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GEOGRAPHIC INFORMATION SYSTEM (GIS) BASED MAP MAKING TRAINING IN DESA JEJANGKIT MUARA, KABUPATEN BARITO KUALA

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Abstract: Desa Jejangkit Muara is located in Kabupaten Barito Kuala, Provinsi Kalimantan Selatan. In 2021, a flood disaster occurred, affecting 11 regencies/cities in Provinsi Kalimantan Selatan. Furthermore, in 2023, the forest and land fire disaster significantly increased, with indications of the burned area reaching 190,394.60 hectares. This study aims to provide training measured by knowledge and skills. This training is based on the results of a field study conducted by the Geography Study Program, Lambung Mangkurat University. Village communities receive GIS training to enhance their comprehension of disaster-prone areas and reduce the risks associated with fires and floods. This study employs the univariate method, which involves calculating the frequency of numbers using field-measured and calculated primary data. Research activities include training in introducing Geographic Information Systems (GIS), mapmaking, layout design, and satellite image processing using the Normalized Burn Ratio (NBR) and overlay methods. The evaluation results indicated a significant improvement in the participants' knowledge and skills during the SIG 1 training, with an average score of 57, compared to 66 and 69 for the first and second examiners, respectively. In SIG 2 training, the average was 63, while the skills of the first examiner were 60, and the second examiner was 50. The results of SIG 3 training averaged 53, while the skills of the first examiner were 55 and the second examiner was 65. This study shows the importance of ongoing training to improve community disaster preparedness and resilience.

Keywords: Geographic Information Systems (SIG), Mapping, forest fires, floods.

INTRODUCTION

Geographic Information Systems (GIS) is a very effective tool or technology and helps in mapping disaster-prone areas (Zulfauzi et al., 2022). GIS has the ability to enter data and display it in map form (Sadewa et al., 2021). Today's increasingly rapid technological development impacts the increasing interactivity of GIS by providing more detailed information about a place on a map (Perrina, 2021).

The use of Geographic Information Systems allows the analysis of spatial and attribute data to produce maps that identify areas at high risk for disasters (Lathifah et al., 2024). Geographic Information Systems play a crucial role in disaster mitigation efforts by mapping the distribution of disaster-prone areas (Ali et al., 2023; Jayanti & Jamil, 2020). The existence of various types of disasters requires an effective strategy to reduce the impacts caused. Disaster-prone mapping can be an effective tool in risk planning and management and is an important aspect in disaster mitigation and preparedness efforts (Lulang et al., 2024; Swandayani et al., 2024).

Through geological mapping of areas with potential for disasters and the use of technology for early detection, the government and the community can coordinate in anticipating disasters that can occur at any time (Nurillah et al., 2022). Disaster hazard mapping also plays a role in decision-making at the local and central government levels (Mustofa & Augustinah, 2022). Information obtained from disaster-prone maps can be used to formulate safer development policies. Desa Jejangkit Muara, located in Kabupaten Barito Kuala, Provinsi Kalimantan Selatan, is one of the villages whose residents make their living from peatlands (Cahyana et al., 2022; Noor & Sulaeman, 2022). Desa Jejangkit Muara community farms by implementing the handil system. In addition to farming, the community also utilizes peatlands to cultivate the fisheries sector. Morphologically, Desa Jejangkit Muara is situated on a lowland, with a settlement pattern along the river and a predominant land use of peatlands. Peatland, which is organic land, functions as a carbon storage area that is able to absorb and hold water in quite large quantities (Pirngadi, 2022; Suyanto dkk., n.d.). In reality, because of its function as a carbon storage and water reservoir, peatlands can result in forest and land fires (karhutla) and flooding disasters (Martin, 2020).

Table 1. Indication of the Extent of Forest and Land Fires in Provinsi Kalimantan Selatan

