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Evaluation of the Level of Vulnerability of Flood Disaster Prone Areas in the Batang Gasan River Basin using the Weighted Product (WP) Method

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ABSTRACT

Indonesia is an area that is prone to hydro-meteorological natural disasters such as floods, landslidesand so on. In Indonesia, especially West Sumatra, the cause of flooding is dominated by high rainfall, as is the case in the Gasan Gadang watershed. In an effort to overcome problems resultingfromflooding, there are several ways, one of which is knowing the causes of flooding and the target areafor flooding, which depends on the characteristics, hydrology and physical conditions of the area. Themain objective of this study is to determine the level of vulnerability to flood disasters and tomapflood-prone areas in the Batang Gasan watershed area to obtain the level of vulnerability andverifyflood-prone areas with measurement results. This research uses several stages of analysis, namelyweighted product (WP) analysis and dynamic analysis. The research results show that areas that havea high level of flood vulnerability are IV Koto Aur Malintang sub-district and Batang Gasansub- district. The area that is vulnerable to moderate-scale flooding is Tanjung Mutiara District. Andthearea that has a low scale flood vulnerability is Sei Geringging District. For areas that are pronetohigh-scale flooding, using the Dynamic Analysis method, the area area can be reduced over the next two year period. And in the 10th (tenth) year the flood area can be reduced by 85.88%. Efforts madeto reduce the area of the flood area are by installing check dams and dredging sediment along the river for District IV Koto Aur Malintang and Batang Gasan District.

Keywords: *Batang Gasan; River; Flood*

INTRODUCTION

Indonesia's territory is located on the equator so it receives a lot of heat from the sun and high rainfall, therefore Indonesia is prone to hydro-meteorological natural disasters such as floods, droughts, large sea waves, and so on. The National Disaster Management Agency (BNPB) noted that of the total hydrometeorological disasters that occur most frequently in Indonesia are floods followed by landslides. In Indonesia, especially West Sumatra, the cause of flooding is still dominated by high rainfall, resulting in river water overflowing and inundating the surrounding area. As is the case in the Gasan Gadang watershed, when rainfall is high and the Gasan Gadang river cannot accommodate the water that comes from rainwater, it overflows and results in flooding. The overflow of the Gasan Gadang inundated riverside areas, especially those traversed by the Gasan Gadang watershed. In an effort to overcome problems resulting from flooding, there are several ways, one of which is knowing the causes of flooding and the target area for flooding, which depends on the characteristics, hydrology and physical conditions of the area. One of the scientific disciplines that is very influential in overcoming flood problems is with the help of the Weaping P (WP) application, namely identifying and

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mapping areas that have the potential to flood. From this map, users and decision makers can use it to anticipate flooding in the research area, so that the losses incurred can be kept to a minimum. The main objective of this study is to determine the level of vulnerability to flood disasters and to map flood-prone areas in the Batang Gasan watershed area to obtain the level of vulnerability and verify flood-prone areas with measurement results.

Watershed (DAS)

A river basin or what is usually called a watershed is a unitary water management area that is formed naturally, where all rainwater that falls into this area will flow through rivers and related tributaries (Robert JK and Roestam S., 2005: 17) . Another definition of a watershed is a land area that is topographically limited by mountain ridges that collect and store rainwater and then channel it to the sea via the main river.

Flood And Vulnerability

In term technical Which intended flood is incident Which happen moment Genreexcessive water soak mainland, Genre river Which flow surpass the river's carrying capacity, and thus the river's flow will be pass river cliff And inundate area in surroundings (Asdak, 2004).

Vulnerability is a series of conditions that determine whether Hazards (both natural and artificial hazards) that occur will be able to occur cause a disaster or not. Klindao (1983) in Munawar, 2008 : 22 put forward that vulnerability (vulnerability) flood is estimate area- area Which Possible become target flood.

