Potency of Smart Water Flow Management at Lowland Residential Area

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Abstract. Most of the residential areas in Palembang were located at lowland such as riverside. The problem of flood is inevitable at this area. Flood brings loss to the property. This paper aims to seek the potency of applying smart water flow management to cope the risk of loss caused by flood. To achieve the aims, the study (1) observed how residents manage their house to cope the flood; (2) mapped the function of the buildings at a riverside settlement in Palembang and (3) formulized the strategy for anticipating the risk. Data were collected by interview and field survey. Qualitatively, data were overlapped with the topography map to understand the flow of the runoff water within the settlement. Findings reveal that the distance from the water body determine the strategy on cope the risk of flood

1. Introduction

Palembang is an old city which is divided by Musi River with area of 400.61 km^2. The initial development of the city was started at Musi riverside. The city is dominated by wetland area. The area of wetland was 11.754 ha and 48,42% of it was categorized as reclamation lowland which can be shifted its function into housing area. Among the lowland area in the city, the development at riverside area is challenging as there are many traditional buildings within this area of high building density. Unlike the relatively new reclaimed area in the city, the Musi riverside area with its traditional buildings is threatened by the flood. The issue of loss caused by the flood is not only limited to the physical damage and socio-economic loss, but also heritage and historical value.

As the riverside is a wetland area, the flood is usual happening in the settlement. In the past time, the houses were used stilt structure as an adaptation to the nature of riverside area. The stilt structure of the house let the runoff water absorbed to the land and the riverside became as water catchment area. The stilt structure also kept the residents and their properties safe from the flood. Nowadays, the riverside area is fulfilled by new buildings and high dense of population. The new buildings occupied the vacant spaces in this area. The space under the stilt structure is used as a part of a house. Therefore, the hydrological function of riverside area is disturbed. The water does not flow to the river properly. The land cannot catch the water to the land. This situation increases the risk of flood. Water must be flowed to the sewerage system included river, so that the risk of flood can be minimized. In this situation, smart water flow management is needed to give best anticipation and mitigation for residents.

This paper aims to seek the potency of applying smart water flow management to cope the risk of loss caused by flood. To achieve the aims, the study (1) observed how residents manage their house to cope the flood; (2) mapped the function of the buildings at a riverside settlement in Palembang and (3) formulized the strategy for anticipating the risk.

2. Smart City Preparedness

The idea of smart cities was started in era of 1990s when the concept of Information and Communication Technology (ICT) started to be applied in modern city [1]. As the use of the high tech instrument or device is widely spread to the urban community, the smart city is more reflecting the intelligent, interconnected, interactive and competitive urban infrastructure in serving the city. The ICT is important aspect in application of smart city. The component of smart city consists of smart economy, smart people, smart mobility, smart governance, smart environment and smart living [1,2]. In urban aspect, the smart environment and smart living are strongly related to the effort to provide better living environment. For faster action, these two smart city elements are complemented by smart mobility as core of smart city concept. In relation to the potency of disaster caused by nature and human false, the components of smart city are complemented by smart disaster management [3]. This new component is specifically given to the concept of smart city in order to give fast and accurate prevention and mitigation on the potency of disaster. Therefore, in effort to create liveable city, the smart disaster management should be taken into account in urban design, particularly in the high risk of disaster area.

There are some considerations in applying smart city. As the ICT is the key of this concept, the internet and huge data analytics must be available in premiere condition [4]. The city also must understand what is already in place and what things can be improved. In another words, the branding of the city is important consideration before taking an action for smart city strategy. The existing condition and the brand show the competitiveness of a city in its service. This leads to future vision of the city [5,6]. By having the vision, the strategy of smart city management will be clear and meet the need of urban communities. The clear vision of a smart city will lead to the appropriate strategy for the six component of smart city.

3. The need of smart water flow management

As water is one of the main human needs, the problem of water is always become a hot discussion for age. The problem related to water is related to water distribution, waste water discharge and sewerage system. Along with the issue of high population rate and climate change, the problem of decreasing of water catchment area and flood becomes one potential problem in the future. To maintain the natural resources of the water, managing the proper water flow management is important.

