KESANS: International Journal of Health and Science
2808-7178 / 2808-7380
http://kesans.rifainstitute.com/index.php/kesans/index

Strategic Policy Development for Flood Control in the Kambang Watershed of Jambi City Using SWOT–AHP Analysis

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Article Information
Submitted: **16 June 2026**
Accepted: **05 July 2026**
Publish: **09 July 2026**

Keyword: Flood Control; Kambang Watershed; SWOT; AHP; Sedimentation; Policy Strategy;

Year: 2026

Abstract
Introduction: *Flooding is one of the major environmental challenges in Jambi City, particularly within the Kambang Watershed. High sedimentation rates, land-use changes, reduced drainage capacity, and rapid urban development have increased flood vulnerability in the area.Objective: This study aimed to identify the internal and external factors affecting flood control in the Kambang Watershed and to determine priority strategies for effective and sustainable flood management.* ***Methods:*** *The study employed an integrated Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis and Analytical Hierarchy Process (AHP) approach. SWOT analysis was used to identify strategic factors influencing flood control, while AHP was applied to prioritize alternative strategies based on their relative importance.* ***Results and Discussion:*** *The results indicated that flood management in the Kambang Watershed is positioned in Quadrant II (Strength–Threat), suggesting that strong internal capacities can be utilized to address significant external threats. The proposed strategies include research and technology collaboration, implementation of sediment-control technology, enhancement of river normalization and rehabilitation programs, and integrated sediment management combined with river widening. The AHP results revealed that the implementation of sediment-control technology was the highest-priority strategy, with a weight of 0.46.* ***Conclusion:*** *Sediment control is the most critical strategy for reducing flood risk in the Kambang Watershed and should be supported by river rehabilitation programs, technological innovation, and stakeholder collaboration to achieve sustainable flood management while enhancing environmental health and public safety.*

How to Cite	**Jempater Agus Salim Sirait, Hutwan Syarifuddin, Fuad Muchlis/Strategic Policy Development for Flood Control in the Kambang Watershed of Jambi City Using SWOT–AHP Analysis/Vol. 5, No. 10, 2026**
DOI	https://doi.org/10.54543/kesans.v5i10.674
e-ISSN/p-ISSN	**2808-7178 / 2808-7380**
Published by	**CV. Rifainstitut/KESANS: International Journal of Health and Science**

Introduction

Flooding is one of the most frequent and destructive hydrometeorological disasters worldwide and continues to pose significant challenges to sustainable urban development. In recent decades, the frequency, magnitude, and economic consequences of flood events have increased substantially due to the combined effects of climate change, rapid urbanization, and environmental degradation. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), global warming has intensified the hydrological cycle, resulting in more frequent and extreme precipitation events in many regions. Consequently, urban areas are becoming increasingly vulnerable to flood hazards, particularly in developing countries where rapid land-use changes often exceed the capacity of existing drainage and river management systems. Similar findings were reported by (Huang et al., 2024) , who emphasized that climate variability and urban expansion have become major drivers of flood risk in rapidly developing cities.

Beyond its environmental and infrastructural impacts, flooding has also emerged as a significant public health concern. Flood events can contaminate water sources, damage sanitation facilities, disrupt health services, and increase the risk of waterborne and vector-borne diseases. According to the World Health Organization (WHO, 2023), recurrent floods adversely affect community health through greater exposure to environmental contaminants and disease outbreaks. Recent studies have also linked flood events to increased incidences of diarrheal diseases, leptospirosis, dengue fever, and mental health disorders (Suhr et al., 2022; Agonafir et al., 2023; Ifejube et al., 2024). Therefore, effective flood management should integrate environmental health and public health considerations to reduce risks and enhance community resilience.

Indonesia is among the countries that experience recurrent flooding due to its tropical climate, high rainfall intensity, and extensive river networks. Flood disasters occur annually in many regions and frequently cause substantial economic losses, infrastructure damage, environmental degradation, and disruptions to community activities. Although natural factors such as topography, rainfall patterns, and watershed characteristics contribute to flood occurrence, human-induced factors have become increasingly influential. Rapid population growth, urban expansion, land-use conversion, and uncontrolled development within watershed areas have significantly altered the natural hydrological balance. The replacement of permeable land surfaces with impervious urban infrastructure reduces infiltration capacity, increases surface runoff, and accelerates the concentration of stormwater into drainage systems and rivers, thereby increasing flood risk (Atharinafi & Wijaya, 2021). Previous studies have also shown that watershed degradation and uncontrolled urban development significantly increase runoff generation and flood susceptibility in urban catchments (Lamptey et al., 2023).

