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Abstract. Makassar City is a large city that is facing climate change, population growth and rapid urbanization. This has an impact on increasing land market and demand for servicing facilities and infrastructure. Those impacts can decrease environmental quality, such as environmental degradation and natural disasters. One problem that often occurs every year is the problem of flooding. One of the districts in Makassar City that experienced a flood was Manggala District. This is the background of the researchers to provide an overview of the level of flood vulnerability based on flood vulnerability variables. The variables used in determining the level of flood vulnerability are land cover, rainfall, drainage density, and slope. The objectives of this study are to (1) identify flood vulnerabilities in Manggala District, and (2) identify steps towards Water Sensitive City in its handling solutions from the perspective of urban water management. This study uses a quantitative analysis method with an overlay analysis approach to analyze the vulnerability of flood disasters.

1. Introduction

Flooding is a form of natural phenomenon that occurs due to high rainfall in which there is excess water that is not accommodated by the network of a region's spreading. This condition has an impact on the emergence of inundation in the region which can be detrimental to the community [1–3].

One of the sub-districts in Makassar City that has overcome the flood disaster in the District of Manggala. The cause lies in the eastern region of Makassar City and has characteristics susceptible to inundation / flooding [4].

Risks and impacts on floods that occur in the city of Makassar, can be reduced or reduced by making readiness and impact on flooding through the concept of Water Sensitive Cities. Based on this, the authors are interested in analyzing and mapping flood-prone areas, as well as steps to overcome them with the concept of Water Sensitive Cities.

2. Methodology

The location of this research is located in the District Manggala, Makassar. First, the decisive parameter above flood in District Manggala identified then given a score, to identify the level of flood vulnerability use done with spatial analysis of GIS (Geographic Information System). Variable vulnerability flooding used in this study is Land Cover [5], Rainfall , Drainange Density [6], and slops [7]. This data can be seen on the table 1.

Tabel 1. The determination score value in the classification of area vulnerable to flood

Parameter	Parameter Reclassified	Category	Score
Land Cover, LC	Badlands / Empty	Very low	1
	Plantations And Moor	Low	2
	Wetland (Lakes, Ponds, Swamps)	Medium	3
	Agricultural Land	High	4
	And Developed Land / Settlements	Very High	5
Rainfall (mm/day), RR	<5	Rain Very Light	1
	5-20	Drizzle	2
	20-50	Moderate rain	3
	50-100	Heavy rain	4
	> 100	Very heavy	5
Drainage Density (m/m2), DD	0 - 0.01473	Very low	1
	0.01473 - 0.02946	Low	2
	0.02946 - 0.04418	Medium	3
	0.04305 - 0.05891	High	4
	0.05891 – 0.7364	Very High	5
Slopes, SS	25-30	Very low	1
	15-25	Low	2
	5-10	Medium	3
	2-5	High	4
	0-2	Very High	5

The data from table 1 were analysed using qualitative and quantitative approaches, scoring analysis and spatial overlay analysis by using Geographic Information System (GIS) technology. At very first, the identification of problem was done, which then followed by literature study. The flood vulnerability level in Manggala Distric was analysed by scoring. Furthermore, the map *overlay* method used in *ArcGIS 10.3*. The first analysis step was creating thematic map based on the parameter which influence the flood vulnerability level.

The equation used in analysing the Flood vulnerability
TOTAL SCORES: LC + RR + DD + SS
Description:
LC = Land Cover factor
RR = Rainfall factor
DD = Drainage Density factor
SS = Slope factor

Flood vulnerability in this study is divided into five classes of level of vulnerability, which are Highly vulnerable, Susceptible, quite vulnerable, Rather vulnerable and not vulnerable

In determining the direction to cope with the flood water used variables sensitive city where there are seven index The index measures the performance of a city based on seven goals to be achieved to get to the water-sensitive city, which is divided into 34 indicators. Objectives and indicators can give an idea of how sensitive a city on the water. In order to achieve a strong city, especially cities resilient to flooding there are several variables that describe the WSC that can be fulfilled or achieved, which in formulating the action of a growing city can learn from other cities in accelerating achieve its objectives.

