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Flood Mitigation Priority Strategy to Reduce Community Vulnerability in the Downstream Area of Setail Watershed, Banyuwangi

Gigik Nurbaskoro[1], Indarto[2,✉], Elida Novita[2], Mohamad Wawan Sujarwo[2]

[1] Master of Agricultural Water Resources Management Study Program, University of Jember, INDONESIA.

[2] Department of Agricultural Engineering, University of Jember, INDONESIA.

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Corresponding Author:
✉ indarto@fateta.unej.ac.id
(Indarto)

ABSTRACT

Floods that frequently occur in the downstream area of Setail Watershed have caused significant damage to infrastructure, community livelihoods, and social systems in the region. This condition demands the implementation of effective and sustainable mitigation strategies to reduce flood risks and impacts. This study aims to determine priority flood mitigation strategies to reduce community vulnerability in the downstream area of the Setail Watershed. The identification of mitigation criteria was first conducted through interviews with flood-affected communities to capture relevant local factors. These criteria were then discussed with disaster mitigation experts and stakeholders, and the results of the questionnaires were analyzed using the Analytical Hierarchy Process (AHP) method to evaluate and rank the mitigation strategies. The results show that the three main priority strategies are flood risk mapping with a score of 0.22, community education and awareness with a score of 0.18, and zoning and spatial planning with a score of 0.15. These strategies are expected to serve as the basis for the preparation of local government action plans to minimize future flood impacts and enhance community resilience and well-being.

1. INTRODUCTION

Flood is a frequent natural disaster with significant impacts, particularly in the downstream areas of the Setail Watershed, Banyuwangi. Based on data from the Regional Disaster Management Agency of Banyuwangi, flood frequency has increased sharply over the past decade, with the worst incident occurring in 2024, causing widespread social and economic impacts, including the destruction of over 1,200 homes (BPBD, 2025). In addition to physical damage of infrastructure and settlements, flood also disrupts economic activity, particularly the dominant farm sector in the region (BPS, 2024). A study by Isia *et al.* (2023) also emphasized that social and economic vulnerability are critical factors that must be considered in flood mitigation planning.

Many studies on flood mitigation have been conducted in various regions, with many focusing on structural engineering approaches and risk mapping (Fernández-Nóvoa *et al*., 2024; Saad *et al*., 2024). However, studies on integrating socio-economic and environmental aspects in a structured multi-criteria assessment are still limited (Vargas *et al*., 2023; Lespez *et al*., 2025), particularly in the context of the downstream Setail Watershed. The use of the Analytical Hierarchy Process (AHP) method to prioritize flood mitigation strategies has been widely applied with effective results (Mokhtari *et al*., 2023; Nugraha *et al*., 2025), but the integration of community participation as stakeholders has not received much attention in the local context (Rahman *et al*., 2024; Samiri *et al*., 2024).

Research combining the AHP method with participatory approaches such as discussions with experts and stakeholders can provide a more comprehensive and adaptive approach to local conditions (Caporale & Rinaldi, 2025;

Kramar & Sternad, 2025). Studies by Agrawal *et al*. (2025) and Kapucu *et al*. (2024) emphasize the importance of community involvement in mitigation planning to encourage sustainable implementation responsive to social and environmental changes.

This study aims to determine priority on flood mitigation strategies to reduce community vulnerability in the downstream of Setail Watershed area, Banyuwangi, using the multi-criteria AHP approach combined with the active participation of the community and local stakeholders. The study is expected to produce recommendations that are not only based on technical aspects but also consider social, economic, and environmental dynamics, thereby increasing community resilience to flooding. This approach also fills the gap in the literature regarding holistic and contextual flood mitigation priority modeling (Slinger *et al*., 2023; Torres-García *et al*., 2025).

2. MATERIALS AND METHODS

The research was conducted from July to December 2024 in several flood-prone villages, including Cluring, Purwoharjo, Tegaldlimo, and Muncar Districts, with Wringinputih Village as the primary study location (Figure 1). Geographically, the Setail Watershed covers 295 km², with a 49.5 km-long main river flowing from the upstream area (Songgon, Glenmore, Kalibaru) to the estuary in Muncar District (Dinas PU Jawa Timur, 2022). The downstream area of the watershed is dominated by irrigated rice fields, densely populated settlements, and some plantations. The primary soil type is fluvisol, which is prone to erosion and surface runoff (Kanianska *et al*., 2022). Average annual rainfall reaches 1422 mm/year, with the highest intensity occurring in December–February. A map of the research location was created using ArcGIS to show the hydrological boundaries of the watershed, river network, and the locations of the villages selected for the study.