Urban flooding has become a major concern for local governments because of its direct impacts on public safety, economic productivity, environmental quality, and community health. Effective flood management requires not only engineering solutions but also integrated planning approaches that address institutional, social, environmental, technological, and public health dimensions. Traditional flood-control measures, such as river dredging and drainage construction, are often insufficient when implemented independently without considering broader watershed management principles. Therefore, contemporary flood-management frameworks emphasize the integration of structural and non-structural measures, stakeholder participation, technological innovation, climate adaptation strategies, and ecosystem-based approaches to improve resilience against future flood events. Nature-Based Solutions (NBS), watershed rehabilitation, and integrated river-basin management have been increasingly recognized as effective strategies for balancing flood mitigation objectives, environmental sustainability, and community well-being (Sun et al., 2022).

Jambi City is one of the urban centers in Indonesia that frequently experiences flooding, particularly within the Kambang River Watershed. The Kambang Watershed functions as an important drainage system that conveys stormwater from urban areas toward downstream river networks. However, increasing urban development and environmental pressures have gradually reduced the watershed's capacity to perform this function effectively. Several factors contribute to the flood problem in the watershed, including river sedimentation, channel narrowing, declining drainage performance, land-use changes, and the expansion of settlements along riverbanks. These conditions have reduced the hydraulic capacity of the river system, making it more susceptible to overflow during periods of intense rainfall.

The problem is further exacerbated by climate change, which has increased the frequency and intensity of extreme rainfall events. Recent studies have shown that sediment accumulation and channel degradation significantly reduce river conveyance capacity and increase the likelihood of urban flooding (Lamptey et al., 2023). In addition, rapid urbanization within the watershed has increased runoff generation, placing additional pressure on drainage infrastructure that was originally designed under different hydrological conditions. Environmental degradation in upstream catchment areas, combined with sedimentation and riverbank encroachment, has further reduced the effectiveness of flood-control systems and increased flood vulnerability. As a result, flood events continue to occur despite various mitigation efforts undertaken by local authorities.

To address these challenges, the Jambi City Government has implemented several flood-control programs, including river normalization, dredging activities, drainage infrastructure improvement, and environmental rehabilitation initiatives. These efforts demonstrate the government's commitment to reducing flood risk and improving urban resilience. Nevertheless, recurring flood events indicate that existing measures have not fully addressed the complexity of flood-generating processes within the watershed. This situation suggests that flood management should not be viewed solely as an engineering issue but rather as a multidimensional problem involving institutional capacity, environmental conditions, public health protection, policy implementation, stakeholder collaboration, technological innovation, and climate adaptation.

Previous studies on flood management have primarily focused on hydrological modeling, hydraulic analysis, drainage design, and infrastructure-based mitigation measures. While these studies provide valuable technical insights, they often pay limited attention to strategic decision-making processes and the interaction between internal organizational capacities and external environmental pressures. Moreover, only a limited number of studies have integrated environmental health considerations with strategic flood-management planning. In particular, studies combining strategic management tools and multi-criteria decision-making approaches for flood-control policy development remain relatively scarce in Indonesian urban watersheds. Consequently, there is a need for comprehensive approaches that can systematically identify critical factors influencing flood management and prioritize strategic actions based on stakeholder perspectives and local conditions.

One approach that can address this gap is the integration of Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis with the Analytic Hierarchy Process (AHP).

SWOT analysis provides a systematic framework for identifying internal and external factors that influence organizational performance, while AHP facilitates the prioritization of strategic alternatives through structured pairwise comparisons. The integration of these methods enables decision-makers to formulate context-specific strategies and assign quantitative priorities to strategic factors. By incorporating expert judgment into a transparent and systematic evaluation process, the SWOT–AHP approach has proven particularly useful in environmental and water resource management planning (Bakalár et al., 2021; Cacal et al., 2023).

