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Effect of flood risk management methods on urban flooding: Article review

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ABSTRACT

Banjarmasin is the capital city of South Kalimantan Province and has a low topography, and is traversed by the Barito River. In addition, Banjarmasin City is also a Java Sea route, so it has a high level of vulnerability to sea-level rise. During the rainy season, most of the Banjarmasin area, especially the riverside, is affected by flooding. Floods in Banjarmasin, not only in quality but also in quantity, have reached a very serious level when viewed from the magnitude of the impact caused by the flood. For flood disaster management in Banjarmasin City to be more integrative and effective, urban flood disaster risk management is carried out. This study aims to identify hazards, assess community vulnerability to risks, develop preparedness and mitigation plans, implement plans, monitor, evaluate, revise and update plans (plans). This study presents a review of literature studies in flood risk management by approaching it through a review of problem identification. The methodology used in developing a methodological map is used to analyze the results to find directions for further research. Based on the analysis, the approach taken is the combination of literature and policy documents and be examined and refined through interviews with stakeholders, shareholders, and those involved in policymaking. Future research will support contributions in flood risk management for urban flooding.

ABSTRAK

Banjarmasin merupakan ibu kota dari Provinsi Kalimantan Selatan dan memiliki topografi yang relatif rendah serta dilalui oleh sungai Barito. Selain itu, Kota Banjarmasin juga menjadi jalur laut Jawa, sehingga mempunyai tingkat kerentanan yang tinggi terhadap kenaikan muka air laut. Ketika musim hujan, sebagian besar wilayah Banjarmasin terutama di daerah pinggiran sungai terdampak banjir. Banjir di kota Banjarmasin tidak hanya secara kualitas tetapi juga secara kuantitas sudah mencapai level yang sangat serius jika dipandang dari besarnya dampak yang diakibatkan oleh banjir. Agar penanganan bencana banjir di Kota Banjarmasin lebih integratif dan efektif maka dilakukan Manajemen Risiko Bencana Banjir Perkotaan. Penelitian ini bertujuan untuk mengidentifikasi risiko bahaya, melakukan penilaian kerentanan komunitas terhadap risiko, mengembangkan kesiapsiagaan dan rencana mitigasi, implementasi rencana, monitoring, evaluasi, revisi dan memperbarui rencana (*plan*). Penelitian awal ini menyajikan tinjauan studi literatur dalam studi manajemen risiko banjir dengan melakukan pendekatan melalui tinjauan identifikasi masalah. Metodologi yang digunakan adalah pengembangan melalui peta metodologi yang digunakan untuk menganalisis hasil untuk menemukan arah penelitian selanjutnya. Berdasarkan analisis, dapat disimpulkan bahwa pendekatan yang bisa dilakukan kombinasi antara literature dan dokumen kebijakan yang diperiksa serta disempurnakan melalui wawancara dengan pemangku kepentingan, pemegang saham dan yang terlibat dalam pembuatan kebijakan. Penelitian seperti ini yang akan mendukung manajemen risiko banjir untuk banjir perkotaan.

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1. Introduction

Locations with high exposure to the threat of danger are targeted for residential locations. The location is a difficult choice for residents because, on the one hand, they need cheap housing but also avoid various types of disasters. The pressure of human activity causes the balance system in the environment to be disturbed. Natural processes and several other natural factors become depressed, thereby reducing ecosystem services, leading to environmental degradation [1].

Following the mandate [3] of Article 35 concerning disaster management, one of the implementations of disaster management is disaster risk reduction. According to [2], a Disaster is a series of events that disrupt people's lives, either by natural factors or non-natural factors and human factors that result in human casualties, environmental damage, property losses, and psychological impacts. Disaster risk activities are carried out to reduce the adverse impacts, especially in situations where there is no disaster. The most common potential hazard in urban areas is flooding. Therefore, intending to minimize the losses suffered by the community due to floods, one thing that can be applied is to deal with the source causing the flood, namely the management of river areas through disaster risk management [3-4].

