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FLOOD MANAGEMENT STRATEGY IN THE LANDAK SUB-RIVER BASIN USING SWOT ANALYSIS

Alfaro, Aldi[1], SB. Soeryamassoeka[1], Danang Gunarto[1],
[1,2,3,4,5] Faculty of Engineering, Tanjungpura University, Indonesia
*Corresponding Author (aldialfa@student.untan.ac.id)

Abstract

Landak Sub-River Basin is part of the Kapuas watershed, which is drained by the Landak River and has an area of approximately 7,921 km2. Every year, flooding happens in the Landak Sub-River Basin, and the number of floods tends to go up. Flooding in the Landak Sub-River Basin inundates about 20 villages, meaning that flood-prone areas dominate. The causes of flooding in the Landak Sub-River Basin are very complex, basically caused by natural and non-natural factors. In particular, flooding is thought to be caused by a number of problems in the Landak Sub-River Basin, such as changes in how land is used, smaller areas where water can collect, clogged small rivers, and so on. This article talks about the results of research on flood management in the Landak Sub-River Basin. Because of the research, a plan was made to lessen the effects of the Landak Sub-River Basin's frequent flooding.

Forty people (respondents) filled out a questionnaire as part of a study to create a flood management strategy to control flooding in the Landak Sub-River Basin. Respondents fill out questionnaires during a focus group discussion (FGD) in Ngabang on August 30, 2022. The respondents who filled out the survey came from Landak Regency, Kubu Raya Regency, Pontianak City, and the National Strategic River Basin (WS) Water Resources Management Coordination Team (TKPSDA WS Kapuas), all of which have a stake in how flood control and management policies are made. Once flood management and control are implemented, a list of the Landak Sub-River Basin's strengths, weaknesses, opportunities, and threats is made. The result is a score, then used to develop strategic issues for flood control and management in the Landak Sub-River Basin. The strategic issues obtained in the FGDs were further regrouped and reassessed by respondents to determine whether they were in line with the strengths, weaknesses, opportunities, and threats in flood management and control in the Landak Sub-River Basin. The assessment results were then used to make short-, medium-, and long-term plans for dealing with flooding and keeping it from happening in the Landak Sub-River Basin.

The analysis shows that the best way to manage and minimize flooding in the Landak Sub-River Basin is to make the Landak Sub-River Basin as strong as possible so that the opportunities can be used to their fullest. For flood management in the Landak Sub-River Basin, the government's top priority is to use flood zoning to support policies, especially those that aim to make it easier to follow existing rules.

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1. Introduction

Floods that occur are basically a reflection of natural phenomena and damage to the earth's surface that is accelerated by human actions, causing a level of potential flood prone in certain areas (Wei et al., 2022). In the Kalimantan Barat Province, flooding upstream areas usually

occurs during the rainy season, while in coastal areas, in addition to occurring during the rainy season, it is also caused by sea tides, namely the rising position of the surface of the waters or oceans caused by the influence of the gravitational forces of the moon and the sun (Soeryamassoeka et al., 2022a).

The Landak Sub-River Basin is part of the Kapuas River Basin, which the Landak River drains, with an area of approximately 7,921 km2. Most of the Landak Sub-River Basin is located in Landak Regency, so the Landak Sub-River Basin has social aspects to the population's lives. Landak mainly floods because of heavy rain and how the Landak Sub-River Basin is set up (Soeryamassoeka et al., 2022b; Rabsanjani et al., 2022). The National Agency for Disaster Countermeasures (BNPB) says that Landak floods every year, and the number of floods tends to increase (Soeryamassoeka et al., 2022b). Changes in how the land is used have caused the primary forests in the Landak Sub-River Basin to shrink, and much of the land has been cleared to make way for oil palm plantations. Thus, flood-prone areas in the Landak Sub-River Basin are expanding.

Considering the various problems in the Landak Sub-River Basin, an effective solution is needed to overcome and mitigate flooding. In this case, regulations regarding flooding are significant because they are under the authority of the local government. By strengthening and putting in place regulations, the Landak Sub-River Basin can be kept in good shape and supervised, making flooding easier to control (Liu et al., 2020). However, a more in-depth analysis is needed to determine the proper regulation.

Planning an integrated flood management strategy, especially flood control, generally starts with a problem that needs a solution (Sayers et al., 2013; Jafar et al., 2022). Problem identification is intended to examine various problems associated with the condition to be improved (Sayers et al., 2013; Glago, 2020). Once the list of problems or causes and effects of a problem is known, the objectives can be formulated. There are many ways and techniques to recognize, explore, and find problems. The most commonly used method of exploring or identifying problems is strategic environmental analysis (SWOT) (Grama et al., 2021). This analysis is intended to look at the strengths, weaknesses, opportunities, and challenges of the problems that occur in the case of flooding in the Landak Sub-River Basin.

2. Materials and Methods

2.1. Theoretical Frame Work

Flood management strategies in the Landak Sub-River Basin must be reassessed more thoroughly. Analysis of flood management strategies is needed so that the flood management steps taken are more effective (Junaidi et al., 2018; Tariq et al., 2021). The analysis must examine the existing conditions in the Landak Sub-River Basin area and relate them to the subject matter. The results of this analysis can then be used as guidelines for flood management policies in the Landak Sub-River Basin.

The analysis used in this case is strengths, weaknesses, opportunities, and threats (SWOT). A SWOT analysis was conducted on the case of flooding in the Landak Sub-River Basin so that the strengths, weaknesses, opportunities, and threats that exist in the Landak Sub-River Basin will be considered in determining the suitable strategy for the Landak Sub-River Basin. The formulation of these factors is based on the points obtained from the Focus Group Discussion (FGD).

The result of the SWOT analysis is the factor that affects the causes of flooding. With this information, the Landak Sub-River Basin can develop the best ways to deal with floods. In addition, these strategies will be classified as pre-flood, during-flood, and post-flood strategies.