Ensure good water sensitive governance	**Increase community capital**	**Achieve equity of essential services**	**Improve productivity & resource efficiency**	**Promote adaptive infrastructure**	**Improve ecological health**	**Ensure quality urban space**
Knowledge, skills and organisational capacity	Water literacy	Equitable access to safe and secure water supply	Maximised resource recovery	Diversify self-sufficient fit-for-purpose water supply	Healthy and biodiverse habitat	Activating connected green - blue space
Water is key element in city planning and design	Connection with water	Equitable access to safe and reliable sanitation	Low GHG emission in water sector	Multi-functional water infrastructure	Surface water quality and flows	Urban elements functioning to mitigate heat impacts
Cross-sector institutional arrangements and processes	Shared ownership, management & responsibility	Equitable access to flood protection	Water-related business opportunities	Integration and intelligent control	Groundwater quality and replenishment	Vegetation coverage
Public engagement, participation and transparency	Community preparedness and response to extreme events	Equitable and affordable access to amenity values of water-related assets	Low end-user potable water demand	Robust infrastructure	Protect existing areas of high ecological value	
Leadership, long-term vision and commitment	Indigenous involvement in water planning		Benefits across other sectors	Infrastructure and ownership at multiple scales		
Water resourcing and funding to deliver broad societal value				Adequate maintenance		
Equitable representation of perspectives						

Figure 1. Water sensitive city index goals and indicators

3. Result and Discussion

3.1. Level Flood Vulnerability in District Manggala

Based on the data area (Table 2), in the district of Manggala dominated by class rather vulnerable area of 865.76 ha or 39% of the area, the class quite vulnerable to 622.70 ha (28%), grade susceptible 514.89 ha (23%), the class is not susceptible 119.54 ha (5%) and very susceptible 77.32 (4%). In entirety of vulnerability maps generated 27% prone to flooding and 73% into the classroom is not susceptible, quite vulnerable, and rather vulnerable.

Table 2. Size potential flood vulnerability in District Manggala

Flood Vulnerability Level	Large	
	Ha	Percentage (%)
Not Vulnerable	119.54	5%
Rather Vulnerable	865.76	39%
Quite Vulnerable	622.70	28%
Susceptible	514.89	23%
Highly Vulnerable	77.32	4%
Total	2200.22	100%

Table 3. Potential Size Flood Vulnerability in District Manggala

Urban Village	Size Potential Flood Vulnerability				
	Highly Vulnerable	Susceptible	Quite Vulnerable	Rather Vulnerable	Not Vulnerable
Kel. Antang	1.65	120.09	154.37	177.62	64.98
Kel. Bangkala	11.21	142.55	135.02	67.17	3.70
Kel. Batua	10.08	73.12	97.31	4.64	0:00
Kel. Borong	52.11	61.96	8.63	6.93	0:00
Kel. Manggala	2.28	69.51	87.98	147.55	27.56
Kel. Tamangapa	0.00	47.67	139.39	461.86	23:30
Total	77.32	514.89	622.70	865.76	119.54

Based on Table 3, there are four villages that have areas that are at a highly vulnerable level, namely, Antang (1.65 Ha), Bangkala (11.21 Ha), Batua (10.08 Ha), Manggala (2.28 ha) and Borong (52.11 Ha). At the vulnerability level Antang has the most extensive vulnerable area of 120.09 Ha, while Tamangapa with an area of 47.67 Ha, this is possible because Tamangapa Village is dominated by rice fields and lakes.

