Application of AS/NZS ISO 31000:2018 in River Flood Mitigation Planning

(Risk Management Study in Olaya Village)

Iswan S. Adjam[1]; Andi Asnudin[2]; Rudi Herman[3]

[1,2,3]Master Program in Civil Engineering, Postgraduate Program, Tadulako University Jl. Soekarno-Hatta Km. 9, Palu 94148, Indonesia

Publication Date: 2026/07/28

Abstract: River flooding is one of the most frequent natural disasters in tropical countries like Indonesia, causing significant material losses and disrupting the socio-economic life of affected communities. Olaya Village, Parigi Moutong Regency, Central Sulawesi, has experienced repeated flooding over the past decade due to drastic changes in river conditions caused by illegal mining activities in the upstream area (Kayuboko Village), leading to severe sedimentation and siltation downstream. This study aims to (1) describe the application of the AS/NZS ISO 31000:2018 standard in river flood mitigation planning, (2) identify the obstacles and supporting factors in the implementation of risk management, and (3) analyze the impact of risk management application on flood preparedness and mitigation in Olaya Village. The research employs a qualitative approach with a case study method. Data were collected through observation, in-depth interviews with 35 respondents consisting of village government officials, community leaders, and affected residents, as well as documentation. Data analysis used thematic analysis with a risk matrix approach (Likelihood × Severity) referring to the AS/NZS ISO 31000:2018 framework. The results identified 11 risk indicators with risk scores ranging from 8.05 to 23.60. The highest risks were illegal mining activities (23.60), river overflow into settlements (21.66), and flood frequency during heavy rainfall (21.15), all falling into the extreme category. Meanwhile, technical and non-technical mitigation capacities remained in the medium category (8.05–9.71), indicating a significant gap between threat levels and existing capacity. The application of ISO 31000 has only reached the context establishment and risk identification stages, while risk analysis, evaluation, treatment, and monitoring have not been formalized. The main obstacles are ongoing illegal mining, limited mitigation infrastructure, and weak institutional capacity. Supporting factors include community awareness and the emerging commitment of the village government, although both still need to be strengthened. This study concludes that the implementation of ISO 31000-based risk management has the potential to improve flood preparedness and mitigation effectiveness if implemented comprehensively, including the crackdown on illegal mining, strengthening technical and non-technical mitigation, and integrating risk management into village planning in a systematic and sustainable manner.

Keywords: *Risk Management, ISO 31000, Flood Mitigation, Illegal Mining, Olaya Village*.

How to Cite: Iswan S. Adjam; Andi Asnudin; Rudi Herman (2026) Application of AS/NZS ISO 31000:2018 in River Flood Mitigation Planning. *International Journal of Innovative Science and Research Technology*, 11(7), 1473-1479. https://doi.org/10.38124/ijisrt/26jul846

I. INTRODUCTION

River flooding is one of the most frequent natural disasters worldwide, particularly in tropical countries like Indonesia. This phenomenon not only causes physical damage to infrastructure but also has broad impacts on the social and economic life of communities. According to the United Nations Office for Disaster Risk Reduction (UNDRR, 2021), flooding is the disaster with the highest frequency and causes significant material losses and casualties in various developing countries. Therefore, flood mitigation efforts have become a priority in disaster risk management.

In Indonesia, river flooding is often triggered by sustained high rainfall, river sedimentation, and inadequate drainage systems (Kurniawan et al., 2022). These conditions are exacerbated by human activities such as deforestation and unplanned land-use conversion. Thus, the implementation of systematic and internationally standardized risk management is essential to address these issues effectively.

The application of ISO 31000-based risk management has proven effective in various disaster mitigation case studies. Research by Asnudin et al. (2024) demonstrated that the application of ISO 31000 in disaster risk evaluation in Sulawesi improved the accuracy of risk identification and the effectiveness of mitigation strategies. Furthermore,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul846

Rachmatullah and Ahyudanari (2023) confirmed that ISO 31000-based risk analysis on infrastructure projects helps reduce potential losses caused by natural disasters.

