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UTILIZATION OF SPACE FUNCTION IN FLOOF PRONE AREAS ON THE BANKS OF THE SADDANG RIVER AND MATA ALLO RIVER IN ENREKANG DISTRIC

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Abstract

Enrekang District is one of the flood-affected Districts in Enrekang Regency. Enrekang District is traversed by 2 major rivers, namely saddang river and mata allo river. The Mata Allo River is one of the watersheds in Enrekang Regency, while the Sadang River is a watershed of North Toraja Regency and Enrekang Regency. The main cause of flooding is due to the overflow of the Saddang River and the Mata Allo River with the characteristics of a fairly fast water flow. The main point of flooding is at the confluence of the two rivers. That's why the area is particularly prone to flash flooding. The utilization of the function of space on the river bank should consider the distance of the flood protection boundary. The distance of the river border must be taken into account properly, so that the misappropriation of the function of space on the border or floodbank of the designation of cultivated areas (settlements or other public facilities) can be avoided. This research uses a naturalistic paradigm with the research method used is a qualitative method with an evaluative descriptive approach. This study observes the natural / existing conditions of space function utilization on the banks of the Saddang River and Mata Allo River which will then be evaluative approached based on the literature review that has been collected. The findings related to the use of space functions include, among others, there is a discrepancy in the river border distance rules in the Enrekang Regency RTRW and the use of floodbanks as housing / settlements. Based on flood calculations, the plan is to obtain a safe distance from the river border as far as 45 meters from the banks of the Saddang River and the Mata Allo River.

Keywords: Enrekang District; Flood Prone; Spatial Function; River Borders.

1. Introduction

Indonesia is one of the archipelagic countries with a very diverse landscape with a variety of natural characters ranging from oceans, lakes and mountains. Indonesia is located in the equatorial area with a tropical climate with two seasons, namely the rainy season and the dry season with the characteristics of changes in weather, temperature and wind direction that are quite extreme. This is what causes various kinds of hydrometeorological disasters, one of which is flood disasters [1]. The problem of flooding in Indonesia is an inexhaustible environmental problem. One of the causes of flood disasters is exploration and even overexploitation of the environment. The importance of maintaining a sustainable built environment is sometimes forgotten so that the ecosystem in an environment does not run optimally.

In architectural science, sustainability has three basic pillars, namely economic, social, and environmental, which are integrated with each other in a balanced and harmonious manner [2]. According to Amin et al. (2019), environmental sustainability in architecture is expected to maintain natural resources related to the vital potential of natural resources and the human ecological environment, the application of this approach is carried out as a form of designing areas and buildings that respond to the conditions of the site and the surrounding environment [3].

According to Kodoatie (2013), flooding is categorized as 2 main causative factors including; natural factors are caused by rainfall, physiography, erosion and sedimentation while, due to human activities such as damage to watersheds, the presence of settlements around banks, damage to drainage and environmental waste, destruction of forests (natural vegetation), and improper planning of flood control systems [4].

Enrekang Regency is one of the regencies in South Sulawesi with a large wilyah topography consisting of hills, mountains, valleys and rivers with an altitude of 47-3,293 meters above sea level. The regency is traversed by several large rivers that are divided into several Districts in Enrekang Regency. Enrekang Regency is traversed by several watersheds including the Saddang Watershed, Bulu Cendrana Watershed, Mata Allo Watershed and Malua Watershed. These rivers generally have a fairly fast flow of water that flows winding from hilly/mountainous areas. According to Fitria (2017), there are several problems with riverside settlements including

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infrastructure, roads and drainage, waste disposal, garbage disposal and a high risk of flooding [5].

Based on the Regional Spatial Plan (RTRW) Enrekang Regency, flood-prone areas in Enrekang Regency occurred in 2 districts, namely Enrekang District and Cendana District, in Enrekang District itself, the flood point was at the confluence of the Saddang River and the Mata Allo River, the main cause of flooding due to high sedimentation that caused siltation in the river confluence area [6].

The utilization of space functions in riverside areas has its own advantages and disadvantages, depending on the characteristics of the river. In spatial planning on the banks of rivers, you should pay attention to the possibilities of natural disasters that will occur such as landslides and floods. Flood disasters that often occur in residential areas on the banks of rivers should pay attention to the rules of river borders as flood control banks.