The following flowchart summarises how the research was conducted;

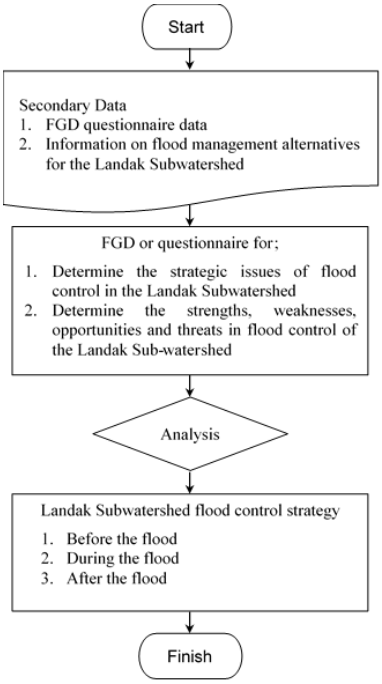

Fig.1 Research Flow Chart

2.2. Resarch Location

The research was conducted in Landak Sub-River Basin, which covers the administrative areas of Landak Regency, Kota Pontianak, and Kubu Raya, consisting of Serimbu Sub-River Basin, Pade Sub-River Basin, Dait Sub-River, Behe Sub-River Basin, Menyuke Sub-River Basin, Belantian Sub-River Basin, Sengah Sub-River Basin, Mandor Sub-River Basin, Sebangki Sub-River Basin (Landak Regency) and Ambawang Sub-River Basin (Pontianak City and Kubu Raya Regency).

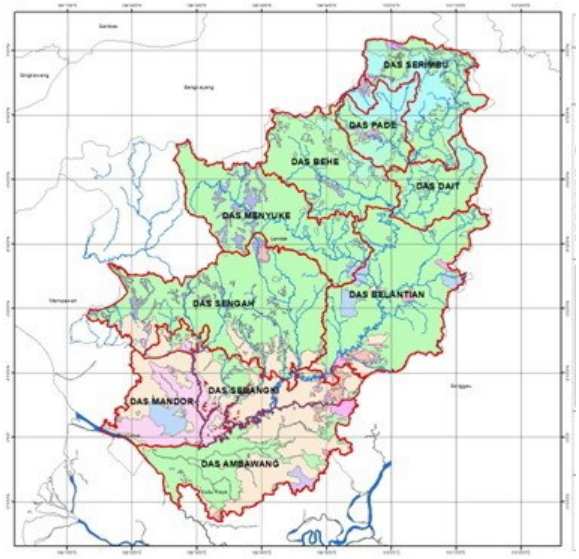

Fig.2. Landak Sub-River Basin

2.1 Data

First, the Analytic Hierarchy Process (AHP) was used to determine the order of importance for flood management in the Landak Sub-River Basin (Soeryamassoeka, 2022b). Due to the focus group discussion (FGD), the data used were strategic questions about flooding. The AHP results were obtained as follows:

Table 1. Alternative Comparison Result (Soeryamassoeka, 2022b)

Kriteria	Rank	%
Strengthening and Implementation of Regulations	1	25,47%
Revision of Spatial Policy	2	24,42%
Reforestation and Watershed Erosion Control	3	17,80%
Fund Allocation for Disaster	4	12,82%
River Restoration	5	11,10%
Control Building	6	8,39%

Therefore, the priority scale for flood management in the Landak Sub-River Basin is strengthening and implementing regulations, which will later be focused on in the SWOT analysis in determining strategies.

2.2 Analysis Method

2.2.1 Internal Strategic Factor Analysis Summary (IFAS)

The stages of preparing the IFAS table are (Soeryamassoeka, 2020b):

a. Determine factors that are strengths and weaknesses.
b. In column 2, give each factor a weight based on the sum of the respondents' scores for each factor divided by the sum of the internal factor respondents' scores.
c. In column 3, calculate the rating for each factor using a numerical scale of 4 (outstanding) to 1 (poor) based on the number of respondents' scores for each factor divided by the number of internal and external factors.
d. Multiply the weight and rating to obtain the weighting factor in the form of a weighted score for each factor.
e. Sum the weighting scores in column 4 to obtain the total weighting score.

2.2.2 External Strategic Factor Analysis Summary (EFAS)

The stages of preparing the EFAS table are (Soeryamassoeka, 2020b):

a. Determine the factors that become opportunities and threats.
b. In column 2, give each factor a weight based on the number of respondents' scores for each factor divided by the number of respondents' scores for internal factors.
c. In column 3, calculate the rating for each factor using a number scale of 4 (outstanding) to 1 (poor) based on the number of respondents' scores for each factor divided by the number of internal and external factors. The greater the opportunity, the greater the rating, but if the opportunity is small, the rating is also smaller. Rating threats is the opposite of rating opportunities, the greater the threat the smaller the rating and vice versa when the threat value is small the rating is greater.
d. Multiply the weight and rating to obtain the weighting factor in the form of a weighted score for each factor.
e. Sum the weighting scores in column 4 to obtain the total weighting score.

2.2.3 Analyzing with SWOT Matrix

TOWS analysis is conducted by combining internal factors (IFAS) and external factors (EFAS) (Radhakrishnan et al., 2020). The priority scale values obtained from the previous

analysis are then summed up in a matrix as in the table below to obtain and compare the value of each strategy.

Table 2. SWOT Matrix

	***Strengths* (S)**	***Weaknesses* (W)**
	SO strategy	**WO Strategy**
***Opportunities* (O)**	Create strategies that use existing strengths to capitalize on opportunities	Create strategies that minimize weaknesses to take advantage of opportunities
	ST Strategy	**WT Strategy**
***Threaths* (T)**	Create a strategy using existing strengths to overcome threats Strategy	Create strategies that minimize existing weaknesses to avoid threats

2.2.4 Quantitative Strategic Planning Matrix (QSPM)

A quantitative Strategic Planning Matrix (QSPM) is a method for determining priority strategies by combining internal and external factors against alternative strategies that have been formulated (Sumiarsih et al., 2018). Then weighting is carried out, determining the value of attractiveness or Attractiveness Scores (AS), and Total Attractiveness Scores (TAS). To carry out this calculation, a questionnaire was returned regarding the level of conformity between strategies and strategic issues (Pazouki et al., 2017). The description of the QSPM calculation is as in the following table.