Additionally, research by Lee (2022) highlighted the importance of adaptive approaches in flood mitigation that integrate internationally standardized risk management. This approach allows for the adjustment of mitigation strategies according to changing environmental and social dynamics. This is highly relevant given the complexity of factors causing river flooding, ranging from climate change, environmental degradation, to uncontrolled land-use patterns (Brown & Green, 2020).

In the context of disaster mitigation, risk management has become a crucial approach for systematically identifying, analyzing, and controlling risks. The international standard AS/NZS ISO 31000:2018 offers a comprehensive framework for risk management applicable across various sectors, including natural disaster mitigation (Smith & Johnson, 2021). This standard emphasizes principles such as integration, structure, and adaptation, enabling organizations or communities to manage risks effectively and sustainably.

Several local studies have also examined the application of risk management in flood mitigation in Indonesia. Research by Wijaya and Santoso (2023) in Central Java found that the application of ISO 31000 principles helped improve inter-agency coordination and community participation in flood mitigation. However, challenges such as limited resources and lack of understanding of international standards remain significant obstacles.

Olaya Village is one of the areas vulnerable to river flooding. Located in a river basin that frequently overflows during the rainy season, the impacts of flooding in Olaya Village not only damage physical infrastructure but also disrupt the economic and social activities of the local community. Over the past ten years, the river has undergone drastic changes primarily due to mining activities in Kayuboko Village, West Parigi District. Consequently, materials from excavation activities such as mud and sand are carried downstream, causing severe siltation. Therefore, effective and sustainable flood mitigation planning is urgently needed to reduce risks and enhance the village's resilience to disasters.

However, based on preliminary observations in Olaya Village, existing flood mitigation planning remains reactive and has not adopted a systematic risk management framework as outlined in AS/NZS ISO 31000:2018. Coordination among stakeholders is still limited, and community participation in the mitigation planning process has not been optimized. This opens an opportunity for further research on the application of this risk management standard in the local context of Olaya Village.

Based on the above description, this study aims to: (1) describe the application of AS/NZS ISO 31000:2018 in river flood mitigation planning in Olaya Village, (2) identify obstacles and supporting factors in the implementation of risk management in Olaya Village, and (3) analyze the impact of risk management application on flood preparedness and mitigation in Olaya Village.

II. MATERIALS AND METHODS

- *Type and Research Approach*

This study employs a qualitative approach with a case study method focused on Olaya Village as the research location. A qualitative approach was chosen because it allows researchers to gain an in-depth and comprehensive understanding of how the AS/NZS ISO 31000:2018 standard is applied in river flood mitigation planning in a real-world context. This approach is particularly suitable for exploring dynamics, processes, and social interactions that occur in the field, which are often difficult to measure quantitatively (Creswell, 2014).

According to Moleong (2017), qualitative research aims to understand social phenomena from the perspective of the actors directly involved, providing rich and contextual results. In this study, the main focus is understanding how ISO 31000-based risk management is implemented by village government, communities, and other stakeholders in facing river flood risks. The case study method allows researchers to explore supporting factors and obstacles encountered, as well as the impact of risk management implementation on flood mitigation effectiveness.

- *Location and Time of Research*

The research was conducted in Olaya Village, West Parigi District, Parigi Moutong Regency, Central Sulawesi Province. This location was selected based on the high vulnerability to river flooding and the presence of illegal mining activities in the upstream area that contribute to river siltation. The research was conducted over a period of 4 months.

- *Population and Sample*

The research population consisted of all community members, including village government officials, community leaders, and affected residents. Respondents were selected using purposive sampling technique with a total of 35 respondents, consisting of village government officials (5 people), community leaders (10 people), affected residents (15 people), and mitigation officers (5 people).

- *Research Variables and Indicators*

This study employs three main variables to analyze flood risk management in Olaya Village.

