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MORALITY BEFORE KNOWLEDGE

Spatial analysis of flood disaster vulnerability in islamic boarding schools

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ABSTRACT

Background: Flooding in urban areas is a priority in the management and mitigation of natural disaster risks, especially floods, because they are the most frequent natural disaster. This study explores flood vulnerability in urban areas by developing research on flood disaster vulnerability variables for Islamic Boarding Schools (IBS) that have a fairly large educational community in Cimahi City. **Methods:** This research methodology is based on the compilation and processing of a series of spatial variables (Slope, Elevation, Land, Rainfall, Land Cover, and River Density), then classification is carried out through the results of the assessment of each variable with a value weight adjusted to the characteristics of the study area and also based on previous studies. The resulting thematic map is then applied using an overlay technique to the distribution of Islamic Boarding School locations in Cimahi City. **Findings:** The study found that most Islamic Boarding Schools in Cimahi City are located in areas with moderate to high flood vulnerability, influenced by slope, elevation, rainfall, land cover, river density, and soil type. Out of 30 schools, 23 are highly vulnerable. Flood risk poses social, economic, and educational challenges, highlighting the need for disaster preparedness, early warning systems, adaptive infrastructure, community engagement, and policy improvements to mitigate future flood impacts. **Conclusion:** The study's results provide a basis for mitigating and preventing ecological disasters in Islamic boarding schools, addressing flood-prone locations and the lack of spatial and social research focused on disaster preparedness within these communities. **Novelty/Originality of this article:** The novelty lies in assessing flood vulnerability specifically for Islamic Boarding School communities in Cimahi City, integrating spatial variables with social considerations, an approach rarely addressed in prior urban flood studies.

KEYWORDS: spatial analysis; flood vulnerability; islamic boarding schools.

1. Introduction

Over the past four decades, scientists have continuously discussed the issue of climate change and its impacts on natural and human systems, making it an increasingly critical global issue. Climate change is driven by global surface temperatures that have risen more rapidly since 1970 than in any other 50-year period, at least for the past 2,000 years (Intergovernmental Panel on Climate Change, 2023). At the same time, climate change has increased rainfall variability, as well as the frequency and magnitude of extreme weather events (Riche et al., 2024). Considering these factors, the risk of flooding increases, and a report from the Center for Research on the Epidemiology of Disasters (CRED) for the 20-year period between 2000 and 2019 stated that flooding was the most frequent disaster during the past decade, causing significant damage to communities (United Nations Office for Disarmament Affairs, 2020). For most countries, flooding can disrupt sustainable development. The damage caused by flooding is accompanied by difficulties in community

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adaptation and mitigation, mostly occurring in developing countries (Balogun et al., 2020; Raza & Hatab, 2025; Malla et al., 2022). Environmental degradation and damage are increasing, while ecological disasters, lacking adequate preparedness, information, and mitigation, are making the situation even more critical.

In addition to increased rainfall, changes in land use and urbanization are also major factors in increasing flood risk. Urban expansion can influence flooding by altering impermeable areas, surface water runoff, and population distribution (Zhong et al., 2025; Roldán-Valcarce et al., 2023). Furthermore, analysis of land use change in Cimahi City shows that over the 30 years from 1976 to 2004, the built-up area in Cimahi City increased by 330% (Nandi, 2011). These significant changes in land cover pose a risk of environmental damage and increase the risk of natural disasters, including flooding. In many cases, floods are disasters with widespread impacts. Floods can have social and economic impacts, ranging from loss of income, education, agriculture, sanitation, infrastructure, and property to loss of life (Badamosi et al., 2024). Loss of life due to flooding is caused by many factors, including direct impacts such as drowning and subsequent impacts such as physical trauma, heart attacks, electrocution, carbon monoxide poisoning, or flood-related fires. However, in most cases, drowning is the primary cause (World Health Organization, 2019). Typically, the severity of a flood is proportional to the extent of the damage caused. Meanwhile, in Cimahi City, there is a well-established community with a sizable and growing following. Typically, the establishment of Islamic Boarding Schools (*Pondok Pesantren*) begins with community recognition of the excellence and depth of knowledge of a Kyai (Islamic figure). Eager to learn from the teacher, local people, even from outside the area, flock to him to study. They then build simple houses near the teacher's residence (Fitri & Ondeng, 2022; Syah & Iswantir, 2023).

Historically, Islamic Boarding Schools began to emerge in Cimahi City in 1923 (Juniawan, 2024). Meanwhile, recent data indicates that there are approximately 30 Islamic Boarding Schools in Cimahi City, spread across various areas of the city (West Java Provincial Government Secretariat, 2021a). The high demand and need for education, driven by the majority Muslim population, make Islamic Boarding Schools a popular educational option. The environmental determinist approach, which explains how social development is determined by the conditions of the natural habitat in which they live, has long been discussed (Iskandar, 2017). However, against this backdrop, the development of Islamic Boarding Schools appears to have paid little attention to the carrying capacity of the surrounding biophysical environment, including disaster aspects that make them vulnerable to natural disasters and could threaten their sustainability. Although many researchers have discussed sustainability and environmentally conscious Islamic Boarding Schools, better known as Green-Pesantren/Eco-Pesantren as an effort to support sustainable development, only a few have discussed disasters and flood mitigation. Previous studies have mostly discussed disaster issues related to earthquakes and tsunamis, while studies that have discussed floods conducted in geographical locations different from the research area have shown that the curriculum implemented by Islamic Boarding Schools has not been fully responsive to the real threat of floods and landslides, even though the Islamic Boarding Schools (IBS) are located in flood-prone areas (Nasution et al., 2025).