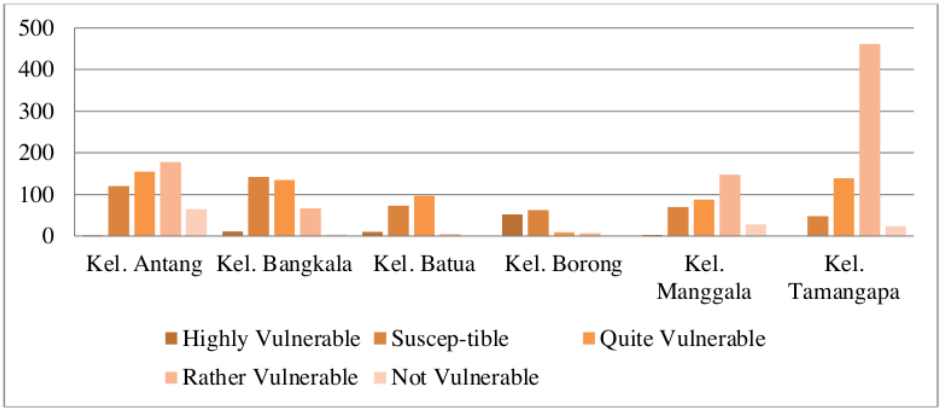

Figure 2. Comparison of regional size each village based vulnerability potential flooding in District Manggala

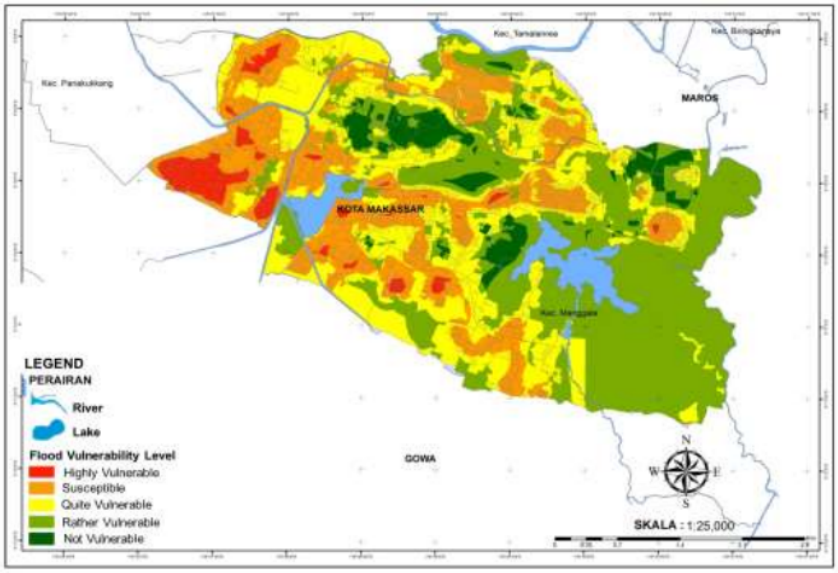

Figure 3. Map flood vulnerability rate in the District of Manggala

3.2. Flood Validation

The approach taken in the process of determining the high or low levels of validation vulnerability map based incidence data in this research is to look at the position of the distribution of flood events based on the level of classification of flood vulnerability [8], Given the characteristics of the data flood event there are only two (2) classes of no flooding and no incidence of flooding it to the

validation process, a class of vulnerabilities flooding also be divided into two classes, namely the class of potentially flooding (vulnerable and very fragile) and classes that do not / less potentially flooding (quite vulnerable, rather and not vulnerable).

Table 4. The degree of vulnerability and the point of the District Flood Manggala

Vulnerable Level	Flooding point
Not Vulnerable	0
Rather Vulnerable	0
Quite Vulnerable	1
Vulnerable	20
Highly Vulnerable	2
Total	23

Validation results are vulnerable to event data map showing the distribution of a total of 23 points the incidence of flooding, as many as 22 points or 96% of flood events into potential areas of flooding from the class of vulnerable and very vulnerable. The rest, only one point of flood events (4%) enter the classroom area is quite vulnerable, vulnerable and somewhat vulnerable. From the validation results, the class area prone to have the number of hot spots inside the largest flood event with 20 points (91%). Validation results are shown in Table 4.

