

# Risk Management of Flood Disaster (A Case Study of Kendal River)

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## Risk Management of Flood Disaster (A Case Study of Kendal River)

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**Abstract.** Kendal River, which runs through the city of Kendal, often overflows causing flood for the immediate areas. This study uses the concept of risk management aimed at relevant stakeholders. Data analysis of this study applied the Risk Breakdown Structure (RBS) method to describe each classification of risk sources to risk sub-classification. The results depicted that there were 20 (twenty) risks of causing flooding in Kendal City, with 5 (five) risks being the main cause. According to the Central Java Provincial Government, there was a 35% risk at the extreme level, 60% at the high level, and 5% at the middle level. On the scale of risk acceptance, there were 35% classified as unacceptable, and 65% classified as unexpected. According to the Kendal District Government, there was a 60% risk at extreme levels and 40% at high levels. On the risk acceptance scale, there were 60% classified as unacceptable and 40% classified as unexpected. The results of this study expected to provide a guideline for stakeholders in risk response according to their role both at the Provincial Government and District Government levels based on priority scales.

**Keywords :** Flood, Risk Management, Stakeholders, RBS

### 1. Introduction

#### 1.1 Background

Kendal River is one of the rivers in Bodri Kuto River Area (RA) in Central Java province divided into 12 (twelve) watersheds, one of which is Kali Kendal watershed (Dinas PSDA Provinsi Jawa Tengah, 2012). Kendal River flows through 10 (ten) sub-rurals in Kendal City Sub-District, including: Sukodono, Trompo, Kebondalem, Kalibuntu Wetan, Pegulon, Pekauman, Patukangan, Ngilir, Balok, and Bandengan [1]. Indonesian President Regulation No. 12 of 2012 concerning Establishment of River Areas related to List of Watersheds (DAS), establishing the pattern of management of Water Resources in the cross-district river area (Bodri Kuto RA) declares the authority and responsibility of the Provincial Government, specifically the Public Works Water Resources and Spatial Planning Office (*Pusdataru*) of Central Java Province [2].

Based on Indonesian Law Number 24 of 2007 concerning Disaster Management, the disaster risk management approach in the preparation of disaster management plans is initiated from Government initiatives and commitments, by identifying disaster risks, choosing disaster risk reduction actions, regulating actors, and allocating tasks and authorities, as well as utilizing the available resources [3]. This research focuses on the disaster mitigation phase, during which no disaster occurs. The results of the study are expected to provide input and description to stakeholders related to the management of



Kendal River and also in flood management, Therefore, the flood disaster management programs is expected to be effectively, synergistically, and efficiently performed.

### 1.2 Research Inquiries

1. What are the main causes of Kendal River's frequent overflow, causing flooding in Kendal City?
2. How are the risks which become the main targets for the management of flood disaster in Kendal City from the perspective of the relevant stakeholders?
3. How much impact does this risk have on the main targets for the management of flood disaster in Kendal City from the perspective of the relevant stakeholders?
4. What is the response to the risks which become the main targets for the management of flood disaster in Kendal City from the perspective of the relevant stakeholders?

### 1.3 Purpose of the Study

1. To identify the main causes of flooding in Kendal City as a result of Kendal River overflow.
2. To analyze the risks which become the main targets in the management of flood disaster in Kendal City from the perspective of the relevant stakeholders.
3. To analyze the extend of how the risk that are the main targets impacts the management of flood disaster in the Kendal City from the perspective of the relevant stakeholders.
4. To analyze the response in order to prevent and deal with risks which become the main targets in handling floods in Kendal City from the perspective of the relevant stakeholders.

## 2. Methods

### 2.1. Research Methodology

This study applies descriptive methods or case studies with a combination of approaches (mixed methods), between qualitative and quantitative. According to Soerjono, research with descriptive methods or case studies aims to learn in depth about one of the real symptoms that exist in people's lives that can be used to examine a situation, groups, local communities, institutions or individuals [4]. Descriptive method will explain whether program implementation is in accordance to the technical/implementation guidelines.

