

Review Article

IDENTIFYING THE CAUSES OF FLASH FLOODS FROM A GEOGRAPHIC PERSPECTIVENurul Azmi^{1)*}, Rahmadi¹⁾¹⁾ Department of Geographic Education, University Mulawarman, Indonesia²⁾ * Corresponding author, Email: nurul_azmi@unmul.ac.id**ABSTRACT**

Background. A geographical approach is important to comprehensively understand the relationship between the physical conditions of an area and flash floods. One of the most devastating hydrometeorological disasters, flash floods frequently result in large losses in terms of fatalities, damage to infrastructure, and socioeconomic effects.

Research Purpose. To identify the causes of flash floods from a geographic perspective.

Research Method. This study employs a qualitative-descriptive literature review method to analyze and synthesize scientific sources related to the causes of flash floods from a geographical perspective. Utilizing secondary data from various journals, textbooks, official reports, and research publications, the study focuses on relevant keywords such as flash floods, topography, and geomorphology for data collection. The analysis follows three main stages: 1) data reduction of information directly linked to geographical causes, 2) thematic classification based on topography, hydrology, geomorphology, and land use, and 3) synthesis and interpretation to identify patterns and relationships among the geographical factors contributing to flash floods.

Findings. Geographically speaking, steep topography, the region's geomorphological features, heavy rainfall, and changes in land use all have a significant impact on the causes of flash floods.

Conclusion. Understanding and lowering the risk of flash floods through sustainable environmental management and spatial planning requires the integration of geographical analysis.

Keywords: Flash Floods, Geographical Factors, Geographic Perspective.

BACKGROUND

Flash floods are one of the most destructive hydrometeorological disasters, often causing significant losses in terms of human lives, infrastructure damage, and socioeconomic impacts[1]. Unlike ordinary floods, flash floods occur suddenly with high water discharge, high flow velocity, and carry sedimentary materials such as rocks, sand, and wood. This phenomenon often occurs in areas with specific geographical conditions, such as mountainous regions, river headwaters, and areas with steep slopes[2].

Geographically, Indonesia is highly vulnerable to flash floods due to its topography, which is dominated by mountains, high rainfall, and short, steep rivers[3]. In addition to natural factors, changes in land use, environmental degradation, and pressure from human activities further increase the potential for flash floods[4]. Therefore, a geographical approach is important to comprehensively understand the relationship between the physical conditions of an area and flash floods.

Indonesia is one of the countries with a high risk of flash floods. This is due to its geographical conditions, namely its archipelagic nature with mountainous topography, high tropical rainfall, and numerous short and steep river basins[5]. Several cities and regions in Indonesia have experienced flash floods with significant impacts. Sentani (Papua) and Wasior (West Papua) are examples of areas that have experienced flash floods due to heavy rainfall in mountainous areas, which triggered the flow of water mixed with mud and wood towards residential areas[6]. In Garut (West Java) and Batu–Malang City (East Java), flash floods occurred in areas geographically located at the foot of mountains and traversed by small rivers[7]. Land use changes in upstream areas, such as reduced forest cover, accelerated surface runoff, and increased flood volume[8]. Meanwhile, in North Luwu (South Sulawesi), flash floods occurred due to a combination of extreme rainfall and environmental damage in the upstream areas of the river. The flow of water carrying large amounts of sediment caused widespread damage to settlements and infrastructure. These events show that flash floods in Indonesia are not only influenced by natural factors, but also by the interaction between geographical conditions and human activities, especially in the upstream areas of watersheds. Flash floods are a global phenomenon that often occur in areas with specific geographical conditions, especially mountainous regions, narrow valleys, and cities that have developed along river basins. In various parts of the world, flash floods show relatively similar patterns, occurring suddenly with high intensity and widespread impact.

In Europe, several cities in Germany and Belgium experienced flash floods due to extreme rainfall that exceeded the capacity of rivers and drainage systems. Cities located in narrow river valleys are particularly vulnerable because water flows are concentrated in a short period of time. In Asia, flash floods often occur in mountainous regions such as India, Nepal, and China. In Henan Province, China, for example, extremely heavy rainfall triggered flash floods in urban and rural areas. Geographical factors such as low-lying plains surrounded by hills and rapid urbanization exacerbated the impact of the floods. In Japan, flash floods often occur in cities traversed by short rivers with mountainous headwaters. High rainfall falling in a short period of time causes rivers to overflow and carry sediment, damaging densely populated settlements. In general, flash floods in cities around the world show that a combination of topography, extreme rainfall patterns, and urban development pressures is the main factor increasing the risk of disasters[9].