Therefore, this study aims to identify the internal and external factors affecting flood-control management in the Kambang River Watershed, Jambi City, and to formulate priority flood-control strategies using an integrated SWOT–AHP approach. By examining institutional strengths and weaknesses alongside external opportunities and threats, the study seeks to provide a comprehensive strategic framework for flood management. The findings are expected to contribute to the development of effective, adaptive, and sustainable flood-control policies while supporting local governments and stakeholders in enhancing urban resilience, environmental quality, and public health protection against future flood risks under changing environmental and climatic conditions.

Method

This study employed a descriptive quantitative approach to formulate flood control policy strategies in the Kambang Watershed, Jambi City. The research was conducted by integrating the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis with the Analytical Hierarchy Process (AHP). The SWOT method was used to identify internal and external factors affecting flood management, while AHP was applied to determine the priority of alternative strategies (Saaty, 1987 ; Sunarsi, D. 2022). The study population consisted of stakeholders involved in flood management and watershed governance, including representatives from government agencies, academics, environmental practitioners, and community leaders. Respondents were selected using purposive sampling based on their expertise and experience related to flood control and watershed management. Primary data were collected through structured questionnaires, interviews, and field observations, while secondary data were obtained from government reports, scientific publications, and relevant policy documents.

The SWOT analysis was conducted by identifying strengths, weaknesses, opportunities, and threats associated with flood control efforts in the Kambang Watershed. These factors were subsequently arranged into Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrices to determine the strategic position of flood management. Alternative strategies were then formulated using the SWOT matrix (Sunarsi, D. 2022). Furthermore, the AHP method was employed to prioritize the proposed strategies through pairwise comparisons based on Saaty’s scale. The relative weights of each strategy were calculated to determine the most effective policy alternative. Consistency Ratio (CR) analysis was performed to ensure the reliability of expert judgments, with a CR value below 0.10 considered acceptable. The integration of SWOT and AHP provided a systematic framework for identifying strategic factors and establishing priority policies for sustainable flood control in the Kambang Watershed.

Result and Discussion

1. Result

Identification of SWOT Factors for Flood Control Policy in the Kambang River Watershed

The identification of strategic factors affecting flood control in the Kambang River Watershed (DAS Sungai Kambang), Jambi City, was conducted through literature review, field observations, expert judgment, and stakeholder consultation. The identified factors were classified into four SWOT categories: Strengths, Weaknesses, Opportunities, and Threats.

Table 1
Final SWOT Factors for Flood Control Policy in the Kambang River Watershed

Internal Factors	Code	Strategic Factor	External Factors	Code	Strategic Factor
Strengths	S1	Availability of urban drainage networks	**Opportunities**	O1	Development of digital flood early warning systems
	S2	Technical and institutional authority of the Public Works Agency		O2	National disaster-risk reduction policy support
	S3	Availability of the Jambi City Spatial Plan (RTRW)		O3	Nature-Based Solutions (NBS) trends
	S4	Local government budget support		O4	Central government funding opportunities
	S5	Technical experience in river normalization and rehabilitation		O5	Collaboration with universities and research institutions
Weaknesses	W1	Declining drainage and river capacity		O6	IoT-based flood monitoring technology
	W2	Sedimentation and river channel narrowing	**Threats**	T1	Increased extreme rainfall due to climate change
	W3	Weak enforcement of river-border regulations		T2	National economic instability
	W4	Land-use conversion in the watershed		T3	Urbanization and expansion of impervious surfaces
	W5	Limited interagency coordination		T4	Informal settlements along riverbanks
				T5	Socio-political resistance to relocation
				T6	Low compliance with spatial planning regulations
				T7	Upstream watershed degradation

Source: Research data, 2026

Respondent Characteristics and Strategic Position Based on SWOT Analysis

Fifteen experts participated in the SWOT-AHP assessment. Respondents consisted of government officials, hydrology experts, legislative representatives, community leaders, and non-governmental organizations.

Table 2
Composition of Respondents Based on Position, Institution, and Area of Expertise

No.	Position/Role	Institution	Area of Expertise	Number of Respondents
1	Head of Water Resources Division	Public Works Agency	Water Resources Policy	1
2	Head of Spatial Planning Division	Public Works Agency	Spatial Planning Policy	1
3	Head of Environmental Control Division	Environmental Agency	Environmental Policy	1
4	Head of Planning Division	Public Works Agency	Infrastructure Planning	1
5	Legislative Member	Regional Parliament	Public Policy	1
6	Functional Water Resources Officers	Public Works Agency	Hydrology	5
7	Community Representatives	Local Community	Community Perspective	3
8	Non-Governmental Organizations (NGOs) Representatives	Non-Governmental Organizations	Environmental Advocacy	2
Total				**15**

Source: Research data, 2026

Internal Factor Analysis (IFAS)

Table 3 presents the results of the Internal Factor Analysis Summary (IFAS) for flood management in the Kambang River area, Jambi City. The analysis identifies key internal strengths and weaknesses influencing flood-control performance. Each factor was evaluated using weighted scores derived from expert assessments to determine its relative strategic importance.