In the context of sustainability, although Islamic Boarding Schools (IBS) in Indonesia have pioneered ecological education through initiatives such as Eco-Pesantren, the direction of its development is carried out by stakeholders, including the government, the private sector, and Islamic NGOs that play a role in the Islamic Boarding School (IBS) environment to realize the regulations for the governance of Green Islamic Boarding Schools, namely: management of organic and inorganic waste into goods of economic value; conversion of wastewater into useful resources; utilization of energy-efficient green architecture-based construction; saving water and electricity resources (Kasanah et al., 2023). Meanwhile, in the context of disasters, this has not been widely implemented, despite being pioneered by an Islamic organization in Indonesia. However, disaster preparedness in Islamic Boarding Schools (IBS) has not been optimally implemented. Therefore, information regarding flood vulnerability for Islamic Boarding Schools is crucial given the

negative impacts of flooding. In general, thematic maps related to flooding are widely available at the district/city level, but maps of flood-prone areas that directly address disaster-impact variables are still limited, particularly for educational communities and Islamic Boarding Schools. Meanwhile, as a baseline data point for flood risk reduction, flood hazard maps are crucial for determining the level of potential risk that needs to be minimized. Furthermore, the large number of Islamic Boarding Schools (IBS) in Cimahi City and the high level of educational and Muslim community activities within them make flood vulnerability analysis a crucial issue to discuss. Utilizing multiple data sources to inform analysis can provide a more reliable basis for flood management and mitigation strategies, with expected more accurate results.

2. Methods

This research was conducted in Cimahi City, West Java Province. Cimahi City has an area of approximately 42.43 km^2 with an administrative area consisting of 3 Districts and 15 Villages. Geographically Cimahi City is located between 107030'30'' – 107034'30'' East Longitude and 6 50'00'' – 6 56'00'' South Latitude, for more details can be seen in Figure 1. Based on the research map displayed, it can be seen that Cimahi City is located in the middle of other cities, thus having a strategic position in urban growth. Based on existing data, it shows that the population of Cimahi City in 2024 reached 598,698 people with an average growth rate of 1.30 percent per year (Central Statistics Agency, Cimahi Municipality, Indonesia, 2025). With this, of course, the need for land increases due to the population pressure that occurs.

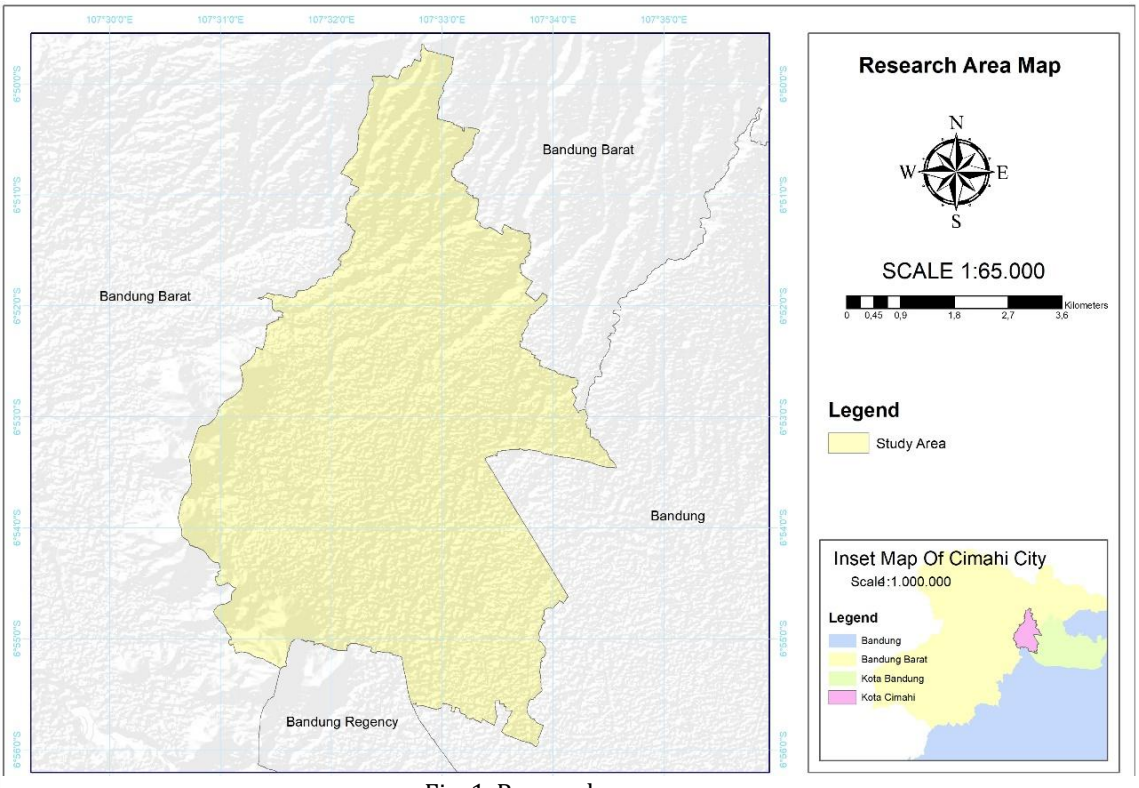

Fig. 1. Research area map

On the other hand, Muslims represent 92% of the total population in 2024, thus urging the Muslim community in Cimahi City to build Islamic boarding schools due to the need for education. So that with these conditions, the risk of flooding increases and this research is important to do. In the flood risk assessment, this study uses several spatial data that are adjusted to the physical parameters of flood disaster vulnerability, spatial research

methodology and flood disaster assessment as well as the availability of spatial data that can be used, the details are presented in Table 1.

Table 1. Details of spatial data used in the research

Variables	Data	Years	Source	Type
Slope	Digital Elevasi Model	2021	BIG	Raster
Elevation	Digital Elevasi Model	2021	BIG	Raster
Land Cover	Satellite Imagery	2025	Google Earth Pro	Raster
River Density	River Buffer	2021	BIG	Vektor
Soil	Soil Type Delineation	2021	Secretariat of West Java Province	Vektor
Rainfall	Climate Hazards Infrared Precipitation with Station data	2020-2024	Climate Hazard Center US Santa Barbara	Raster
List of IBS	Name of IBS	2025	Secretariat of West Java Province	Tabular

The details of the spatial data used in this study are adjusted to the physical parameters for flood disaster assessment and adjusted to the availability of data in the research area. For physical variable spatial data, raw data is obtained then spatial processing is carried out to produce thematic maps so that further assessments can be made for flood disaster vulnerability for each parameter. Meanwhile, for social variables, namely Islamic boarding schools, are obtained based on secondary data from the local government. Then the data is validated by searching for each Islamic boarding school location on various internet information sources such as Instagram, Google Maps and the web to ensure the existence of the Islamic boarding school and then take the coordinates of each Islamic boarding school.

2.1 Flood disaster risk variables

To achieve the research objectives, this study is divided into three main stages. For ease of understanding, a research flow framework is created as described in Figure 2 below.