Based on the description above, it can be seen that the utilization of the function of space in an area should know and understand the strengths, weaknesses, opportunities and threats that exist in the area. As is the case in Enrekang District, the use of space functions on the banks of the Saddang River and the Mata Allo River should consider the threat of floods and even flash floods. Utilization of space functions by considering the characteristics, types and threats of flood disasters, is an effort to minimize the impact of damage caused.

2. Literature Review

2.1 Typology of Flood-Prone Areas

Area typology is the classification of areas based on the main characteristics or characteristics of a physical object or region [7]. Meanwhile, flooding is an event or situation where an area or environment is submerged due to an increased volume of water [8]. So that the typology of flood-prone areas is the classification of flooded areas according to the characteristics of the area where they occur.

Flood disasters are distinguished by 5 types of them; flash floods (floods with heavy currents), mud floods (mud floods with harmful gases are usually due to mining activities), water floods (floods due to overflowing river, lake or drainage water), ROB floods (sea tide floods), Cileunang floods (floods due to high rainfall) [9]. While floods based on the area where they occur are divided into 4 areas including coastal / coastal areas (floods are caused by lower ground level elevations or equal to the average high tide seawater elevation), floodplain areas (lowland areas on the left and right of the river, whose ground level elevation is very gentle or relatively flat), river border areas (floods that are about 100 m on the left - right of the big river, and 50 m on the left - right of tributaries or small rivers) and basin areas (lower right-left areas of rivers or lakes) [10],.

2.2 Spatial function of Disaster Prone Areas

The definition of space in Law No. 26 of (2007) concerning Spatial Planning (Undang-undang No. 26 tahun 2007 tentang Penataan Ruang), space is a container that includes land, sea, and air space, including space in the earth as a unit of territory, where humans and other creatures live, carry out activities, and maintain their survival. The spatial pattern is a distribution of space allocation within an area which includes the allocation of space for protected functions and the allocation of space for cultivation functions. Meanwhile, space utilization is an effort to realize spatial structure and spatial patterns in accordance with spatial plans through the preparation and implementation of programs and financing [11].

Spatial function arrangement plays an important role in determining a plan for the use of space that is safe from the impact of natural disasters because in spatial planning, criteria for disaster-prone locations and disaster-prone areas have been raised [12]. The provisions for the use of space functions in flood-prone areas based on the Regional Spatial Plan (RTRW) Enrekang Regency, including; (1) Utilization of space taking into account the characteristics, types, and threats of disasters. (2) Determination of the location and evacuation routes of residential areas. 3) Restrictions on the erection of buildings except for the purpose of monitoring disaster threats and the public interest. (4) Establishment of floodplain boundaries. (5) Utilization of floodplains for green open space and construction of public facilities with low density. (6) Provisions prohibiting the use of space for residential activities and other important public facilities [6].

In addition, the utilization of space functions in flood-prone areas has also been regulated by the Ministry of Public Works (Departemen PUPR) in the Guidelines for Controlling the Utilization of Space Functions in Flood-Prone Areas. The use of space in flood-prone areas is carried out through countermeasures to minimize the impact of disasters that may arise. This condition cannot be separated from the pattern of controlling the use of space upstream, within the scope of the river basin unit. The target to be achieved is the realization of controlling the use of space in flood-prone areas, including appropriate space utilization licensing mechanisms and supporting efforts to implement space utilization plans, and appropriate handling procedures [10].

2.3 Borders or River Banks

The riverside area is a waterfront area that has several advantages in terms of accessibility and strategic function [13]. As for the river border in the Regulation of the Minister of Public Works and Public Housing (Permen PUPR) No. 28 of 2015 concerning the Determination of the River Boundary Line and the Lake Boundary Line, the river border is a riverside protected area that becomes an integral part of the river. River borders protect rivers from scouring, erosion, and pollution, while also having high biodiversity and property value/landscape beauty. In addition the river boundary includes the space on the left and right of the river trough between the boundary line and the river trough bank for non-stemmed rivers, or between the boundary line and the outer bank of the embankment legs for the stemmed river [14].