The first variable is the context of the flood risk environment, which includes physical environmental conditions assessed based on river conditions, land use, sedimentation levels, and flood frequency; social conditions assessed based on community livelihoods, population density, and cultural factors affecting vulnerability; and the identification of relevant stakeholders.

The second variable is risk analysis and evaluation, which includes risk identification to recognize events or

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul846

conditions that can cause negative impacts, likelihood analysis to determine the probability of risks occurring, impact analysis to assess the severity of consequences, and the determination of risk priority levels. All indicators in these two variables were measured using a Likert scale of 1-5, where a score of 1 indicates a very low level and a score of 5 indicates a very high level for each parameter assessed.

The third variable is mitigation strategy planning includes technical mitigation efforts such as physical structures (embankments, gabions, dams), environmental engineering (reforestation, terracing), early warning systems, and supporting infrastructure; as well as non-technical mitigation such as institutional strengthening, regulations and policies, education and socialization, and community empowerment.

➢ *Data Collection Techniques*

Data collection was conducted through three techniques.

First, observation involving direct observation of the research object to obtain accurate data that reflects actual conditions. The researcher acted as an observer with limited participation, interacting with the environment and activities being observed without full involvement. Observations were conducted in Olaya Village, particularly focusing on the flood mitigation planning and implementation processes involving various stakeholders.

Second, in-depth interviews were conducted as directed conversations between the researcher and informants to explore information in depth regarding the implementation of AS/NZS ISO 31000:2018-based risk management in river flood mitigation. Semi-structured interviews were conducted using interview guides containing open-ended questions focused on the main research issues. This technique enabled the researcher to obtain rich and contextual qualitative data from various involved parties, such as village government, community leaders, and affected residents.

Third, documentation was used as a data collection technique by gathering and examining documents related to the research focus. The documents reviewed included flood mitigation planning documents, risk reports, regulations related to risk management and disasters, and activity archives supporting the analysis. This technique aimed to complement primary data and provide broader context and validation of information obtained through observation and interviews.

➢ *Instrument Validity and Reliability*

Validity testing was conducted to determine the accuracy level of the research instruments in measuring the variables and indicators used in the study. Validity testing was performed using Pearson Product Moment correlation by comparing the calculated r value against the table r value at a significance level of 5%. With df = 33 (n-2) and $\alpha = 0.05$, the r-table value = 0.344.

The validity test results for all indicators showed that all calculated r values were above the r-table value of 0.344, with calculated r values ranging from 0.623 to 0.901. Since all calculated r values were greater than the r-table value, all statement items were declared valid. These results indicate that each statement item is capable of measuring the variables accurately and in accordance with the research objectives.

Reliability testing was conducted to determine the consistency level of the research instruments in measuring the research variables. Reliability testing employed the Cronbach Alpha method with the provision that the instrument is declared reliable if the Cronbach Alpha value is greater than 0.60. The test results showed that the Cronbach's Alpha value for all variables was 0.867. This value was greater than the minimum required value of 0.60. Cronbach's Alpha values approaching 1 indicate that the research instruments have a very high level of internal consistency, thus the research instruments are declared reliable.

➢ *Data Analysis*

Data analysis in this study refers to the ISO 31000:2018 framework, which emphasizes a systematic process in managing risks, from identification to risk treatment, and was conducted qualitatively and descriptively with simple quantitative support through risk scoring in three stages.

The first stage is risk identification to recognize events or conditions that can cause negative impacts on the community and environment, covering physical river conditions, environmental factors, community livelihoods, and preparedness aspects of community members.

The second stage is risk analysis by calculating the average likelihood and impact values of each risk indicator based on questionnaire results from 35 respondents using a Likert scale of 1-5. The risk value is then calculated using the formula Risk = Likelihood × Impact and the results are mapped into a risk matrix with categories of Extreme (15-25), High (10-12), Medium (6-9), and Low (1-5) to group risks based on the combination of probability and impact levels to facilitate decision-making.