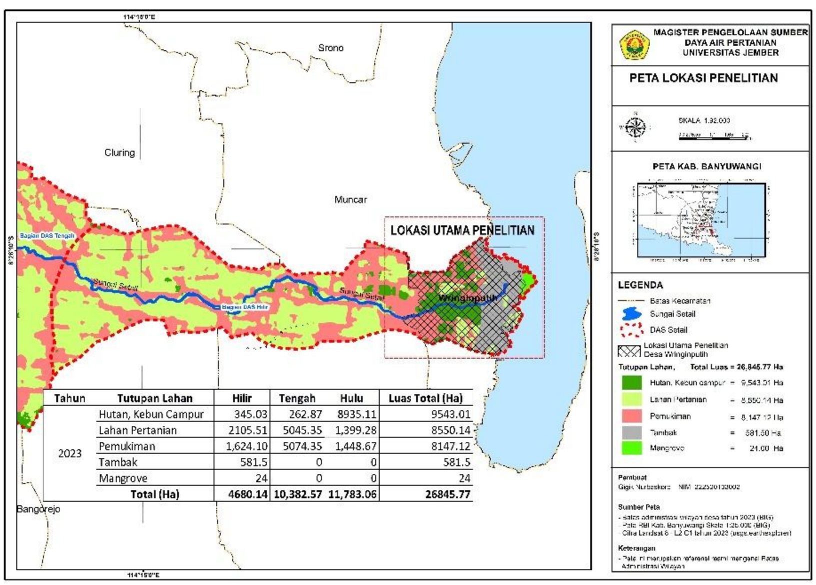

Figure 1. Map of the research location (within square box with dotted side lines)

2.2. Methods

This research employed a mixed methods approach (quantitative and qualitative) to analyze flood mitigation strategies and reduce community vulnerability in the downstream of Setail Watershed, Banyuwangi Regency. The quantitative approach was used to determine flood distribution and community vulnerability levels through surveys, question-naires, and spatial analysis. The qualitative approach explored community experiences and formulated locally based mitigation strategies through in-depth interviews and discussions with stakeholders and experts.

Primary data was obtained through field observations, questionnaires, and interviews with community members and experts. Observations were conducted in eight flood-affected villages to document physical conditions such as drainage, embankments, and surface flow patterns. The number of respondents was determined using the Slovin formula as in Equation (1). With a population of 93,065 and a 10% margin of error, 100 respondents were required.

$$n = \frac{N}{1+Ne^2} \tag{1}$$

Respondents were then distributed into 8 villages (Figure 2), proportional to population of each village. For example, Purwoharjo Village received 12 respondents, Sumberberas Village received 21 respondents, and Wringinputih Village received 15 respondents. In each village, respondents were selected using a purposive sampling technique by considering factors such as flood exposure, residential experience, and involvement in mitigation activities. The respondent profile shows that the majority were aged 41–50 years, with 80% male and 20% female, and the main livelihoods were farmers (54%), fishermen (20%), and the rest were traders or informal workers.

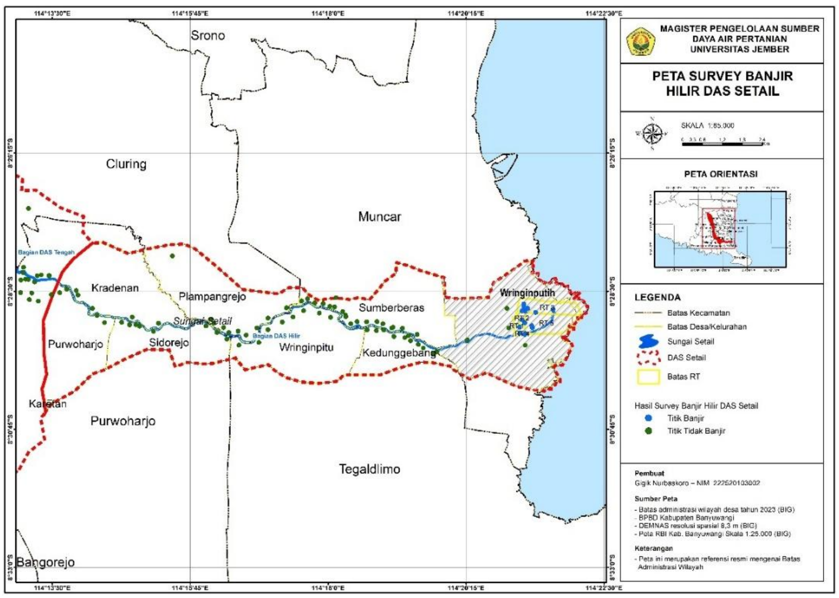

Figure 2. Flood survey map (research location is indicated by the shaded area.)

In-depth interviews were conducted with five experts from the Banyuwangi Regional Disaster Mitigation Agency (BPBD), the Banyuwangi Public Works and Irrigation Agency (PUI) for Infrastructure, the Juanda Meteorology, Climatology, and Geophysics Agency (BMKG) for Extreme Weather Early Warning, the Wringinputih Village Head, and a lecturer in Water Resources from Polytechnic of Banyuwangi. Secondary data was obtained from the Statistics Indonesia (BPS), village profile reports, and literatures. Flood locations were identified through coordination with village officials and measured using GPS. Next, spatial data was analyzed using the Inverse Distance Weighted (IDW) method to estimate the extent and depth of floodwater (Berens *et al*., 2021; Karmegam *et al*., 2021).