Meanwhile, according to Maryono (2005), river borders are often also referred to as riverbanks although there are actually slight differences, riverbanks can also be called floodbanks, while river borders are floodbank areas plus the width of river cliff avalanches that may occur, plus the width of ecological banks and the width of the necessary security related to the location of the river (residential and non-residential) [15].

The boundary distance for non-emptive rivers in urban and rural areas that have a risk of flooding should be different from areas that do not have a risk of flooding. According to Maryono (2009), the width of the river border can be determined based on planned flood counts and based on physical studies of the ecology, hydraulics and morphology of the river directly in the field. Calculating the distance of the river border by identifying flood plains, sliding plains, buffer ecological banks and safety banks [16]. The scheme for calculating the distance commensurate with flood protection according to Maryono (2009), can be seen in figure 1.

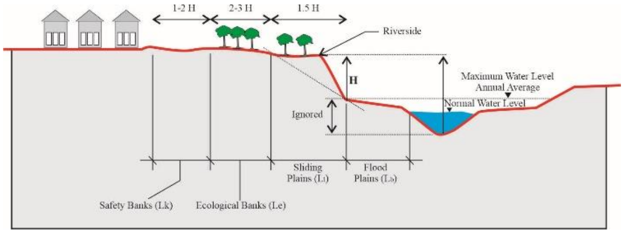

Figure 1. River Border Calculation Scheme

River border = Lb + (Ll = 1.5 x H) + (Le = 3 x H) + (Lk = 2 x H)

Information:

H = Cliff height

Lb = The width between the boundary point of the normal water level of the river and the boundary point at the time of flooding (the most frequent flooding).

Ll = The width of the sliding plains is obtained at least one and a half times the height of the cliff calculated from the foot of the cliff (1.5 H).

Le = Ecological banks located outside the landslide banks whose function is to maintain the ecology in them, namely ecology on floodbanks and landslide banks.

Lk = The width of the area that serves as a river security space is related to the insistence of the social community.

The criteria for the width of the river border are distinguished into the river border in the urban area, the river border outside the urban area with the type of handled river and the untangleated river as well as flood protection and meandering space. The criteria for the width of the river border in the Permen PUPR No. 28 of 2015, the Regional Spatial Plan (RTRW) Enrekang Regency and Maryono (2009), can be seen in table 1 as follows:

Table 1. River Border Criteria

River type	Outside urban areas		Inside urban area	
	Criterion	Border width	Criterion	Border width
Stemmed river	-	10 m	-	5 m
Untangleated river	Large river (area < 500 km2)	100 m	Depth > 20 m	30 m
			Depth 3 m - 20 m	15 m
	Small river (area < 500 km2)	50 m	Depth < 3 m	10 m
Rivers affected by tides	-	100 m	-	100 m
Flood protection borders	5 m – 90 m			
	Determined based on the count of flood plans directly in the field			

3. Reseach Method

This study will comprehensively analyze the pattern of space utilization on the banks of the Saddang River and Mata Allo River, especially in areas with high flood intensity. This research uses a naturalistic paradigm, which is a study by means of observation and data collection carried out in a natural setting setting in the sense that without manipulating the subject under study or as the existence [17]. Meanwhile, the research method used is a qualitative method with an evaluative descriptive approach. The evaluative approach is that researchers collect data related to policies both to be carried out and those that have been carried out related to the use of space functions.

The data sources in this study include primary data and secondary data. Primary data were obtained from the results of field observations of the existing conditions of the study site. Meanwhile, secondary data was obtained through literature studies and related agencies such as the Regional Disaster Management Agency (Dinas BPBD) of Enrekang Regency, the Public Works Office (Dinas PU) of Enrekang Regency, as well as aerial images in the form of macro and micro maps (research locations in Enrekang District). The technical analysis that will be carried out in this study is as follows:

- Describes the physical condition of the environment at the research site.
- Describes the existing conditions of space utilization on the banks of the Saddang river and the Mata Allo River.
- Analyze the safe distance of the protection boundary and meandering space on the Saddang River and Mata Allo River at the research site.
- From these results, conclusions were then obtained, recommendations for non-structural flood control (control of space function utilization) in Enrekang District.