Flood Vulnerability Parameters

In characterizing flood vulnerability, it is necessary to distinguish between areas that are vulnerable to flooding or flooding and potential flood water supply areas which are water catchment areas of flooded areas. The parameters that make up the flood vulnerability formula are divided between natural parameters, which are factors that relatively do not change much and are difficult to manage, and management parameters that are dynamic and relatively easier to manage. These parameters can be seen in the following table:

Indicator	Sub Indicator		Weight	Honor	Source
Water discharge	5 < M3/sec	(small)	0.25	3	
	6 - 20m3/dt	(currently)		2	Sumate BWS data
	>21 m3/sec	(big)		1	Padang
Erosion	15 < Tons/ha	(small)	0.15	3	
	60-180 m3/ha	(currently)		2	Sumate BWS data
	181> m3/ha	(big)		1	Padang
Sedimentation	10< Tons/year	(small)	0.15	3	
	11-80 Tons/year	(currently)		2	Sumate BWS data
	81>Tons/year	(big)		1	Padang
Abrasion	5 < ha	(small)	0.10	3	
	6-10 ha	(currently)		2	Sumate BWS data
	11> ha	(big)		1	Padang
Land Use	1 < m	(small)	0.20	3	
	2 - 3 m	(currently)		2	Sumate BWS data
	3> m	(big)		1	Padang
Water quality	900-1200mg/L	(bad)	0.15	3	
	300-600mg/L	(laiak)		2	Sumate BWS data
	300<mg/l	(Good)		1	Padang

Table.1 Indicator And Sub Indicator

Land vulnerability to flooding is grouped into 6 categories. Each category is given a score from 2 to 8. To make it easier to obtain and determine the level of vulnerability, as follows:

CIVED Journal of Civil Engineering and Vocational Education
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Vol 11 No.3 September 2024
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- Water discharge
- Erosion.
- Sedimentation.
- Sea tide.
- Water quality.

For each category and level of flood vulnerability and flood land that will be used as a reference in determining the classification of each watershed being reviewed.

METHOD

In the Weighted Product (WP) method, the data used consists of two main components: decision matrix and weight vector. Let's discuss both draft This:

Matrix Decision (Decision Matrix):

- Alternative (Row): Every line on matrix decision represent One alternative Which currently evaluated. Alternatives This can form various choice, like product, project, or decision other Whichmust made.
- Criteria (Columns): Every column on matrix decision represent Onecriteria Which used For evaluate alternative. Criteria This can covers various aspects Which relevant with decision taken. Example of a decision matrix (as an example, we will use selection product with three alternative And three criteria): Vector Weight (Weight Vector):
- Criteria Weight: Weight is given to each criterion to indicate level interest relative. Vector weight usually arranged in form a row vector or column vector, and Criterion weights are denoted as Example vector weight: [w 1 w 2 w 3]

After matrix decision And vector weight conceptualized, steps Next, the Weighted Product method involves matrix normalization decision, multiplication weight with mark performance, And calculation total score Forevery alternative. Data This Then used For compare And choose alternative Which best based on total value score highest.

Source Data Weighted Products (WP).

In the Weighted Product (WP) method, the data source involves information that is required to construct the decision matrix and weight vector. A number of source data Which relevant including:

a. Evaluation Expert:
   - Experts in related fields can provide insight into what the criteria are Which most important And How give weight on every criteria.
   - Expert Also can help in determine how much Good every alternative fulfil criteria which has set.
b. Survey or Approach Participative:
   - Survey can done For gather preference And evaluation fromgroup people involved in decision-making.
   - Approach participative involve involve holder interestin determine criteria And give weight
c. Data Historical or Performance Measurement:
   - If available, data historical or measurement performance from alternative- alternative Which The same or similar can used as base For evaluate performance relatively them against the criteria certain.
d. Documentation And Report:
   - Report internal or document official can give outlookabout criteria Which relevant And important.
   - Documentation Also can give information about experiencepreviously with alternatives

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Which relevant.

e. Opinion Management And Stakeholder Interest:
   - Opinion management And holder interest, especially Which related with objective And preference organization, can become sourcedata important to determine criteria and weight.

Once data is collected from these sources, the next steps including determine criteria, give weight, And gather mark performance of alternatives against criteria to build a decision matrix. Vector weight Then determined based on preference And interest Which identified through sources the.