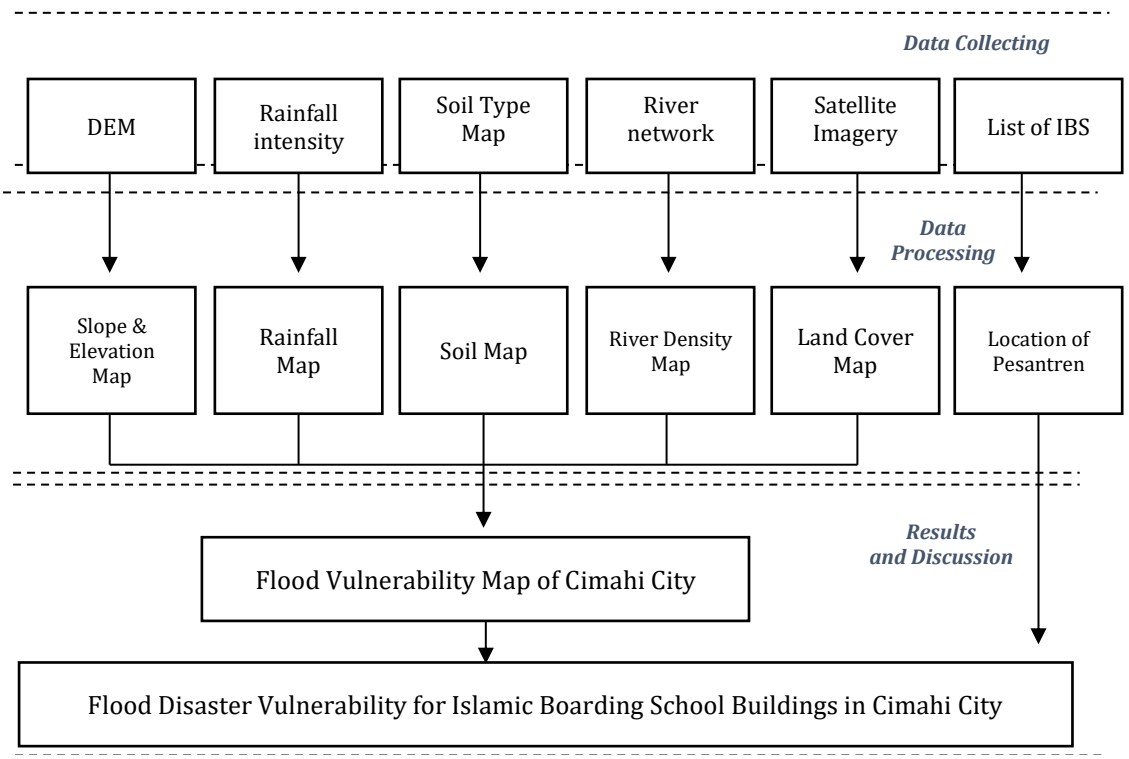

Fig. 2. Research flow chart

The first stage is to identify the study area and collect the data necessary for the flood risk analysis. Several spatial datasets are required for this analysis, each with its own type and purpose, as described in Table 1. The second stage of the study involves the compilation and calculation of each variable. The calculation of the value and class for each variable is based on the classification of previous studies, the conditions of the study site, and the value ranges for the flood risk assessment classes. The flood vulnerability assessment in this study is based on six variables or parameters that influence and can cause flooding: slope, elevation, rainfall, land cover, soil type, and river flow density. Next, each parameter is categorized based on its respective indicator class and assigned a predetermined score. Each parameter has its own class, and each class of each parameter has a different influence on the likelihood of causing flooding, which determines the score for each class. The assessment results for each parameter at the study site are then multiplied by the parameter's weighted value. Each variable has a different weighting value, adjusted according to its influence on the occurrence of flood disasters. The scores and weights for each variable or parameter in the flood vulnerability assessment can be seen in Table 2.

Table 2. Calculation value of each flood vulnerability variable

Parameter	Classification	Score	Calculation weight
Slope (%)	0 - 8	5	0.20
	>8 - 15	4	
	>15 - 25	3	
	>25 -45	2	
	>45	1	
Elevation (mdpl)	<10	5	0.20
	10. -50	4	
	50 - 100	3	
	100 - 200	2	
	> 200	1	
Average Rainfall (mm/Period)	1500 - 2000	1	0.15
	2000 - 2500	2	
	2500 - 3000	3	
	3000 - 3500	4	
	3500 - 4000	5	
Land Cover	Forest	1	0.25
	Plantation land	2	
	Empty land/bushes	3	
	Rice fields	4	
	Built-up land	5	
River Density (Km/Km2)	<0,62	5	0.10
	0,62 - 1,44	4	
	1,45 - 2,27	3	
	2,28 - 3,10	2	
	>3,10	1	
Soil Type	Aluvial, Planosol, Hidromorf, Laterik.	5	0.10
	Latosol.	4	
	Miditeran.	3	
	Andosol, Laterik, Grumosol, Podsol, Podsolic.	2	
	Regosol, Litosol, Organosol, Renzina.	1	

(Aziza et al., 2021; Kusumo & Nursari, 2016; Setiawan et al., 2022; Faria et al., 2023; Darmawan et al., 2017; Haryani et al., 2012; Rakuasa et al., 2022; Syawal et al., 2025)

The third stage is determining the vulnerability of the study area to flooding. The spatial analysis of flood risk is based on a Geographic Information System (GIS) with the assistance of overlay analysis techniques, namely operational techniques that combine value scales from various inputs to produce an integrated analysis. Simply put, overlay is a combination of geographic visual data to produce other visual data according to the

required analysis objectives. Through spatial data processing, thematic maps are then generated from each variable which are then overlaid to produce a flood hazard map for Islamic Boarding Schools in Cimahi City. Next, in the third stage, an analysis of flood vulnerability was conducted at the Islamic boarding school locations. The spatial data obtained were processed into a thematic map of flood vulnerability through spatial analysis techniques using a raster calculator. The weighted thematic maps, such as Slope maps, Elevation maps, Rainfall maps, River Density maps, and Soil Type maps, were calculated based on equation (1) for estimation and classification of value weights for flood vulnerability levels (Table 2).

$$\rho = \sum (0.20 * Slope) + (0.20 * Elevation) + (0.15 * Ra\,inf\,a\,ll) + (0.25 * Land\,cov\,e\,r) + (0.10 * River) + (0.10 * Soil) \quad \text{(Eq. 1)}$$

After obtaining the total value of the weighting of each variable and overlaying each variable, the flood disaster vulnerability class was calculated using equation (2). In this study, the flood disaster vulnerability class was categorized into 3 classes, namely Low, Quite Vulnerable, and High Vulnerable. The final result of data processing was a thematic map related to the level of Flood Disaster Vulnerability, which was then re-overlayed with the coordinates of each Islamic Boarding School to determine the vulnerability value of the Islamic Boarding School to flood disasters.

$$RS = \frac{(nMax - nMin)}{nClass} \quad \text{(Eq. 2)}$$

Explanation of terms: RS = Score Range, nMax = Maximum score, nMin = Minimum score, nClass = Number of Disaster Classes.