Disasters occur as a single or complex sequence of events. Divide the disaster management cycle into three stages, namely before the incident (mitigation and preparedness), impact, and after the incident (response and recovery) [5]. Meanwhile, [6] goes directly to preparedness, vulnerability reduction, emergency response, rehabilitation, reconstruction, risk assessment, disaster prevention, and mitigation. In addition, it is also categorized in several stages, namely emergency response, rehabilitation, reconstruction, prevention, and preparedness. These steps show that the disaster management cycle is not static but rotates continuously and involves various stakeholders.

Banjarmasin is the capital city of South Kalimantan Province and has a low topography, and is traversed by the Barito river. In addition, Banjarmasin City is also a route from the Java Sea, so it has a high level of vulnerability to sea-level rise. Calculation of sea-level rise in Banjarmasin has been carried out for 2010, 2050, and 2100. The estimated sea level increase is to reach a height of 0.37 m for 2010, 0.48 m for 2050, and 0.934 for 2100 [7]. During the rainy season, most of the Banjarmasin area, especially the riverside, is affected by flooding. Floods in Banjarmasin are not only qualitatively but also quantitatively already at a very serious level when viewed from the magnitude of the impact caused by the flood disaster [8].

It is hoped that flood disaster management in Banjarmasin City will be more effective, so Urban Flood Disaster Risk Management is carried out. This study aims to identify hazards, assess community vulnerability to risks, develop preparedness and mitigation plans, implement plans, monitor, evaluate, revise and update plans (plans). Using the Disaster Risk Management approach it is hoped that it will contribute to one of the methods to identify risks and develop preparedness and mitigation plans. Thus, it is hoped that the research results obtained are more realistic and, according to the conditions, can significantly impact determining what needs to be done.

2. Research Methodology

This study presents a literature study of the effect of flood risk management methods on urban flooding. Previous studies are needed to clarify the issues raised in this study. The aim is to distinguish what has been done and what needs to be done to be useful for research development and can be a basis for thinking. The literature study method uses the following steps: collecting related literature, analysis, and mapping methodology.

The literature review process begins by collecting literature from previous research by reading the literature. Then proceed with the development of relevant keywords. After that, the literature was filtered by reading the title and research abstract. The analysis process is carried out by mapping the previously collected research based on the research methodology used. The mapping results are then analyzed by relating the similarities and differences of each previous research based on the mapping. This research uses literature review, method, case study, modeling, and map application based on research content. These studies analyzed the similarities and differences to determine the effect of flood risk management methods on urban flooding on the solutions implemented.

3. Result and Discussion

The study results about flood risk management are compiled and discussed in Figure 1 in a mapping of the research methodology. Based on the mapping results, there are four research groups on flood risk management: primary qualitative, secondary qualitative, primary quantitative, and secondary quantitative research. The mapping in Figure 1 appears by looking at literature reviews, methods, case studies, modeling, and map applications based on research content. The next step is for each study to analyze the similarities and differences in the research objectives to find supporters of the influence of flood risk management methods on urban flooding.

Based on the mapping in Figure 1, it is found that most of the approaches from the literature taken are secondary quantitative ones. The primary qualitative research explained that the research used questionnaires as data collection [9, 17], interviews [8, 17, 20], in-depth interviews [9], and FGDs [11, 13] to assess the efficiency of implementing watershed flood mitigation policies [11], systematic involvement students (students who monitor larvae) as partners from health institutions in preventing dengue disease [12], depth interviews with key informants that aim to determine community readiness in dealing with floods [13], identify risks from the questionnaire by reviewing secondary data. Furthermore, it will be developed by conducting field observations, brainstorming, and direct interviews with experts in the drainage field [17]. [37] analyzed flood responses using standard survey data and interviews to understand better the processes underlying public risk perceptions of pluvial flooding. [47] conducted a questionnaire-based telephone survey.[49] explored appropriate flood-related urban planning using a qualitative approach in five steps and surveyed to investigate perceived risk (RP). RP was assessed through a score built on four items covering personal, residence, and sociodemographic variables related to RP flooding [50].