Flood vulnerability was analyzed based on indicators from BNPB Regulation No. 2 of 2012, which comprises four dimensions: social (weighted 0.4), economic (0.25), physical (0.25), and environmental (0.1) (BNPB, 2012). Scoring was applied to each indicator and then integrated to produce a flood vulnerability map divided into three classes (low, medium, and high). Spatial mapping was performed using ArcGIS 10.8 to illustrate the distribution of vulnerability in the study area.

Flood mitigation priority strategies were analyzed using the Analytical Hierarchy Process (AHP) method (Mokhtari *et al*., 2023). The Analytical Hierarchy Process (AHP) is a decision-making method developed by Thomas L. Saaty to solve complex problems with multiple criteria by decomposing them into a structured and logical hierarchy. The AHP method was used to determine the most relevant priority flood mitigation strategies in the study area, both structural and non-structural (Saaty & Vargas, 2001). The analysis stages included:

a. *Determining Mitigation Criteria.* Criteria such as structural and non-structural mitigation are used to determine the priority scale for flood mitigation measures, namely river embankment construction, river rehabilitation, drainage channel construction, zoning and spatial planning, flood risk mapping, flood early warning system, and public education and awareness. Each criterion is then analyzed based on expert and stakeholder opinions.

b. *Weighting with AHP.* Weighting each mitigation criterion is performed based on pairwise comparisons. The final weights obtained indicate the priority of the most effective mitigation strategy according to the needs and conditions in the Setail Watershed.

c. *Creating a hierarchical structure*. Beginning with the problem to be resolved, which must be described according to criteria and alternatives, then arranged into a hierarchical structure (Szabo *et al*., 2021).

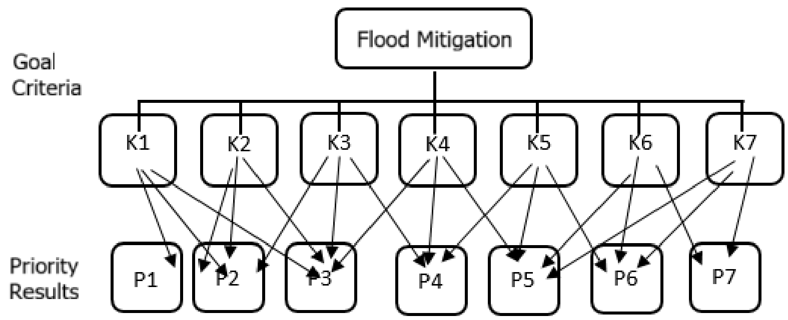

Figure 3. Flood mitigation hierarchical structure

Searching for eigenvalues between criteria is used to determine the ranking of existing criteria. To obtain the criteria's eigenvalues, a questionnaire survey is first conducted with selected respondents.

1. *Criteria Assessment Using a Comparison Scale*. An assessment is conducted using a comparison scale for each existing criterion to determine the level of importance of one criterion relative to the others. The assessment of criteria and alternatives using a comparison scale was shown in Table 1.

Table 1. Important intensity rating scale (Saaty, 1990)

Importance Intensity	Description
1	Both elements are equally important
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is clearly more strongly important than the other
9	One element is absolutely more important than the other
2, 4, 6, 8	Mean values between two adjacent judgments are used

2. *Compiling a Reciprocal Matrix of Criteria*. Criteria that have been assessed using a comparison scale are then arranged in a reciprocal matrix. The AHP calculation method uses a comparison matrix (reciprocal): if $Aij = a$, then $Aji = 1/a$. Pairwise comparisons begin at the top of the hierarchy, aimed at selecting criteria, then select the elements to be compared, for example, A, B, and C, as shown in the matrix in Table 2.

Table 2. Pairwise comparison matrix (Saaty, 1990)

Criteria	A	B	C
A	1		
B		1	
C			1

3. *Priority Eigenvector Calculation*. Eigenvector values were calculated to indicate the importance ranking of the existing criteria and sub-criteria by normalizing the pairwise comparison matrix data. Then, the consistency index (*CI*) was calculated using Equation (3), and then tested to find consistency ratio (*CR*) using Equation (2), where *RI* is the random consistency index. If $CR \leq 0.1$ is obtained, the results are considered consistent. Conversely, if *CR* value ≤ 0.1, then the pairwise comparison assessment needs to be repeated.

$$CI = \frac{\lambda maks - n}{n-1} \tag{3}$$

$$CR = \frac{CI}{RI} \tag{4}$$

where *CR* is consistency index, *CI* is consistency index, and *RI* is random consistency index. The *RI* values was listed in Table 3 (Saaty, 1990). Once consistent eigenvalues are obtained, the ranking of each criterion can be determined.

Table 3. Values of random index *RI* according to matrix size *n* (Saaty, 1990)

Matrix Size (n)	Random Index (RI)	Matrix Size (n)	Random Index (RI)
1, 2	0.00	9	1.45
3	0.58	10	1.49
4	0.90	11	1.51
5	1.12	12	1.48
6	1.24	13	1.56
7	1.32	14	1.57
g	1.41	15	1.59

4. *Priority Eigenvalues*. Repeat step 3 for each mitigation alternative to obtain the priority eigenvalues .