The novelty of this research lies in its attempt to synthesize various findings from the literature with a focus on the main geographical factors (topography, geomorphology, hydrology, and land use) as causes of flash floods. This study not only inventories the contributing factors but also compiles the interrelationships between geographical factors as a single spatial system, thereby providing an integrative perspective in understanding the risk of flash floods.

This research contributes to the field of geography and disaster studies by providing a spatially integrated analysis of flash flood causes, emphasizing the interaction between physical and human geographic factors. Unlike studies that focus solely on hydrological or meteorological aspects, this research combines topography, land use patterns, soil characteristics, drainage networks, and settlement distribution to explain how flash floods occur in specific geographic contexts. From a theoretical perspective, the study strengthens geographic hazard frameworks by demonstrating that flash floods are not merely natural phenomena but the result of complex relationships between environmental conditions and human activities. It reinforces the importance of spatial analysis in understanding disaster risk and vulnerability.

Methodologically, the research contributes by utilizing geographic tools such as GIS, remote sensing, and spatial mapping to identify flood-prone areas and causal patterns with

greater accuracy. These approaches enable more precise risk zoning and support evidence-based disaster mitigation planning. Practically, the findings provide valuable insights for local governments, planners, and disaster management agencies in designing targeted mitigation strategies, such as land-use regulation, watershed management, and early warning systems. By grounding flash flood analysis in geographic perspectives, this research supports sustainable spatial planning and enhances community resilience to sudden flood hazards. This research aimed to identify the causes of flash floods from a geographic perspective.

RESEARCH METHOD

This study uses a literature review method with a qualitative-descriptive approach[10]. This method aims to collect, analyze, and synthesize various scientific sources relevant to the topic of flash flood causes from a geographical perspective. The data used is secondary data obtained from national and international journal articles discussing flash floods, geomorphology, hydrology, and disasters. Textbooks and scientific references in the fields of physical geography and disaster mitigation. Official reports from government agencies and disaster management institutions. Scientific publications and research reports relevant to the topic.

Data collection was carried out by searching scientific databases using keywords such as flash floods, geographical factors, topography, and geomorphology. The collected literature was then selected based on the relevance and credibility of the sources. Data analysis was carried out in the following stages: 1)Data reduction, by selecting information directly related to the geographical factors causing flash floods, 2)Thematic classification, based on aspects of topography, hydrology, geomorphology, and land use, 3)Synthesis and interpretation, to formulate patterns and relationships between geographical factors that contribute to flash floods.

FINDINGS

The results found in this study are described in terms of topographical factors[11], geomorphological [12] and soil type factors, hydrological factors and rainfall, land use factors, and integration of geographic factors.

1. Topographical Factors

A review of the literature shows that steep topography is a dominant factor in flash flooding. Areas with high slope gradients accelerate surface runoff, preventing rainwater from infiltrating into the ground. This condition increases river discharge suddenly and triggers flash flooding, especially in upstream areas.

2. Geomorphological and Soil Type Factors

Geomorphological aspects, such as mountainous terrain and narrow valleys, play a major role in directing water flow at high speeds. Soil types that are easily eroded and have low binding power exacerbate the condition because soil material is easily carried away by water flow, and increases the destructive power of flash floods[13].

3. Hydrological Factors and Rainfall

High-intensity rainfall in a short period of time is the main trigger for flash floods. Literature shows that extreme rainfall in catchment areas that are limited in size but steep can produce large surface runoff in a short time, thereby increasing the potential for flash floods[14].

4. Land Use Factors

Changes in land use, particularly the conversion of forests to agricultural land, settlements, or mining areas, contribute significantly to the increase in flash floods[15]. The loss of ground cover vegetation reduces the ability of the land to retain water and increases erosion, which ultimately accelerates surface runoff.

