Model of Community Wisdom in Mitigation of Flood Disasters

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ABSTRACT

This research aims to design a model of community wisdom in flood disaster mitigation in Padang City - Indonesia based on the floor height of the house, drainage conditions, and the wisdom of working together against flood heights. This research uses a quantitative approach where the population in this study is the flooded community in Padang City with a sample of respondents taken proportionally random sampling based on the Slovin formula from a total population of 950,871 people to 100 respondents. The results of this research are: 1) The physical wisdom carried out by the community is to increase the floor of the house to more than 65 cm as much as 10% still experience flood heights of less than 20 cm and 6%. Most of the floors of the houses in the study area were between 36 to 50cm high, 41% experienced flooding as high as 41 to 60 cm; 2) 60% of the community understands not to throw garbage into the sewer and 23% of the community understands to take care of the drainage for the smooth flow of water; and 3) social wisdom 45% of the people closed waterways into their homes and housing complexes before the flood, 35% of the people who always worked together. From the results of the research, it was not found that there was an effort to make infiltration bio-pure holes and infiltration wells as required in PERDA No. 3/2019 Paragraph 7 which reads "in the context of flood control every residential complex, industry, business/service area must make bio-pure holes and infiltration wells".

Keywords: Community Wisdom Model, Flood, Mitigation, Padang.

INTRODUCTION

Life is a dynamic that contains shifts and changes continuously. Therefore, every human being must be able to adapt to nature and the environment following the changes that occur, these changes can occur due to nature and also be caused by humans. The environment is a very good and complete natural laboratory, where humans are students of nature or the environment that must be studied (*Alam Takambang Jadi Guru*).

Along with the changes made by humans because of their needs, it does not always produce positive natural changes, including disruption of the ecological system. In an ecological system, if there is a disturbance to one component, it can affect other components, which will affect the system as a whole[1]. Where one of the consequences of the disruption of the ecological system will be the occurrence of flooding[2].

Flood disasters are caused not only by natural factors but also by human factors. From the human factor, the problem arises because of rapid population growth, especially in cities, where cities are places of concentration of population driven by various interests[3]. Cities have characteristics that are determined by their functions within the scope of the region, by taking into account the scope of a city and its functions in development, the existing natural environment is converted into a man-made environment[4 5]. This is done because to accommodate population growth, the change in the natural environment into an artificial environment is greater in urban areas, besides that flooding is very closely related to weather and seasons. development of settlements, so that the land becomes a threat to its inhabitants.

Many physical flood control efforts have been carried out such as repairing waterways, deepening and widening drainage, reforesting cities and settlements, and prohibiting cutting down forests and other businesses. The repair effort turned out to be not fully able to reduce flooding because there are natural factors that cannot be controlled directly by humans, namely weather or climate factors.

Flood events in Padang City can occur at any time if rainfall falls with high intensity, most of which occur at the end of the year and the beginning of the year, namely floods in the form of puddles, flash floods, and tidal flooding. Of the three types of floods, flash floods are the flood that brings the greatest losses. In the period 2011-2018, there have been four flash floods in Padang City, namely flash floods on July 24, 2012 and September 12, 2012 in Pauh sub-district, and October 19, 2013 in Bungus Teluk Kabung sub-district. The flash flood disaster on July 24, 2012 was declared a provincial disaster and caused the largest losses in the infrastructure, education, and housing sectors where the total loss was estimated at Rp 263.9 billion[6 7 8]. Flash floods on October 2, 2018 caused the bridge to be washed away in the Lubuk Kilangan sub-district and triggered by 250mm/6 hour rainfall. Meanwhile, for other types of flooding in the form of puddles, the effect is to disrupt the activities of the population in various sectors.

Based on the assessment of the flood hazard index in Padang City[9], the areas threatened by floods almost cover all sub-districts in the city of Padang. When viewed from the total area of flood hazard at the district level of Padang City as a whole of 14,901 Ha, where there are 11 subdistricts in Padang City that have a high flood hazard class, each flood event location never changes and decreases it expands to other residential areas. Mitigation efforts are one solution to reduce the risk of flooding in this city.