2.2 Islamic boarding school

In Indonesia, Islamic Boarding Schools (IBS), more commonly known as "*Pesantren*," are traditional Indonesian educational institutions with distinct characteristics that distinguish them from conventional schools. First, there are *Pondok* (boarding houses) that serve as both residences and teaching spaces. Second, there is a Mosque, a crucial element in a *Pesantren*, as it is the center of education. Third, specific religious texts are taught according to the school of thought adopted or developed by the *Kyai* (Islamic cleric). Fourth, there are *Santri* (students), both those who reside at the pesantren and those who return after completing their studies.

Table 3. List of islamic boarding schools in Cimahi City

Name of Islamic Boarding School	Map Code	Name of Islamic Boarding School	Map Code
Fatihul Huda	IBS 1	Ar-Riyadi	IBS 16
Ummul Quro	IBS 2	Assiroji	IBS 17
Daarul Hidayah	IBS 3	Shollahudin al Ayyubi as Salafiah	IBS 18
Manba'ul Huda	IBS 4	Nurul Hikam	IBS 19
Salafiyah Attaqwa	IBS 5	Sabiilul Waffa	IBS 20
Darussurur 8	IBS 6	Baitul Izzah	IBS 21
Cibereum Kidul	IBS 7	Misbahunnur	IBS 22
Nurul Anwar	IBS 8	Darussurur 2	IBS 23
Darussurur 3	IBS 9	Baitul Anshor	IBS 24
Al Fauziyyah	IBS 10	Albasariah	IBS 25
Al-Mukhlisin	IBS 11	Darul Hamid	IBS 26
Al Maqom	IBS 12	Miftahul Huda	IBS 27
Jati	IBS 13	Assanusiyyah	IBS 28
Al Mas'udiyah	IBS 14	Al-Mu'awanah	IBS 29
Al-Musyahadah	IBS 15	Riyadhul Mahirin	IBS 30

(West Java Provincial Government Secretariat, 2021a)

Fifth, and most importantly, there is the *Kyai*, who serves as the center for institutional development (Musaddad, 2023). With these characteristics, Cimahi City currently has approximately 30 Islamic Boarding Schools, both those that have survived the 20th century and those that have recently been established. The list of these 30 Islamic Boarding Schools was used as the basis for the flood risk assessment. Table 3 shows the list of Islamic Boarding Schools in Cimahi City used as an analytical tool. Based on the tabulated list, identification and data processing were performed to generate spatial data for Islamic Boarding Schools in Cimahi City. The spatial data required for assessing the vulnerability of Islamic Boarding Schools to flooding is the coordinate data for each location. To generate the coordinate data, each Islamic Boarding School location was tracked using Google Earth and sorted by name. The data was then processed using a mapping application to generate a map of the distribution of Islamic Boarding Schools in Cimahi City.

3. Results and Discussion

3.1 Islamic boarding schools in Cimahi City

The development of Islamic boarding schools (pesantren) in Cimahi also has a long history, rooted in the city's growth and development. Historically, Cimahi became known around 1811 when Governor Herman Willem Daendels initiated the construction of a post road (groote postweg). The road, built by Governor Herman Willem Daendels from Anyer to Panarukan, crossed Cimahi, which was part of the Afdeeling Bandung area. This road began to develop with the construction of a loji (guard post) around the Cimahi town square. Then, from 1874 to 1893, the Bandung-Cianjur railway line and the Cimahi train station were built (Cimahi City Government, 2020). This development attracted many people to Cimahi, making it a center of growth, especially given its strategic location connecting Bandung and Batavia, now Jakarta, further accelerating its growth.

Concurrently, the development of Islamic communities and Islamic boarding schools in West Java also occurred. The increasing number of Islamic Boarding Schools in the Priangan region (West Java), including Cimahi (which was then still part of Bandung), was due to the close relationship between these Islamic Boarding Schools. This happened because these Islamic Boarding Schools had kinship ties with each other such as scientific ties, genealogical ties, marital ties, a shared vision of the heroic movement against the colonialists, and also similar tarekat (worship procedures and organizational procedures) that had developed in several Islamic Boarding Schools and were then followed by other Islamic Boarding Schools (Kusdiana et al., 2014). The development of Islamic Boarding Schools in Cimahi itself began with the establishment of the Cibeureum Kidul Islamic Boarding School founded by Mama Mukodar, the Cibabat Islamic Boarding School founded by KH. Muhammad Kurdi (1923), the As-Siroji Islamic Boarding School founded by KH. Abdul Shobur (1930), the Darussurur Islamic Boarding School founded by KH. Muhammad Yahya (1947), Al-Musyaahadah Islamic Boarding School founded by KH. Asep Saepudin (1960s), and At-Taqwa Islamic Boarding School (1981), which continues to thrive to this day (Juniawan, 2024). The strong influence of Islamic boarding schools in Cimahi City led the community to name a street "Jalan Pesantren," a well-known street that still exists today.