State of the report, with loss figures as measured in terms of insurance claims data [46]. There is also a secondary qualitative approach that explains that research is based on knowledge about the role of protected forests which is expected to be a reference for determining targeted actions about protected forest management in the context of handling hydrometeorological disasters [10]. [18, 23] conducting studies on data secondary and literature related to disaster risk management. [26] conducted a literature study on FRMP ranging from work processes to risk evaluation and determination of floodplains to FRMP creation. [43] identified the potential of local participatory monitoring networks to address existing data gaps, which are a major obstacle to building an effective community-based flood early warning system, and compared the latest versions of national flood risk models in the form of environmental agencies.

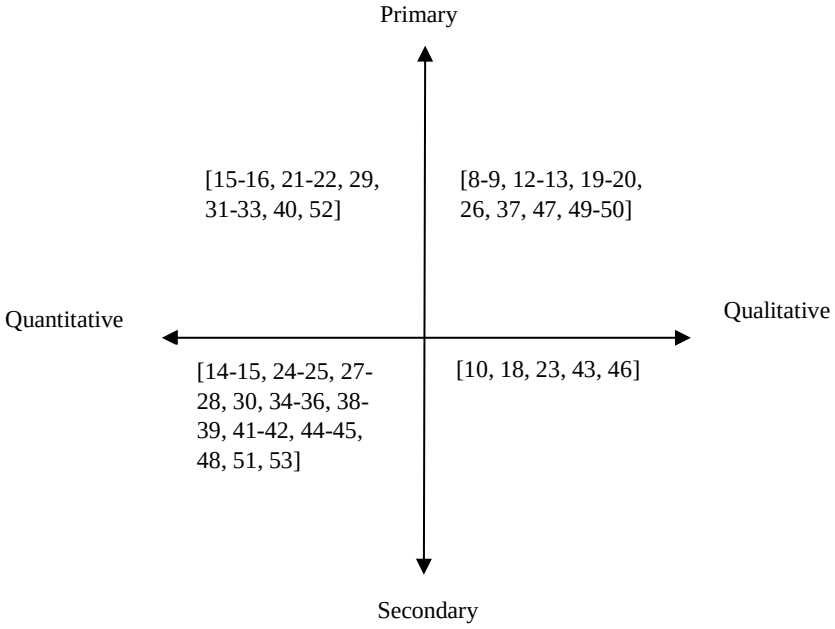

Figure 1. Mapping of research methodology.

The third type of methodology is secondary quantitative, namely, attribute analysis in the form of weighting on each parameter that affects the flash flood occurrence. Spatial analysis overlays all thematic maps used as flash flood parameters [14]. The 2-dimensional MIKE21 hydrodynamic model is used to simulate the flooding process, determined by the initial water level and boundary conditions [19]. The model uses the framework used by the World Meteorological Organization [24], then identifies areas affected by flooding for hazard analysis using a geographic information system based on digital elevation model data and flood volume. After that, the vulnerability level analysis can be carried out by applying the MCDA spatial method and weighting using the Process Hierarchy Analytical Method (AHP) on the physical, social, and land exposure criteria [25]. Morphometric analysis with the main parameters was carried out by considering the drainage density height, flow frequency, high basin relief, basin slope, total roughness, circulation ratio, and basin shape value [29]. Analysis can also be performed using the complete iCOW framework to assess the overall performance of an unprotected city against the exogenous aggregate sequence of storm surges [30].