Mitigation of flood disasters is not enough if only improving the physical environment of the area, but also the role of the community in the flooded area. The large community in urban areas is not only at risk for high disaster victims but also has potential that can be used to minimize the impact of flooding on the environment. This research was conducted to examine the wisdom of the community to minimize the risk of flood victims apart from the efforts made by the government, especially in the field of environmental care and management together in their living environment, therefore the purpose of this study can be formulated to find a model of community wisdom in reducing the risk of flooding in Padang City in terms of house floor height models, drainage conditions and the wisdom of working together against flood heights.

METHODS

This research uses a quantitative approach, where the data obtained are analyzed by simple and multiple regression formulas. Community wisdom data in the qualitative form is made into quantitative data using a Likert scale assessment [10 11 12].

Population and Sample

The population in this research is divided into two, namely, 1) the population of the region and the population of respondents, the population of the region is a flood-prone location in Padang

City as many as 11 sub-districts; and 2) the respondents were the entire population of Padang City, which was 950,871 people, due to a large number of respondents, and not all peoples were exposed to flooding, the sample taken was residents who lived in flood-affected areas using proportional random sampling technique, the number of respondents was determined using the Slovin formula[13 14 15]. Based on the slovin formula, the number of respondents' samples is calculated as follows:

$$n = \frac{N}{1 + Ne^2}$$

Information:
n = sample size
N = population size
e^2 = error/percent allowance for inaccuracy due to a tolerable sampling error (10%)[16].

So the result of the calculation is the number of samples is 99.99 people, fulfilled to be 100 people.

Data and Data Processing

The types of data needed in this study can be divided into two, namely primary data and secondary data. Secondary data include area, location, and the number of flood-prone residents of Padang City, while primary data is used to measure community adaptation by using a questionnaire. Community wisdom data in the qualitative form is weighted based on a Likert scale with a value of 5 4 3 2 1[17 18]. To see the effect of each variable X = namely physical condition and community wisdom on the Y = flood variable, two ways are used: 1) To test the hypothesis; and 2) modeling of flood mitigation using a regression formula[19 20] where the formulation is as follows:

$y = a + b_1 x_1 + b_2 x_2 + b_3 x_3$

y = is the variable that is affected, namely in the form of a flood height variable
a = constant
x^1 = Floor height
x^2 = Drainage condition
x^3 = mutual cooperation wisdom

RESULTS

A. Physical model of house building in flood prone area

The shape and physical model of the house, in addition to following the changing times, should also adapt to the circumstances of the environment to live comfortably to avoid various kinds of problems that may arise. One way is to adapt physically in the context of flood disaster mitigation. From the results of the study, we can see the physical conditions as follows:

Physical Design of House Building

As many as 12% of community houses in flooded areas were designed using the services of a Consultant, of which 10% experienced a flood height of less than 20cm and 2% a flood height of up to 40cm. Next, 27% of the buildings were designed and built by developers with a flood height of more than 41cm. The physical model of the house that was designed by the owner was 21% with a flood height of less than 41cm. Most of the (66%) flooded areas with a height of more than 41cm were designed and built by the Developer. The results of this analysis reveal that the physical design of the house is very significant for security from flood inundation, meaning that a good house design hurts the flood height in the house. The contribution of house design to flood height is 28.2%.

House Floor Height Against Flood

The floor height of the house in the study area was found to be from 5 cm to 80 cm from the ground. At a height of 80 cm, 10% of houses were found to be flooded with flood heights ranging from 20 cm to 60 cm. Most of the floors of the houses in the study area were between 36 to 50cm high as much as 41% and experienced flooding as high as 41 to 60 cm, namely 24%. The floor of the house that is less than 21 cm high is flooded with a height of more than 41 cm. For details, see Table 1 below.