In addition to social ties within the community, the need for Islamic education has driven the increase in the number of Islamic boarding schools in Cimahi City. Islamic boarding schools maintain close ties with the surrounding community and function not only as educational institutions but also as agents of development within the community, thus playing a unique role in society (Karim et al., 2025; Azhar & Haryanto, 2024; Aminy, 2018). In addition, the strong influence and trust in the academic abilities of a Kyai (Islamic scholar/figure) also encourages people to study and acquire knowledge in Islamic boarding schools (Fitri & Ondeng, 2022; Syah & Iswantir, 2023). Cimahi City currently has a population of 598,698 people, with 549,293 Muslims representing 92% of the total population in 2024 (Central Statistics Agency, Cimahi Municipality, Indonesia, 2025). This figure significantly increases the opportunities and growth of Islamic boarding schools as

an educational option for the majority of the population, considering the large Muslim population in Cimahi City. Based on the results of secondary data identification and information searches on the internet through social media and the web, the number of Islamic boarding schools in Cimahi City is 15 spread across three sub-districts in Cimahi City, with 12 Islamic boarding schools in North Cimahi District, 6 in Central Cimahi District, and 12 Islamic boarding schools in South Cimahi District. To facilitate understanding of the distribution of Islamic boarding schools (pesantren) in Cimahi City, Figure 3 below presents this map.

Based on identification results using Google Earth, spatial data was obtained in the form of the distribution of Islamic Boarding Schools in Cimahi City. The results of the search obtained coordinates for each Islamic Boarding School (IBS), which were then processed to produce a thematic map related to the distribution of Islamic Boarding Schools in Cimahi City. This thematic map is the main map used as a basis for assessing flood vulnerability in each Islamic boarding school. Based on the administrative boundaries of Cimahi City, Islamic Boarding Schools are spread across three sub-districts in Cimahi City, with 12 Islamic Boarding Schools in North Cimahi District, 6 in Central Cimahi District and 12 Islamic Boarding Schools in South Cimahi District. To facilitate understanding regarding the distribution of Islamic Boarding Schools in Cimahi City is shown in Figure 3 below.

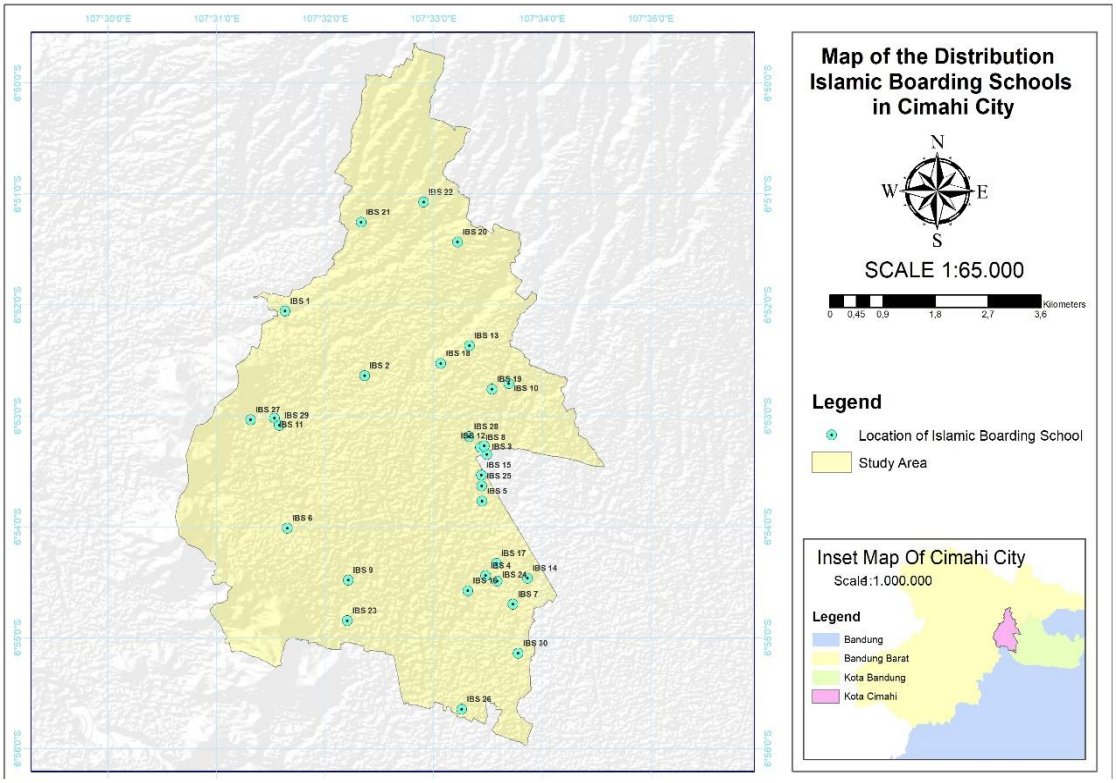

Fig. 3. Distribution of islamic boarding schools in Cimahi City

This map was obtained by processing spatial data obtained in the form of a tabulation of the names of Islamic boarding schools (*pesantren*) in Cimahi City. Then, a search was conducted based on the tabulation of Islamic boarding school names to obtain the coordinates for each Islamic boarding school (SMA), resulting in a thematic map of the distribution of Islamic boarding schools in Cimahi City. This thematic map serves as the primary basis for assessing flood vulnerability in each Islamic boarding school.

3.2 Flood disaster vulnerability assessment

Based on the spatial data processing results for each variable, six thematic maps were obtained. The resulting thematic maps were based on the class of each variable related to and contributing to flooding. The resulting thematic maps included slope gradient, elevation, land use, river density, rainfall, and soil type, as shown in Figure 4. The following is a discussion of the results for each variable in the flood vulnerability assessment.