Table 3. Strategic Factors Analysis Summary Matrix

Faktor	Bobot	Rumusan Strategi								Jumlah TAS
		S_1		S_2		S_3		…		
Isu Strategis		AS	TAS	AS	TAS	AS	TAS	…	…	
Isu 1	x_1	y_{11}	$x_1.y_{11}$	y_{21}	$x_1.y_{21}$	y_{31}	$x_1.y_{31}$	…	…	$\sum x.y$
Isu 2	x_2	y_{12}	$x_2.y_{12}$	y_{22}	$x_2.y_{22}$	y_{32}	$x_2.y_{32}$	…	…	$\sum x.y$
Isu 3	x_3	y_{13}	$x_3.y_{13}$	y_{23}	$x_3.y_{23}$	y_{33}	$x_3.y_{33}$	…	…	$\sum x.y$
…	…	…	…	…	…	…	…	…	…	…
Jumlah			$\sum x.y$		$\sum x.y$		$\sum x.y$	…	…	

2.2.5 Strategic Factors Analysis Summary (SFAS)

Strategic Factor Analysis Summary (SFAS) is a summary of the analysis of strategic factors taken from the EFAS table and IFAS table while determining the timeframe of each strategy.

Table 4. Strategic Factors Analysis Summary Matrix

Rumusan Strategi	Bobot	Rating	Skor	Jangka Pendek	Jangka Menengah	Jangka Panjang
S1	x_1	y_1	$x_1.y_1$			
S2	x_2	y_2	$x_2.y_2$			
…	…	…	…	…	…	…
Total	$\sum x$	$\sum y$	$\sum x.y$			
Max						
Min						
SFAS			Max-Min			

The steps to compile the SFAS table are as follows:

a. Identify and compile several items for each of the most important internal and external strategic factors based on the scores in the IFAS and EFAS tables.
b. Give weight to these items starting from based on the results of the QSPM analysis.
c. Give a rating in column 3 for each factor based on the importance of each factor.
d. Multiply the weight of each factor in the second column by the rating in the third column to get the weighted score in the fourth column.
e. Based on the final score, determine whether each strategy factor can be used in the short term, long term, or medium term. If the score value < $(\frac{SFAS}{3} + Min)$ strategy is declared short-term, if the score value > $(Max - \frac{SFAS}{3})$ strategy is stated to be long-term, and if the score value is between $(\frac{SFAS}{3} + Min)$ and $(Max - \frac{SFAS}{3})$ the strategy is stated to be medium-term.

3. Result and Discussion

3.1 IFAS and EFAS Weighting

From the questionnaire data, the sum of the respondents' scores for each strategic issue and the total score of the factors are obtained to obtain the weight value. For internal factors of strength on the first strategic issue, the calculation description is as follows.

a. Calculate the weight by dividing the sum of the respondents' scores for each factor by the sum of the respondents' scores for the internal factors.

$$\text{Weight} = \frac{\sum respondent\ score\ for\ each\ factor}{\sum internal\ factor\ respondent\ score} = \frac{95}{1839} = 0{,}05$$

b. Calculating the rating by means of the sum of the respondents' scores for each factor divided by the number of internal and external factors.

$$\text{Rating} = \frac{\sum respondent\ score\ for\ each\ factor}{Number\ of\ strategic\ issues} = \frac{95}{36} = 2{,}64$$

c. Calculating the weighted score by multiplying the weight and rating.

$$\text{Weighted Score} = Weight \times Rating = 0{,}05 \times 2{,}64 = 0{,}14$$

For other strategic issues and external factors, the same calculation was done. The overall

results for the IFAS and EFAS weightings are summarized in the following tables.

Table 5. Results of Weighting Strength Factors

No	Strength	Average	Total	Weight	Rating	Weighted Score
1	The Landak Sub-River Basin still has a large catchment area	2,38	95	0,05	2,64	0,14
2	There are laws related to environmental protection and management and laws on disaster management.	3,6	144	0,08	4	0,31
3	The existence of RTRW in the administrative areas included in the Landak Sub-River Basin.	2,75	110	0,06	3,06	0,18
4	The existence of a Regional Disaster Management Agency (BPBD).	2,6	104	0,06	2,89	0,16
5	The existence of the National Strategic River Basin Water Resources Management Coordination Team (TKPSDA) institution in West Kalimantan	2,1	84	0,05	2,33	0,11
6	The existence of local cultural wisdom regarding the shape of houses on stilts and customary laws regarding land use.	1,98	79	0,04	2,19	0,09
7	There is already an	1,58	63	0,03	1,75	0,06
8	There is already coordination between agencies in flood management in the upper and middle parts of the Landak Sub-River Basin.	2,18	87	0,05	2,42	0,11
9	A revised spatial plan for flood-prone areas and riparian utilization.	1,95	78	0,04	2,17	0,09
	Total of Power		**844**	**0,46**	**23,44**	**1,26**

Table 6. Results of Weighting Weakness Factors

No	Weakness	Average	Total	Weight	Rating	Weighted Score
1	Recurring flood events.	3,53	141	0,08	3,92	0,3
2	Weak coordination and supervision of environmental utilization by the government.	2,45	98	0,05	2,72	0,15
3	The RTRW that was created adjusted the vision and mission of the district.	2,53	101	0,05	2,81	0,15
4	BPBD's scope of work still follows the administrative area.	2,6	104	0,06	2,89	0,16
5	The role of TKPSDA in flood management and river maintenance has not been optimized.	2,65	106	0,06	2,94	0,17
6	Lack of socialization of local wisdom that is usually spoken from generation to generation	1,75	70	0,04	1,94	0,07
7	The flood early warning system has not been running optimally.	3,15	126	0,07	3,5	0,24
8	Inter-agency coordination in flood management in the Landak Sub-River Basin has not been integrated from upstream-middle and downstream.	2,9	116	0,06	3,22	0,2
9	Flood-prone zoning in the Landak Sub-River Basin is not yet available.	3,33	133	0,07	3,69	0,27
	Total of Weaknesses		**995**	**0,54**	**27,64**	**1,72**
	Total Strengths and Weaknesses		**1839**	**1**		