### 2.2 Samples and Respondent Selection

The respondents were chosen by using purposive sampling method. Purposing sampling method is a technique in which a set of consideration is applied in choosing research sample [6]. According to Bouma, by using the Purposive Sampling method, the researcher believes that they can use their discretion or intuition in selecting the best people or groups to study or to provide the most accurate information [7]. Table 1 and Table 2 indicate the description of respondents for Qualitative and Quantitative methods.

**Table 1.** Respondents for In-depth Interviews using Qualitative Methods

No.	Institution	Number	Experience
1	Public Works Water Resources and Spatial Planning Office of Central Java	1 person	Managing Flood Disaster in Kendal City $\geq$ 10 Years
2	Public Works Water Resources and Spatial Planning Office of Bodri Kuto Semarang	2 persons	Managing Flood Disaster in Kendal City $\geq$ 10 Years
3	Planning, Research and Development Office of Kendal District	1 person	Managing Flood Disaster in Kendal City $\geq$ 10 Years
4	Public Works and Public Housing Office of Kendal District	1 person	Managing Flood Disaster in Kendal City $\geq$ 10 Years

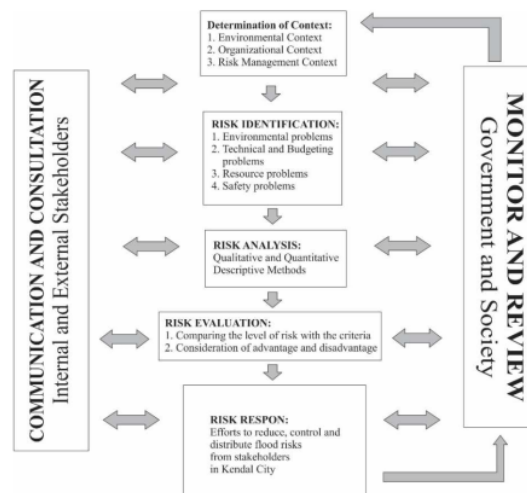
No.	Institution	Number	Experience
5	Regional Disaster Management Agency of Kendal District	1 person	Managing Flood Disaster in Kendal City ≥ 10 Years
6	Women and Children Empowerment Office of Kendal City	1 person	Managing Flood Disaster in Kendal City ≥ 10 Years
<b>Total Respondents</b>		<b>7 persons</b>	

**Table 2.** Respondents for Research Interviews and Questionnaires using Quantitative Methods

No.	Institution	Number	Experience
1	Public Works Water Resources and Spatial Planning Office of Central Java	2 persons	Managing Flood Disaster in Kendal City ≥ 8 Years
2	Public Works Water Resources and Spatial Planning Office of Bodri Kuto Semarang	2 persons	Managing Flood Disaster in Kendal City ≥ 8 Years
3	Public Works and Public Housing Office of Kendal District	4 persons	Managing Flood Disaster in Kendal City ≥ 8 Years
<b>Total Respondents</b>		<b>8 persons</b>	

### 2.3 Data Analysis

Data analysis in this study utilizes the process according to the stages of risk management, especially for floods in the City of Kendal. The stages of risk management carried out are depicted in Figure 1 below:



Source: Extracted from AS/NZS 4360 (2004)

**Figure 1.** the Flood Disaster Risk Management Process For Kendal River

#### 1. Risk Identification

Based on risk classification in Godfrey, *et al.* [9], the author limited to only four main risk sources to be more detailed and in-depth, such as: environmental issues, technical and budgeting matters, resource problems, and security/safety issues.

## 2. Risk Analysis and Evaluation

The risk analysis in this study was carried out by using the Risk Breakdown Structure (RBS) method. According to the Project Management Institute, RBS provides a list of categories and subcategories that might arise in a project [10]. RBS is advantageous as a reminder for at-risk population of the risk sources that might arise on the project. The amount of risk according to Godfrey, *et al.* is determined from the value of multiplication between the probability/frequency value and the impact/consequence value [9]. Risk probability is often interpreted by the term risk likelihood, while the consequence if the risk occurs is known as risk impact, and the significance of risk defines risk exposure calculated by using the formula of:

$$\text{Risk Exposure} = \text{risk likelihood} \times \text{risk impact} \quad (1)$$