General

Research methods are the steps and procedures used to gather, analyze, And evaluate data in A studies. Method study in context method Weighted Products (WP) will discuss ways Which used For apply WP in decision making or evaluation of a situation. Following are the steps- step general in research methods for methods Weighted Products:

a. Determination Objective Study:
   - Determine your research objectives. Do you use method WP For taking decision in business, election employee, orevaluation project? Objective study You will guide step-step furthermore.
b. Identification Criteria And Alternative:
   - Determine the criteria that will be used to evaluate alternatives. Make sure criteria This relevant with your research goals.
   - Identification alternative Which will evaluated use method WP.
c. Election Source Data:
   - Determine source data Which will used For gather information about criteria and alternatives. This may involve interviews with expert, survey, historical data analysis, and data source other.
d. Determination Weight Criteria:
   - Based on the data sources that have been collected, determine the weights for every criteria. This can involve approach participative with involve holder interest or use expert assessment
e. Development Matrix Decision:
   - Get up matrix decision with evaluate every alternative to each criterion. Make sure the data is normalized so it can be processed by the methodWP.
f. Election Model Weighted Products:
   - Choose a Weighted Product model that suits your research needs You. Make sure you understand the formula and steps required in method This.
g. Calculation Total Score Alternative:
   - Count total score For every alternative with use vector weightand matrix that decision has normalized.
h. Interpretation And Analysis Results:
   - Analyze the total score results to determine the best alternative based on method WP.
   - Interpret results And for conclusion related with objective study.
i. Validation And Sensitivity Analysis:
   - Do validation to results For ensure reliability method WPin context study You.
   - Perform sensitivity analysis to identify so far wherechange in weight or the value of the criterion influences the results.
j. Drafting Report Study:
   - Compile research reports which include all the steps thatalready picked up,

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Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

methodology used, results, And conclusion.

Method study For method Weighted Products This can customized with the context and scale of decision making faced by the researcher or holder interest. Important For consider validity, reliability,And relevance data used in taking decision.

From study mapping level vulnerability area vulnerable flood in Area GenreBatang Gasan River uses the Weigt Product (WP) method. Based on map watershed beginning.

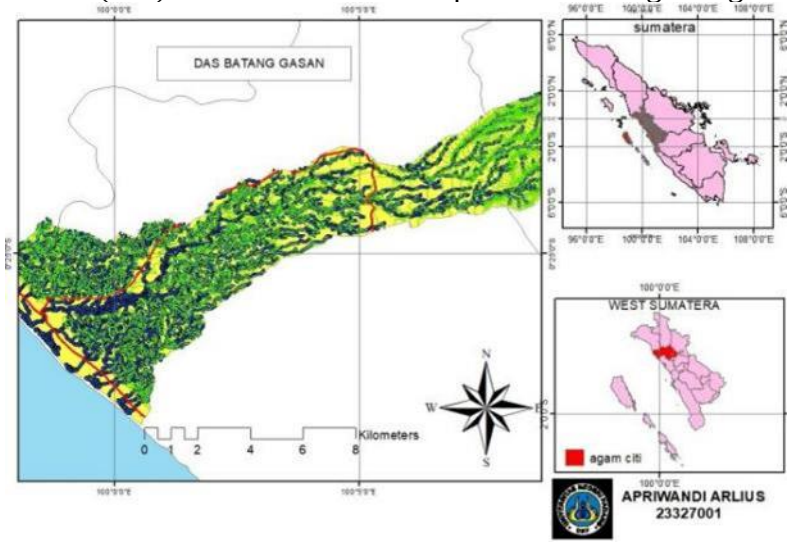

Figure 1. Map Batang Watershed Gasan .

RESULTS AND DISCUSSION

Results Analysis Weighted Products (WP).

From research mapping the level of vulnerability of flood-prone areas in the region Gasan Gadang River Flow using ArcGIS 10.4 and survey softwarein the field obtained mark Which quite meaningful from observation.

Objective Determining the Disaster Level in the Batang Gasan River Watershed (DAS).