Table 7. Results of Weighting Opportunities Factors

No	Opportunities	Average	Total	Weight	Rating	Weighted Score
1	Availability of green open space.	3,45	138	0,06	3,83	0,23
2	Creating conducive and environmentally sound land use.	3,35	134	0,06	3,72	0,22
3	Establishment of cooperation between administrative regions.	3,53	141	0,06	3,92	0,24
4	Disaster levels can be managed to a minimum.	3,55	142	0,06	3,94	0,25
5	Water resources management in the Landak Sub-River basin can be organized.	3,45	138	0,06	3,83	0,23
6	People can utilize the land wisely.	3,28	131	0,06	3,64	0,21
7	Floods can be anticipated so as not to cause loss of life and property.	2,65	106	0,05	2,94	0,14
8	Increased support from provincial and central government for flood management.	3,48	139	0,06	3,86	0,23
9	Flood zoning can be mapped.	3,55	142	0,06	3,94	0,25
	Total of Opportunities		**1211**	**0,53**	**33,64**	**1,99**

Table 8. Results of Weighting Threats Factors

No	Threats	Average	Total	Weight	Rating	Weighted Score
1	More and more land conversion to oil palm plantations and mining.	3,53	141	0,06	3,92	0,24
2	Much of the land development in the Landak Sub-River Basin is not in accordance with laws related to environmental protection and management and laws on disaster management.	3,28	131	0,06	3,64	0,21
3	Regional development often does not refer to the RTRW.	2,38	95	0,04	2,64	0,11
4	The Landak Sub-River Basin has an increasing risk of flooding which can slow down the development process.	3,58	143	0,06	3,97	0,25
5	At some points in the Landak Sub-River Basin there is silting of the river channel due to erosion and sedimentation and lack of maintenance.	2,43	97	0,04	2,69	0,11
6	Local wisdom continues to erode along with the times.	2,38	95	0,04	2,64	0,11
7	There are casualties of life and property due to flood hazards in the Landak Sub-River Basin.	2,43	97	0,04	2,69	0,11
8	Pengelolaan Sub DAS termasuk banjir masih berorientasi skala wilayah administrasi	3,33	133	0,06	3,69	0,22
9	Many settlements were built on riverbanks, and relocation was difficult.	3,53	141	0,06	3,92	0,24
	Total of Threats	**1073**	**0,47**	**29,81**	**1,6**	
	Total Opportunities and Threats	**2284**	**1**	**57,1**		

3.2 Comparing Factors with SWOT

SWOT analysis followed by TOWS is an analysis to determine the grand strategy, namely the matching stage so that it can show the position of strengthening the implementation of regulations in flood management, whether the tangent points of IFAS and EFAS are in quadrant-1, quadrant-2

quadrant-3 and quadrant-4. Based on the weighted score obtained from the previous calculation, with a combination of internal and external factors, the following results are obtained.

Table 9. IFAS and EFAS Matching Results

EFAS / IFAS	Strength (S)	Weakness (W)
Opportunities (O)	S+O 1,26 + 1,99 = 3,26	W+O 1,72 + 1,99 = 3,71
Threats (T)	S+T 1,26 + 1,60 = 2,87	W+T 1,72 + 1,60 = 3,32

The value entered into the SWOT matrix table above is the weighted score value obtained when weighting IFAS and EFAS. From the SWOT matrix, the best alternative strategy is the W-O strategy, namely a combination of weaknesses and opportunities with a score of 3,71.

Determination of coordinate points in the quadrant position of the SWOT analysis results by means of positive factors against negative factors. The x-axis represents strengths and weaknesses, while the y-axis represents opportunities and threats.

$$x = 1,26 - 1,72 = -0,45$$

$$y = 1,99 - 1,60 = 0,39$$

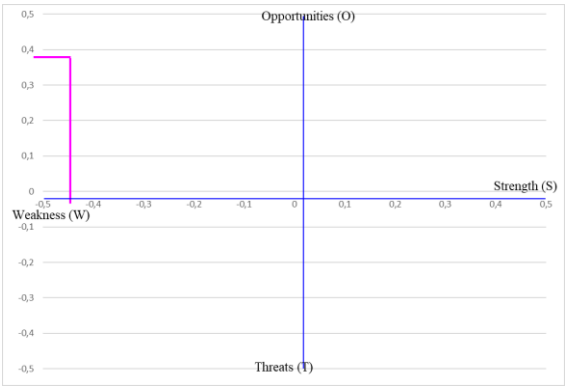

Fig.3. Strategic Factor Position.

Based on the analysis, it is clear that the W-O strategy is the best way to strengthen and put flood management rules into place in the Landak Sub-River Basin. This plan is to fix the Landak Sub-River Basin's problems so that it can make the most of its opportunities. Thus, for the policy of strengthening the implementation of regulations to be carried out, a strategy that refers to Minister of Home Affairs Regulation No. 13/2006 and the BNPB Regulation on Disaster Mitigation Guidelines are formulated as follows:

Table 10. Strategy Formulation

No	Strategy Formulation
1	The government can make policies and regulations regarding the extent of buffer/infiltration areas that must be available.
2	Local governments can make derivative regulations from laws related to environmental protection and management.
3	The RTRW related to land use can be redrafted in an integrated manner between the upstream-middle and downstream areas of the Landak Sub-River Basin.
4	The government can make rules/MOUs regarding the working area of BPBDs in a river basin unit.
5	The government can create Flood Zoning to support the policy.
6	Improving the role of TKPSDA, especially in flood management and river maintenance
7	Reapplying local wisdom that exists in the community.
8	Redevelop the Landak Sub-River Basin flood early warning system (EWS) that is easy for the community to digest and socialize the flood EWS to all levels of society.
9	The provincial government can formulate policies to improve coordination of flood management in the Landak Sub-River Basin as a whole watershed unit that has not been well integrated

3.3 Determining Strategy Priorities with QSPM

The quantitative strategic planning matrix (QSPM) is the final stage of strategy formulation analysis and involves selecting the best policy alternative. The nine strategies are coded S1 through S9 to be put in the QSPM table. Before the QSPM analysis, a questionnaire was used to determine how well the strategies fit the strategic issues shown in Table 10.