Table 3
Internal Factor Evaluation Summary (IFAS)

Internal Factors	Weight	Rating	Weighted Score
Strengths			
S-1. Availability of urban drainage networks	19.10	3.75	71.63
S-2. Technical authority and institutional capacity of Jambi City Public Works Agency (PUPR) in water resources management	20.70	4.13	85.49
S-3. Spatial Planning Regulation (RTRW) as a legal instrument for flood-prone area management	18.80	3.73	70.12
S-4. Local government budget support for flood and inundation control programs	20.70	4.06	84.04
S-5. Technical experience in river normalization, dredging, and rehabilitation activities	20.70	4.15	85.91
Total Strengths	**100**		**397.19**
Weaknesses			
W-1. Reduced capacity of drainage systems and Kambang River	20.40	3.33	67.93
W-2. Sedimentation and narrowing of the Kambang River channel	21.10	3.46	73.01
W-3. Weak supervision and enforcement of riverbank regulations	19.60	3.17	62.13
W-4. Land-use conversion within the watershed increasing surface runoff	19.60	3.22	63.11
W-5. Limited inter-agency coordination in flood management	19.20	3.29	63.17
Total Weaknesses	**100**		**329.35**
S − W			**67.84**

The IFAS results indicate that internal strengths (397.19) outweigh weaknesses (329.35), resulting in a positive score difference of 67.84. This suggests that flood management in the Kambang River area possesses favorable internal conditions. Technical experience in river rehabilitation emerged as the strongest factor, while sedimentation and river-channel narrowing remain the most significant weaknesses requiring attention.

External Factor Analysis (EFAS)

Table 4 presents the results of the External Factor Analysis Summary (EFAS) for flood management in the Kambang River area, Jambi City. The analysis evaluates external opportunities and threats that may influence the effectiveness of flood-control efforts. Each factor was assessed using weighted scores based on expert judgments to determine its strategic significance.

Table 4

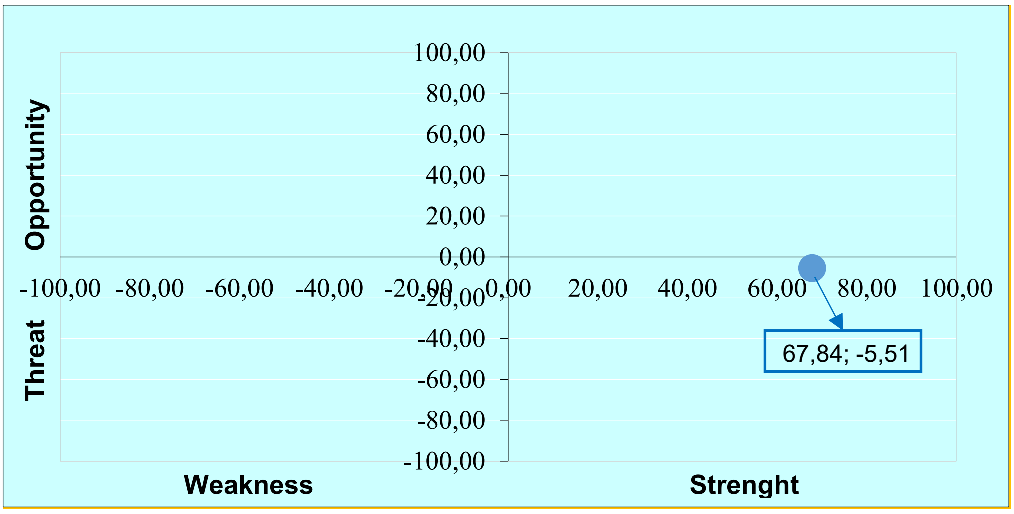
External Factor Evaluation Summary (EFAS)