5. Integration of Geographic Factors

A review of the literature shows that flash floods are not caused by a single factor, but rather by a complex interaction between topography, geomorphology, hydrology, and land use. A geographic approach allows for a comprehensive spatial understanding of the flash flood process, which can serve as the basis for region-based mitigation planning[16].

DISCUSSIONS

The results of this study indicate that flash floods are a geographical phenomenon influenced by complex interactions between topography, geomorphology, hydrology, and land use. These findings are consistent with previous studies that confirm that the physical conditions of an area play a dominant role in determining the level of vulnerability to flash floods, especially in upstream areas and mountainous regions[17].

Previous studies have mentioned that steep slopes accelerate surface runoff, thereby increasing river discharge in a short period of time. This is reinforced by the results of this study, which show that areas with high slope gradients are more prone to flash floods than low-lying areas[18]. The similarity of these findings confirms that topography is a key factor in the geographical analysis of flash flood risk.

From a geomorphological perspective, previous studies have suggested that landforms such as narrow valleys, short river channels, and limited catchment areas increase the potential for rapid water accumulation[19]. The findings of this study reinforce this view by showing that the geomorphological characteristics of mountains not only direct water flow but also contribute to high flow energy capable of carrying large amounts of sediment.

Previous studies have also highlighted the role of extreme rainfall as the main trigger of flash floods[20]. The results of this study confirm that high-intensity rainfall over a short period in areas with steep topography causes a drastic increase in surface runoff. Thus, hydrological factors do not stand alone but work in conjunction with the physical conditions of the area.

In addition to natural factors, previous studies have revealed that changes in land use play a significant role in increasing the frequency and intensity of flash floods[21]. The findings of this study are in line with previous studies showing that deforestation and land conversion reduce the ability of soil to absorb water, increase erosion, and increase the volume of material carried by flood flows.

Unlike some previous studies that tended to discuss the causal factors separately, this study emphasizes the importance of an integrative geographical approach. The synthesis results show that flash floods occur due to the accumulation and interaction of geographical factors, not because of a single factor[22]. Steep topography accelerates water flow, geomorphology determines the direction and energy of the flow, hydrology provides large volumes of water, and changes in land use weaken the carrying capacity of the environment.

This geographical approach provides a more complete understanding of the spatial process of flash floods, thereby explaining why areas with similar rainfall can have different

levels of vulnerability. The main contributions of this study can be seen in the following aspects:

- 1) **Theoretical Contribution.** This study enriches the study of disaster geography by presenting a conceptual framework that places flash floods as the result of geographical system interactions. These findings reinforce the theory that the risk of hydrometeorological disasters is greatly influenced by the physical characteristics of the region and environmental dynamics.
- 2) **Methodological Contribution.** Through a structured literature review approach, this study integrates various previous research results into a single geographical analysis framework. This approach can be a reference for further research in assessing region-based natural disasters.
- 3) **Practical Contribution.** The results of this study provide a scientific basis for flash flood mitigation planning, particularly in regional spatial planning, watershed management, and environmental conservation. The identification of dominant geographical factors can be used as a reference in mapping flash flood-prone areas.
- 4) **Policy Contribution.** The findings of this study support the importance of development policies based on geographical characteristics. The government and stakeholders can use the results of this study to formulate more adaptive and sustainable disaster risk reduction strategies.

This research is limited by its reliance on secondary sources, which may vary in data quality, methodological rigor, and geographic scale. Differences in regional characteristics across the reviewed studies make it difficult to generalize the causes of flash floods to all geographic contexts. In addition, many articles emphasize physical geographic factors, while socio-economic and institutional dimensions are less consistently addressed, resulting in a partial understanding of flash flood causality. The review is also constrained by the availability and timeliness of published literature, as rapid land-use change and climate variability may not be fully reflected in existing studies. Consequently, the findings provide a synthesized overview rather than definitive causal conclusions for specific locations.

CONCLUSION

The causes of flash floods, when viewed from a geographical perspective, are greatly influenced by steep topography, the geomorphological characteristics of the region, high rainfall, and changes in land use. Integrating geographical analysis is key to understanding and reducing the risk of flash floods through spatial planning and sustainable environmental management.

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