Table 1. House floor height against flood height

No	House floor height (cm)	Flood height (cm)					Amount (%)
		≤ 20	21 - 40	41 - 60	61 – 80	≥81	
1	66 – 80	6	1	2	-	1	10
2	51 – 65	4	5	1	-	-	10
3	36 – 50	11	9	24	7	-	41
4	21 - 35	2	1	9	2	2	16
5	≤ 20	-	-	5	8	10	23
Total		23	16	31	17	13	100

Source: Data analysis, 2022.

B. Forms of Community Social Wisdom

Efforts to Overcome Flood

Most (45%) of the efforts made by the community when a flood occurs is by closing the water inlet into their housing complex, this closure is only temporary because the covering material is not a permanent material, such as a pile of soil or sand. In addition, the number of people who do it is 17%. A fairly large number is that 27% of the community just let the flood waters pool until the water recedes again. The choice to raise the floor of the 6% house and build a 5% two-story house depends on the economy of the community or the owner of the house. The distribution of each community business can be seen in Table 2 below.

Table 2. Community wisdom in overcoming floods

No	Community effort	Frequency (%)
1	Raising the floor of the house	6
2	Building a two-story house	5
3	Hoarding the home page	17
4	Closing waterways into houses and complexes	45
5	Just let it go	27
TOTAL		100

Source: Data analysis, 2022.

Condition of Got/Drainage

There are five categories of sewers in flooded areas, the first is clean and smooth as much as 12%, less clean 23%, and the most shallow sewers 34%, especially those in public housing complexes and housing development complexes. From each of these categories, the area experienced an average flood height of between 21-40 cm for each event as much as 32%. 10% of areas without sewers experience flooding up to 61-80 cm. Some locations where sewers were not found are in residential areas that are not development areas, or natural/indigenous community settlements, including around the beachfront, Pasir Nan Tigo Village, Koto Tangah sub-district. Some of the sewers were found that had been buried for a long time and had never been repaired so that the pile was the same height as the surrounding road. For details, we can see Table 3 below.

Table 3. Got conditions against flood

No	Condition of Got/Drainage	Flood height (cm)					Amount
		≤ 20	21 - 40	41 - 60	61 – 80	≥81	(%)
1	Clean and smooth	2	-	8	2	-	12
2	Not clean enough	11	5	6	1	0	23
3	Shallow	6	8	10	4	6	34
4	Damaged	2	3	6	4	6	21
5	There's no got	1	1	2	5	1	10
TOTAL		22	17	32	16	13	100

Source: Data analysis, 2022.

From the data above, the condition of Got (X_3) against Flooding (Y) has a significant effect, namely, it is found with a contribution of X_3 of 8% where the better the condition of Got, the less flooding will be.

Type of Building Got/Drainage

There are four models of drainage buildings found in the field, each of which can be stated as follows; The most popular model is drainage where only the walls are made of concrete, namely 40%, from the information obtained this model is useful for increasing the infiltration process, but there is a risk that in certain places the walls will collapse and can cover the water net. Gutters or drainages that are built with permanent walls and bases are 17% this number is as much as those with earthen walls are generally found in residential locations bordering rice fields and swamps.

Mutual Participation

The distribution of communities who involve themselves to participate in mutual cooperation as a form of community wisdom can be explained as follows; those who stated that they always participated as much as 35%, often participated at 33% and sometimes 27%, and the group that never participated was only 4%. This illustrates that the community's wisdom in working together is still very good. Regarding the mutual cooperation schedule in flood-prone areas, we can explain that most (43%) are not scheduled properly, it can be said that they are incidental when the rainy season has started, other schedules are once a month as much as 24% and those who have a program every month are there. as much as 24%, the complete data can be seen in Table 4 below.

Table 4. Schedule of mutual cooperation

No	Timetable	Frequency (%)
1	Almost every week	-
2	Once every two weeks	13
3	Once a month	24
4	When the Got is dirty & clogged	20
5	No schedule	43
TOTAL		100

Source: Data analysis, 2022.