The attractiveness score (AS) is the average of the respondents' scores. The AS value for each item is as follows.

Table 11. Attractiveness Score for Strength

No	IFAS	Weight	Strategy Formulation								
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
	Strength		AS	AS	AS	AS	AS	AS	AS	AS	AS
1	The Landak Subwatershed still has a large catchment area.	0,052	2,68	2,73	2,73	2,05	2,73	2,08	2,7	1,83	2,8
2	There is a law on environmental protection and management and a law on disaster management.	0,078	2,7	2,65	2,68	2	2,8	2,03	2,18	2,73	2,73
3	The existence of RTRW in the administrative areas included in the Landak Subwatershed.	0,060	2,73	2,78	2,78	2,23	2,68	2,2	1,93	2,03	2,73
4	The existence of a Regional Disaster Management Agency (BPBD).	0,057	2,78	2,2	2,8	2,73	2,7	2,83	2,83	2,8	2,68
5	The existence of the National Strategic River Basin Water Resources Management Coordination Team (TKPSDA) institution in West Kalimantan	0,046	2,83	2,75	2,08	2,25	2,73	2,7	2,2	2,78	2,78
6	The existence of local cultural wisdom regarding the shape of houses on stilts and customary laws regarding land use.	0,043	2,75	2,7	2,78	2,63	2,73	2,7	2,78	2	1,98
7	There is already an early warning system for flooding in the upper and middle parts of the Landak Sub-watershed.	0,034	2,28	2,7	2,7	2,79	2,73	2,78	2,03	2,7	2,7
8	There is already coordination between agencies in flood management in the upper and middle parts of the Landak Sub-watershed.	0,047	2,73	2,78	2,65	2,7	2,73	2,7	2,83	2,6	2,78
9	A revised spatial plan for flood-prone areas and riparian utilization.	0,042	2,68	2,68	2,73	2,33	2,75	2,8	2,7	2,75	2,2

Table 12. Attractiveness Score for Weakness

No	IFAS	Weight	Strategy Formulation								
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
	Weakness		AS	AS	AS	AS	AS	AS	AS	AS	AS
1	Recurring flood events.	0,077	1,1	1,13	1,1	1,18	1,18	1,18	1,2	1,18	1,23
2	Weak coordination and supervision of environmental utilization by the government.	0,053	1,98	1,3	2,28	1,2	1,38	1,3	2,18	2,25	2,08
3	The RTRW that was created adjusted the vision and mission of the district.	0,055	1,28	1,25	1,38	2,13	1,2	2,05	2	2,08	2,18
4	BPBD's scope of work still follows the administrative area.	0,057	2	2,13	1,93	1,23	1,25	2,23	2,35	2,2	1,88
5	The role of TKPSDA in flood management and river maintenance has not been optimized.	0,058	1,95	2,05	2	1,83	1,25	1,28	1,75	2,23	1,88
6	Lack of socialization of local wisdom that is usually spoken from generation to generation	0,038	2,38	2,88	2,35	2,78	2,23	2,8	1,3	2,28	2,3
7	The flood early warning system has not run optimally.	0,069	2,05	1,73	1,7	2,03	1,25	1,23	2,08	2,13	1,3
8	Inter-agency coordination in flood management in the Landak Sub-watershed has not been integrated from upstream-middle and downstream.	0,063	1,28	1,25	1,23	1,83	1,2	1,18	1,8	1,85	2,18
9	Flood-prone zoning in the Landak Subwatershed is not yet available.	0,072	1,33	1,2	1,38	2,08	1,3	1,25	1,93	1,3	1,28

Table 13.Attractiveness Score for Opportunities

No	EFAS	Weight	Strategy Formulation								
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
	Opportunities		AS	AS	AS	AS	AS	AS	AS	AS	AS
1	Availability of green open space.	0,060	2,78	2,83	2,75	1,25	2,83	1,9	2,73	1,18	1,28
2	Creating conducive and environmentally sound land use.	0,059	2,73	2,7	2,78	1,28	2,78	1,73	2,78	1,15	1,25
3	Establishment of cooperation between administrative regions.	0,062	2,15	2,73	2,33	2,83	2,75	2,68	1,3	2,78	2,15
4	Disaster levels can be managed to a minimum.	0,062	2,8	2,85	2,65	2,78	2,83	2,78	2,8	2,83	2,73
5	Water resources management in the Landak sub-watershed can be organized.	0,060	1,18	2,73	1,18	2,83	2,65	2,68	2,25	2,05	1,25
6	People can utilize the land wisely.	0,057	2,7	2,23	2,78	1,18	2,65	2,33	2,75	1,3	1,23
7	Floods can be anticipated so as not to cause loss of life and property.	0,046	2,7	2,73	2,78	2,85	2,7	2,73	2,73	2,78	2,75
8	Increased support from provincial and central government for flood management	0,061	2,75	2,73	2,78	2,85	2,78	2,75	2,7	2,63	2,7
9	Flood zoning can be mapped.	0,062	2,68	2,25	1,98	2,7	2,7	2,1	2,1	2,73	2,65

