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Analysis of Environmental Adaptation of Flooded Areas in Padang City

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Abstract

Many factors cause flooding in a region, as the main factor is its natural and human factors. In Padang, the land is transformed into a built-up land, as well as more densely populated, coupled with the physical condition of areas prone to flooding. The average annual rainfall studied is 3997 mm/year, with the highest rainfall chart occurring in November, December, and starting to fall in January. The physical characteristics of flooded land soil in Padang city consist mostly of dust between 37.69% to 43.67% and clay between 10.05% to 41.48%, with soil permeability from 1.5 cm/hour to 0.25 cm/hour with slow to very slow category. Meanwhile, community adaptation reduces the risk of flooding in the form of a physical building which is not very significant because the community only cleans drainages from barrier factors, but does not make improvements to their homes or their environment. Social adaptation is in the form of mutual cooperation, only a small part of the community participates, some only help in the form of money as a substitute for mutual cooperation.

Keywords: *social adaptation, flood, environment, padang.*

I. INTRODUCTION

Flooding is one of the most devastating disasters in the world that can cost many people and materials including land. Flooding will cause many people to have to evacuate as it can occur over large areas and damage many properties. Flood risk not only comes from natural hazards but also comes from social processes. Therefore, flood risk management (FRM) assumes that the interaction between water and the risk of influence of flood land. Meanwhile, the national tradition of flood management aims to prevent flooding by interventions of water systems only [1].

Flooding is a relatively high surface water flow that cannot be accommodated by drainage channels or rivers, thus overflowing to the right and left and causing puddles/streams over normal amounts and resulting in losses to humans and the surrounding environment [2].

Flood events cannot be prevented, but can only be controlled and reduced the impact of the losses caused. The arrival is relatively quick, to reduce losses due to the disaster need to be prepared quickly, precisely and integrated. Thus, in general, flooding can be interpreted as an event where water is flooded on land that should be dry to impact physical, social and economic losses [3].

Flooding can occur by many factors that trigger it even though the main factors are high rainfall and inadequate land capacity due to the need for population growth that requires residential land and land to be active in work. Changes in land use, especially in urban areas, such as land that can absorb rainwater, turn into watertight, denser land, coupled with the physical condition of areas prone to flooding can be a trigger factor. As a

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natural factor, the average annual rainfall of Padang city that has been studied is 3997 mm/year [4] with the highest rainfall intensity occurring in November, December, and starting to fall in January.

The results of the study of the physical characteristics of flooded land soil in Padang City found that the texture of the soil consists mostly of dust which is between 37.69% to 43.67% and clay between 10.05% to 41.48% with permeability from 1.5 cm/ hour to 0.25 cm/h i.e. with slow to very slow category. The land used for these settlements is mostly flooded especially during the rainy season. The flooding can come from overflowing streams, puddles of rain that are not absorbed into the soil through the infiltration process, as well as rob floods due to the encounter of sea tides with streams [5].

To solve the flood problem, physically there has been a lot of improvement of waterways such as dredging of the river, drainage repairs, and even the creation of canal flooding [6]. Nevertheless, flooding still occurs and still causes fatalities and property in Padang City. It seems that the problem of flooding can not be solved if only doing a physical repair of the area, then there must be a role of the community in it so that the problem of this flood can reduce the event of losses.

II. METHODS

This research uses a quantitative approach using surveying and data collection in the field through questionnaires that will then be processed to be described integrated until it produces conclusions and suggestions in an integrated way. The population in this study is the entire area that is often hit by flooding in Padang City which can be administratively distinguished by sub-district area.

Table 1. Flood hazard areas in Padang City

	sub-districts	Large (ha)	Hazard	
		total	index	class
1.	Bungus Tl. Kabung	394,02	0,755	high
2.	Koto Tangah	5.688,72	0,791	high
3.	Kuranji	2.935,89	0,734	high
4.	Lubuk Begalung	810,27	0,695	high
5.	Lubuk Kilangan	713,79	0,682	high
6.	Nanggalo	927,45	0,810	high
7.	West Padang	482,67	0,826	high
8.	South Padang	214,11	0,756	high
9.	East Padang	826,92	0,754	high
10.	North Padang	771,66	0,818	high
11.	Pauh	1.136,07	0,682	high
	Total	14.901,57	0,755	

Source: [7]

The sample in this study was taken in two ways: 1) The sample of the area taken in purposive sampling i.e Koto Tangah sub-district, taking into consideration that this sub-district is the largest area charged by flood disaster which is 5,688.72 ha with a population of 177,908 people; and 2) The sample of respondents was taken proportionally random sampling as many as 10 people for each village so that the respondents would number 130 people, where the data needed in this study are primary data obtained from respondents through poll filling and interview records. Secondary data is obtained from local authorities, community leaders, youth leaders, and others. For more details see Table 2 below.