The basis for determining the frequency scale/value and impact scale/value is presented in following Table 3 and Table 4:

**Table 3.** Level and Scale of Likelihood

No.	Frequency Level	Likelihood (%)	Scale
1	Very seldom	< 20	1
2	Seldom	$20 \leq x < 40$	2
3	Sometimes	$40 \leq x < 60$	3
4	Often	$60 \leq x < 80$	4
5	Very often	$\geq 80$	5

Source Extracted from Godfrey, *et al.* (1996)

**Table 4.** Level and Scale of Consequence

No.	Frequency Level	Likelihood (%)	Scale
1	Very Low	< 5	1
2	Low	$5 \leq X < 15$	2
3	Moderate	$15 \leq X < 45$	3
4	High	$45 \leq X < 80$	4
5	Extreme	$\geq 80$	5

Source: Extracted from Godfrey, *et al.* (1996)

Risk Evaluation with the RBS method is conducted by plotting the value of frequency and impact into the risk level matrix map to obtain the risk level of each risk that occurs. The risk matrix map is presented in following Table 5:

**Table 5.** Risk Level Matrix

			CONSEQUENCE				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	3	4	5
LIKELIHOOD	Almost Certain	E	Moderate	High	Extreme	Extreme	Extreme
	Likely	D	Moderate	High	High	Extreme	Extreme
	Possible	C	Low	Moderate	High	High	Extreme
	Unlikely	B	Low	Low	Moderate	Moderate	High
	Rare	A	Low	Low	Low	Low	Moderate

Source: Extracted from Godfrey, *et al.* (1996)



The risk value is obtained from the multiplication of frequency / probability with the impact determines the Risk Acceptance Scale for sources of risk causes of flood disasters. Risk acceptance indicators are presented in the following Table 6:

**Table 6.** Risk Acceptance Indicator

No.	Risk Acceptance Indicator	Risk Value
1	Negligible	$X < 3$
2	Acceptable	$3 \leq X < 8$
3	Undesirable	$8 \leq X < 15$
4	Unacceptable	$X \geq 15$

Source: *Extracted from Godfrey, et al. (1996)*

### 3. Treatment/Risk Response

This stage depicts the result of in-depth interviews conducted by the author to the respondent. The results of this in-depth interview are presented in the form of tables and risk responses, risk response strategies, and which leading sector of each identified risk are then determined.

### 4. Risk Monitoring and Review

This stage presents the result of in-depth interviews and brainstorming (combining ideas/views) of the author with the respondents relating to monitoring activities and reviews coupled with secondary data collection. This stage indicated the monitoring and review activities that were carried out and the mechanism by the Central Java Provincial Government represented by the Public Work in Water Resources and Spatial Planning Office of Central Java. In addition, the Public Work in Water Resources and Spatial Planning Office of Bodri Kuto with the Kendal Regency Government are represented by the Public Works and Public Housing Office.

## 3. Results and Discussions

The concept of risk management for natural disasters, especially floods that occur in the city of Kendal due to the overflowing of Kali Kendal, in this section is limited to 3 (three) main contexts according to the author's limits, including: the context of the environment, the organizational context (stakeholders) and the context of risk management that has been carried out so far.

### 3.1 Risk Identification

Risk identification in the flood disaster risk management process in Kendal City was conducted by in-depth interviews with each respondent. The results of risk identification are presented in the following Table 7:

**Table 7.** Risk Identification

No	Source of Risk	Risk
1	Environmental Issues	a. High level of sedimentation. b. The wet cross section of the river does not hold sufficient water at the peak of wet season. c. Shallow river slope. d. Accumulation of garbage in the river. e. The merging of the Kendal River and Buntu River mouths. f. Shift in land utilizations and the number of buildings on the river banks. g. Fishing boats hindering the flow of river water. h. Overflow of water from Blorong River.
2	Technical and Budgeting Issues	a. Poor coordination between stakeholders. b. Lack of commitment of stakeholders during land acquisition phase. c. Kendal River is situated in a higher elevation than the drainage system of its surrounding settlements. d. Provision of OP and rehabilitation budgets is very dependent on conditions in the field.