Table 14. Attractiveness Score for Threats

No	EFAS	Weight	Strategy Formulation								
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
	Threats		AS	AS	AS	AS	AS	AS	AS	AS	AS
1	More and more land conversion to oil palm plantations and mining.	0,062	1,25	1,3	1,25	1,38	1,95	1,65	1,2	1,2	1,3
2	Much of the land development in the Landak Subwatershed is not in accordance with laws related to environmental protection and management and laws on disaster management.	0,057	1,23	1,25	1,2	1,15	1,38	1,23	1,83	2,08	1,93
3	Regional development often does not refer to the RTRW.	0,042	1,25	1,15	1,28	2,88	1,23	2,73	2,85	2,2	1,9
4	The Landak Subwatershed has an increasing risk of flooding which can slow down the development process.	0,063	1,08	1,18	1,23	1,2	1,18	1,18	1,2	1,25	1,2
5	At some points in the Landak Subwatershed there is silting of the river channel due to erosion and sedimentation and lack of	0,042	1,18	2,23	1,95	2,78	1,18	2,68	2,88	2	2,08
6	Local wisdom continues to erode along with the times.	0,042	2,73	2,2	2,03	1,28	2,03	2,3	1,3	1,3	1,3
7	There are casualties of life and property due to flood hazards in the Landak Subwatershed	0,042	2,2	2,25	2,25	1,3	1,38	2,2	1,25	1,28	2,13
8	Sub-watershed management including flooding is still oriented to the scale of the administrative area	0,058	1,3	1,25	1,3	1,28	1,3	1,3	1,35	1,35	1,35
9	Many settlements were built on riverbanks, and relocation was difficult.	0,062	1,28	1,28	1,08	1,13	1,23	1,2	1,3	2,03	1,35

Next, determine the TAS (Total Attractiveness Score) value by multiplying the weight and AS value. So that the following results are obtained.

Table 15. QSPM Analysis Results for Strength

No	IFAS	Weight	Strategy Formulation									Total TAS
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	
	Strength		TAS	TAS	TAS	TAS	TAS	TAS	TAS	TAS	TAS	
1	The Landak Subwatershed still has a large catchment area.	0,052	0,14	0,14	0,14	0,11	0,14	0,11	0,14	0,09	0,14	1,15
2	There is a law on environmental protection and management and a law on disaster management.	0,078	0,21	0,21	0,21	0,16	0,22	0,16	0,17	0,21	0,21	1,76
3	The existence of RTRW in the administrative areas included in the Landak Subwatershed.	0,060	0,16	0,17	0,17	0,13	0,16	0,13	0,12	0,12	0,16	1,32
4	The existence of a Regional Disaster Management Agency (BPBD).	0,057	0,16	0,12	0,16	0,15	0,15	0,07	0,16	0,16	0,15	1,28
5	The existence of the National Strategic River Basin Water Resources Management Coordination Team (TKPSDA) institution in West Kalimantan	0,046	0,13	0,13	0,09	0,10	0,12	0,05	0,10	0,13	0,13	0,98
6	The existence of local cultural wisdom regarding the shape of houses on stilts and customary laws regarding land use.	0,043	0,12	0,12	0,12	0,11	0,12	0,11	0,12	0,09	0,08	0,99
7	There is already an early warning system for flooding in the upper and middle parts of the Landak Sub-watershed.	0,034	0,08	0,09	0,09	0,10	0,09	0,08	0,07	0,09	0,09	0,79
8	There is already coordination between agencies in flood management in the upper and middle parts of the Landak Sub-watershed.	0,047	0,13	0,13	0,13	0,13	0,13	0,10	0,13	0,12	0,13	1,13
9	A revised spatial plan for flood-prone areas and riparian utilization.	0,042	0,11	0,11	0,12	0,10	0,12	0,06	0,11	0,12	0,09	0,94
	Total	**0,46**	**1,24**	**1,22**	**1,22**	**1,09**	**1,25**	**0,87**	**1,12**	**1,13**	**1,20**	

Table 16. QSPM Analysis Results for Weakness

No	IFAS	Weight	Strategy Formulation									Total TAS
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	
	Weakness		TAS	TAS	TAS	TAS	TAS	TAS	TAS	TAS	TAS	
1	Recurring flood events.	0,077	0,08	0,09	0,08	0,09	0,09	0,09	0,09	0,09	0,09	0,80
2	Weak coordination and supervision of environmental utilization by the government.	0,053	0,11	0,07	0,12	0,06	0,07	0,07	0,12	0,12	0,11	0,85
3	The RTRW that was created adjusted the vision and mission of the district.	0,055	0,07	0,07	0,08	0,12	0,07	0,11	0,11	0,11	0,12	0,85
4	BPBD's scope of work still follows the administrative area.	0,057	0,11	0,12	0,11	0,07	0,07	0,13	0,13	0,12	0,11	0,97
5	The role of TKPSDA in flood management and river maintenance has not been optimized.	0,058	0,11	0,12	0,12	0,11	0,07	0,07	0,10	0,13	0,11	0,93
6	Lack of socialization of local wisdom that is usually spoken from generation to generation	0,038	0,09	0,11	0,09	0,11	0,08	0,11	0,05	0,09	0,09	0,81
7	The flood early warning system has not run optimally.	0,069	0,14	0,12	0,12	0,14	0,09	0,08	0,14	0,15	0,09	1,06
8	Inter-agency coordination in flood management in the Landak Sub-watershed has not been integrated from upstream-middle and downstream.	0,063	0,08	0,08	0,08	0,12	0,08	0,07	0,11	0,12	0,14	0,87
9	Flood-prone zoning in the Landak Subwatershed is not yet available.	0,072	0,10	0,09	0,10	0,15	0,09	0,09	0,14	0,09	0,09	0,94
	Total	**0,54**	**0,89**	**0,86**	**0,89**	**0,95**	**0,71**	**0,83**	**1,00**	**1,02**	**0,94**	**8,09**