Tabel 2. Secondary data collection in villages Koto Tangah sub-district

Villages	Sample (people)
1. Air Pacah	10
2. Balai Gadang	10
3. Batang Kabung	10
4. Batipuh Panjang	10
5. Bungo Pasang	10
6. Dadok Tunggul Hitam	10
7. Koto Panjang Ikua Koto	10
8. Koto Pulai	10
9. Lubuk Buaya	10
10. Lubuk Minturun	10
11. Padang Sarai	10
12. Parupuk Tabing	10
13. Pasir/Pasie Nan Tigo	10
Total	130

To analyze this research data is used as an analysis tool with a percentage formula that is:

$$X = \frac{f}{N} X\ 100\%$$

Where:
X = Percentage value
f = frequency
N = Number of respondents

III. RESULTS

Flooding is a stream that flows beyond the capacity of the river, by flooding the surrounding area. Concerns about flooding generally take place downstream and deep in the upstream area of a watershed, debiting the associated peaks of multiple streams with different land use, soil types, vegetation, and topography. Changes in land use, especially forestation, have an effect, which is also the case when changes from forests, especially land use that further compresses soil level (soil permeability) thus lowering the rate of infiltration or increasing water flow (run-off) [6].
To reduce the risk of flooding, it is necessary to adapt to the community. Adaptation is an effort for people to adjust to their environment to live comfortably. Adaptation is an attempt to adapt to a new environment, or a new change that occurs. Meanwhile, social adaptation is one form of self-adjustment in the social environment.
Adaptation is a personal adjustment to the environment. This adjustment can mean changing one's self according to environmental circumstances, so it can mean changing the environment according to personal circumstances [5]. Physical adaptation efforts in mitigation can be seen among others:

Physical adaptation of house buildings

The results found that only 33.3% of physical models of home buildings were designed by their owners, 50.3% of homes were designed by working people. The house was designed by a builder 47% inundated by flooding with a height of more than 40 cm.
Furthermore, the home of its design from its owner only 10% experienced flood height of more than 40 cm. It is possible that the landowners already know that the land that will be used as a place of the building is prone to flood disaster. The distribution of building models on flood-prone land can be seen in Table 3 below.

Table 3. Physical building model against flood height

Model house/high flooding (cm)	Own design (%)	Builder design (%)	Design developer (%)
< 10	10	-	6,6
10 – 20	3,3	-	-
20 – 30	10	3,3	6,6
30– 40	-	-	3,3
>40	10	47	-
Total	33,3	50,3	16,5

Source: Primary data processing, 2019.

Of all the buildings found at the research locations, 16.63% had a flood height of less than 10 cm. The flood-free houses were found to have a floor height of more than 10 cm by 13.3%, overall the floor height of the people's house was 23.2% had a house floor height of less than 10 cm and 43.4% between 10 to 20 cm, more than 20 cm as much as 33.2%. While the average flood height of flooding is 42.2% more than 50 cm. More details can be found in Table 4 below.

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Table.4 High floor of house against flood height

Floor height and flood height (cm)	< 10 cm (%)	10 – 20 cm (%)	21 – 30 cm (%)	>30 cm (%)
< 10	3,3	6,7	3,3	3,3
10 – 20	3,3	-	-	-
20 – 30	3,3	10	3,3	
– 40	3,3	-	3,3	-
>40	10	26,7	13,3	6,7
Total	23,2	43,4	23,2	10

Source: Primary data processing, 2019

The condition of the floor is low, so in the event of flooding most people only secure their belongings to the table, chairs and others as much as 53.3 %, only 2.2 % have a 2-storey house and safe from flooding there is as many as 18% of the rest just leaving their belongings inundated with water. Another adaptation made by the community in flood disaster mitigation is to close flood waterways or hinder either using mounds of soil and other materials as much as 56.6 % other ways of heightening the yard by 10 % and 6.8 % let alone without any effort.