4. Results and Discussion

4.1. *Physical Condition*

Enrekang Subdistrict consists of 6 Districts and 12 villages with the capital of Kacamatan, namely Juppandang Village. Based on data from the Regional Disaster Management Agency (Dinas BPBD) of Enrekang Regency, there are 3 villages affected by floods in

Enrekang District, including Juppandang Village, Galonta Village and Lewaja Village. Documentation of flood disasters that have occurred in Enrekang District can be seen in figure 2.

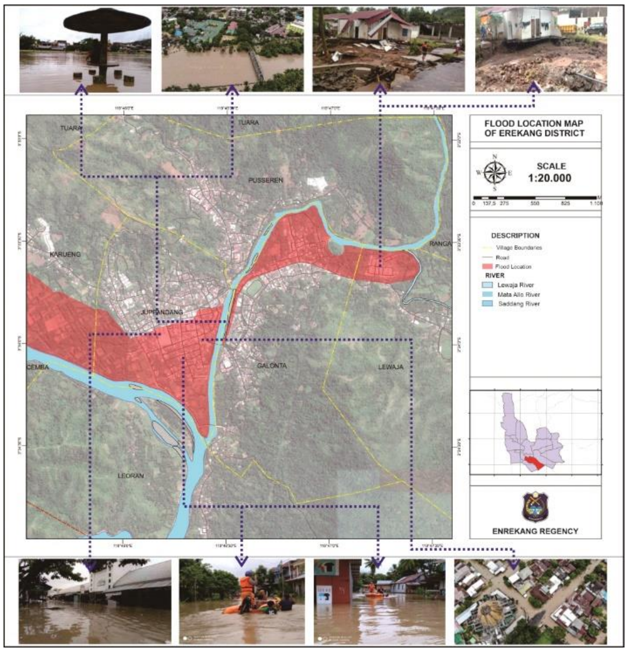

Figure 2. Flood Affected Locations

The flood disaster that occurred in the Enrekang Regency area was different from floods in other regions in Indonesia in general. Flood disasters, both ordinary floods and flash floods that occur in Enrekang Regency in general, have their own characteristics, especially at the time of the shortest event between 2 hours to 5 hours with a fairly heavy flow discharge of >50 m^3/s. The location of the flood in Enrekang District is at the confluence of the Saddang River and the Mata Allo River. The main cause of the flooding is the high sedimentation which causes siltation in the area where the river is confluent. During the rainy season, the volume of flow capacity in the Saddang River and Mata Allo River is reduced, causing flooding due to overflowing flows into the riverbanks.

Topographic conditions that tend to be low / flat will be more prone to flooding, compared to topography in high altitude areas. The topography of Juppandang Village, Galonta Village and Lewaja Village is generally located at an altitude of 0-500 meters above sea level. As for the slope pecan, it starts from 0% to the steepest >40%. From the varied topographical conditions of Enrekang District, the location of the flood is only on a slope that tends to be sloping / flat and traversed by large rivers. Figure 3 is a tophography situation in flood-affected areas in Enrekang District

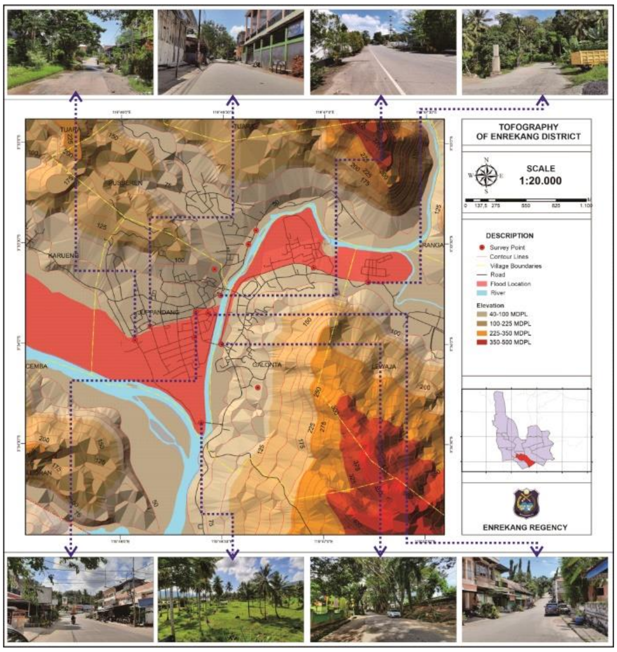

Figure 3. Topography of Flood-Affected Areas

From on the picture above, it can be seen that the flood locations in Juppandang Village, Galonta Village and Lewaja Village are on average at an altitude of 40-50 MDPL. The slope of the slope at the flood site in the previous study was that the vulnerable area was on a slope of 0-2% while the medium area was on a slope of 2-5% and the safe area was on a slope of 5-15% of the topography of the area of the three urban villages.