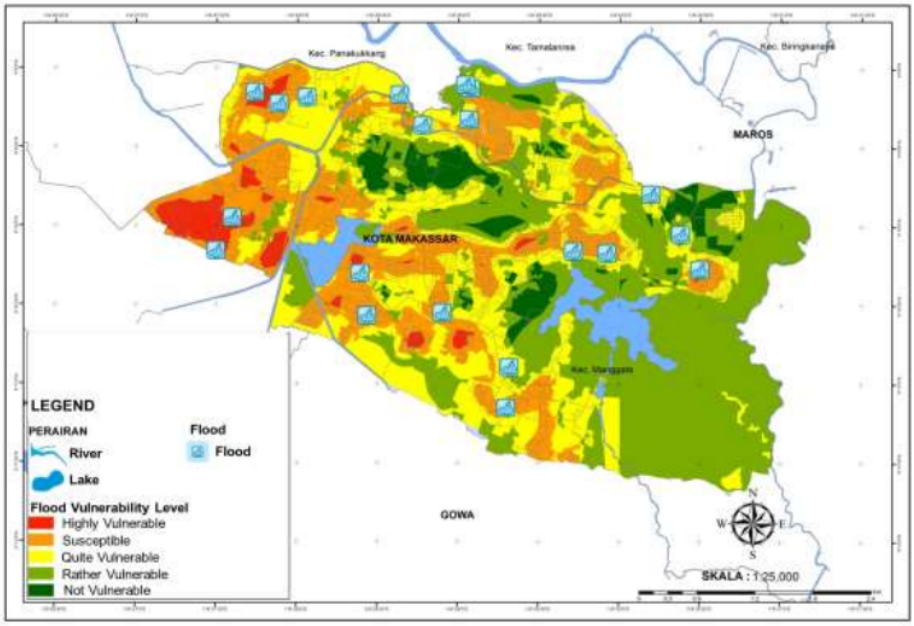

Figure 4. Distribution map location based flood vulnerability in the District Level Manggala

3.3. Water Sensitive City To Handle Vulnerability of Against Flooding

In formulating confectionary action floods in the district Manggala first thing is to determine the level of the District Manggala using water sensitive city index.

Table 5. Indicators score water sensitive city in District Manggala

Ensure good water Sensitive governan	Increase Community capital	Achive equity of essential service	Improve Productiveity and resource efficienc	Promote adaptive infrastructure	Improve ecologica 1 healt	Ensure quality urban space
3	1	3	1	3	3	3
1	3	3	1	1	1	3
3	3	1	3	1	3	3
3	1	1	1	3	1	
3	3		3	3		
3				1		
1						

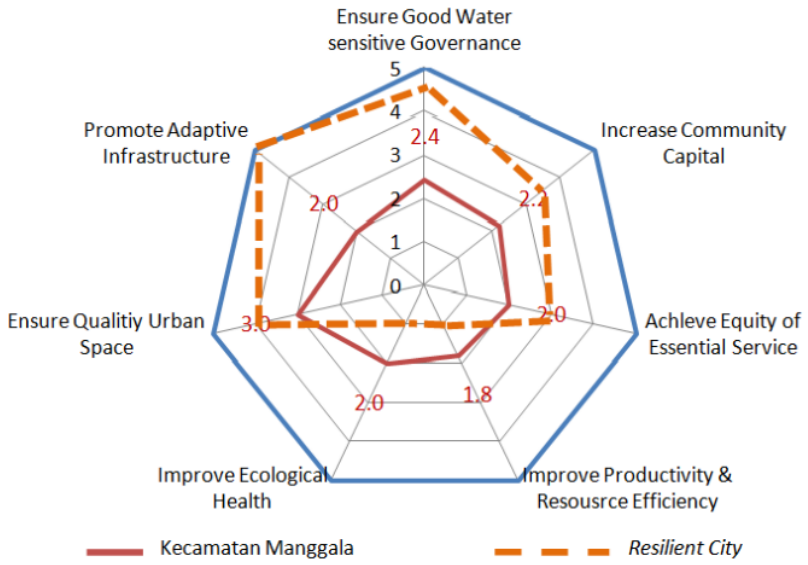

Figure 5. Diagram water sensitive city District of Manggala

From Figure 6 it can be seen the state of the District Manggala measured using goals and indexes of Water Sensitive City (WSC), the red line depicts condition District of Manggala by seven goals, which the District Manggala has the highest value on the quality of urban space, especially concerning green open spaces and open spaces waterfront. The dotted orange line, giving out the idea of the Resilient City. In tough on reaching the city, there are three objectives that need to be achieved, namely the government's role in ensuring the implementation of water-sensitive, promote adaptive infrastructure, and to increase public knowledge about the water.