Table. 5 Flood mitigation efforts

Effort/high flooding (cm)	Heightening the floor (%)	Inhibiting water (%)	Heightening pages (%)	Building a 2-storey space (%)
< 10	6,7	10	-	-
10 – 20	-	3,3	-	-
20 – 30	3,3	6,7	6,7	-
30-40	3,3	3,3	-	-
>40	10	33,3	3,3	3,3
Total	23,3	56,6	10	3,3

Source: Primary data processing 2019.

Environmental Conditions

The average flood-prone area already has a water flow or drainage system, where 57.8% of drainage distance with its home is less than 5 meters. 17.8% with a distance of 5 to 10 meters, only 22% have no drainage meaning rainwater or puddles are only left in such a way and waiting to dry themselves.

Table 6 Housing distance with drainage (trench)

Distance From Housing (m)	Frequency (%)
No drainage	22
< 5	57,8
5 - 10	17,8
> 10	3,4

Only 46.7% of the people participate in mutual cooperation, 33.3% often participate, and 17.8% rarely participate. The schedule of mutual cooperation in each complex varies widely, namely the scheduled one every week, 26.7%, unscheduled or only under certain conditions of 37.8%, and once a month 28.9%. The existing sewer structures 46.7% are made of permanent buildings, 33.3% are only permanent walls while the ground is ground, and 6.6% are made of earthen gutters and only in the form of waterways. Below can be seen in the distribution table of the people participating in the mutual cooperation activities.

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Table 6. The mutual participation

Participate and high flooding (cm)	Always (%)	Often (%)	Sometimes (%)	Never (%)
< 10	3,3	10	3,3	2,2
10 – 20	6,7	3,3	-	-
20 – 30	6,7	6,7	3,3	-
– 40	-	3,3	3,3	-
>40	30	20	7,9	-
Total	46,7	33,3	17,8	2,2

Source: Primary data processing, 2019.

The drainage condition is only 33.3% maintained and clean, 26.7% unmaintained and unsany from garbage and other clogging materials, 15.6% drainage condition is heavily damaged and the water is not smooth.

Table 7. Condition of trenches in settlements environment

Environment and high flooding (cm)	Clean (%)	Not clean (%)	Shallow (%)	Damage (%)
< 10	20	-	6,7	6,7
10 – 20	3,3	-	-	-
20 – 30	10	-	6,7	-
30– 40	-	6,7	-	3,3
>40	-	20	6,6	10
Total	33,3	26,7	20,0	20,0

Source: Primary data processing, 2019.

The frequency distribution of people planting their lawns with vegetation can be seen in Table 8 below.

Table 8. The frequency of pages planted by plants

Types of plants	Frequency (%)
Flowers, vegetables and medicinal plants	40
Fruits	15,6
Grass plants	2,2
Wild plants	2,2
Not planted	40

Most settlements pages (60%) already planted with various vegetation, the vegetation is mostly in the form of vegetables and medicinal plants that are 40% and 15.6% others with fruit crops, but 6.6% are overgrown by grass and wild plants. A considerable frequency is a page that is not planted with plants, in other words, left arid which is 40%. After further research, the cause of the unplanted yard can be seen in Table 9 below.

Table 9. Reasons not to plant home pages with plants

Reasons not to Plant	Frequency
Hardened yard/in concrete	37,8
Don't have an open page	11,1
Don't want to be bothered	13,3
Fear of animal disturbances (caterpillars)	2,2
Because it's not home alone	35,6

Most of the reason respondents did not plant their yard with yard plants because it was hard with concrete or other hard materials is 37.8% and the other large frequency is that some respondents inhabit houses that do not own rent or hitchhike on the house of relatives or friends and others. The above data can be used as a guideline for targeted counselling for the community on plant planting as one of the methods of flood disaster mitigation and also refresh the air that has many polluting materials.