Based on the description above, it can be concluded that the type of flood that occurs in Enrekang District is a flash flood with a concentration time of 2 hours to 5 hours with a flow discharge of >50 m^3 / s. As for the karectter, the flow is very fast and carries materials such as mud, stones and tree trunks. Meanwhile, based on the typology where floods occur in Enrekang District, it is a river border area and a flood plain area. This can be seen from some settlements/housing estates that have been affected by flooding due to building too close to the river bank. In addition, the flood-affected area in Enrekang District is also a flood plain area because there is a confluence of large rivers that divide the area with a very sloping or relatively flat land level elevation on the left and right of the river.

4.2. *Space Function Calculation*

Misappropriation of space functions in flood-affected areas can endanger the surrounding environment. One of the things that is often forgotten in spatial planning on river banks is the distance of the river border. The lack of attention to the distance of the river border in flood-prone areas in Enrekang District has resulted in the use of land on part of the riverbank as a settlement. This is very dangerous for the surrounding community and damages the natural retention of the watershed. The use of space in flood-affected areas in Enrekang District can be seen in figure 4 as follows:

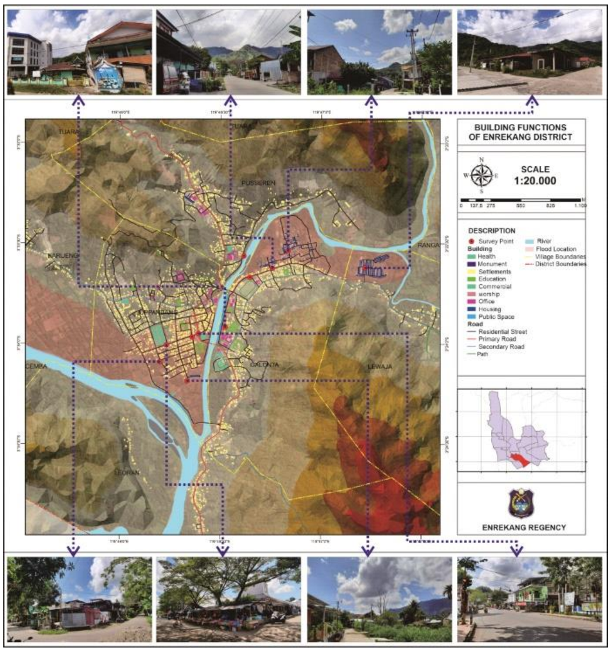

Figure 4. Use of Space in Flood-Affected Areas

Based on the results of the analysis, the area affected by floods in 3 villages in Enrekang District is 127.35 ha. The village with the largest flood-affected area is found in Juppandang Village with an area of 73.85 Ha, while the area affected by Galonta Village and Lewaja Village is 53.5 Ha. The details of the area affected by floods in Enrekang District can be seen in table 2 as follows:

Table 2. Area Affected by Floods

No	Types of Space Usage	Luas (ha)	Persentase (%)
1	Settlement	45,85	36,00%
2	Housing	15,01	11,79%
3	Commercial	2,7	2,12%
4	Public spaces	1,31	1,03%
5	Worship	0,31	0,24%
6	Office	1,81	1,42%
7	Education	2,3	1,81%
8	Vacant land	58,06	45,59%
	Total	127,35	100,00%

As in the table above, the area of residential areas affected by floods is 45.85 Ha or 36.00% while for residential areas it is 15.01 Ha or 11.79%. From the results of field observations, there are several spatial functions that are not in accordance with the distance of the river border in the flood-affected area in Erekang District. The errors in the use of river borders obtained include the creation of buildings on the river and the use of river meandering space as housing. Figure 5 is a documentation of the use of the spatial function of flood-affected areas on the banks of the Saddang River and Mata Allo River in Enrekang District.