Naturally, water flow from high to lower place, from the springs at mountains to the river or sea. At the lower place, land absorbs the water and runoff water becomes the ground water. The water catchment area is important for maintaining the resources of ground water. Beside as ground water, the water also flows to the lowland area such as riverbank, ocean, mangrove forest, swamp and other flood plain area. The flow of water should be in balance with nature. The unbalanced flow will damage the living environment.

The flood is considered as natural disaster when the flow of water is over or unusual that can be happened suddenly or in certain period of time. The unusual flow along with the regular one can cause the flood since the two create a surplus water flow. The causes of flood can be purely natural cause or a combination between nature and human factors. In detail, the flood is caused by the hydrological condition, meteorological condition, geographical condition and planning problem. The hydrological condition includes the discharge of heavy rainfall, enormous water. The meteorological condition is untimely cycle and storm. The geographical condition is flows of water from neighbouring states, flow of river across the state & the topography. The planning problem includes poor drainage, high siltation in river or breaching of the embankments [7,8]

In urban context, the flood become serious problem as it relates to high population and economic value. The unanticipated flood brings the damage to the urban development. Therefore the water flow management should provide information to the urban community and authority to minimize the damage. The fast and reliable information is needed to allow the best anticipation and mitigation effort. The smart water flow management is one way to gain precise data on flood pattern, accurate analysis and fast information delivery to the urban community. The smart water flow management helps urban community to overcome the flood and minimize the damage.

4. Mitigation and early warning system

Generally, there are two classes of damage caused by flood, which are physical damage and intangible losses. The damage on buildings and infrastructure are the physical damage. Intangible loses includes the loss of socio-economic convenience before the flood such as delay of traffic, business activities and health. [9]. Mitigation related to early detection. Accurate detection requires a good quality of sensor. Some studies mentioned the use of sensor is used for detecting pattern of water consumption, distribution, and quality. Sensor at smart meter can gathered the data on pattern of water use, which is integrated with wireless communication networks and information management to provide useful information for the planner, developer and architect [10]. The pressure sensor is used along with flow meters, noise logger and water quality sensor to inform for analyzing data on water consumption, storage and distribution. The application of this network is called as smart water system which consist of smart meters, smart valve and smart pumps [12,13]. Sensor is also used for monitoring the salinization of ground water, to ensure that the ground water is not contaminated [14], so that the water resources at a certain area can be managed and controlled.

Detection is related to early warning. The previous study has revealed the method to provide an early warning for hazard. Mapping the topography data, spatial analysis and hazard prediction can be conducted. Sensor has been used widely in detecting the landslide hazard in mountainoue area [14] tsunami detection [15,16]. A combination with remote sensing technique and Real-Time Strong Motion Signals allow sensor to detect and give early warning for earthquake [14,17].

There are also some studies has discussed the early warning for flood hazard. The early warning can use ultrasonic sensor to detect the water level, flow level, and precipitation level in monitoring the potency of flood. [8,18,19,20,21,22,23] Another way to predict the rivers' discharge is by using microwave remote sensing method for informing the soil moisture conditions [24]. To make the information of warning are easily and fast to be received, these detection system are complemented by the web or short message system to alert the threatened populace and authority [8, 19, 20, 25, 21]. The sensor can be installed under the water level [22] or upon it [19]. The data collected from sensor can be processed for calculating the prediction of flood. The collected data is also giving warning to disaster management server and forwarded to the alert system such as android smart phone for residents and public service web for community. Therefore, predicting the flood is important since it let the community to prepare the proper action of mitigation and calculate the risk of loss.