Table 17. QSPM Analysis Results for Opportunities

No	EFAS	Weight	Strategy Formulation									Total TAS
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	
	Opportunities		TAS	TAS	TAS	TAS	TAS	TAS	TAS	TAS	TAS	
1	Availability of green open space.	0,060	0,17	0,17	0,17	0,08	0,17	0,11	0,16	0,07	0,08	1,18
2	Creating conducive and environmentally sound land use.	0,059	0,16	0,16	0,16	0,07	0,16	0,10	0,16	0,07	0,07	1,12
3	Establishment of cooperation between administrative regions.	0,062	0,13	0,17	0,14	0,17	0,17	0,17	0,08	0,17	0,13	1,34
4	Disaster levels can be managed to a minimum.	0,062	0,17	0,18	0,16	0,17	0,18	0,17	0,17	0,18	0,17	1,56
5	Water resources management in the Landak sub-watershed can be organized.	0,060	0,07	0,16	0,07	0,17	0,16	0,16	0,14	0,12	0,08	1,13
6	People can utilize the land wisely.	0,057	0,15	0,13	0,16	0,07	0,15	0,13	0,16	0,07	0,07	1,1
7	Floods can be anticipated so as not to cause loss of life and property.	0,046	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	1,15
8	Increased support from provincial and central government for flood management	0,061	0,17	0,17	0,17	0,17	0,17	0,17	0,16	0,16	0,16	1,5
9	Flood zoning can be mapped.	0,062	0,17	0,14	0,12	0,17	0,17	0,13	0,13	0,17	0,16	1,36
	Total	**0,530**	**1,32**	**1,40**	**1,29**	**1,21**	**1,45**	**1,27**	**1,30**	**1,14**	**1,06**	

Table 18. QSPM Analysis Results for Threats

No	EFAS	Weight	Strategy Formulation									Total TAS
			S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	
	Threats		TS	TS	TS	TS	TS	TS	TS	TS	TS	
1	More and more land conversion to oil palm plantations and mining.	0,062	0,08	0,08	0,08	0,08	0,12	0,10	0,07	0,07	0,08	0,77
2	Much of the land development in the Landak Subwatershed is not in accordance with laws related to environmental protection and management and laws on disaster management.	0,057	0,07	0,07	0,07	0,07	0,08	0,07	0,10	0,12	0,11	0,76
3	Regional development often does not refer to the RTRW.	0,042	0,05	0,05	0,05	0,12	0,05	0,11	0,12	0,09	0,08	0,73
4	The Landak Subwatershed has an increasing risk of flooding which can slow down the development process.	0,063	0,07	0,07	0,08	0,08	0,07	0,07	0,08	0,08	0,08	0,67
5	At some points in the Landak Subwatershed there is silting of the river channel due to erosion and sedimentation and lack of	0,042	0,05	0,09	0,08	0,12	0,05	0,11	0,12	0,08	0,09	0,80
6	Local wisdom continues to erode along with the times.	0,042	0,11	0,09	0,08	0,05	0,08	0,10	0,05	0,05	0,05	0,68
7	There are casualties of life and property due to flood hazards in the Landak Subwatershed	0,042	0,09	0,10	0,10	0,06	0,06	0,09	0,05	0,05	0,09	0,69
8	Sub-watershed management including flooding is still oriented to the scale of the administrative area	0,058	0,08	0,07	0,08	0,07	0,08	0,08	0,08	0,08	0,08	0,69
9	Many settlements were built on riverbanks, and relocation was difficult.	0,062	0,08	0,08	0,07	0,07	0,08	0,07	0,08	0,13	0,08	0,73

Based on the highest TAS value for internal factors and the lowest TAS value for external factors, which are shown in the table, the fifth strategy, which is for the government to make flood zoning a top priority, is clear.

3.4 Determining the Strategy Timeframe with SFAS Analysis

a. Rating the weight values from the QSPM analysis, which is the average value of the TAS of internal and external factors for each strategy, the highest rating is 9, and the lowest is 1.
b. Enter the rating value based on the rank for strategies with the highest weight given a rating of 9 and strategies with the lowest weight given a rating of 1.
c. Calculate the score by multiplying the weight and rating, for example, for the first strategy, with a weight value of 0.115 and a rating of 7, multiply the weight by 7.

$$TAS = 0{,}115 \times 7 = 0{,}8$$

d. Do the same math for each strategy and determine the highest and lowest possible scores. As a result, the maximum score is 1.04, and the minimum score is 0.11.
e. Calculate the strategic factor analysis summary (SFAS) by subtracting the maximum value from the minimum value so that 0.94 is obtained.
f. Determine boundary values to define short-term, medium-term, and long-term strategies..
g. Lower limit value $= \frac{SFAS}{3} + Minimum$

$$= \frac{0{,}94}{3} + 0{,}11 = 0{,}42$$

h. Upper limit value = $Maximum - \frac{SFAS}{3}$

$$= 1{,}04 - \frac{0{,}94}{3} = 0{,}73$$

i. Obtained short-term limit value score < 0.42, medium-term limit value 0.42 < score < 0.73 and long-term limit value score > 0.73.

Table 19. Strategic Factor Analysis Summary Results

No	Strategy Formulation	Weight	Rating	Score	Short Term	Mid Term	Long Term
1	The government can make policies and regulations regarding the extent of buffer/infiltration areas that must be available.	0,115	7,00	0,80			
2	Local governments can make derivative regulations from laws related to environmental protection and management.	0,116	9,00	1,04			
3	The RTRW related to land use can be redrafted in an integrated manner between the upstream-middle and downstream areas of	0,113	5,00	0,57			
4	The government can make rules/MOUs regarding the working area of BPBDs in a river basin unit.	0,110	3,00	0,33			
5	The government can create Flood Zoning to support the policy.	0,113	6,00	0,68			
6	Improving the role of TKPSDA, especially in flood management and river maintenance	0,105	1,00	0,11			
7	Reapplying local wisdom that exists in the community.	0,116	8,00	0,93			
8	Redevelop the Landak Subwatershed flood early warning system (EWS) that is easy for the community to digest and socialize the flood EWS to all levels of society.	0,113	4,00	0,45			
9	The provincial government can formulate policies to improve flood management coordination in the Landak Subwatershed as a whole watershed unit that has not been well integrated.	0,109	2,00	0,22			
	Total	**1,01**	**MAX =**	**1,04**			
			MIN=	**0,11**			
			SFAS	**0,94**			
			Short Term		s.d. 0,42		
			Mid Term	0,43	- 0,73		
			Long Term		> 0,73		

4. Conclusion

From the research that has been done, it can be concluded that;

a. The W-O strategy is the best way to strengthen and implement flood management rules and policies in the Landak Sub-River Basin so that flooding is limited and not widespread. This strategy aims to improve the weaknesses of the Landak Sub-River Basin so that the opportunities can be fully utilized.
b. The best way to deal with floods in the Landak Sub-River Basin is for the government to make flood zones to support the policies that have already been made, like policies that make it easier to follow the rules that are already in place.
c. From the summary of the strategic factor analysis (SFAS), we obtained:
   1) Long-term strategy
      - The government can make policies and regulations regarding the extent of buffer/infiltration areas that must be available.
      - Local governments can make derivative regulations from laws related to environmental protection and management.
      - Re-applying local wisdom that exists in the community.
   2) Medium-term strategy
      - RTRW related to land use can be redrafted in an integrated manner between the upstream, middle, and

downstream areas of the Landak Sub-River Basin..