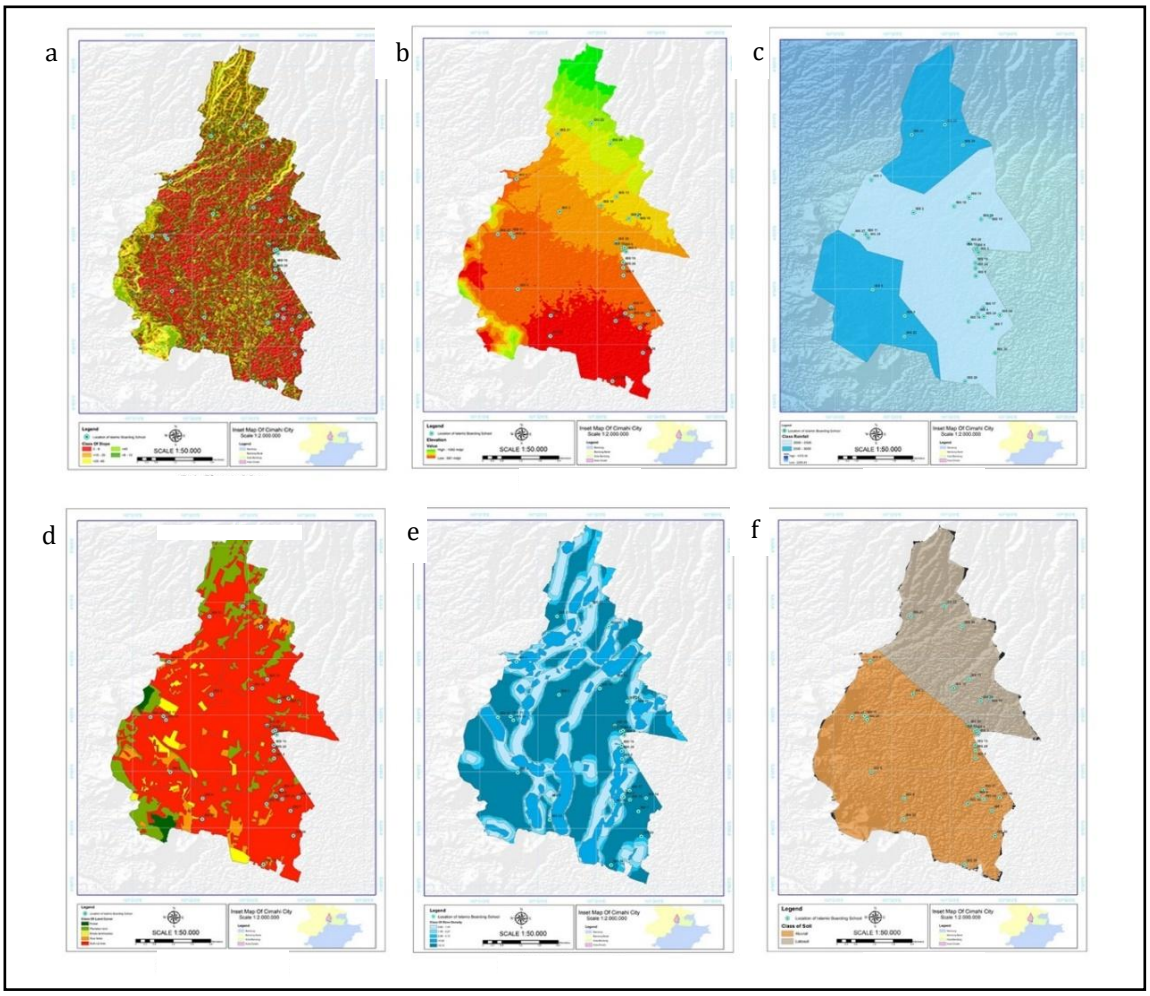

Fig. 4. Thematic map of each variable (a) Slope map; (b) Elevation map; (c) Rainfall map; (d) Land cover map; (e) River density map; (f) Soil map

3.2.1 Slope and elevation

Based on the results of raster spatial data processing, results were obtained related to the slope conditions of Cimahi City. In the categorization of slope classes in Cimahi City, the 0-8% (Flat) class dominates with a percentage value reaching 46% of the total area. Then followed by the slope class >8-15 (Gentle Slope) with a percentage reaching 32%. Next, the slope class >15-25 (Moderately Steep) reached 14%, for the slope class >25-45 (Steep) which reached 7% and for the slope class with the lowest area is the slope class >45 (Very Steep) which reached 2%. Slope slope is one of the main variables or parameters in determining the possibility of flooding because the slope can affect the movement or speed of water. The flatter an area, the higher the possibility of water pooling and flooding. Quoted from the Flood Disaster Risk Assessment Preparation Module of the West Java Province, National Disaster Management Agency for 2022-2026, areas with an accumulated height of less than or equal to 75 cm are included in the low hazard category; Areas with an altitude of 75 - 150 cm are included in the moderate hazard category; and areas with an altitude

above 150 cm are included in the high hazard category (National Disaster Management Agency, 2021). For the results of the value weighting, the highest result was obtained with a value of 1 and the lowest with a value of 0.2. Based on the overlay results, the location of Islamic Boarding Schools in Cimahi City is on average in the 0-8% slope class with a total of 15 Islamic boarding schools, for the slope class >8-15% with a total of 9 Islamic Boarding Schools and the slope class >15-25% with a total of 6 Islamic boarding schools.

Based on the results of spatial data processing and analysis, Cimahi City is at an altitude range of approximately 681 MSAL to 1,082 MSAL. Altitude is an important factor in assessing flood disaster vulnerability, because the higher an area is, the lower the potential for flood disasters and vice versa. Based on the land elevation classification guidelines, the results of the elevation variable for flood disaster vulnerability are included in the category of >200 MASL with a score of 1 and a weight value of 0.2. Based on the results of the thematic elevation map, all Islamic boarding school locations in Cimahi City are also at minimal flood vulnerability because the elevation of the Cimahi City area is above >200 MASL.

3.2.2 Average rainfall and land cover

Based on the results of the average rainfall data processing, Cimahi City is categorized into 2 categories. Based on the processing of rainfall data for a 5-year period, namely from 2020 to 2024, the Cimahi City area is dominated by an average rainfall class of 2000-2500 mm/year with a total percentage reaching 57% of the area and an average rainfall class of 2500-3000 reaching 43%. Based on these results, Cimahi City is categorized into 2 classes with a score of 2 and 3, while the weighting results are 0.3 and 0.45. The determination of the weighting value of 1.5 for rainfall is based on the results of the average rainfall for a 5-year period, although rainfall is a very determining variable in the occurrence of floods, but because the Cimahi City area is dominated by these 2 classes, there is no significant difference in the calculation of vulnerability regionally. Based on the overlay results, the location of Islamic Boarding Schools in Cimahi City is mostly in areas with an average 5-year rainfall of 2000-2500 mm/year with a total of 24 Islamic boarding schools, while the remaining 6 Islamic Boarding Schools are in areas with an average 5-year rainfall of 2500-3000 mm/year.