Besides the data gain from sensor and satellite, the data on location also can be used to predict the flood. The residential distance from the floodplain boundary is also an important factor in predicting the location of flood and with the amount of losses. The location determined the physical damage. The further location of properties from the boundary of flood, the less amount of damage will be [26]. Not only the data on properties location, the location of social-economic activities such as the location of road, recreational facilities, economic activities and so forth are also determined the socio economic losses. By combining the data on location, the extent and depth of flood, the damage cost estimation can be determined [9].

5. Methodology

The aim of this study is to seek the potency of applying smart water flow management to cope the risk of loss caused by flood. Location of study is the old settlement located at Musi riverside, Lorong Kenduruan,7 Ulu District, Palembang. This location is chosen as it is an old settlement in Palembang that is near by the Musi river and Kenduruan river. The existence of the two rivers as well as the buildings represents the high potency of urban flood. Data were collected by interview and field survey. The interview is done to gain the information on how the residents respond to the possibility of flood in their living environment. The field survey was conducted to elaborate how residents manage the house on function, physical changes and distance from water body. Qualitatively, data from field survey were mapped and overlapped with the topography map to understand the flow of the runoff water within the settlement. The overlapping map shows the potency of application smart water flow management.

6. Results and Discussion

To analyse the results of the forming of good or no good corrugated metal gasket products, the main concern was directed at the four sections of the peak corrugated section of the metal gasket. This is because the performance of the corrugated metal gasket is affected by the peak of the corrugated gasket. The forming result is said to be good if the formed gasket meets the die completely. The indicator of fulfilling die mould in this simulation is indicated by the number of contact elements between the gasket plates and die mould (Figure 5). The more elements that contact the better the shape of the forming result. The elements that are not contacted are said to be forming products are defective.

As mentioned before, the observed settlement at Lorong Keduruan, KH.Azhari Street is located at riverside area. The houses are connected by concrete stilt path called *jeramba*. It lays from the riverbank to the KH. Azhari Street. This old city village is near to the 7 Ulu traditional market. Generally, the houses in this area consist of the stilt and modern house. The stilt house typologies are *limas, gudang* and *panggung cina*. These three houses are the typology of traditional houses in Palembang. Besides the traditional, there are also some modern houses in this settlement. The modern houses use masonry and concrete structure and landed. The other type of the house is the stilt house that is modified as modern house. This type is a combination of stilt house that occupied the space under the house as living place.

The interview questioned how interviewee responded the flood. There were 10 interviewees who have stayed there for more than 15 years. According to them, most of residents in this settlement work in informal sector such as running a store at the market, trading household goods and informal worker. All residents get used to experience the flood. They realized that the geographical condition of the living environment is a low land. There are two types of flood. The first flood is regular flood that can be happen annually or in certain period of year. The regular annually flood has maximum 30 cm in high. The biggest flood happens in every 3 or 5 years. The level of flood has reached to 50 cm in high. The second flood is the incidental flood. This flood happens because of heavy rainfall and bad drainage system. According to them, flood does not make them to leave their current living place. The family bonding is become the first reason of stay. They realized that the flood has threatened their property. However, they just accept it just the way it is. No significant anticipation efforts have been done.

Most of residents managed their house by two actions; expanding the function and changing the physical form of the house. The survey found that most of the houses in the observed area expand the function of house for economic reason. The functions were shifted from residential to economic activity such as rental unit of house, office, small stall or storage. Survey found some micro economic activities in the settlement such as home scale bakery and pastry, wedding organizer, small food vendors, rental house unit, in house cloth store and laundry. As this settlement is near to the traditional market, the small stores are easily to be found at KH Azhari Street. Therefore, the physical change of the house can be in form of additional space in front of the house for food stall, space use under the stilt structure, full renovation of the house into one and two floor building.