External Factors	Weight (%)	Rating	Weighted Score
Opportunities			
O-1. Flood early warning system has not yet been digitally integrated and real-time	14.20	2.89	41.04
O-2. National disaster-risk reduction policies support the strengthening of local flood-control systems	16.40	3.42	56.09
O-3. Increasing adoption of Nature-Based Solutions (NBS) for sustainable urban flood management	17.30	3.56	61.59
O-4. Potential funding support from the central government for flood-control infrastructure development	17.60	3.76	66.18
O-5. Opportunities for collaboration with universities and research institutions in flood-mitigation technology development	17.60	3.77	66.35
O-6. Development of digital and Internet of Things (IoT)-based flood early warning technologies	17.00	3.62	61.54
Total Opportunities	**100.00**		**352.78**
Threats			
T-1. Increasing intensity of extreme rainfall due to climate change	15.70	4.03	63.30
T-2. National economic instability potentially limiting flood-control funding allocation	15.20	3.88	59.00
T-3. Urbanization and expansion of built-up areas increasing impervious surfaces	14.40	3.68	53.00
T-4. Growth of informal settlements along riverbanks reducing water conveyance space	14.40	3.48	50.10
T-5. Socio-political pressure regarding relocation of communities in flood-prone areas	12.90	3.19	41.20
T-6. Low public compliance with spatial planning regulations	13.70	3.35	45.90
T-7. Environmental degradation in upstream watershed areas increasing runoff and sedimentation	13.70	3.35	45.90
Total Threats	**100.00**		**358.29**
O − T			**−5.51**

The EFAS results show that total threats (358.29) slightly exceed total opportunities (352.78), resulting in a negative difference of −5.51. This indicates that external challenges remain dominant. Collaboration with research institutions and central-government funding represent the most promising opportunities, while increasing extreme rainfall due to climate change constitutes the most significant threat to flood

SWOT Quadrant Position

The SWOT analysis produced coordinates of (67.84, -5.51), indicating that flood-control management in the Kambang River Watershed is positioned in Quadrant II (Strength–Threat).

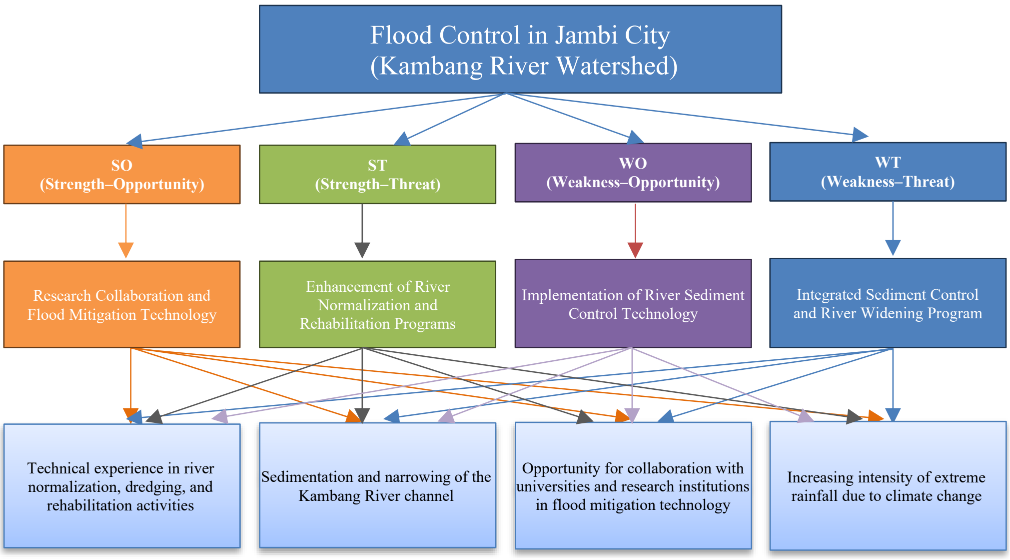


Picture 1. SWOT Strategy Position in the Strength–Threat (ST) Quadrant

The results indicate that internal strengths exceed weaknesses, while external threats slightly outweigh available opportunities.

SWOT–AHP Priority Strategi

The figure illustrates the integrated SWOT–AHP framework used to formulate flood control strategies in the Kambang River Watershed, Jambi City. Key internal and external factors were identified through SWOT analysis to generate strategic alternatives, which were subsequently evaluated using the Analytical Hierarchy Process (AHP)



Picture 2. SWOT-AHP Structure

Based on this framework, four strategic alternatives were assessed through pairwise comparisons in the AHP model to determine their priority levels. The results indicate that the implementation of river sediment control technology is the most preferred strategy for supporting effective and sustainable flood management.