No	Source of Risk	Risk
		e. Lack of community involvement. f. Poor city drainage system. g. Lack of accessibility to early disaster information systems.
3	Resources Issues	a. OP River in Kendal River has just been initiated in the last three years. b. Equipment limitations, especially when there are simultaneous floods in other locations.
4	Security Issues Safety	a. The location is in the center of transportation, economic and public service activities. b. Damage to commodities in the agricultural area. c. The existence of densely populated settlements in the immediate vicinity of Kendal River.

### 3.2 Risk Analysis and Evaluation

The followings are the results of the Risk Analysis between the Provincial and District Governments:

#### a. Provincial Government

- 7 (seven) highest risk level, which are: 35% at the extreme level with a risk value of 20 (twenty), 1 (one) levels of risk namely 5% at the medium level with a risk value of 12 (nine) remaining, 12 (twelve) levels of risk that is 60% at high level with risk values ranging from 12 (twelve) to 16 (sixteen).
- The greatest impact risk based on the four main risk sources according to the Provincial Government is the risk originating from the shifting of land functions and the density of buildings on river borders, while the highest risk based on frequency and impact is the existence of densely populated settlements on both sides of Kendal River.

#### b. District Government

- 12 (twelve) highest risk level, which are: 60% at the extreme level with a risk value of 25 (twenty), the remaining 8 (eight) levels of risk are 40% at the high level with a risk value from 12 (twelve) to 16 (sixteen).
- The risk that has the greatest impact is based on four main risk sources from the District Government's point of view lacking the capacity of the river cross section at the peak of the rainy season, while the highest risk based on the frequency and impact value becomes the high level of sedimentation on the river body.

Risk Evaluation Results based on the impact of the risks on the acceptance scale indicate 7 (seven) risks or 35% which are classified as unacceptable, and 13 (thirteen) risks or 65% which are classified as undesirable according to the Provincial Government. Whereas, according to the Regency Government there are 12 (twelve) risks or 60% classified as unacceptable, and 8 (eight) risks or 40% classified as undesirable (not expected). The study revealed that the Provincial Government and District Government had different views on 9 (nine) items of risk or 45% of all items of risk; in other words, almost half of all items of risk are in debate.

### 3.3 Treatment/Risk Response

In every risk that occurs in the field, every stakeholder, both at the Central Java Provincial Government and Kendal District Government have their respective roles in responding to these risks, in addition to their obligation to cooperate in synergy. Every response to these risks must be delivered by all relevant parties with an equal role. Table 8 illustrates an example of a risk response, specifically responses to extreme levels of risk.

**Table 8.** Examples of Response to Risk with Extreme Levels

Risk	Risk Response Strategy
High levels of sedimentation.	a. Holding as much water as possible or build water catchment areas in the upper (upstream) area in two ways, by vegetative and structural methods.