Regency/City	2018	2019	2020	2021	2022	2023
Balangan	610.00	894.00	0	33.00	5.00	1,040.33
Banjar	24,390.00	22,943.00	469.00	911.00	34.00	49,529.82
Barito Kuala	6,584.00	20,927.00	675.00	53.00	212.00	22,027.55
Hulu Sungai Selatan	26,609.00	29,587.00	1,097.00	3,194.00	0	33,031.51
Hulu Sungai Tengah	973.00	2,635.00	0	216.00	0	3,390.38
Hulu Sungai Utara	4,360.00	8,294.00	395.00	498.00	0	10,710.36
Kota Banjarbaru	5,469.00	4,644.00	457.00	703.00	0	5,893.69
Kota Banjarmasin	0	88.00	0	0	0	103.46
Kotabaru	569.00	7,565.00	269.00	287.00	156.00	2,421.95
Tabalong	7.00	335.00	14.00	17.00	0	705.79
Tanah Bumbu	1,940.00	0	0	0	0	3,611.66
Tanah Laut	12,509.00	18,255.00	606.00	1,581.00	18.00	31,095.95
Tapin	14,619.00	19,789.00	35.00	1,131.00	3.00	26,832.15
Kalimantan Selatan	98,639.00	135,956.00	4,017.00	8,624.00	428.00	190,394.60

Source: Sipongi Provinsi Kalimantan Selatan, 2022

The forest and land fire monitoring system, Sipongi+, at Provinsi Kalimantan Selatan, recorded the highest area of forest and land fires in 2019 at around 135,956 hectares. In 2020 the area of forest and land fires dropped drastically to 4,017 hectares, which may reflect the success of forest control efforts, while in 2023 there was a significant increase with a total area reaching 190,394.60 hectares. According to the PPID KLHK website (Grace, 2021), the floods in Kalimantan Selatan in 2021 affected 11 out of the 13 districts/cities in Provinsi Kalimantan Selatan.

The Geography Study Program, Lambung Mangkurat University, conducted a fieldwork lecture (KKL) in Jejangkit Timur in 2023, focusing on ecological studies of forest and land fire spatial planning, which led to the selection of Jejangkit Muara Village as the research location. The study results indicate that the Kecamatan Jejangkit area experiences a higher frequency of disasters compared to other areas in Kalimantan Selatan.

The Desa Jejangkit Muara Government has established a disaster response group known as BPK Jamur. BPK Jamur serves to assist the community in managing forest fires and floods, but it still faces several challenges. The issue stems from the limited resources available in the field of information technology, resulting in a minimal distribution of information about forest fires and floods. Therefore, the goal of this research is to continue the KKL program in 2023 and provide BPK Jejangkit Muara (Jamur) with training that measures knowledge and skills based on Geographic Information Systems. The practical benefits are as follows: The practical benefits include: (a) enhancing the effectiveness of BPK Jamur in responding to disasters; (b) enhancing community awareness and preparedness for disasters; and (c) providing accurate and up-to-date spatial data to support disaster mitigation planning in Desa Jejangkit Muara.

Figure 1. Floods in Desa Jejangkit Muara in 2023

Source: Ahmad

Figure 2. Forest and Land Fires in Desa Jejangkit Muara in 2023

Source: Ghinia Anastasia Muhtar, 2023

LITERATURE REVIEW

1) Forest and Land Fires

According to (Iqbal, 2020) and is a crucial natural resource for human life. Land, also known as soil, constitutes the uppermost layer of the lithosphere and is the thinnest layer overall, yet it plays a crucial role in ensuring the sustainability of life on Earth. The process of forming the soil that exists today takes thousands to millions of years.

Burning land on mineral soils, such as red-yellow podzolic, can damage the soil structure, reduce soil permeability, and increase the rate of erosion and surface flow. Soil erosion causes the loss of fertile topsoil. People usually practice forest burning to improve soil fertility on old soils, such as red-yellow podzolic soils. Land fires are also detrimental because they eliminate germplasm, including the death of soil microorganisms due to extreme temperatures during fires.

Naturally, peat soil has a low fertility rate. However, peat fires significantly damage the organic soil by causing the loss of peat layers and vegetation (forests), which in turn halts the production of organic materials that form peat. The process of restoring damaged peat can take hundreds to thousands of years.

2) Flood

Indonesia is a country that is vulnerable to various types of natural disasters. These disasters inflict numerous losses, both direct and indirect, including loss of life and damage to facilities and infrastructure. Law No. 24 of 2011 defines a disaster as an event or series of events that threaten and disrupt the lives and livelihoods of the community. Natural, non-natural, or human factors can trigger these events, resulting in fatalities, environmental harm, material losses, and psychological effects.

Meteorological and hydrological conditions, such as tornadoes, storms, floods, extreme rain, or high-intensity rain in a short period of time, can cause hydrometeorological disasters. In general, a flood is an event when the volume of water in a channel increases and exceeds its capacity (Suradi et al., 2021).