The Analytical Hierarchy Process (AHP) was employed to prioritize alternative flood-control strategies. The consistency ratio obtained was below the acceptable threshold (CR < 0.10), indicating reliable expert judgments.

Table 5

Priority Flood Control Strategies in the Kambang Watershed

No	Strategy	Weight	Rank
1	Implementation of sediment control technology	0.46	1
2	Enhancement of river normalization and rehabilitation	0.24	2
3	Research and technology collaboration	0.18	3
4	Integrated sediment management and river widening	0.12	4

Source: processed primary data, 2026.

The results indicate that the implementation of sediment control technology received the highest priority weight (0.46), making it the most recommended strategy for flood management in the Kambang Watershed.

2. Discussion

The SWOT analysis demonstrates that flood-control management in the Kambang River Watershed is supported by strong institutional and technical capacities. The highest-rated strength was technical experience in river normalization, dredging, and rehabilitation activities. This finding highlights the importance of practical expertise and operational capability in addressing flood-related problems. Experienced institutions are generally better equipped to implement structural flood-mitigation measures, optimize maintenance programs, and respond effectively to hydrological challenges.

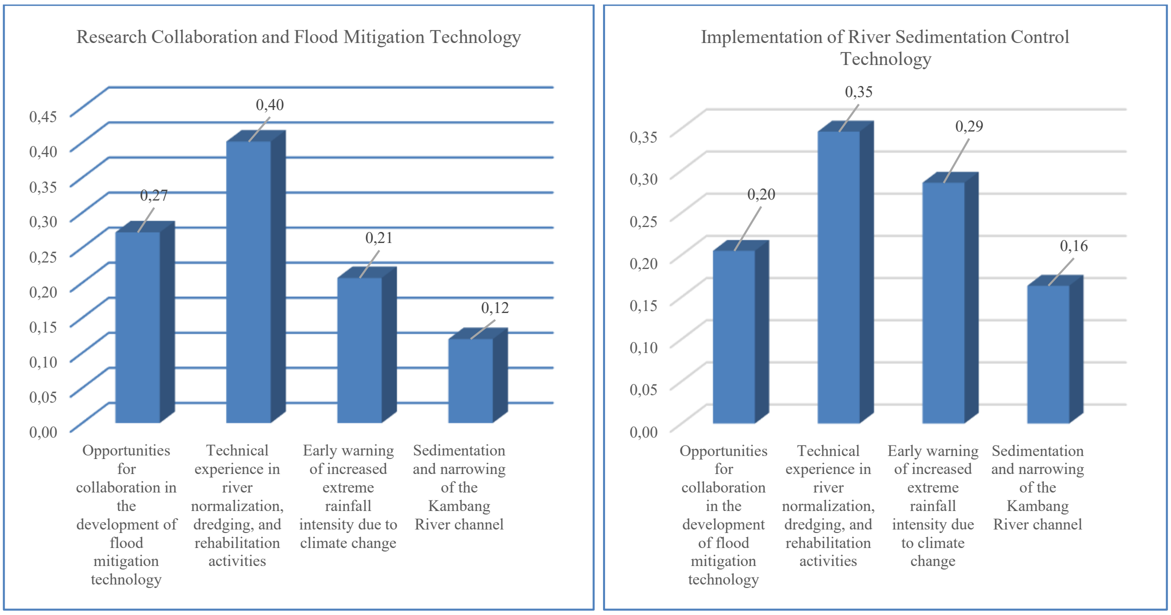
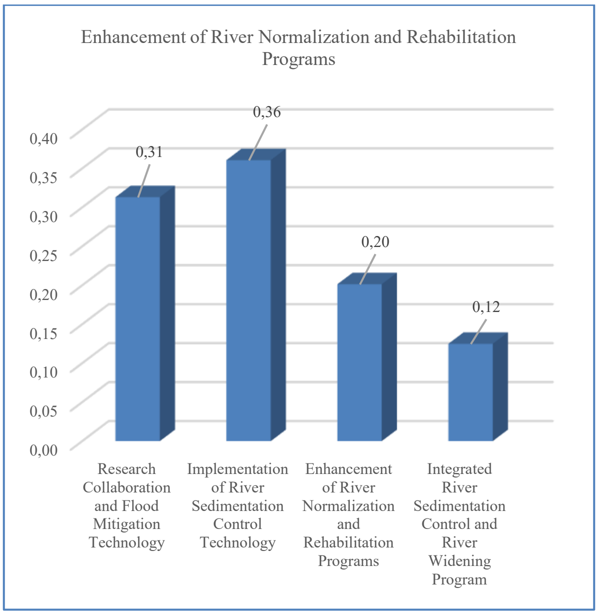
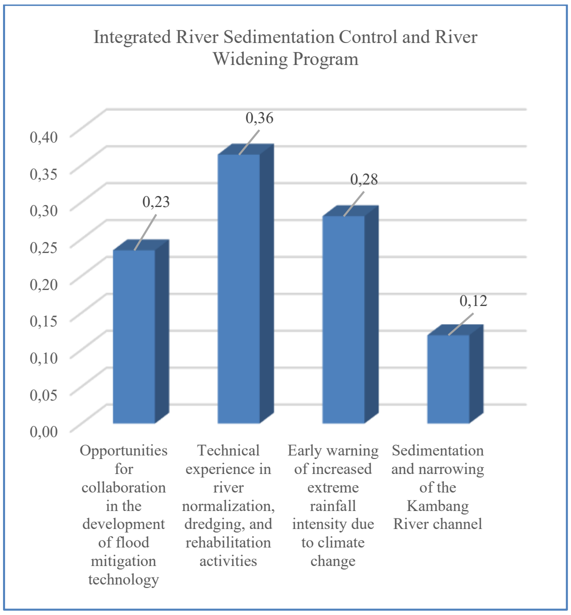