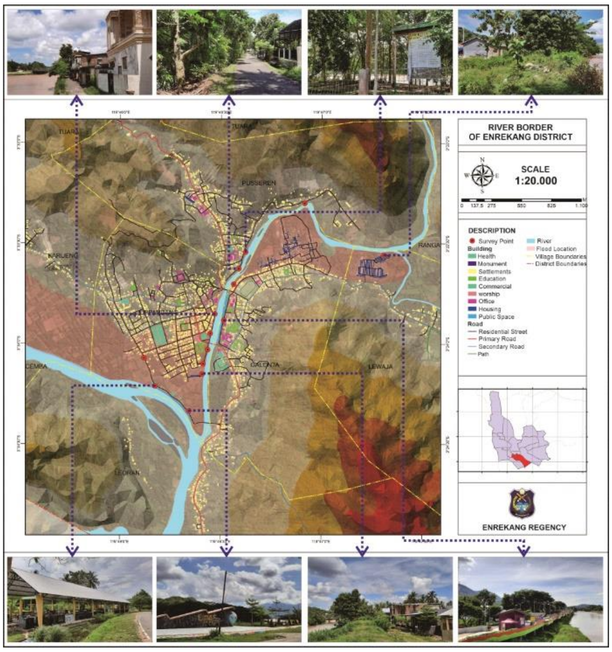

Figure 5. Use of River Border Space

The image is one of the public open spaces built on the body of the Mata Allo River. In the Regional Spatial Plan (RTRW) Enrekang Regency, the distance of the river boundary that stretches in the urban area is at least 5 meters from the river bank. Based on this, there is a mismatch between the construction of public open space and the distance of the river boundary. In addition, there is an error in the use of space functions in Kukku housing in Lewaja District. The housing estate is surrounded by a tributary which is the meandering area of the Mata Allo River. Basically, the river meandering area is still the border area of the river. River meandering is a river-bending area that is very prone to flooding. The meandering area of the river with a low topography is a floodbank so it is not recommended for residential/residential activities and other important public facilities.

4.3. Boundary Distance Analysis

Determining the width of the river border in flood-prone areas in Enrekang District by calculating the direct flood plan in the field. This is to get the distance between the borders of flood protection and meandering space on the Saddang River and Mata Allo River in Enrekang District, especially in areas that are often affected by floods. From field identification, it is known that the slope of the landslidebank averaged at $>33.7^0$ to $>45^0$.

The characteristics of the shape of the Saddang River and the Mata Allo River are rivers that have floodbanks with a lower elevation so that the river bank is at the top of the cliff outside the floodbank. The identification points carried out in the border area of the tampa embankment on the Saddang River and Mata Allo River in Enrekang District can be seen in figure 6 as follows:

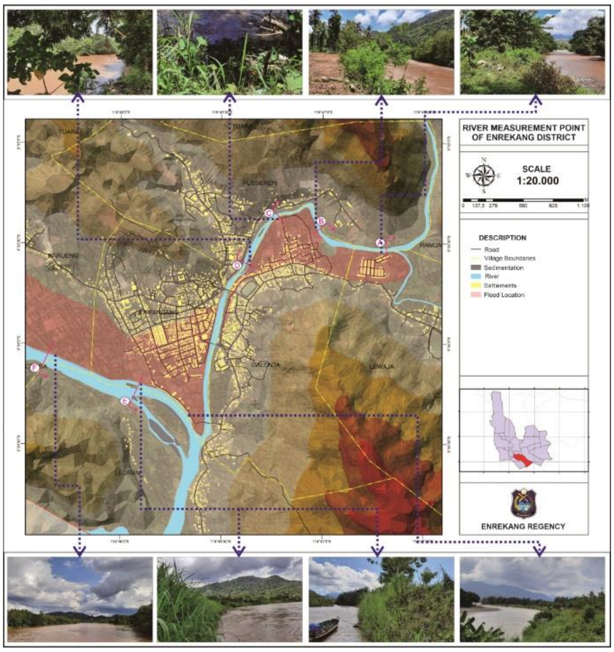

Figure 6. River Border Measurement Point

Point A
River borders = (1,5 x H) + (3 x H) + (2 x H)
= (1,5 x 7,5)+(3x7,5)+(2x7,5)
= 49 m
Point B
River borders = (1,5 x H) + (3 x H) + (2 x H)
= (1,5 x 6)+(3x6)+(2x6)
= 39 m
Point C
River borders = (1,5 x H) + (3 x H) + (2 x H)
= (1,5 x 7)+(3x7)+(2x7)
= 46 m
Point D
River borders = (1,5 x H) + (3 x H) + (2 x H)
= (1,5 x 7,5)+(3x7,5)+(2x7,5)
= 49 m
Point E
River borders = (1,5 x H) + (3 x H) + (2 x H)
= (1,5 x 6,5)+(3x6,5)+(2x6,5)
= 42 m
Point F
River borders = (1,5 x H) + (3 x H) + (2 x H)
= (1,5 x 7)+(3x7)+(2x7)
= 46 m

From the results of field surveys at several points, it was found that the height of the river varied from 6 meters to 7.5 meters. The measurement results at several points can be seen in table 3 as follows:

Table 3. River Border Measurement Results

No	Measurement Points	Border distance (meters)
1	Point A	49
2	Point B	39
3	Point C	46
4	Point D	49
5	Point E	42
6	Point F	46
	Average	45 Meters

Based on the calculations in the table above, the distance of the river boundary is obtained from 39 meters to 49 meters. From these results, it was then averaged, so that the distance between the flood protection boundary and the meandering room on the Saddang River and mata Allo River in Enrekang District was as far as 45 meters from the river bank.

4.4. Non-structural restraint (control of space function utilization)

Based on the Guidelines for Controlling the Utilization of Spatial Functions in Flood-Prone Areas and the river border distance rules in Regulation of the Minister of Public Works and Public Housing (Permen PUPR) No. 28 of 2015 and Regional Spatial Plan (RTRW) Enrekang Regency, the typology of flood risk is distinguished based on the distance of river borders. The flood typologies obtained include; Distance 0-45 meters (high risk), distance 45-100 meters (medium risk) and distance >100 meters (low risk). The utilization of the recommended space function in flood-prone areas in Enrekang District can be seen in table 4 as follows:

Table 4. Recommendations for Utilization of Space Functions

Typology	Space compression		
	Conditional Permissions	Limited Permits	Forbidden
High risk (0-45 meters)	-	Protected areas	All cultivation activities
Medium risk (45-100 meters)	-	- Protected areas - cultivated areas including community forests, production forests, agriculture and fisheries.	Activities that cause flooding
Low risk (>100 meters)	Settlements, trade, industry, agriculture, mining, tourism, transportati on	- Protected areas - cultivated areas including community forests, production forests, agriculture and fisheries.	Activities that cause flooding

From the description above, the direction of controlling the use of runag functions in flood-prone areas in Enrekang District, with Non-Structural control efforts (control of space utilization) is carried out as follows:

- Regulations in the form of regional regulations (PERDA) related to border rules on the upper reaches of the Saddang River and Mata Allo River with a minimum distance of 50-100 meters from the river bank as a ground water protection area.

- Determination of flood protection boundaries and meandering spaces in flood-prone areas in Enrekang District as far as 0-45 meters (high risk) from the river bank.
- At a distance of 45-100 meters with moderate risk provisions for the use of space for protected areas and some cultivated areas.
- Meanwhile, the distance >100 meters with low risk of space utilization provisions for cultivation areas including settlements, trade, industry, agriculture, mining, tourism, transportation.
- Provisions prohibiting activities that cause flooding

5. Conclusion

The main factor causing flooding in Enrekang District is silting of the river due to sedimentation of soil and sand caused by erosion in the upper reaches of the Saddang River and the Mata Allo River. In addition, the alignment or spacing in the meandering space of the river results in the overflow of the river flow up to the riverbank. Misappropriation of the function of space on the river bank such as violations of river borders and the construction of housing / settlements in the meandering space of the river which is a floodbank. The area affected by floods in 3 villages in Enrekang District is 127.35 ha.

The public facilities affected by the flood include worship facilities, offices, education, trade, housing, housing, settlements and public open spaces. There are misappropriations of space functions on the river bank such as violations of river borders and housing/settlement construction in river meandering spaces which are floodbanks. Meanwhile, in flood-affected areas, the determination of the distance of the flood protection boundary as far as 45 meters from the river bank and the provisions for the implementation of the use of cultivated areas in areas with a high risk of flooding.

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