Alternative

A1	Tanjung Mutiara District
A2	Batang Gasan District
A3	Sungai Geringging District
A4	IV Koto Aur Malintang District

			Sub Criteria			
Criteria		Weight	1	2	3	NK
K1	Water Discharge	8	Small	Currently	Big	0,26
K2	Erosion	6	Small	Currently	Big	0,2
K3	Sedimentation	6	<20	20-60	>60	0,2
K4	Abrasion	4	< 35	35-65	>65	0,13
K5	Sea Tide	4	< 30	30-60	>60	0,13
K6	Water Quality	2	Murky	Clear	Transparen	0,08
Amount		30				1

Weight Scale	level
2	Slightly Severe
4	
6	
8	Awfully

		0,26	0,2	0,2	0,13	0,13	0,08
Alternatif		K1	K2	K3	K4	K5	K6
A1	Tanjung Mutiara District	2	1	2	2	2	1
A2	Batang Gasan District	3	2	2	2	2	1
A3	Sungai Geringging District	2	1	1	2	2	2
A4	IV Koto Aur Malintang District	3	2	2	2	3	1

From processing data Alternative based on indicator criteria so get it rank zone district Which is at in region watershed Stemgasan which has a high to low risk of flood disaster risk as follows:

Area Prone to Flood:

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Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

a) Map watershed And Topography;
b) Map Zoning Flood Disaster Vulnerability.

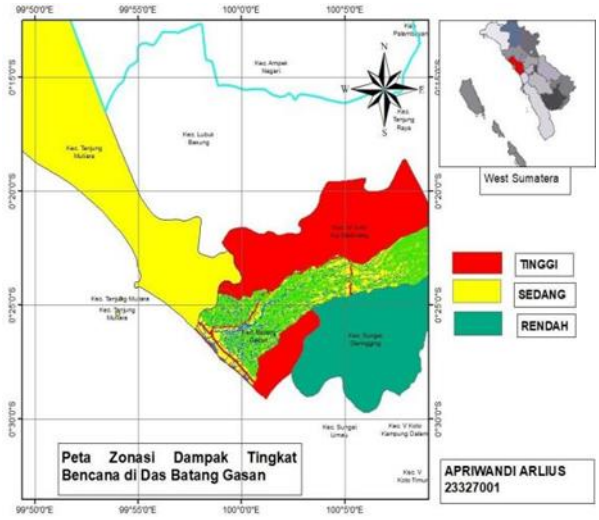


Figure 2. Map Zoning Vulnerability Disaster Flood .

Results Analysis Manipulation Model Dynamic.

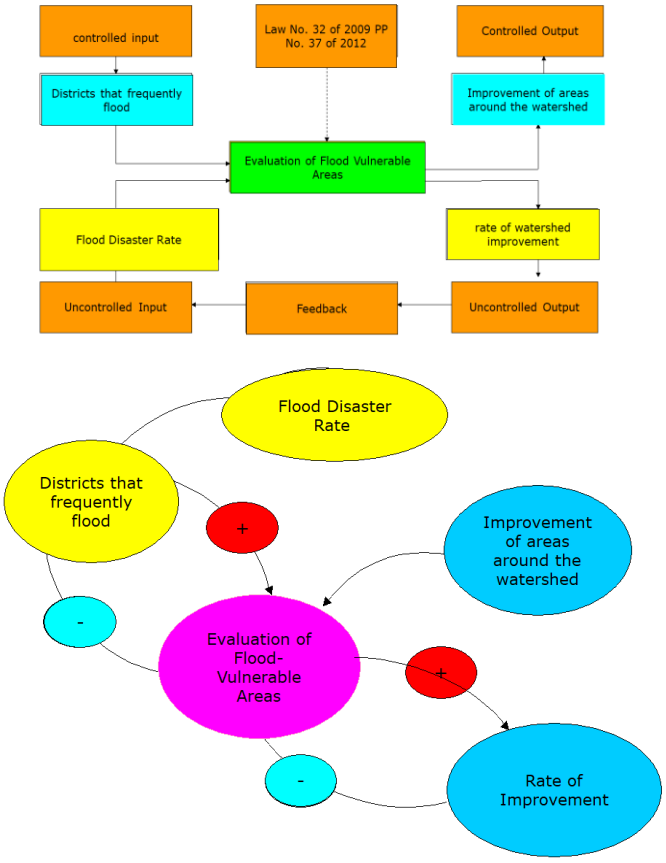
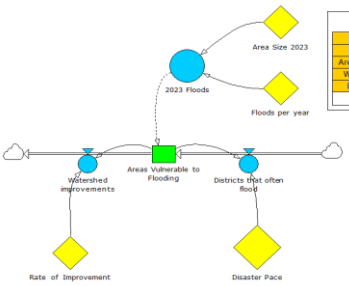