- The government can create flood zoning to support the policy made.
- Reassemble the Landak Sub-River Basin flood Early Warning System (EWS) so that the community can digest and socialize the flood EWS to all levels of society.

3) Short-term strategy
   - The government can make rules or MOUs regarding the working area of BPBDs in a river basin unit.
   - Improve the role of TKPSDA, especially in flood management and river maintenance.
   - The provincial government can make policies to improve flood management coordination in the Landak Sub-River Basin, a river basin unit that has not been well integrated.

d. The results of the strategy analysis can be considered, but local stakeholders need to conduct a deeper study so that the strategy strategies implemented are more optimal.

e. The applied strategy needs to be adjusted and evaluated in the future because, in its development, it will always experience changes.

f. Institutions that deal with water resources and disaster management need to work together in a comprehensive and integrated way in the Landak Sub-River Basin so that flood control measures can be done better.

g. The strategic issues determined based on FGDs in this study do not include all flood management activities such as normalization, erosion and sedimentation control, flow diversion, and others, so if this research is to be continued, it is recommended to include these activities as variables to be taken into account..

5. References

Ashley Richard, Gersonius Berry, and Horton Bruce. (2020). **Managing flooding: from a problem to an opportunity**. Phil. Trans.R. Soc. A.3782019021420190214

Glago, Frank Jerome. (2022). **Flood Disaster Hazards; Causes, Impacts, and Management: A State-of-the-Art Review**. Natural Hazard. Edited by Ehsan Noroozinejad Farsangi.

Grama, V.; Avanzi, A.; Nistor-Lopatenco, L. (2021). **SWOT Principle In Flood Risk Management**. Journal of Engineering Science Vol. XXVIII, no. 2 (2021), pp. 125-137.

Handayani, I Gusti Ayu Ketut Rachmi; Glaser, Henning; Palil, Mohd Rizal; Najicha, Fatma Ulfatun; Akhmadian, Suwari . (2017). **Flood Management In Jakarta: Reconstruction Of Jabodetabek Eight Priority Watershed Regulations.** South East Asia Journal of Contemporary Business, Economics and Law, Vol. 14, Issue 4 (December). ISSN 2289-1560.

Jafar, A; Sakke, N; Mapa, T; Kumalah, J. (2022). **Flood Risk Management: An Integrated Approach In Sustaining Human And Environmental Surrounding**. International Journal of Mechanical Engineering. Vol. 7 (Special Issue 4, 2022).

Junaidi, A.; Nurhamidah; Daoed, D. (2018). **Future flood management strategies in Indonesia**. MATEC Web of Conferences, 229.

Liu, Z.; Cai, Y.; Wang, S; Lan, F.; and Wu, X. (2020). **Small and Medium-Scale River Flood Controls in Highly Urbanized Areas: A Whole Region Perspective**. Water 2020, 12, 182; doi:10.3390/w12010182

P. Sayers, Y. L.i, G. Galloway, E. Penning-Rowsell, F. Shen, K. Wen, Y. Chen, and T. Le Quesne. (2013). **Flood Risk Management: A Strategic Approach**. Paris, UNESCO.

Pazouki, M.; Jozi, S.A.; Ziari, Y.A. (2017). **Strategic management in urban environment using SWOT and QSPM model**. Global J. Environ. Sci. Manage., 3(2): 207-216, Spring 2017

Rabsanjani, G. R., Akbar, A. A., & Herawati, H. (2022). **Valuasi Dampak Banjir Di Kabupaten Landak, Kalimantan Barat**. Jurnal Ilmu Lingkungan, 20(1), 65-75.

Radhakrishnan, Mohanasundar; Pathirana, Assela; Zevenbergen, Chris. (2020). **Capturing the changing dynamics between governmental actions across plausible future scenarios in urban water systems**. Sustainable Cities and Society 62:102318.

Soeryamassoeka (a), S.B.; Irwansyah , M., Azhar; Kartini; Herawati, H; Siahaan, Sarma; Mukti, Elsa Tri; Herwani. (2022). **Pengaruh Perubahan Tata Guna Lahan Terhadap Debit Aliran di Bagian Hulu Wilayah Sungai Kapuas**. Penerbit Top Indonesia, ISBN: 978-623-6403-62-4.

Soeryamassoeka (b), S.B.; Kartini; Herawati, H; Irwansyah, M., Azhar. (2022). **Pengelolaan Banjir Terpadu di Kalimantan Barat (Studi Kasus: DAS Landak)**. Laporan Akhir Penelitian Kerjasama Badan Penelitian dan Pengembangan Provinsi Kalimantan Barat dengan Lembaga Penelitian Universitas Tanjungpura.

Sumiarsih, Ni Made; Legono, DJoko; Kodoatie, Robert, J. (2018). **Strategic Sustainable Management for Water Transmission System: A SWOT-QSPM Analysis**. Journal of the Civil Engineering Forum. Vol. 4 No.1 (January 2018).

Tariq, Muhammad Atiq Ur Rehman; Farooq, Rashid; and Van de Giesen, Nick. (2020). **A Critical Review of Flood Risk Management and the Selection of Suitable Measures**. Applied Sciences Journal. 2020, 10(23), 8752.

Wei, Ding; Wu, Jidong; Tang, Rumei; Chen, Xiaojuan; Xu, Yingjun. (2022). **A Review of Flood Risk in China during 1950–2019: Urbanization, Socioeconomic Impact Trends and Flood Risk Management**. Water 2022, 14, 3246.