Based on the results of satellite image data processing in 2025, a thematic map of land cover for the Cimahi City area was obtained. In producing thematic maps of land use or cover using Google Earth Satellite Imagery dated 02-08-2025 with the digitizing method or map digitization. Meanwhile, the results of the analysis show that land cover in the Cimahi City area is dominated by the Built-up cover class, the built-up class is a class that covers land due to natural changes caused by humans which usually have watertight characteristics such as buildings such as residential, office, industrial and others. This factor of land cover changes into buildings also increases vulnerability to flooding. The dominance of the built-up cover class itself reaches 77% of the total area of the study area. Followed by the Garden cover class reaching 14%, the Rice Field cover class 4%, vacant land 3% and the Forest cover class which only reaches 1% of the total area of the study area. The results of the weighting of the land cover variable value have a value of 0.25 to 1.5. Meanwhile, the results of satellite image analysis and observation show that of the 30 Islamic Boarding Schools located in the built-up cover class area, the association of 30 Islamic Boarding Schools in Cimahi City is located around the cover class of Rice Fields, Gardens and Empty Land.

3.2.3 River density and soil type

Based on the results of spatial data processing, it was found that the Cimahi City area is dominated by dry watersheds. The results of river density processing in Cimahi City are dominated by river density classes >3.10 Km/Km^2 with a percentage of area reaching 43% of the total area of the study area, this value states that the watershed area in Cimahi City often experiences drought. Furthermore, related to the percentage of the area of river

density levels in Cimahi City, it is followed by classes <0.62 Km/Km^2 and 0.62-1.44 Km/Km^2 which reach 18% of the total area of the study area, then classes 1.45 Km/Km^2-2.27 Km/Km^2 reach 12% and classes 2.28 Km/Km^2 - 3.10 Km/Km^2 reach 9% of the total area of the study area. For the results of the River Density assessment of the location of Islamic Boarding Schools in Cimahi City, it is dominated by the River Density class >3.10 Km/Km^2. Of the total of 30 Islamic Boarding Schools, 17 are located in the River Density class location >3.10 Km/Km^2. Furthermore, there are 6 Islamic Boarding Schools located in the density class of 0.62-1.44 Km/Km^2, 3 Islamic Boarding Schools are in the class <0.62 Km/Km^2 and there are 2 Islamic Boarding Schools each located around areas with river densities of 2.28-3.10 Km/Km^2 and 1.45-2.27 Km/Km^2.

Based on the results of spatial data processing, it is known that the Cimahi City area has 2 types of soil, namely Alluvial soil and Latosol soil. This type of soil determines the infiltration process, the greater the absorption capacity or water infiltration capacity, the lower the level of flood vulnerability. Meanwhile, Alluvial soil has a sensitive character to water and Latosol has a fairly sensitive or somewhat sensitive character, thus increasing the risk of flood vulnerability. In the research area, Alluvial soil dominates with a percentage level reaching 64% of the total research area, while Latosol soil reaches 36% of the total research area. Regarding the assessment of soil type variables on flood vulnerability for Islamic Boarding Schools, there are 11 Islamic Boarding Schools located in locations with Latosol soil types and there are 19 Islamic Boarding Schools located in locations with Alluvial soil types.

3.3 Flood disaster vulnerability level

Based on the Spatial Analysis of Flood Vulnerability in Cimahi City, the vulnerability level is dominated by the Flood Disaster Vulnerable class. The analysis results show that Cimahi City has areas with a level of vulnerability to flood disasters with a Vulnerable category, with a percentage reaching 73% or around 3,000 hectares of the total study area. Furthermore, for the High vulnerability category to flood disasters, it reaches 22% of the total study area or around 882 hectares. Meanwhile, for the Low vulnerability category to flood disasters or in the Safe category to flood disasters, it reaches 5% or only around 211 hectares of the total study area.

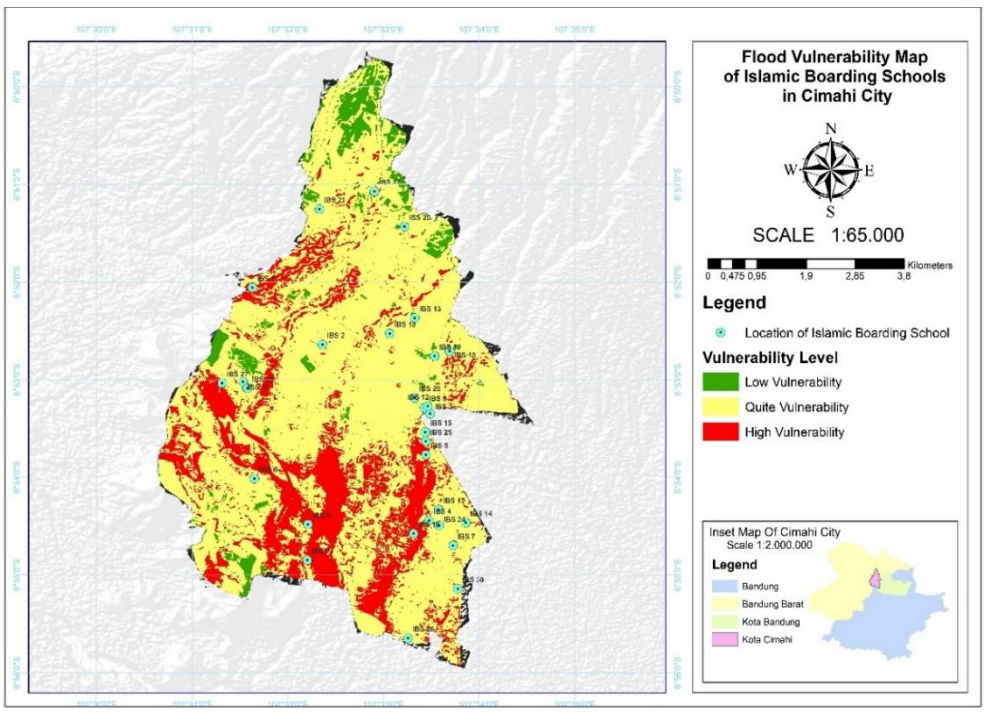

Fig. 5. Flood vulnerability map of islamic boarding schools in Cimahi City

Based on observations from thematic maps, areas with a Vulnerable to High vulnerability level are in the southern part of the city, while areas with a Low or Safe vulnerability level are in the northern part of the city. Based on these factors, the area is safe from flood disasters because land elevation, slope gradient, and land cover are factors that influence the northern area of Cimahi City so that it is safe from flood vulnerability. to facilitate understanding as can be seen more clearly in Figure 5. A study of the vulnerability of Islamic Boarding Schools to flooding in Cimahi City shows that most are located in areas with a moderate flood vulnerability rating. Of the 30 Islamic Boarding Schools studied in Cimahi City, spatial results indicate that 23 are located in areas with a high flood vulnerability rating, while the remaining 7 are in the high flood vulnerability category. Details of the flood vulnerability assessment results for the 30 Islamic Boarding Schools in Cimahi City can be seen in more detail in Table 4 below.