Diagram 1. Priority Ranking of Flood Control Strategies Based on AHP





Source: processed primary data, 2026.

Diagram 1 illustrates the priority ranking of flood-control strategies derived from the AHP analysis. This result is consistent with (Huang et al., 2024), who emphasized that institutional capacity and technical experience significantly influence the effectiveness of urban flood-control systems. Furthermore, the strong performance of the Public Works and Spatial Planning Agency (PUPR) and the availability of local government funding indicate that organizational resources are adequate to support flood-risk reduction programs.

Despite these strengths, sedimentation and river-channel narrowing emerged as the most critical weaknesses. Sediment accumulation reduces the hydraulic capacity of rivers, restricts flow conveyance, and increases the probability of overbank flooding during heavy rainfall events. The reduction of drainage and river capacity further aggravates flood vulnerability in urban areas.

These findings are consistent with (Lamptey et al., 2023), who reported that sedimentation is a major contributor to urban flooding because it decreases channel storage capacity and increases runoff overflow during extreme rainfall. Consequently, continuous river maintenance, dredging activities, and sediment-management programs are required to maintain river functionality.

Regarding external factors, collaboration with universities and research institutions was identified as the most significant opportunity. This finding suggests that technological innovation and scientific support can strengthen flood-management effectiveness. Partnerships among government agencies, researchers, and academic institutions facilitate the development of data-driven mitigation technologies, hydrological monitoring systems, and innovative flood-risk management approaches (Sun et al., 2022)

The rapid development of Internet of Things (IoT)-based monitoring systems and digital early warning technologies provides additional opportunities to improve real-time flood forecasting and emergency response. These technologies can enhance decision-making processes and increase community preparedness for flood events. On the other hand, climate change-induced extreme rainfall was identified as the most influential threat. Increasing rainfall intensity has become a major challenge for urban flood-control systems because existing drainage and river infrastructure may not be designed to accommodate future hydrological extremes. This finding supports the (IPCC, 2023) assessment, which concluded that climate change has increased both the frequency and intensity of extreme precipitation events worldwide.

The SWOT matrix positioned the Kambang River Watershed in Quadrant II (Strength–Threats), indicating that adaptive and resilient strategies are required. In this situation, existing institutional and technical strengths should be utilized to counter external threats through proactive flood-risk management, infrastructure enhancement, watershed rehabilitation, and climate-adaptation measures. Such strategies are increasingly important in watersheds experiencing rapid land-use change and urban expansion, which contribute to higher surface runoff and flood susceptibility (Atharinafi & Wijaya, 2021)

The SWOT–AHP analysis identified the implementation of river sedimentation-control technology as the highest-priority strategy. This result reflects the central role of sediment accumulation in reducing river capacity and increasing flood risk. Effective sediment-management technologies can improve channel conveyance, reduce maintenance costs, and increase the long-term effectiveness of flood-control programs.