5. *Geometric Mean* (*Geomean*) *Matrix*. Once the matrix from expert is compiled, the next step is to calculate the geometric mean (geomean) for each element in the pairwise comparison matrix. The geomean calculation was performed using the nth square root formula of the product of the values for each element, where n is the number of experts.

$$Geomean = (x_i . x_2 . x_3 . \dots . x_n)^{\frac{1}{n}} \tag{5}$$

where $x_i, x_2, x_3, \dots . x_n$ are the scores from each expert on a particular element and *n* is the number of experts (in this case, $n = 5$).

6. *Correlate Reasons Criteria and Mitigation Alternatives*. Reason criteria and mitigation alternatives are linked through a multiplication process between the priority vectors of each criterion. The results of this process form the final model in the AHP analysis, which is structured based on the solution formula described by Saaty (1990):

$$M = [\{X_m^n\}] \times \{Y_n\} \tag{6}$$

$$M = [\{X_m^1 \times Y_1\} + \{X_m^2 \times Y_2\} + \{X_m^3 \times Y_3\} + \cdots + \{X_m^n \times Y_n\}] \tag{7}$$

where *M* is flood mitigation alternative, *X* is summary of priority vectors from mitigation selection based on reason criteria (constant), and *Y* is reason criteria (variable).

AHP data processing was performed using Microsoft Excel software, while spatial maps were created using ArcGIS 10.8. The AHP method was chosen because it has been widely used in flood mitigation research, such as in Ethiopia (Mulu *et al*., 2025; Ajin *et al*., 2025), Nepal (Chaudhary *et al*., 2024), and Ghana (Kabenla *et al*., 2024), which demonstrated its effectiveness in prioritizing multi-criteria-based strategies. Therefore, this research methodology is designed in a transparent, measurable, and literature-based manner, thus providing a scientific contribution to the formulation of flood mitigation strategies in the downstream Setail watershed. Figure 4 shows overall stages performed to accomplish this research.