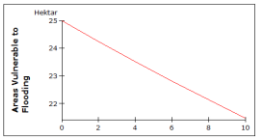
Figure 3. Black box and Casual Loop

EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED



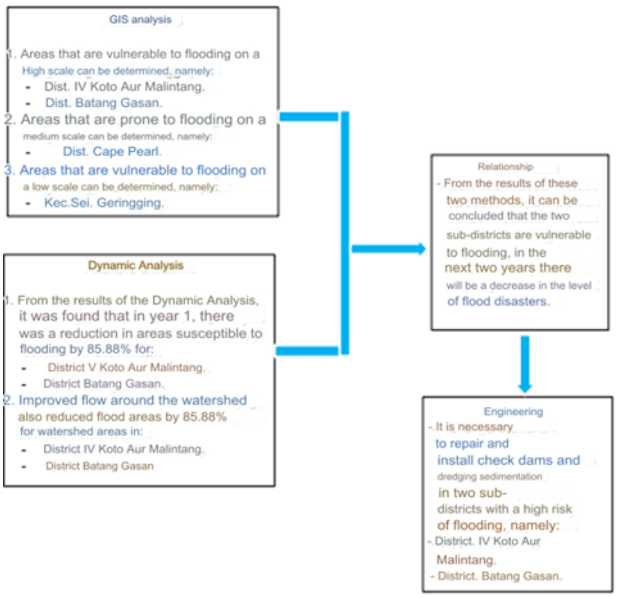
(Hektar)

year	0	2	4	6	8	10
2023 floods	25,00	25,00	25,00	25,00	25,00	25,00
Areas Vulnerable to Flooding	25,00	24,25	23,52	22,82	22,13	21,47
Watershed improvements	1,63	1,58	1,53	1,48	1,44	1,40
Districts that often flood	1,25	1,21	1,18	1,14	1,11	1,07



The flood vulnerability map in the Gasan Gadang watershed was produced using the method Weighted Product (WP) and Dynamic Model Engineering Analysis. Level value vulnerability And vulnerable to flood in produce from total score ranking Which in do so that own results form level high vulnerability in several areas such as Aur Malintang District and Batang Gasan District, because both areas have topographywhich tends to be flat with low flow density and gradients high river. Meanwhile, Tanjung Mutiara District has level vulnerability currently Because own area topography wavy, with density Genre Which currently, as well as on Subdistrict River Geringging level vulnerability Which low Because It has rough topography with steep terrain and land useland that is forest protect still beautiful.

From results Analysis Dynamic obtained that on 10 (ten) year In the future, there will be a decrease in the flood area for two sub-districts from the WP analyst earlier it was 85.88%. As is River improvements watershed areas in these two sub-districts. The results obtained from the second Analysis the form predictions vulnerability flood on watershed Stem Gasan. furthermore done validation data to field. After get validation data, furthermore do marking on validation point to region affected as well as taking documentation to region affected flood.
Framework Linkages.
Draft framework linkages between Analysis GIS using n methods WP with Analysis Dynamic.



CONCLUSION

From second Analysis Good method (WP) and Analysis Dynamic that is:
1. Got it specified area vulnerable to flooding with scale Tall that is:
   - District IV Koto Aur Malintang.

- District Stem Gasan.

Can specified area vulnerable to flooding on a Medium scale that is:
- District Tanjung Mutiara.

Can specified area prone to flood with a Low scale, namely:
- Kec. Sei. Geringging

2. For areas prone to high-scale flooding using the method Dynamic Analysis can reduce the area size over a two year periodforward. And in the 10th (tenth) year the extent of flooding can be reduced as big as 85.88%.
Efforts made to reduce the area of flood areas are byinstallation check dam And dredging sediment throughout river For
- District IV Koto Aur Malintang.
- District Stem Gasan.

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