Table 4. Level of vulnerability of islamic boarding school locations to flood disasters

Name	Vulnerability level	Name	Vulnerability level
Pondok Baitul Izzah	Quite Vulnerable	Manba'ul Huda	High
Misbahunnur	Quite Vulnerable	Nurul Anwar	Quite Vulnerable
Sabiilul Waffa	Quite Vulnerable	Darussurur 8	Quite Vulnerable
Gawir Fatihul Huda	High	Miftahul Huda	Quite Vulnerable
Jati	Quite Vulnerable	Al-Mukhlisin	Quite Vulnerable
Shollahuddin Al Ayyubi Salafiah	Quite Vulnerable	Darussurur 3	High
Ummul Quro	Quite Vulnerable	Darussurur 2	Quite Vulnerable
Al Fauziyyah	Quite Vulnerable	Al-Mu'awanah	Quite Vulnerable
Nurul Hikam	Quite Vulnerable	Darul Hamid	High
Riyadhul Mahirin	High	Ar-Riyadi	Quite Vulnerable
Assanusiyyah	Quite Vulnerable	Cibereum Kidul	Quite Vulnerable
Al-Maqom	Quite Vulnerable	Al Mas'udiyah	Quite Vulnerable
Al-Musyahadah	Quite Vulnerable	Assiroji	Quite Vulnerable
Albasariah	High	Baitul Ansor	Quite Vulnerable
Salafiyah Attaqwa	High	Daarul Hidayah	Moderate

The results of this study provide important information and a warning to residents of Islamic boarding school communities and stakeholders, including the government, to be responsive to flood disaster preparedness, especially in existing Islamic boarding school institutions. The results of this study are expected to serve as a basis for evaluation, ensuring that every development project takes into account the environmental carrying capacity and capacity to avoid negative impacts in the future. It has long been discussed that sustainable carrying capacity is determined by many factors, both biophysical and socio-cultural-economic. Biophysical factors are important because they determine sustainable carrying capacity through ecological processes that are life-support systems (Otto, 2004). Considering the impact of floods can be detrimental, both socially, economically, and even in the loss of life. When discussing disasters, especially natural disasters, their impact on humans cannot be separated.

A natural event is considered a disaster when there are victims of living creatures affected, because an event that does not involve humans or other living creatures is only referred to as a natural process, not a disaster or natural disaster. Based on available data, the number of people involved in all Islamic Boarding Schools in Cimahi City is 3,991 students and 574 teachers, bringing the total number of people involved in the Cimahi City Islamic boarding school community to 4,565 (West Java Provincial Government Secretariat, 2021b). This number does not include cleaning, administrative, and other staff, so the number may be higher than the available data. Meanwhile, a study by the National Disaster Management Agency estimated the total potential physical and economic losses from flooding in Cimahi City at 5,955,839, categorizing this as a High potential loss (National Disaster Management Agency, 2021). However, further analysis and a more detailed economic valuation approach are needed to better quantify the damage and losses caused by flooding.

The results of this study can be the basis for improvements and recommendations for Islamic Boarding Schools and stakeholders. Based on this research, it is recommended to improve and strengthen supporting policies related to the implementation and management of disasters at all levels of society, including educational institutions and Islamic boarding schools. Furthermore, the development of facilities for easy access to disaster information, especially in educational institutions, should be increased as an early warning system for disasters. The frequency and impact of flooding can also be reduced through various measures to increase the effectiveness of disaster prevention and mitigation, such as maintaining water catchment areas, not littering, building good drainage channels, making biopori holes, and other effective measures that can reduce the frequency of flooding. In terms of spatial planning, it is necessary to establish special standard operating procedures (SOP) for Islamic Boarding Schools to avoid areas prone to natural disasters, especially flooding, as well as infrastructure or educational facilities that are adaptive to natural disasters. Internally, Islamic Boarding Schools are expected to implement a disaster curriculum in Islamic boarding schools, and training on strengthening disaster preparedness and disaster management is important. Most importantly, government officials and stakeholders involved in Islamic Boarding Schools and disaster management can conduct disaster assessments of other Islamic boarding schools, even all existing Islamic boarding schools, as an effort to mitigate the impact of natural disasters and support sustainable development. Given that climate change and its impacts are becoming more frequent, and if we continue to ignore them, we will ultimately be the ones affected in the future.

4. Conclusions

The results of this study indicate that spatial analysis using Geographic Information Systems (GIS) is effective and efficient in predicting flood risk. Furthermore, these results are useful in zoning and flood risk management for Islamic Boarding Schools in Cimahi City, West Java Province. These results will be a valuable resource for local governments as a basis for managing hazards/risks, land use zoning, damage estimation, good governance, and remediation efforts to reduce risks for Islamic boarding school communities in Cimahi City. Furthermore, the techniques applied in this study can easily be extended to other areas, where other factors can be considered, depending on data availability and the objectives of the study. Apart from environmental issues, the recognition that unplanned and uncontrolled development, especially without considering environmental factors, can increase negative risks to life and damage to assets in the form of property or buildings as well as health and loss of life is fundamental to the success of floodplain management. Awareness of this issue is not only the responsibility of local governments, but also all stakeholders, including the public and private sectors. Land developers, in this case Islamic boarding schools, have a social responsibility for flood-friendly development. The government, or permit issuers, also share a significant share of this responsibility through effective floodplain management implemented transparently and impartially. The private sector can pay greater attention to the distribution of Corporate Social Responsibility (CSR) to have a greater impact on the development of sustainable programs and environmental protection, particularly in the development of disaster mitigation programs, especially in areas at risk and vulnerable to natural disasters.

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During the preparation of this work, the author(s) used Google translate to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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