Waste management

Waste management is also a flood disaster mitigation effort because the garbage can clog the flow of water, especially in sewers. For this reason, it was found that the method of managing waste found in flooded areas was found as follows: 30% of the community disposed of it directly at a temporary disposal site (TPS), which was managed by stacking it using plastic or sacks and then some officers picked it up to be delivered to the TPS as much as 30%. 35% of those who still throw garbage into the gutter and other drainage are still found among as many as 9% of the population. Table 5 below shows the waste disposal sites in the community.

Table 5. Garbage disposal by community

No	Garbage dump	Frequency (%)
1	Temporary Disposal Site (TPS)	30
2	Burned	25
3	Just piled up and there are officers who take it	35
4	Thrown around the house	1
5	Dumped into gutters/waterways	9
TOTAL		100

Source: Data analysis, 2022.

Community Wisdom in Cleaning Got

The efforts made by the community in cleaning or maintaining the condition of the Got can be explained that most of them are on their own initiative as much as 38%, through mutual cooperation only 9%, it can be seen that the figure is also lower than the wage method, which is

18%. Cleaning sewers aims to smooth the flow of water so as to minimize the occurrence of puddles, especially sewers in front of and around their houses.

Table 6. Community efforts to clean got (x_4) against flood height

No	How to clean	Flood height (cm)					Amount
		≤ 20	21 - 40	41 - 60	61 – 80	≥81	(%)
1	Personal initiative	2	4	17	12	3	38
2	Mutual cooperation	8	1	-	-	-	9
3	Wages	11	6	1	-	-	18
4	Rarely come	-	5	9	6	5	25
5	Never come	2	1	3	-	5	11
TOTAL		23	16	30	18	13	100

Source: Data analysis, 2022.

Flood Disaster Mitigation Model

The floor height of the house against flooding is modeled by the graph (Fig 1) below:

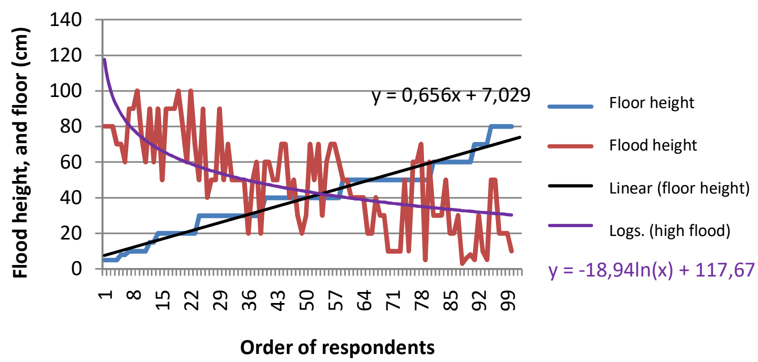

Figure 1. Model of house floor height against flood height

The distribution of data between the floor height of the house and the flood height in the picture above can inform that the floor height can reduce the high risk of flood inundation to the house (Log. flood height) described by a linear line formed from flood height and floor height data. The floor height that is safe from flood inundation is at least 80 cm and it is also necessary to pay attention to the morphology of the residential land because of the morphology of the alluvial plains of Padang City[21, 22] consists of three forms, namely alluvial fan plains, sand dunes, and former back swamp.