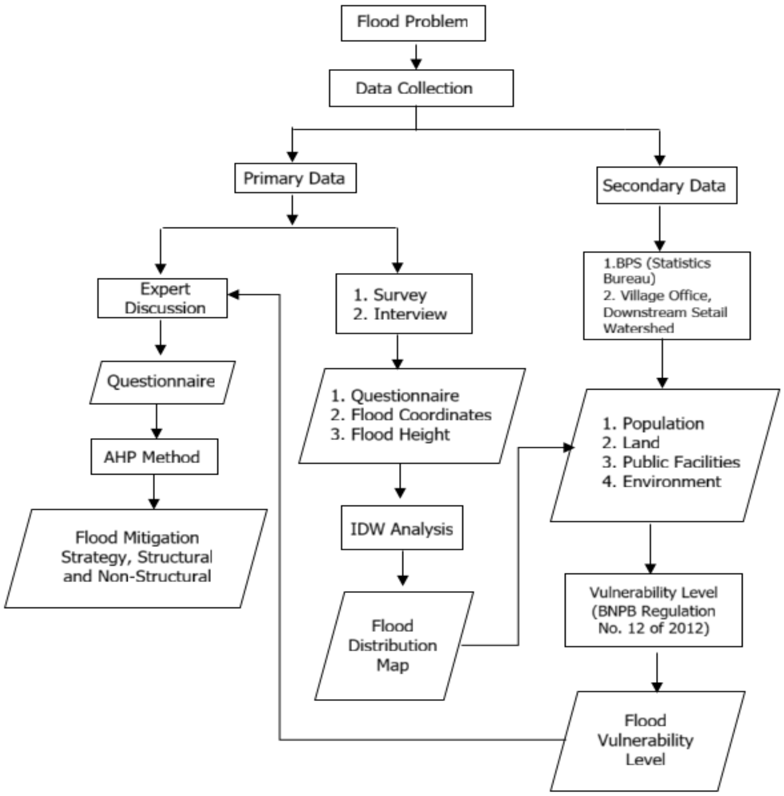

Figure 4. Flowchart to complete the research steps

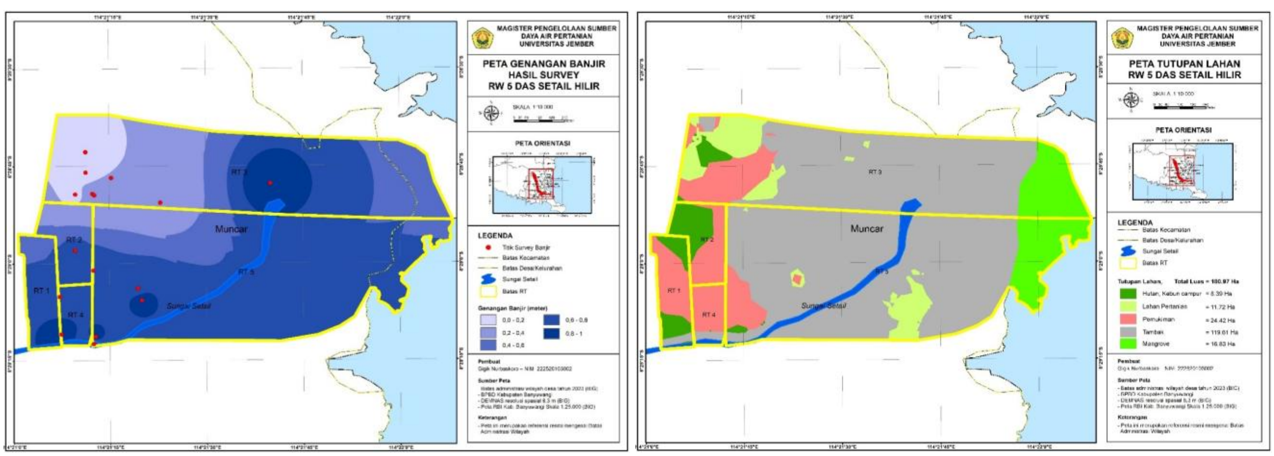

Figure 5. (a) Flood inundation map based on field survey, (b) Land cover map on the downstream of Setail Watershed

3. RESULTS AND DISCUSSION

3.1. Distribution of Flood Inundation

The results of field survey data processing using the Inverse Distance Weighting (IDW) interpolation method in GIS software produced a spatial map of the distribution of flood inundation height in RW 5, Wringinputih Village (Figure 5a, Table 4). This map shows variations in inundation depth across five neighborhood units (RT-1 to RT-5). The most widespread inundation depth was 0.8–1 m, particularly in RT-3 and RT-5, which are adjacent to the Setail River. This indicates that areas near the river are at a higher risk of inundation than areas further away.

Table 4. Population data and flood-affected areas in Wringinputih Village

No	Vulnerability Indicator	RT-1	RT-2	RT-3	RT-4	RT-5
1	Population density	1,211 / Km^2	1,364 / Km^2	339 / Km^2	1,538 / Km^2	240 / Km^2
2	Male population	57 people	56 people	78 people	37 people	49 people
3	Female population	49 people	52 people	74 people	31 people	46 people
4	Sex ratio	101 %	108 %	105 %	119 %	107 %
5	Poor population	3 people	5 people	10 people	2 people	3 people
6	Poverty ratio	2.94 %	4.63 %	6.58 %	2.94 %	3.16 %
7	Population with special needs	1 person	2 people	2 people	0	0
8	Disabled population ratio	0.98 %	1.85 %	1.36 %	0 %	0 %
9	Vulnerable population	27 people	29 people	32 people	19 people	26 people
10	Vulnerable population ratio	26 %	27 %	21 %	28 %	27 %
11	Productive agricultural land	1.2 Ha	1 Ha	2.5 Ha	0 Ha	1 Ha
12	Productive plantation land	2.4 Ha	4 Ha	2 Ha	1 Ha	800 m^2
13	Productive fishponds	0 Ha	0 Ha	5 Ha	0 Ha	11 Ha
14	Productive land value	Rp. 114 M	Rp. 148 M	Rp. 182 M	Rp. 27 M	Rp. 204 M
15	Residential houses	35	38	54	20	31
16	Public facilities	1	2	1	0	0
17	Critical facilities	3	3	3	4	2
18	Mangrove forest	0 Ha	0 Ha	8 Ha	0 Ha	9 Ha
19	Swamp	0 Ha	0 Ha	2 Ha	0 Ha	8 Ha
20	Shrubs	0 Ha	0 Ha	0 Ha	0 Ha	2 Ha

3.2. Land Cover and Affected Areas

The land cover map downstream of the Setail Watershed (Figure 5b) shows that flooding not only impacted residential areas but also extended to agricultural land, plantations, fish ponds, and mangrove areas. Neighborhood Associations (RT) 3 and 5, for example, have significant areas of fish ponds and mangroves, while RT 1 and 2 are predominantly densely populated. This finding is important because it indicates that flooding has implications not only for social aspects but also for the community's productive land-based economic resilience.

3.3. Flood Vulnerability Analysis

a. Social Vulnerability

Analysis based on the existing regulation (BNPB, 2012) shows that RT-1, RT-2, and RT-4 have the highest social vulnerability score (0.732) and are categorized as high (Table 5). This is influenced by the high population density, resulting in a much greater potential impact of flooding on the population. Meanwhile, RT-3 and RT-5 have a score of 0.364, categorized as medium. This condition shows that demographic factors are still the main determinant of high social vulnerability. This is in line with the research results of Ajin *et al*. (2025) which emphasized the role of population density in flood vulnerability in tropical regions.