The third stage is data integration by deepening the quantitative findings using qualitative data as the basis for formulating mitigation strategies. This includes risk evaluation by comparing the analysis results against established criteria to determine treatment priorities, and risk treatment through the selection of the most appropriate actions after the risk level is determined.

III. RESULTS AND DISCUSSION

➢ *General Overview of Research Locations*

Olaya Village is located in West Parigi District, Parigi Moutong Regency, Central Sulawesi Province. Geographically, Olaya Village is situated in an area influenced by the river basin system. The presence of settlements and productive land around the river flow makes this area highly exposed to river flooding events, especially during the rainy season.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul846

The physical condition of Olaya Village is dominated by relatively flat lowlands, particularly in areas around the riverbanks. This flat topography results in slow surface runoff when water volume increases. When river discharge rises and exceeds river cross-section capacity, water potentially overflows into settlements and surrounding productive land. Additionally, soil characteristics and erosion processes around the river basin also affect the physical condition of the river.

Over the past ten years, the river conditions have undergone drastic changes. Based on field conditions and information regarding land use development in the river basin area, there has been mining activity in Kayuboko Village, West Parigi District, located in the upstream section connected to the Olaya Village area. This mining activity has resulted in materials such as mud and sand being carried downstream, causing severe siltation that reduces the river's capacity to accommodate water flow.

➢ *Respondent Characteristics*

The respondents in this study numbered 35 people from Olaya Village. Based on gender, male respondents numbered 18 people (51.43%) and female respondents numbered 17 people (48.57%). The distribution of male and female respondents was relatively balanced. Based on status, village government officials numbered 5 people (14.29%), community leaders numbered 10 people (28.57%), affected residents numbered 15 people (42.86%), and mitigation officers numbered 5 people (14.29%). The majority of respondents were affected residents, indicating that the research successfully captured the perspectives of those most directly impacted by flooding. Based on length of residence in Olaya Village, respondents who had lived for less than 5 years numbered 4 people (11.43%), 5-10 years numbered 8 people (22.86%), and more than 10 years numbered 23 people (65.71%). The majority of respondents had lived in the village for more than 10 years, thus expected to have good knowledge of the flood events and environmental changes that have occurred.

➢ *Risk Identification*

Based on the results of field observations, interviews, and document studies, 11 risk indicators were identified that have the potential to affect the safety and well-being of the Olaya Village community. These risks were grouped into four categories: (1) flood risks (3 indicators), (2) technical mitigation (3 indicators), (3) non-technical mitigation (2 indicators), and (4) supporting factors and obstacles (3 indicators). Observation results showed that Olaya Village has very limited disaster mitigation facilities. The available mitigation facilities are still inadequate to address the extreme flood threat that occurs almost every year.

➢ *Flood Risk Analysis*

The risk analysis results showed risk values ranging from 8.05 to 23.60. All risk values fell into the moderate to extreme categories, with details presented in Table 1.

Table 1 Risk Analysis Results

Risk Code	Risk Indicator	Likelihood Score	Severity Score	Risk Score	Category
R4	Illegal mining activities still ongoing	4.86	4.86	23.60	Extreme
R1	River overflow into settlements	4.60	4.71	21.66	Extreme
R2	Flood frequency during heavy rainfall	4.57	4.63	21.15	Extreme
R3	Community worry about future floods	4.51	4.43	19.98	Extreme
R8	Village government commitment to flood mitigation	2.66	3.46	9.20	Medium
R6	River has been normalized (dredged)	2.66	3.66	9.71	Medium
R9	Existence of disaster preparedness group	2.57	3.49	8.97	Medium
R10	Community participation in evacuation drills	2.57	3.49	8.97	Medium
R7	Community awareness of flood mitigation	2.57	3.34	8.60	Medium
R5	Availability of evacuation routes/shelters	2.63	3.43	9.00	Medium
R11	Existence of embankments/gabions	2.43	3.31	8.05	Medium

The highest risk was illegal mining activities still ongoing (R4) with a score of 23.60, followed by river overflow into settlements (R1) with a score of 21.66, and flood frequency during heavy rainfall (R2) with a score of 21.15. These three indicators fell into the extreme category. The extreme category indicates that these risks are unacceptable and require immediate corrective action.