The survey found that the flood effect on the houses can be mapped into three areas. The first area is the nearest one from water body, the Musi river. The distance is approximately 100 meters from the water bank. The houses are on the water or muddy land. Having this condition, the physical changes are limited. The space under the structure is still as empty space, not being use for activity. However, there are a few changes in function such as mini food stall at the front of the house. According to the interview, the houses in this area are never submerged even the big flood happened. The second area has 100 meters from the first one which has higher contour than the first one. The land is harder and relatively drier than the first area. The space under the stilt is occupied for different function such as rental unit, stall or addition room of the house. However, the access path is higher than the level of space. Then, the flood affects the space under the stilt structure. The interviewees mentioned that the average flood level is 50 cm in height. The third area is relatively higher than the two previous. The highest level of flood reached to 30 cm. The land is dry throughout the year. The stilt houses use the space under the house as additional room. As the land is dry, the modern landed houses are found in this area, with one or two storey concrete structure. Survey also found that some of the stilt houses use the space under structure as place of living and food stall. The last area is near by the street. It has highest topography and not being impacted by the flood. Same as the stilt house at the previous three area, the stilt house in this last area also expanding the room to the space under the stilt. The distance determines the impact on the flood on the physical and functional of the house.

This settlement has relatively low contour as there are two rivers nearby it, Musi River and Kenduruan River. The contour is started from 0.92 meter at first area to 3.1 meter at the last area. Between these two contour lines, there are 1.9 meter in second area and 2.67 meter at the third area. The contour of 0.92 is near the Musi river bank. The contour if 1.9 is at the Keduruan River. This topography enables water flow from Kenduruan to Musi River or from last area to the first area of flood effect. Having this condition, the application of smart water flow management will use the two rivers as the references data of water level. Figure 1 shows the analysis of overlapped maps on function, physical changes, distance, contour and area of flood.

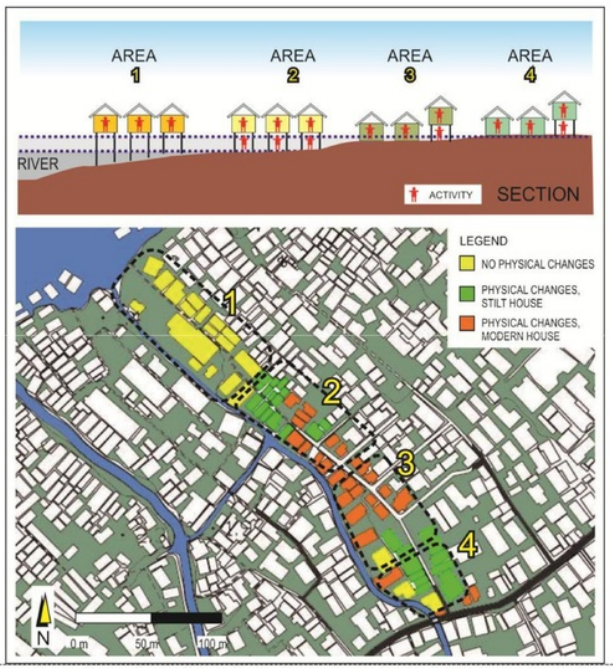

Figure 1. The analysis of overlapping maps on function, physical changes, distance, contour and area of flood.

The smart water flow management enables the end user to understand the most recent condition of water level. Based on the data, the areas that have impacted by flood are the second and the third. The flood brings physical damage and intangible loss. Smart water flow management addresses the residents at these two areas. The information of water level is crucial for people at this area. To get the latest information, the sensor should be installed in two ways. Firstly, it is installed in many places with in the four areas. Then, data from sensor is sent to the residents at area 2 and 3. The other way is installing the sensor on area that is impacted by the flood or water level raising, area 2 and 3. Information given from the sensor is sent to the residents in the two areas, so that they can be prepared in facing the upcoming flood at their area.

7. Conclusions

Not all the houses get effects from the flood. The distance of the house from water body determines the effects. The effects influence the shift of function and physical change. As lowland area has low bearing capacity and experiencing flood, the buildings use stilt structure for adaptation. The area 2 and 3 experience the flood because of the usage of space under the stilt structure. The application of smart water flow management can be applied in the area 2 and 3. Future research on variation of sensor devices and technical aspect in placement of the sensor in this type of area should be conducted to let the concept of smart water flow management can be applied.

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