Table 5. Social vulnerability score

No	Area	0.6* Population Density	0.1*Sex Ratio	0.1*Poverty Ratio	0.1*Disability Ratio	0.1*Age Group Ratio)	Social Vulnerability	Class
1	RT-1	0.6	0.033	0.033	0.033	0.033	0.732	High
2	RT-2	0.6	0.033	0.033	0.033	0.033	0.732	High
3	RT-3	0.198	0.033	0.033	0.033	0.067	0.364	Medium
4	RT-4	0.6	0.033	0.033	0.033	0.033	0.732	High
5	RT-5	0.198	0.033	0.033	0.033	0.067	0.364	Medium

b. Economic Vulnerability

Table 6 shows that most areas fall into the moderate category (0.402–0.600), except for RT 04, which falls into the low category (0.198). This moderate level of economic vulnerability indicates the community's dependence on productive land that is prone to flooding. However, because Gross Regional Domestic Product (GRDP) data is not available at the village level, the economic analysis is still limited to productive land indicators. This limitation is noteworthy as it can impact the accuracy of the results.

Table 6. Economic vulnerability score

No	Area	(0.6 * Productive Land Score)	(0.4 * GRDP Score)	Economic Vulnerability	Class
1	RT01	0.6	-	0.600	Medium
2	RT02	0.6	-	0.600	Medium
3	RT03	0.402	-	0.402	Medium
4	RT04	0.198	-	0.198	Low
5	RT05	0.6	-	0.600	Medium

c. Physical Vulnerability

The physical aspect shows significant variation in scores (Table 7). RT-5 received the highest score of 1.000 (high), influenced by the high number of houses, public facilities, and critical facilities exposed to flooding. RT-1 and RT-2 also fall into the high category (0.802), while RT-3 (0.466) and RT-4 (0.598) fall into the moderate category. This confirms that flooding in the Setail Watershed has the potential to disrupt public services such as health facilities, education, and basic infrastructure.

Table 7. Physical vulnerability score

No	Area	(0.4 * Housing Score)	(0.3 * Public Facilities Score)	(0.3 * Critical Facilities Score)	Physical Vulnerability	Class
1	RT01	0.400	0.201	0.201	0.802	High
2	RT02	0.400	0.201	0.201	0.802	High
3	RT03	0.268	0.099	0.099	0.466	Moderate
4	RT04	0.400	0.099	0.099	0.598	Moderate
5	RT05	0.400	0.300	0.300	1.000	High

d. Environmental Vulnerability

Environmental analysis shows that all areas have a low level of vulnerability 0.033–0.267 (Table 8). This is due to the absence of protected or natural forests, as well as limited natural vegetation cover. However, despite the low score, the minimal vegetation actually indicates the ecosystem's weak flood mitigation capacity. In other words, environmental aspects do not contribute significantly to the vulnerability index, but they have the potential to exacerbate the impact of flooding in the long term.

Table 8. Environmental vulnerability score

No	Area	(0.3 * Protected Forest Score)	(0.3 * Natural Forest Score)	(0.1 * Mangrove Forest Score)	(0.1 * Shrub Score)	(0.2 * Swamp Score)	Environmental Vulnerability	Class
1	RT01	0	0	0.000	0.033	0.000	0.033	Low
2	RT02	0	0	0.000	0.033	0.200	0.233	Low
3	RT03	0	0	0.033	0.033	0.066	0.132	Low
4	RT04	0	0	0.000	0.033	0.000	0.033	Low
5	RT05	0	0	0.100	0.033	0.134	0.267	Low

Table 9. Flood vulnerability score

No	Area	Social Vulnerability (0.4)	Economic Vulnerability (0.25)	Physical Vulnerability (0.25)	Environmental Vulnerability (0.1)	Flood Hazard Vulnerability	Class
1	RT01	0.732	0.600	0.802	0.033	0.6466	Moderate
2	RT02	0.732	0.600	0.802	0.233	0.6666	Moderate
3	RT03	0.364	0.402	0.466	0.132	0.3758	Low
4	RT04	0.732	0.198	0.598	0.033	0.4951	Moderate
5	RT05	0.364	0.600	1.000	0.200	0.5656	Moderate

e. Flood Vulnerability

The integration of all aspects shows that the majority of RW 5 falls into the moderate category, with scores between 0.4951–0.6666 (Table 10, Figure 6). RT 02 recorded the highest score of 0.6666 (moderate–high), followed by RT 01 (0.6466) and RT 05 (0.5656). Meanwhile, RT 03 scored relatively lower, with a score of 0.3758 (low). This means that mitigation efforts should focus primarily on RT 01 and RT 02 as priority intervention locations.