There are several types of floods, including those caused by extreme rain, flash floods, upstream floods, tidal floods, and flash floods (Noryana, 2021). Each type of flood has its own characteristics. Flash floods are floods that occur briefly, around 6 hours, caused by heavy rain, dam failure, or embankment failure.

The main characteristic of flash floods is the rapid rise in water levels in rivers or channels. In flash floods, landslides often occur first, triggered by heavy rain, followed by flash floods as a continuation of the landslide. Floods occur when the river water discharge increases significantly from normal conditions due to continuous rain upstream or at certain locations, so that the river flow is unable to accommodate it and the water overflows into the surrounding area. Floods are caused by two main factors, namely: 1) natural factors, such as high rainfall, erosion and sedimentation, topography and geophysical conditions of the river, inadequate river capacity and drainage, land subsidence, and damage to flood control structures; 2) human factors, such as changes in land use, waste disposal, slum areas along the river, and inappropriate flood control system planning.

3) Geographic Information System

Geographic Information Systems (GIS) possess the capability to store data derived from geographic information (Adil & Triwijoyo, 2021). This is what distinguishes geographic information systems from other information systems used to collect, store, process, analyze, and present data related to geographic location or position (Erkamim et al., 2023). Geographic Information Systems is a technology that combines spatial data with non-spatial data to provide more in-depth information about a particular location (Falih & Nabilah, 2021). Geographic information systems also play an important role in the management and analysis of geographic data covering areas such as urban planning, disaster management, and environmental conservation (Danardono & Fikriyah, 2021; Roziqin, 2024). Meanwhile, the Basic Geographic Information System, a type of geographic information system (GIS), encompasses fundamental elements and concepts that serve as the foundation for comprehending and utilizing GIS on a more simplified level (Supuwiningsih & Muhammad Rusli, 2020).

4) Scoring Model

Scoring models are used to create flood maps to identify areas vulnerable to flooding based on several parameters and stages of spatial analysis (Ronga et al., 2024). rocessing slope data first involves entering Digital Elevation Model (DEM) data for the area under analysis, such as Kabupaten Barito Kuala. After the DEM data is entered, the next step is to open the Arc Toolbox and select the Reclassify function to group the elevation data into several classes based on the degree of slope. Then, the slope calculation is carried out using the Slope function to obtain land slope information at each location. Once the slope map is ready, the next step involves converting the raster data into polygon data, enabling further analysis of the results.

The second step involves creating an elevation map by dividing the data into several classes, for example 20 elevation classes that describe the height above sea level. In this process, the elevation data is adjusted using the Field Calculator to calculate the height with a certain formula, which refers to the sea level in the area concerned. This step provides more detailed information about the differences in land height in the study area. Next, a soil type map is created by importing soil type shapefile (SHP) data and performing the Clip process to cut the soil type data according to the study area boundaries. After that, a rainfall map is created by entering data from the Meteorology, Climatology, and Geophysics Agency (BMKG) or other data such as from CHIRPS (Dewi et al., 2022).

This rainfall data is then processed using interpolation methods, such as Inverse Distance Weighting (IDW), to estimate the distribution of rainfall at various points in the region. This rainfall data is then reclassified into several classes to facilitate analysis. Then, to analyze the influence of land cover, the area's land use data is imported and clipped according to the boundaries of the study area. This land cover plays a crucial role in determining the likelihood of flooding, as areas with abundant vegetation can decrease the flow of rainwater into rivers, thereby reducing the likelihood of flooding compared to areas with minimal vegetation (Muzaki et al., 2022).

A river density map is the most recent creation. The Line Density function in Spatial Analysis Tools processes river data to calculate the density of river flow (Utama et al., 2022). The results of this analysis are then reclassified and converted into polygon data, to be used in further spatial analysis.

After all flood vulnerability parameters (such as slope gradient, elevation, soil type, rainfall, land cover, and river density) are ready, weighting and scoring are given to each parameter (Febriyeni, 2022). This weighting adjusts how much each parameter affects the potential for flooding, with the scoring method assigning higher values to parameters at greater risk of flooding. The resulting scores are then summed to obtain the total vulnerability value.

The final step is to overlay all parameters using the Union function in the Geoprocessing menu. The Union function in the Geoprocessing menu combines all parameter layers to create a combined map that includes flood vulnerability information from various factors. A new field such as "Total Bobot" is added to accumulate all the calculated scores and weights. The flood hazard map, the final result, offers an overview of the area's level of vulnerability and can serve various purposes in disaster mitigation analysis and planning.