➢ *Risk Matrix and Risk Evaluation*

Based on the mapping in the risk matrix, the results showed that four risk indicators fell into the extreme category (scores 15-25), while the remaining seven risk indicators fell into the medium category (scores 6-9). There were no risk indicators in the high or low categories.

Table 2 Risk Matrix Mapping

Likelihood (L)	Impact (I)	Risk Score	Category	Risk Codes
5 (Almost Certain)	5 (Catastrophic)	25	Extreme	-
4.86	4.86	23.60	Extreme	R4
4.60	4.71	21.66	Extreme	R1
4.57	4.63	21.15	Extreme	R2
4.51	4.43	19.98	Extreme	R3

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul846

3-4 (Possible-Frequent)	3-4 (Moderate-Severe)	6-12	Medium-High	-
2.43-2.66	3.31-3.66	8.05-9.71	Medium	R5, R6, R7, R8, R9, R10, R11

The high-category risks are all related to natural disaster threats due to geographical conditions and anthropogenic activities (illegal mining) that worsen the situation. Moderate-category risks are mostly related to non-structural preparedness aspects and limited technical mitigation capacity. The risk evaluation results indicate that the factor of illegal mining activities remains the primary source of risk, contributing significantly to river sedimentation and siltation. Non-structural preparedness aspects such as disaster preparedness groups, evacuation drills, and institutional capacity also require serious attention. The gap between the extreme threat level and medium mitigation capacity indicates that Olaya Village is not yet prepared to face recurring flood risks.

➢ *Causes of Flooding*

Based on questionnaire responses from 35 respondents, the main causes of flooding in Olaya Village were identified.

Table 3 Main Causes of Flooding

Cause	**Number of Respondents**	**Percentage**
Sedimentation/siltation due to mining activities	28	80%
Extreme rainfall	5	14%
No embankments/gabions	2	6%

80% of respondents identified illegal mining activities in the upstream area (Kayuboko Village) as the root cause of flooding. This finding confirms that the physical changes in the river dominated by sedimentation are the main driving factor for the increasing frequency and intensity of flooding. Thus, illegal mining activities can be categorized as the dominant risk driver and must become the main focus of risk treatment strategies.

➢ *Technical Mitigation Analysis*

The evaluation of technical mitigation in Olaya Village showed that all indicators fell into the medium category with risk scores between 8.05 and 9.71. The relatively low likelihood scores (around 2.4-2.6) for these indicators indicate that technical mitigation efforts such as embankment construction, river normalization, and provision of evacuation routes are rarely carried out or not yet adequately available. This indicates that the existing technical mitigation capacity is still not aligned with the flood threat level in the extreme category.

Table 4 Distribution of Technical Mitigation Risk Categories

Indicator	**Medium (M)**	**High (H)**	**Extreme (E)**
Existence of embankments/gabions	33 (94%)	2 (6%)	0
River has been normalized	25 (71%)	10 (29%)	0
Availability of evacuation routes	27 (77%)	8 (23%)	0

As many as 94% of respondents rated the existence of embankments/gabions as inadequate, 29% of respondents stated that river normalization is never or rarely carried out, and 23% of respondents stated that evacuation routes are not adequately available. This data indicates that the existing technical mitigation is unable to reduce flood risk to an acceptable level based on the AS/NZS ISO 31000:2018 criteria.

➢ *Non-Technical Mitigation Analysis*

The evaluation of non-technical mitigation showed that all indicators fell into the medium category with risk scores of 8.97. The risk scores at the medium category indicate that institutional structures and non-technical activities have begun to form but are not yet functioning optimally.