Simulation of flood processes in the karst watershed can be carried out using the Xinjiang karst hydrological model (DXAJKHM), which is based on topographic information extracted from a digital elevation model [34]. Changes in water management policies from flood protection to flood risk management [35] can be carried out using the European Flood Directive (FD). The impact of seawater vegetation when considering real-time flood control performance can use a predictive control (MPC) model scheme [36]. The impact of water structures on flooding [38] can be seen using numerical models and models. The development of new flood forecasting models can use artificial neural network algorithms (ANN) [39]. Improved flood risk management (FRM) [41] can be carried out using disaster risk zoning, which is an effective technique in investigating the potential impact of SFD [42]. A data-driven urban pluvial flood approach is proposed using a regression-based analysis of 1,010 respondents divided between rural coastal communities and urban communities [44]. A deep convolution neural network is trained using flood simulation data obtained from three catchments 18 hyetographs [45]. Another solution to overcome this is to use the analytic hierarchy process (AHP) questionnaire, which was developed using the risk breakdown structure (RBS), and the risk impact/frequency analysis questionnaire (RIFA) was developed using the performance analysis method (IPA) [48]. Analysis of the flood impact on the reinforced masonry structure is simulated numerically. The masonry structure's failure process, stress, and deformation behavior is a solution to overcome the flood problem [51].

The last method is primarily quantitative, aiming to mitigate flood disasters by using pumps to operational effectiveness. Inflow discharge is measured by HSS-SCS so that the water level changes over time. The operating scheme of the pump depends on the length of the period [15] and 3D spatial analysis of the volume of landslides that fill the area to determine the affected area in detail. The analysis was carried out using an uncrewed aerial vehicle [16] and applying the overlapping analysis to the flood parameters in a weighted manner. Analysis can also be carried out using a geographic information system (GIS) [21] to study flood-related issues' social perceptions and find possible compatibility with existing flood management.

Sociological surveys can be carried out in the local population to analyze flood risk [28], as [27] carried out in floodplains in the Bohemia Strait. Used the stochastic differential equation method, used hydrodynamic modeling and analyzed GIS for 60 years of floodplain development for five Austrian rivers [31], used an automated hyetograph–hydrograph analysis tool [32], used flood maps currently extracted from synthetic aperture radar (SAR) or optical or development satellite imagery using hydraulic model simulations [33]. In addition, a digital elevation map with high spatial resolution and an integrated hydrodynamic model [40] might be used. Another viable option is using an external Python coupler to link the HEC-RAS 2D hydrodynamic model to the water analysis simulation program (WASP). It's a good idea to use WASP [52]. Table 1 maps the four methods and studies using these methods. The next step is for each study to analyze the similarities and differences in the research objectives to find supporters of the influence of flood risk management methods on urban flooding.

Table 1. Research methodology.