Table 6. Strategies against flood vulnerability based on the WSC

Locations	Issues	Action	WSC Variables
Kel. Antang Kel. Manggala Kel. Batua Kel. Borong	The large number functions of river borders has become settlements, meaning that water has not yet become a key or	- Encourages widening river banks to increase the discharge capacity of the river, where the river border was changed to open spaces that will accommodate the	Water is a key element in city planning and development of an adaptive

Locations	Issues	Action	WSC Variables
	major factor in planning.	overflow of river water during the rainy season. - Re-optimizing the reservoir capacity of antang to handle flooding.	infrastructure
Kel. Antang Kel. Manggala Kel. Batua Kel. Borong	Every time a flood occurs, there is no readiness of the community for flooding, marked the number of material losses due to flooding.	Provide insight and training to the community how to manage the impact of flood-prone areas with better, by accepting that it is impossible to avoid flooding in flood-prone areas and how to protect homes from the effects of flooding.	Community preparedness in the face of extreme disasters
Kel. Antang Kel. Manggala Kel. Borong	There is no incentive to the community, in the context of post-flood recovery that involves repairing buildings to make community property more flood resistant, this makes opportunities to improve flood resistance not utilized.	Providing incentives to communities affected by flooding, through post-flood recovery with the aim of increasing flood resistance to people's homes and property.	Equality of access to flood and post-flood protection

Based on Table 6, the directions to overcome floods in Makassar City are explained, especially in Manggala Subdistrict using goals and indexes from the Water Sensitive City (WSC), which encourage the widening of river banks to increase river discharge capacity, where these river edges are converted into green open spaces that will accommodating river water overflows during the rainy season, and re-optimizing the capacity of antang reservoirs to handle floods then giving the community understanding and training on how to better manage the impact of flood-prone areas, by accepting that it is not possible to avoid flooding in flood-prone areas and how ways to protect homes from the effects of flooding and provide compensation to flood-affected communities, by post-flood recovery by increasing flood resistance to homes and property.

4. Conclusion

The level of vulnerability of areas that affect flooding in Manggala District is seen from several parameters, namely land cover, rainfall, drainage density, and slope. The results of the analysis resulted in the level of vulnerability of flooded areas in Manggala Subdistrict dominated by a rather vulnerable class of 865.76 ha or 39% of the total area, the class is quite vulnerable 622.70 ha (28%), vulnerable class 514.89 ha (23%), the non-vulnerable class 119.54 ha (5%) and very vulnerable 77.32 (4%). Overall the vulnerability map produced 27% prone to flooding and 73% entered the class as not vulnerable, somewhat vulnerable, and quite vulnerable. From the data of the total area per kelurahan, all Villages have areas that are very vulnerable to flooding except kel. Tamangapa For very vulnerable classes dominated by Borong Village with an area of 52.11 ha, this is possible because Borong Village has an area with the widest settlement area based on the area of its village.

Based on the results of the level of vulnerability and literature / theory review on adaptation strategies to flooding in Makassar City in the direction of Water sensitive City, especially in becoming a Resilient City, directives are formulated based on WSC goals and indexes, which encourage the widening of river borders to increase river discharge capacity, where this river border converted into a green open space that will accommodate river water overflows during the rainy season, and re-optimizing the capacity of Antang reservoirs to cope with floods further provides the community with

understanding and training on how to better manage flood-affected areas, accepting that it is impossible to avoid flooding in flood-prone areas and how to protect homes from the effects of flooding and provide compensation to flood-affected communities, by post-flood recovery by increasing flood resistance to homes and property.

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