher the landslide potential, but this can’t be separated from the type of rock and soil type in the area. Figure 2 shows that areas prone to landslides reach 1.807 Hectares. The most vulnerable areas of landslides are Tapos and Cinere Districts with a total of 7 vulnerable villages. This region has a fairly steep slope along the stream.

3.2. Normative approach regarding risk at Depok

Instead of climate change management, it is more common with disaster management while climate change effects include in it. Although, the policies and regulations on the disaster in Depok City are

still overlapping. This is due to the absence of agencies that focus on disaster management affairs. Unlike other cities such as Jakarta that already have Regional Board for Disaster Management (abbreviated as BPBD DKI Jakarta), the Disaster Management Regional Board Depok needs to be completed because the level of disaster threat is increasing every year.

Recently, disaster-related policies are downgraded into several plans and programs can be identified through urban planning regulation (RDTR Depok City in City Regulation No.1 Year 2015). The plans and programs are as follows:

Table 1. Flood and landslide management program.

Item	Program
Flooded Area Plan	Normalization of drainage channels Building new channels to the river Building embankments
Landslide Area Plan	Protecting and building of river/lake walls Normalization of riverbank and lake with mud dredging and develop jogging track Building an evacuation road Reforestation by planting landslide prevention plants along riverbank Limit the utilization of space around riverbank

Source: Urban planning of Depok City.

Several programs can also be identified through a series of Focus Group Discussions (FGD) with the Local Government of Depok City and field findings.

Regarding the early warning system, there is no standard scheme regarding early warning system in Depok City. Society has its own way to know when and where the disaster will happen. For example, some people living near the river basin said that until now there is no early warning from the government, they actually have an early warning system via messages on mobile phones. Communities are inevitably forced to adapt to their homes. The importance of communication between households also makes it easier for information about disaster events.

Meanwhile, disaster preparedness in Depok City is still very low include climate change effect management than the other cities. This condition is reflected by the inadequate condition of infrastructure and the lack of government's role in tackling disasters. This research believes that humanitarian interventions should as soon as possible include efforts to help affected people rebuild a disaster management and develop the capacity of local communities to recover if a new disaster would occur. With this approach, vulnerable people in hazard-prone areas allow building resilience by themselves. Therefore, strengthening the understanding of resilience at the community level becomes an important factor.

3.3. *Alternative Approach in 4 Categories Areas*

The inadequate condition of infrastructure and the lack of government's role in tackling disasters, leads people in Depok to manage their environment by their own “style” due to their capacity. Each community has local adaptive in managing floods and environmental degradation.

Based on the interview results, the coverage of the health center with house location is important. Access to local public health services center called *puskesmas* is a problem because there are differences in health care systems such as providing treatment to citizens KIS card (*Kartu Indonesia Sehat*) and so on. Some residents also stated to seek treatment tailored to the availability of facilities in the hospital or *puskesmas*. In addition, the public also often get regular health information counseling from *puskesmas* and government. This issue gives some impacts either from health aspects or material loss. Some efforts to overcome these problems are still done individually and communally. The absence of a maximum strategy with the local government to prevent the coming of the disaster.

The fulfillment of water needs in Depok City according to 4 research areas tend to give the same picture with the report given by the government. 90.25% of people use groundwater for toilet and 72% for cooking. Fulfilling the need for a drink is still dominated by gallon water as much as 58.75%. This illustrates that most people in Depok are still dependent on the groundwater used every day and it takes an additional cost to buy clean water. Waste management in 4 research areas tended to be done individually. As with garbage management, many of the 66.04% of the community don't have trash cans and dispose of the waste by burning or dumped it into the river. 31.13% of them have done communal management or have a good garbage disposal system [3]

Some forms of community role in tackling disasters can be seen from the level of the role of formal leaders in the scope of RT, RW, sub-district and local government. In addition, in interviews, some roles of informal and community leaders are also present in responding to and tackling when a hydrometeorological disaster occurs. Some of the roles of these institutions have been summarized and can be seen from the table below.

Table 2. The roles of the institution.

Institution	Forms of role
RT	Population data collection, <i>fogging</i> , evacuate during a disaster, community services program
RW	Community services program, <i>fogging</i> , food aid.
Sub District	Logistic assistance
<i>Puskemas</i>	Health counseling and immunization, aid post during disaster
City Government	Logistic aids, health counseling, medical aid, flood embankment
NGO	Cleaning the trash in the river, incoming flood's information, evacuation
Mosque	Flood's announcement and temporary shelter
Other Party	Help in terms of borrowing money and medication.

Hydrometeorological hazards directly provide the various impacts that must be anticipated by the community. Based on interviews, some forms of adaptation and community mitigation of floods, landslides and droughts are as follows:

Table 3. Forms of adaptation and mitigation.

Hazard	Forms of adaptation and mitigation	
	Short term	Long-term
Floods	Refuge to a higher place Cleaning the trash in the river	Elevate the foundation of the house Raised the terrace of the house / added floor of the house Build stilts house Build a water channel
Land Slide	Home improvement Refuge to relatives/neighbors	Build a cemented foundation of the house Moving to lower area
Drought	Buy a water/gallon Ask for water to relatives/neighbors	Deepening the depth of the well Relocating the water

4. Conclusion

The current local capacity in adapting to disaster and climate change impact in Depok city is still at the community level. Lack of preventive action been to force people to adapt individually and communally as to elevate the house, create a stronger and taller foundation and create waterways. The presence of a strongly linked familial relationship is also one of the adaptation and mitigation factors running as long as the community is struggling with disasters. In addition, the distance factor between the residence of a relative or family becomes important when the post-disaster mitigation period occurs.

The stronger the social interaction in the community, the stronger the level of adaptation to disasters including climate change effects. Factors of spatial closeness and the existence of reciprocal relationships facilitate the community in the process of adaptation and mitigation. It is also closely related to community resilience to disasters occurring in the environment.

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