No	Author	Year	Method
1	Fitrianingrum dan Ruslanjari	2018	Observation, in-depth interview, and questionnaire [9].
2	Tjiptono	2018	This paper aims to know the role of protected forests, which can later be used as a reference for determining targeted actions about protected forest management in the context of hydrometeorological disaster management [10].
3	Wijono	2018	This research is qualitative descriptive using primary data and secondary data. Primary data obtained from the Focus Group Discussion (FGD) is used to analyze the effectiveness of implementing flood mitigation strategies in the Sampean watershed. For secondary data obtained from literature studies and data published by official institutions [11].
4	Nasution	2018	The involvement of Sismantik (Latin Monitoring Students) as partners from health institutions to prevent dengue disease needs to be supported by the right form of media [12].
5	Noverma dkk	2018	Two methods are used, namely observation and in-depth interviews with village heads and farmer group leaders, to determine community readiness on their agricultural land [13].
6	Risma, dkk	2014	There are two types of analysis used in this paper. The first is attribute analysis in the form of weighting on each parameter that affects the incidence of the flash flood. Spatial analysis overlays all thematic maps used as flash flood parameters [14].
7	Purnaditya	2018	This study provides an overview of flood disaster mitigation through the operation of pumps to operate effectively. Inflow discharge is measured using HSS-SCS, and this causes the water level to change over time. The operation scheme of the pump depends on the length of the planned flood return period [15].
8	Usman dkk.	2018	In this study, to determine the affected area, a 3D spatial analysis was carried out on the volume of landslides that buried Banaran Village. An uncrewed aircraft or UAV (unmanned aerial vehicle) is used [16].
9	Purbawijaya	2011	In collecting data, the researcher used a questionnaire. The questionnaire's content is a risk assessment obtained from respondents' opinions about the possibility of occurrence and the effect of risk. Next, identify the risks obtained from the questionnaire by reviewing secondary data and then conducting field observations by brainstorming and direct interviews with experts in the drainage field [17].
10	Santoso	2013	A study was conducted on secondary data, namely the literature related to Disaster Risk Management. The secondary data used were obtained from mass media news publications [18].
11	Feng wu,dkk	2021	Using the 2-dimensional MIKE21 hydrodynamic model to simulate the flooding process by simulating the evolution of the flood, which is determined by the initial water level and boundary conditions, and Collected data on maximum rainfall and small watershed inflow in the Baiyangdian lake basin [19].
12	Awalia, dkk	2015	The approach used by this research is qualitative research. Meanwhile, three collection methods are applied, namely documentation, interviews, and observations [20].
13	Subhan, dkk.	2012	In this study, the data analysis uses the Miles and Huberman model, or the analysis applied when collecting data within a certain period. In collecting research data used interviews, documentation, and observation methods [21].
14	Dianasari	2018	Using a quantitative approach, interviews, and observations [22].
15	Sudamara, dkk	2012	A case study was conducted with data collection techniques from various kinds of literature related to the study, then conducted interviews with experts and distributed questionnaires to respondents who had participated in disaster management [23].
16	Utomo	2012	Using the framework used by the World Meteorological Organization [24].
17	Seniarwan	2010	Identification of flood-affected areas for hazard analysis using a Geographic Information System based on the Altitude Model and flood volume data. Vulnerability analysis was carried out by combining the criteria for the physical and social vulnerability and land exposure by applying the MCDA spatial method and weighting using the Analytical Hierarchy Process (AHP) method [25].
18	Johann	2013	This study discusses how a flood risk management plan (FRMP) can be created for urban areas with multiple high-level risks and conducts a literature study on FRMP from the work process to risk evaluation and determining flood plains to making FRMP [26].
19	Cudlínová	2015	Studying social perceptions of flood-related issues to find possible compatibility with existing flood management. A sociological survey was then carried out in the local population living in the floodplain in the Bohemia Strait (N = 89). The results are discussed about changes in Czech government policy on flood control over the last 15 years [27].
20	Zhou	2018	This article contains matters regarding the operation of reservoirs, including flood control, uncertainty in inflow estimates, the capacity curve of the voir discharge in the reservoir, and the reservoir storage curve that have a significant impact. This article uses the stochastic differential equation method to analyze flood risk [28].
21	Obeidat	2020	This article contains a morphometric analysis and sub-watershed priority carried out in Jordan's Wadi Easal Basin. The main morphometric parameters that underlie this are high drainage density, flow frequency, high basin relief, basin slope, total roughness, circulation ratio, and low basin shape values [29].