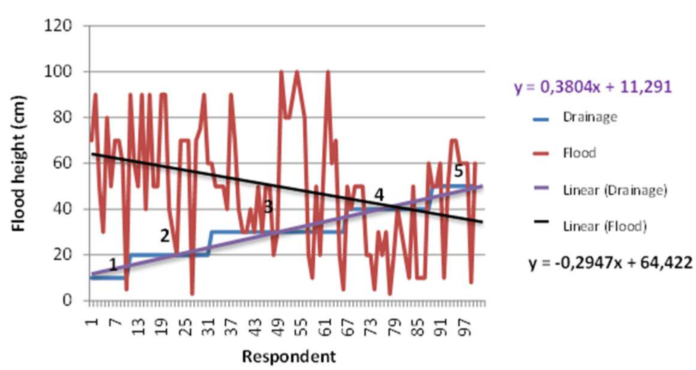

Figure 2. Drainage condition model against flood height

Description (Condition of Got/Drainage):
1. No got
2. Got broken
3. Shallow got
4. Got Less clean
5. Clean and smooth

The graphic model generated from the relationship of flood height with drainage conditions is significant inversely (Fig. 3), where the better the drainage, the less likely the flood height will be. The good condition of the drainage is influenced by the width of the ditch, the depth of the ditch, the cleanliness of the factors inhibiting the flow of water, and the type of ditch building. The community plays a role here as maintainers and regularly carries out maintenance in the form of mutual cooperation.

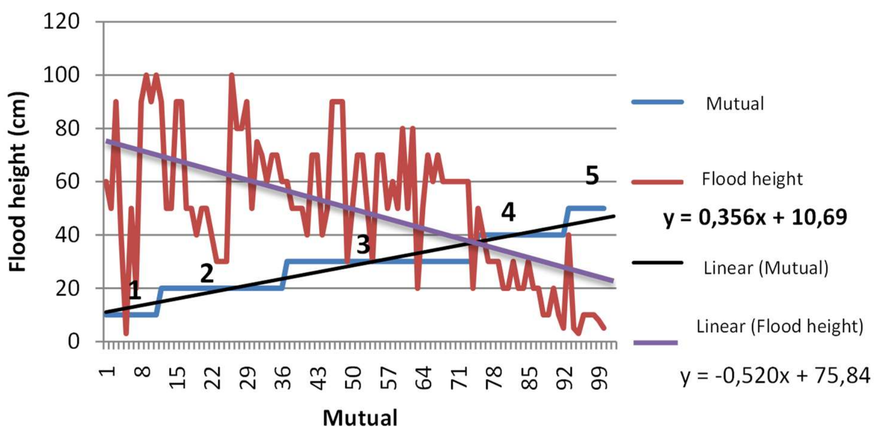

Figure 3. Mutual cooperation model against flood height

Description (Mutual):
1. Never participate in mutual
2. Rarely participate in mutual cooperation
3. Mutual cooperation is hired
4. Participate in mutual cooperation
5. Self-initiative cleaning

The community's mutual culture is very decisive in reducing the risk of flooding, this is evidenced by the graphic model generated from research data that communities who are more frequent and diligent in working together tend to decrease the flood level in their area, and reduce the risk of inundation flooded is high. From the results of the study, flood events in the city of Padang are not solely caused by high rainfall but often occur simultaneously with the tide of seawater, so that water from the mainland becomes blocked because seawater also moves to land (rob) lasted until the tidal flood retreated. Another contributing factor is the high land surface area of the beach (sand dunes).

CONCLUSIONS

Most of the houses built by developers have a high risk of flooding, this is due to a poor drainage system with inadequate gutter width and depth, so it is easy to overflow in case of heavy rain.

The model of building houses using the services of civil consultants is better than using ordinary builders, it is found that houses using the services of civil consultants are safer from flood disasters. The social adaptation model of the community in the form of working together to close waterways into homes and housing complexes before the flood, as well as cleaning and maintaining sewers, is very helpful in reducing the risk of flooding. The environmental management model, especially waste management by the community, is quite good because most have followed environmentally friendly behavior, but there are still a small number of people who still throw garbage into waterways such as sewers or rivers closest to where they live. The community's environmental knowledge still needs to be improved because there are still people who throw it into the drainage and rivers. It is recommended to the government that the implementation of PERDA No. 3/2019 regarding flood control is applied to the maximum, and not only to new buildings to be built but also to existing building complexes.

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