This finding is consistent with (Mörtl et al., 2021) and (Shrestha et al., 2021), who emphasized that sediment management is a critical component of sustainable river management and flood-risk reduction. Sediment-control measures not only improve hydraulic performance but also contribute to the ecological sustainability of river systems. Furthermore, beyond their hydraulic benefits, sediment-control technologies may indirectly support public health protection by reducing flood duration, minimizing human exposure to contaminated floodwaters, and decreasing the risk of waterborne and vector-borne disease transmission following flood events.

River normalization and rehabilitation ranked second, highlighting the continued importance of structural interventions in restoring river capacity and improving ecosystem conditions. These interventions are also consistent with the spatial planning and watershed management objectives outlined in the Jambi City Spatial Plan (Pemerintah Kota Jambi, 2024). Research collaboration and technological innovation ranked third, reflecting the growing importance of knowledge-based flood management. Meanwhile, integrated sediment control and river widening remained relevant as complementary measures for long-term watershed management.

Environmental Health and Public Safety Implications

Flood events in the Kambang Watershed have consequences that extend beyond infrastructure damage and hydrological disturbances. Prolonged inundation can deteriorate environmental quality through contamination of surface water, disruption of sanitation systems, and accumulation of solid waste. These conditions increase the risk of waterborne and vector-borne diseases, including diarrheal diseases, leptospirosis, and dengue fever, which commonly occur after flood events (WHO, 2023; Ifejube et al., 2024).

The prioritization of sediment-control technology identified in this study may provide substantial environmental health benefits. By improving river conveyance capacity and reducing flood duration, sediment management can minimize exposure to contaminated floodwaters and reduce stagnant-water areas that serve as breeding habitats for disease vectors. In addition, the development of digital monitoring systems and flood early warning technologies can enhance community preparedness, reduce injuries and fatalities, and improve emergency-response effectiveness.

Furthermore, collaboration among government agencies, universities, and research institutions provides opportunities to incorporate environmental health indicators into flood-management planning. Such integration supports evidence-based policy development and contributes to long-term community resilience under increasing climate-related risks. Therefore, flood management in the Kambang Watershed should be viewed not only as a hydraulic and engineering challenge but also as an essential component of environmental health protection and public safety enhancement.

Overall, the study demonstrates that sustainable flood mitigation in the Kambang River Watershed requires the integration of institutional strength, technical expertise, climate adaptation, technological innovation, sediment-management interventions, and public health considerations. Combining structural and non-structural approaches is expected not only to improve river performance and reduce flood risk but also to protect environmental health, enhance public safety, reduce flood-related disease burdens, and strengthen urban resilience against future climate-related challenges.

Conclusion

This study applied an integrated SWOT–AHP approach to formulate priority flood-control strategies in the Kambang Watershed, Jambi City. The SWOT analysis revealed that flood management is positioned in Quadrant II (Strength–Threat), indicating that existing internal strengths can be strategically utilized to address significant external threats, particularly those associated with climate change and rapid urbanization.

The Internal Factor Analysis (IFAS) identified technical experience in river normalization, dredging, and rehabilitation activities as the principal strength, while sedimentation and river-channel narrowing emerged as the most critical weaknesses. Meanwhile, the External Factor Analysis (EFAS) highlighted collaboration with universities and research institutions as the most promising opportunity and increasing extreme rainfall associated with climate change as the most significant threat. Based on these findings, the AHP analysis was conducted to prioritize the most appropriate flood-control strategies.

The AHP results demonstrated that the implementation of sediment-control technology is the highest-priority strategy, with a weight of 0.46. This strategy is followed by enhancement of river normalization and rehabilitation (0.24), research and technology collaboration (0.18), and integrated sediment management combined with river widening (0.12). These findings indicate that strengthening sediment-control measures, supported by institutional collaboration and sustainable river-management programs, is essential for reducing flood risk and improving watershed resilience. Beyond their hydraulic and engineering benefits, these strategies are also expected to contribute to environmental health and public safety by reducing water contamination risks, limiting the spread of flood-related diseases, improving monitoring and early warning capabilities, and enhancing community resilience to future climate-related hazards.

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