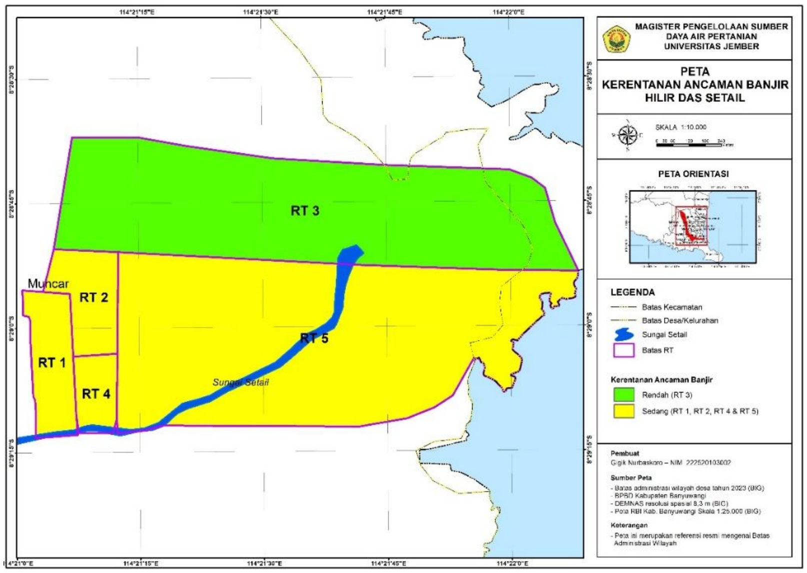

Figure 6. Flood hazard vulnerability map

Table 10. Summary of flood mitigation priorities according to residents in Wringinputih Village

No	Respondent	Mitigation Criteria*									
		K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
1	Sarengat	1	1		1						
2	Jarkni	1		1		1		1			1
3	Suharsi	1		1		1		1		1	1
4	Sokirin	1	1	1	1	1		1		1	1
5	Mrs. Suharto	1		1		1		1		1	1
6	Supeno	1	1	1	1	1	1	1		1	1
7	Andi	1	1	1				1		1	1
8	Eni	1			1		1				
9	Ponijan	1		1							
10	Riyan Suyitno	1		1		1				1	
11	Mrs. Musirah	1	1				1	1			1
12	Mrs. Painten	1	1	1			1				
13	Mr. Aris (village head)				1	1		1		1	1
14	Mr. Purwanto	1		1							1
15	Mr. Wahyudi	1	1	1						1	1
	Total†	14	7	11	5	7	4	8	0	8	10

*) K1 = River embankment construction; K2 = River rehabilitation and dredging; K3 = Drainage channel construction; K4 = Reforestation; K5 = Flood risk mapping; K6 = Construction of trash bins on riverbanks; K7 = Flood early warning system; K8 = Relocation of affected residents; K9 = Zoning and spatial planning; K10 = Public education and awareness. †) Criteria with total score ≥ 7 were selected to be further analyzed

3.4. Mitigation Strategy Analysis Using AHP

Based on interviews and questionnaires completed by Wringinputih villagers (Table 10), seven alternative mitigation strategies were selected to be further analyzed. These 7 criteria along with the type of vulnerability reduction are detailed in Table 11. In addition to the assessment by the general public, in the context of the downstream flood mitigation criteria for the Setail Watershed, the analysis of the 7 selected criteria was also conducted through interviews and discussions with five experts. They are (1) Head of Wringinputih Village, (2) Head of BPBD Banyuwangi Regency, (3) Head of the Juanda Meteorological Station Class 1 (Sidoarjo), (4) Head of Operations and Maintenance, Public Works and Irrigation Agency, Banyuwangi Regency, and (5) Faculty member of Banyuwangi State Polytechnic, especially one who is specializing in watershed hydrology. During the interviews, the experts wrote down their choices in a paired questionnaire matrix, resulting in flood mitigation strategies that served as criteria for developing the Analytic Hierarchy Process (AHP).

Table 11. Flood mitigation strategy categories

Criteria	Description	Category of Vulnerability Reduction
K1	River Embankment Construction	Physical
K2	River Rehabilitation and Dredging	Economic
K3	Drainage Channel Construction	Physical
K5	Zoning and Spatial Planning	Environmental
K7	Flood Risk Mapping	Physical
K9	Flood Early Warning System	Social
K10	Community Education and Awareness	Social

These seven criteria were selected because they complement each other in reducing community vulnerability to flooding, both through structural (K1-K3) and non-structural (K5-K10) approaches. After completing the questionnaire, a pairwise comparison matrix was compiled, depicting the relative importance of each factor based on expert assessments. This matrix served as the basis for analysis using the Analytical Hierarchy Process (AHP) method to determine the priority weighting of each factor. The resulting comparison matrix was further processed to ensure consistency, calculate eigenvalues, and determine the final priority of each identified factor. The pairwise comparison matrix processing results show a CR value of 0.009, less than 0.1, thus consistent. Table 12 presents the Geomean matrix from the five experts, whereas Table 13 presents the matrix normalization to determine the weights and eigenvalues.