Waste management

The habit of the community in managing until still mostly is by burning 40.2%, while by stacking and continuing to be disposed of by garbage officers only 37.8%, besides that only 22% are dumped into temporary landfills (TPS) and that bad behaviour such as throwing into sewers is no longer found.

Table 10. Waste management techniques

Managemen/high flooding	Dumped into landfill (%)	Burn (%)	Stacked In front of the house (%)
< 10	8,8	-	3,3
10 – 20	3,3	-	-
20 – 30	3,3	10	6,7
30 – 40	3,3	3,3	-
>40	3,3	26,9	3,3
Total	22,0	40,2	37,8

Source: Primary data processing, 2019.

Knowledge of flooding

Data obtained by 24.4% of the community revealed that the cause of the flooding was due to heavy rains and 28.8% was also caused by lower settlements land than the surrounding land, and if combined between the factor narrow and clogged streams would have a figure of 44.6%. This last factor can be the main factor causing flooding. The complete details can be seen in Table 11 below.

Table 11. Causes of flooding

Causes of Flooding	Frequency (%)
Heavy Rain	24,4
Land of Humility	28,8
Clogged Water Flow	22,0
Narrow Water Flow	22,6
No Yard Plants	2,2
No Water Flow	0

Source: Primary data processing, 2019.

About the flooding, only 13.3% of the public knew that should not throw garbage into trenches or waterways and 57% said that it should not dispose of garbage carelessly, also, 51% of the community affirmed that the need to do maintenance and cleaning of trenches at all times. Other efforts to prevent flooding from entering the homes of 42.2% of the community made efforts to create water embankments, while those that raised the foundation or floor of the house only 18%, in addition to making higher storage of goods was 24.4% and that let only puddles enter the house 6.7%.

Table 12. Community Mitigation Efforts

Mitigation Efforts	Frequency (%)
Making a Water Embankment	42,2
Elevate the Floor of the House	18,0
Evacuate goods	24,4
Improving Drainage	8,7
Let it go	6,7

Source: Primary data processing, 2019.

The making of the embankment carried out by the community there are several places, namely an embankment that deflects surface water towards the lower ground that is where drainage flows, on the doorstep of houses and embankments on the road that often places a large flow of water. Water embankments are mainly made by people whose floor height often becomes stagnant in times of flooding.

Mutual activities

The culture of the community about mutual is generally still alive in Padang city, but what is somewhat shifted is the problem to its participation, were after research only 35% who always participate mutual, besides that 40% who often participate and 20% rarely participate 5% who do not participate at all. Other data obtained is that almost 70% of mutual activities are carried out unscheduled meaning that it is only done depending on the situation.

Adaptation in the form of economic assistance in the form of economics

To mitigate flood disasters 62% of the community also contributed funds as a form of participation, also, 9.7% donated in the form of goods such as building materials and equipment Mutual the remaining 28.3% only contributed in the form of energy. The impact of the flooding of 68.9% of the community revealed that flooding disrupted jobs as well as was economically detrimental. This is because people can not go to work. After all, it is blocked by flooding, also, it is time to use to be vigilant at home and clean up the mud and garbage left behind when the flood has receded. Only 31.1% are not affected by flooding, these communities likely have businesses elsewhere that are safe from flooding.

IV. CONCLUSION

Based on the research results above, it can be concluded that: 1) As many as 47% of the house building models were designed by the masons who worked on it, and only 33.3% were designed by the homeowner, from the above design it turned out that only 11% were free from flooding. The flood-free houses have a floor height above the ground level of more than 50 cm. The average flood height in the housing complex is more than 50 cm; 2) The average flood height in settlements complexes is more than 50 cm. Drainage condition is only 33.3% maintained and clean, 26.7% unmaintained and unsany clean from garbage and other clogging materials, 15.6% drainage condition is heavily damaged and the water is not smooth; 3) The public habit of 42.2% managing garbage by way of burning, while by stacking and continuing to be disposed of by garbage officers only 37.8%, other habits 68.9% of garbage is not sorted; 4) The public's knowledge of flooding is good enough, it is seen from 57% of the public not to waste indiscriminately, and 51% of the public explained that trenches should be maintained and cleaned always; and 5) Only 35% of people who always participate in the mutual, 40% who often participate, and 20% rarely participate 5% who do not participate at all.

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