No	Author	Year	Method
22	Ceres	2021	Used the full iCOW framework to assess the overall performance of an unprotected city against the exogenous aggregate sequence of storm surges [30].
23	Schober	2020	Using hydrodynamic modeling and GIS analysis of floodplain development over 60 years for five Austrian rivers [31].
24	Allnutt	2020	This article investigates and establishes the suitability of the currently recommended definition of time parameters and proportionality ratios for small watersheds in larger sub-watersheds exceeding 50 km^2 using an automated hyetograph–hydrograph analysis tool [32].
25	Scotti	2020	Using flood maps currently extracted from synthetic aperture radar (SAR) or optical satellite imagery or developed using hydraulic model simulations [33].
26	Yang	2020	The model used is the Xinjiang karst hydrological model (DXAJKHM) for simulating flood processes in the karst watershed, which is based on topographic information extracted from a digital elevation model [34].
27	Nouzari	2021	The European Flood Directive (FD) changes water management policies from flood protection to flood risk management. According to FD, the flood risk management plan must first consider the relevant aspects. Starting from water management, nature conservation, land use, spatial planning, navigation, and port infrastructure [35].
28	Fermuyten	2020	This paper examines the impact of seawater vegetation when considering real-time flood control performance based on a predictive control (MPC) model scheme. This scheme uses a conceptual stream model to limit computational time and a reduced genetic algorithm (RGA) to optimize flood control gates [36].
29	Jehmlich	2020	This study analyzes the flood response of sixty-four businesses in Dresden, Germany, urban district, experienced severe flooding in 2002 and 2013. Using standardized survey data and interviews [37].
30	Kouhi	2021	Using numerical models and models of the impact of water structures on flooding [38].
31	Tabbussum	2020	Develop a new flood forecasting model using an artificial neural network (ANN) algorithm. Models were assessed and validated for the case study of alluvial rivers in the Indian Kashmir region, Himalayas-Jhelum River [39]
32	Sai	2020	Using the latest digital elevation maps in high spatial resolution and integrated hydrodynamic models. It is used to obtain optimal operation for emergency solutions. Optimal scenarios were determined to minimize the level of flood risk to residential areas and optimize the inflow discharge at the Van Coc Gate and the overflow point and the outflow discharge at Day Weir to ensure the operating system's safety [40].
33	Almoradie	2020	This article evaluates current gaps and describes opportunities to improve flood risk management (FRM) in Ghana, West Africa. A participatory approach method consisting of questionnaires, workshops, interviews with key stakeholders, and a systematic literature review was used [41].
34	Liu	2020	Using disaster risk zoning is an effective technique in investigating the potential impact of SFD. This study collected statistics on natural, social, and risks associated with SFD [42].
35	Pandeya	2020	Identify potential working local participatory monitoring networks to address existing data gaps, which are a major obstacle to building an effective community-based flood early warning system [43].
36	Hudson	2020	Using a regression-based analysis, 1,010 respondents were divided between rural coastal communities and urban communities in Thua Thien-Hue Province [44].
37	Guo	2020	The proposed data-driven urban pluvial flood approach is based on a deep convolution neural network trained using flood simulation data obtained from three catchments and 18 hyetographs [45].
38	Rowsell	2020	This study compares the latest models the version of national flood risk, in State Environment Agency form of the report, with loss figures measured in terms of insurance, claims data for 1998 to 2018 [46].
39	Netzel	2020	A questionnaire-based telephone survey was conducted to understand better the processes underlying public risk perceptions of pluvial flooding [47].
40	Chou	2020	Using the Analytic Hierarchy Process (AHP) Questionnaire, which was developed using the risk breakdown structure (RBS), and risk impact. The frequency analysis questionnaire (RIFA) was developed using the Performance Analysis Method (IPA) [48].
41	Echencu	2020	Explores how urban planning relates to flooding in Port Harcourt and reports on qualitative research conducted with five urban planners in Port Harcourt [49].

No	Author	Year	Method
42	Zabini	2020	In this work, Risk Perception (RP) is investigated through a survey involving 483 people living in Tuscany. RP was assessed through a score built on four items covering personal, residence, and sociodemographic variables related to RP flooding [50].
43	Xiao	2020	Analyzing the impact of flooding on numerically simulated reinforced masonry structures and their failure processes, stresses, and deformation behavior of masonry structures [51].
44	Shabani	2020	Developed External Coupler in Python to link Hydrological Engineering Center-River Analysis System (HEC-RAS), 2D hydrodynamic model, to water quality analysis simulation program (WASP) [52].
45	Santos	2020	Uses statistical methods to assess the compounding effects of storm surge and multiple river discharges on Lake Sabine. We used several trivariate statistical models, including vine-copulas and conditional extreme value models, to test the sensitivity of the results to the choice of data pre-processing steps, statistical model settings, and outliers [53].

4. Conclusion

The effect of flood risk management methods is very large in urban flooding. There are four research groups on flood risk management: primary qualitative, secondary qualitative, primary quantitative, and secondary quantitative research. The research trend is to use a combination method between literature and policy documents, then examined and refined through interviews with stakeholders, shareholders, and parties involved in policymaking.

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