Table 12. Geomean matrix for five experts

	K1	K2	K3	K5	K7	K9	K10
K1	1	0.36	0.57	0.52	0.33	0.50	0.41
K2	2.75	1	0.87	1.06	0.46	0.68	0.56
K3	1.75	1.15	1	0.79	0.64	1.04	0.53
K5	1.93	0.94	1.27	1	0.47	0.94	1.48
K7	3.00	2.19	1.55	2.14	1	1.15	1.06
K9	2.00	0.68	0.96	1.06	0.87	1	0.87
K10	2.46	1.78	1.89	0.67	0.94	1.15	1
TOTAL	14.90	8.10	8.12	7.24	4.72	6.45	5.91

Table 13. Matrix normalization

	K1	K2	K3	K4	K5	K6	K7	Total	Priority / Weight	Eigen Value
K1	0.07	0.04	0.07	0.07	0.07	0.08	0.07	0.47	0.07	1.00
K2	0.18	0.12	0.11	0.15	0.10	0.10	0.09	0.86	0.12	0.99
K3	0.12	0.14	0.12	0.11	0.14	0.16	0.09	0.88	0.13	1.02
K4	0.13	0.12	0.16	0.14	0.10	0.146	0.25	1.04	0.15	1.07
K5	0.20	0.27	0.19	0.30	0.21	0.18	0.18	1.53	0.22	1.03
K6	0.13	0.08	0.12	0.15	0.18	0.15	0.15	0.97	0.14	0.89
K7	0.17	0.227	0.23	0.09	0.20	0.18	0.17	1.26	0.18	1.06
TOTAL	1	1	1	1	1	1	1	7	1	7.07

3.5. Consistency Calculation Results

Based on the calculation results, the following results were obtained, namely CI = 0.0120, RI = 1.32, and CR = 0.0091. The CR value is less than 0.1, so the matrix is considered consistent and acceptable. Table 14 shows the ranking of flood mitigation strategies based on priority or weight values. These results indicate that non-structural strategies are prioritized over structural strategies. Non-structural strategies are considered more effective because they can increase community capacity to cope with flooding at a relatively lower cost. These findings are consistent with studies (Mulu *et al*., 2025) in Ethiopia and (Kabenla *et al*., 2024) in Ghana, which showed that spatial planning-based strategies and community education were more sustainable than infrastructure interventions alone.

Table 14. Criteria ranking

Criteria	Description	Priority / Weight	Ranking
K1	River Embankment Construction	0.07	7
K2	River Rehabilitation and Dredging	0.12	6
K3	Drainage Channel Construction	0.13	5
K5	Zoning and Spatial Planning	0.15	3
K7	Flood Risk Mapping	0.22	1
K9	Flood Early Warning System	0.14	4
K10	Community Education and Awareness	0.18	2

Therefore, in determining flood mitigation strategies in the downstream Setail Watershed area, using the Analytic Hierarchy Process (AHP) method, which involved discussions with five experts, the following priority rankings were obtained for each alternative strategy, including: (1). Flood risk mapping, (2). Public education and awareness, (3). Zoning and spatial planning, (4). Flood early warning system, (5). Drainage channel construction, (6). River rehabilitation and dredging, and (7). River embankment construction. This priority ranking reflects the relative importance of each strategy based on expert assessments, which can then be used as a reference in formulating the most effective mitigation measures appropriate to field conditions.

3.6. Implications of the Research Findings

The results of this study provide several important implications for local government, local community, and academic community. For local governments, the AHP priority weights can form the basis for planning mitigation programs, for example by integrating flood risk maps into the Banyuwangi Regency Spatial Plan (RTRW) and strengthening the role of the BPBD in disaster awareness campaigns. For communities, these results emphasize the importance of active involvement in disaster education, drainage maintenance, and community-based early warning systems. For academics, this study provides empirical evidence of the dominance of social and physical aspects in increasing flood vulnerability, while emphasizing the role of non-structural strategies in mitigation.

4. CONCLUSIONS AND SUGGESTIONS

Based on the analysis of flood vulnerability levels in Wringinputih Village, downstream of the Setail Watershed, the results show that vulnerability level of the community is in the low to moderate category in accordance with the Regulation BNPB Head No. 2 of 2012. However, the economic vulnerability indicator that uses GRDP in the regulation still has limitations because it is not yet available at the sub-district or village level, so alternative indicators that are more representative at the local level are needed. 2. The results of the flood mitigation strategy analysis using the Analytic Hierarchy Process (AHP) method involving five experts indicate that the priority order of mitigation strategies is as follows (from the most): (1) Flood risk mapping (0.22, ranked 1), (2) Public education and awareness (0.18, ranked 2), (3) Zoning and spatial planning (0.15, ranked 3), (4) Flood early warning system (0.14, ranked 4), (5) Drainage channel construction (0.13, ranked 5), (6) River rehabilitation and dredging (0.12, ranked 6), and (7) River embankment construction (0.07, ranked 7). These findings confirm that non-structural strategies such as risk mapping, community capacity building, and spatial planning are given higher weight than structural strategies. Thus, a community-based approach and spatial governance are key to reducing flood vulnerability in the downstream Setail Watershed area.

Based on these findings, recommendations are proposed: (1) Local governments can use the results of this strategic priority as a reference in developing Regional Action Plans for Disaster Risk Reduction (RAD PRB) and budget allocation, with an initial focus on risk mapping and community education. (2) Economic indicators are still limited because GRDP data is not available at the village/sub-district level, so alternative indicator approaches are still needed.

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