Risk	Risk Response Strategy
Lack of water storage capacity in the wet section of the river during the peak of the rainy season	<p>Vegetative: planting trees (conservation) by means of terracing, planting trees with strong roots and long-term economic values such as fruit trees. In principle, the soil surface is covered with a canopy, preventing from direct raindrops, and then the remaining leaves will formpeat, which in turn will retain water.</p> <p>Structural: The most impactful structures are check dam, water reservoir, and sediment and reservoir control structures. At the household level, roraks (holes in the ground covered with plastic) can be made in case of sediment buildup, to collect and return the sediments to its original place. Dams can also be built, noting that the impact is small because the dam's main function is to raise the water level and control water, not to reduce flooding.</p> <p>b. Performing normalization of river areas, if conditions in the field are conducive (still possible on certain spots).</p> <p>c. Improving the bridge design along the Kendal River to prevent the girders to be too low and removing the pillar structure in the middle that can cause sedimentation.</p> <p>d. Controlling the street vendors and illegal buildings along the river banks by collaborating with the Civil Service Police Unit at the Provincial and District levels, related to the enforcement of regional regulation.</p> <p>a. Performing normalization of river bodies must be carried out, with priority areas of rehabilitation starting from the Trompo dam to the Bandengan village.</p> <p>b. Ensuring that river boundaries in conservation areas must be free from buildings and services for normalization activities must be carried out. There must be an inspection road to transport the normalized sediment in the border area.</p> <p>c. Redesigning the river body to add water storage capacity, because the wet filter that should be able to accommodate <math>\pm 25</math> m<sup>3</sup> in fact has now run out when it is filled with <math>\pm 10</math> m<sup>3</sup>. Widening of the river can be widened if possible, or dikes can be made to raise both banks of the river. Widening the river requires land, and making dikes means increasing safety and security risks.</p> <p>d. Separating theKendal River with Buntu River estuaries.</p>
Accumulation of garbage in the river.	<p>a. Disseminating and guiding the community around the river to increase awareness so as not to carelessly dispose of garbage. Currently the KSI (Indonesian River Congress), River School, or Asia River Conference have often been held in relation to the concerns of river conditions in Indonesia in general, especially in Central Java.</p> <p>b. Empowering of the community regarding waste, especially green waste, for example counseling in waste sorting and composting and working with farmers to use the resulting product as organic fertilizer.</p> <p>c. Pursuing a synergy between the Provincial Government and the District Government; for example, the Provincial Government is tasked with taking garbage from irrigation canals and river bodies, then the District Government takes the garbage to be transported to the Final Disposal Site (TPA).</p>
Shift in the land utilization and the number of buildings on the river border	<p>a. Controlling and utilizing the impacted area immediately, for example, to be made as a Green Open Space (RTH).</p> <p>b. Pursuing synergy between the Provincial Government and District Government, not only with the technical service but also with the BPN/ATR (State Land/Agrarian Agency and Spatial Planning Agency), to track residents in possession of land certificate in that location.</p> <p>c. Promoting law enforcement / regional regulations concerning River boundaries for existing buildings, and spatial control for illegal buildings, required for structuring the Kali Kendal Watershed upstream.</p>
There are densely populated settlements in the immediate area of Kali Kendal	<p>a. Creating disaster mitigation maps, for example maps of shelter/evacuation locations, evacuation routes, locations designated as public kitchen places, and so on.</p> <p>b. Conducting spatial planning by considering aspects of flood disaster mitigation.</p> <p>c. Providing immediate solutions, for example by providing water pumps to accelerate the reduction of inundation.</p> <p>d. Promoting the importance of conservation of river border areas to the local community.</p>

### 3.4 Risk Monitoring and Review

The monitoring and review activities are carried out by the Government through related agencies, both by the Central Java Provincial Government and the Kendal District Government, in relation to water resources management, particularly in the management of Kendal river starting from upstream to downstream, which are conducted annually.

## 4. Conclusions and Recommendations

### 4.1 Conclusions

1. From the 20 (twenty) risk factors identified as the main causes of the flood disaster in Kendal City due to Kali Kendal overflowing, there are 5 (five) risk factors with extreme risk values, including: high sedimentation, lack of water storage capacity for river cross sections during rainy peaks, poor city drainage system, land conversion and the number of buildings on the river border, and the existence of densely populated settlements in the immediate area of Kendal River.
2. Risk analysis indicates that at least 60% of the factors identified as the cause of flooding in Kendal City have high risk values, requiring a better handling and focus on risks with extreme values as a priority scale.
3. Every stakeholder, both the Central Java Provincial Government and the Kendal Regency Government, have their respective roles in the treatment / response to these risks, and both need to work in synergy. The difference that can be underlined is that the Provincial Government is more concerned with the technical planning and management section in the physical or infrastructure section, while the Kendal District Government is more concerned with its social aspects.

### 4.2 Recommendations

1. The results of risk identification in accordance with the risk source are expected to function as a guide for stakeholders in conducting risk mitigation based on the main tasks and functions of each Regional Apparatus Organization (OPD), both the Central Java Provincial Government and Kendal District Government.
2. The risk treatment / response that have been carried out should be improved by prioritizing treatment according to the frequency of the incident and its impact scale, and by focusing on extreme levels of risk both from the perspective of the Provincial Government and District Government, without diminishing focus to other risks.

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