Table 5 Distribution of Non-Technical Mitigation Categories

Indicator	**Medium (M)**	**High (H)**
Existence of disaster preparedness group	22 (63%)	13 (37%)
Community participation in evacuation drills	25 (71%)	10 (29%)

As many as 37% of respondents assessed that there is no effectively functioning disaster preparedness group in the village, while 29% of respondents stated that evacuation drills have not been adequately implemented. This finding is important because institutional capacity and community education are the main foundations in disaster risk management according to ISO 31000. Weak institutional capacity causes the processes of risk identification, analysis, evaluation, and treatment not to be carried out in a structured manner, while the lack of drills and education reduces community preparedness when flooding occurs.

➢ *Supporting Factors and Obstacles*

Three main factors influencing flood mitigation efforts in Olaya Village were analyzed: community awareness, ongoing illegal mining activities, and village government commitment.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul846

Table 6 Supporting Factors and Obstacles

Indicator	Likelihood	Severity	Risk Score	Category
Community awareness of flood mitigation	2.57	3.34	8.60	Medium
Illegal mining activities still ongoing	4.86	4.86	23.60	Extreme
Village government commitment to flood mitigation	2.66	3.46	9.20	Medium

Ongoing illegal mining activities obtained the highest risk score of 23.60, categorized as extreme. All respondents (100%) stated that illegal mining activities are still ongoing, with 80% rating the frequency as "Always". This indicates that illegal mining is no longer a sporadic event but has become a routine phenomenon that is very visible and whose impacts are felt by the community.

In the perspective of risk management, this finding confirms that illegal mining is a chronic main risk driver. This condition falls into the category of unacceptable risk, because it directly increases the likelihood and impact of flooding. Without controlling mining activities, other mitigation efforts risk being ineffective because the main source of risk remains active.

- *Application Level of AS/NZS ISO 31000:2018*

The assessment of the application of ISO 31000:2018 in Olaya Village was conducted by mapping existing conditions into six main stages: context establishment, risk identification, risk analysis, risk evaluation, risk treatment, and monitoring and review.

Table 7 Application Level of ISO 31000:2018 Stages in Olaya Village

ISO 31000 Stage	Status in Olaya Village	Description
Context Establishment	Existing	Community and village government understand flood risks
Risk Identification	Existing	Flooding and mining identified as main sources
Risk Analysis	Limited	L×S analysis not formalized in official documents
Risk Evaluation	Not Yet	Risk priorities not formally established
Risk Treatment	Not Yet	Technical and non-technical mitigation limited
Monitoring and Review	Not Yet	Periodic monitoring system not yet developed

Based on this mapping, it can be concluded that Olaya Village has only reached the early stages of the risk management cycle, particularly in context establishment and risk identification. The risk analysis stage is beginning to emerge through frequency and impact assessments, but has not been integrated into formal evaluation systems and risk treatment planning. This condition indicates that the maturity level of ISO 31000 implementation in Olaya Village is still at an early level, requiring institutional strengthening, capacity building, and the preparation of structured planning documents as the basis for developing a more comprehensive risk management system.

IV. CONCLUSION

Based on the results of data analysis and discussion, the following conclusions are drawn:

- The application of the AS/NZS ISO 31000:2018 standard in Olaya Village has only reached the context establishment and risk identification stages. Flood risks and illegal mining activities have been recognized, but analysis, evaluation, treatment, and monitoring have not been formalized in documents and have not become a systematic part of village planning. The maturity level of risk management remains low, so the ISO 31000 standard has not yet functioned as the main framework for flood mitigation.
- The main obstacles in implementing risk management are the continuation of illegal mining activities in the upstream area, limited technical mitigation infrastructure, and weak institutional capacity and risk monitoring systems. Existing supporting factors include moderate community awareness, emerging village government commitment, and the beginnings of disaster preparedness institutions and evacuation drill activities, although all still need to be strengthened to be effective.
- The implementation of AS/NZS ISO 31000:2018-based risk management has the potential to improve flood preparedness and mitigation in Olaya Village if implemented comprehensively. Clear risk priority setting, control of illegal mining, strengthening of technical and non-technical mitigation, and integration of risk management into village planning will help reduce flood risk levels from the extreme category to a more acceptable level.

ACKNOWLEDGMENT

The authors express their gratitude to Dr. Andi Asnudin, ST., MT as the primary supervisor and Dr. Ir. Rudi Herman, ST., MSc as the co-supervisor for their guidance and direction throughout the research. Appreciation is also extended to the Head of Olaya Village, community leaders, and all affected residents who provided permission and participation in this research. Thank you to all respondents who were willing to take the time to complete questionnaires and provide valuable information for this research.

REFERENCES

[1]. Asnudin, A., Ali, A. A., & Muhtar, T. (2024). Evaluation of Disaster Risk and Mitigation Strategies for Post-Disaster Permanent Residential Relocation Using AS/NZS ISO 31000. *Engineering, Technology & Applied Science Research, 14*(6), 18941-18948.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul846

[2]. Asnudin, A., Labombang, M., Rizal, A., Rivani, A., Lioni, C. Z., & Sarungallo, W. A. (2026). Risk analysis of the tsunami evacuation infrastructure based on the ISO 31000 in the disaster-prone coastal area in Teluk Palu. *Engineering, Technology & Applied Science Research*, *16*(1), 32479-32484. https://doi.org/10.48084/etasr.15293

[3]. Brown, T., & Green, P. (2020). Principles of Risk Management and ISO 31000. *Risk Management Journal*, *12*(3), 45-60.

[4]. Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications.

[5]. International Organization for Standardization. (2018). *ISO 31000:2018 Risk Management – Guidelines*. ISO.

[6]. Kurniawan, A., Nugroho, Y., & Putra, R. (2022). Flood Risk Assessment in River Basin Areas: A Case Study in Indonesia. *Journal of Hydrology, 610*, 127867. https://doi.org/10.1016/j.jhydrol.2022.127867

[7]. Lee, S. (2022). Adaptive Flood Mitigation Strategies Based on Risk Management. *Journal of Environmental Management, 250*, 109567.

[8]. Martinez, A., & Lopez, J. (2023). Integration of PDCA Cycle in Risk Management for Sustainable Development. *Sustainability Science, 15*(2), 345-360.

[9]. Moleong, L. J. (2017). *Metodologi Penelitian Kualitatif*. Remaja Rosdakarya.

[10]. Nugroho, A., Santoso, B., & Wibowo, H. (2023). Implementation of Risk Management Framework in Indonesian Public Sector: Challenges and Opportunities. *Indonesian Journal of Public Administration*, *9*(1), 15-29.

[11]. Rachmatullah, N., & Ahyudanari, E. (2023). Risk Management Based IT Analysis Using ISO 31000: A Case Study. *Indonesian Journal of Information Systems*, *18*(2), 120-135.

[12]. Silva, R., & Silva, M. (2024). Holistic Risk Management for Sustainable Organizations: Application of ISO 31000. *Journal of Risk and Sustainability*, *9*(1), 22-38.

[13]. Smith, J., & Johnson, L. (2021). Application of AS/NZS ISO 31000 in Disaster Risk Reduction. *International Journal of Disaster Risk Science*, *12*(1), 77-89.

[14]. Tiwari, P., Gupta, R., & Sharma, N. (2023). Customizing Risk Management Frameworks: Principles and Applications. *International Journal of Risk Assessment*, *11*(4), 101-115.

[15]. UNDRR. (2021). *Global Assessment Report on Disaster Risk Reduction*. United Nations Office for Disaster Risk Reduction.

[16]. Wijaya, A., & Santoso, B. (2023). Application of ISO 31000 Principles in Flood Mitigation in Central Java. *Indonesian Journal of Disaster Management, 8*(2), 112-128.