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RESEARCH METHODS

This study uses a quantitative descriptive analysis method that aims to provide an overview of the research area and measure the level of respondents' skills in making forest and land fire (karhutla) and flood maps. The main focus of the study is to analyze the effectiveness of training that includes making forest and land fire (karhutla) maps and flood maps. The design of this training consists of three main stages: the introduction to basic GIS, the creation and layout of thematic maps, and the processing of satellite images using the Normalized Burn Ratio (NBR) and overlay methods. The training structure integrates theory and practice at each stage, enabling participants to directly understand and apply GIS concepts.

This study used two types of data for data collection: primary data and secondary data. Primary data was obtained through direct measurement of respondents' knowledge and skills in making forest and land fire maps and flood maps, which was carried out through a series of test stages and questionnaires. A questionnaire containing 10 questions was given to the people of Desa Jejangkit Muara in order to evaluate the respondents' skills. In addition to the questionnaire, skill measurement was also carried out through practical tests, including map digitization, map layout creation, forest and land fire map creation using the Normalized Burn Ratio (NBR) method, and flood map creation using the overlay method. Secondary data used to support this study were collected from various literature, scientific articles, and other relevant references to strengthen the analysis of respondents' skills and provide theoretical background related to mapmaking techniques and methodologies used.

This study used a variety of methods to analyze the data. Univariate analysis is a statistical analysis method that solely describes data in one variable, disregarding the relationship or influence of other variables. This analysis aims to describe the variables in the study.

Frequency distribution tables and descriptive statistics carry out this analysis to determine the average value, maximum value, minimum value, and standard deviation. This study employs univariate analysis to depict the descriptive distribution of respondents' skill values using basic statistical calculations like average, median, and standard deviation. This study also employs Pearson correlation analysis to examine the correlation between knowledge and skill levels and factors such as age, education level, and prior experience in disaster mitigation.

To complement the quantitative data, this study also uses qualitative analysis through semi-structured interviews with participants, as well as field observations to document the challenges faced during the training. We analyzed all data to ensure the accuracy and validity of the research results. This combined approach is designed to provide a more comprehensive evaluation, not only in terms of improving technical skills but also from a conceptual understanding and factors that influence the success of the training. The measurement of the success rate of skills training was carried out using a one-tailed t-test to test the significance of the difference between the pre-test and post-test results. This test aims to determine whether the training has a significant effect on improving participants' skills. The formulas and parameters used are:

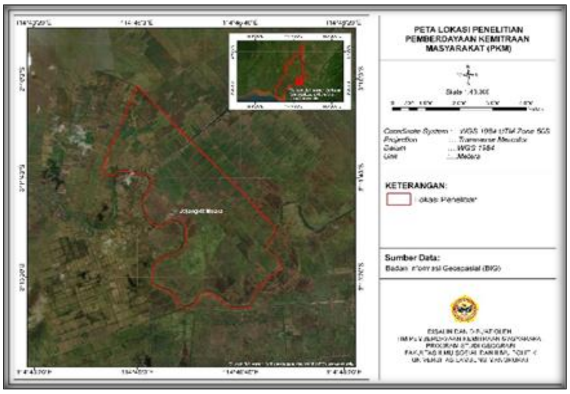
$$\boldsymbol{t\ calculation}\,\frac{y-x}{\frac{S\sqrt{1}}{n1}+1/n2}\boldsymbol{t}$$

y	= Average post-test score
x	= Average pre-test score
S	= Combined Variance
n1 and n2	= Number of respondents in the pre-test and post-test

This one-tailed test uses a 95% confidence level (α = 0.05), and the data were analyzed to calculate the value$t$and determine the significance of the results. The assessment criteria in this study are based on two types of evaluation, namely questionnaire scores and practical test scores. The questionnaire score is calculated based on the total number of questions with the same weight, where each correct answer is given a score of 1 and a wrong answer is given a score of 0.

A rubric, which includes several indicators such as digitization accuracy, map layout design accuracy, and the ability to use the Normalized Burn Ratio (NBR) and overlay methods, assesses the practical test score. For measuring long-term success, the evaluation value is categorized as very good if the score is in the range of 80–100, good if the score is 70–79, sufficient if the score is 56–69, and lacking if the score is less than or equal to 55.

Figure 3. Research Location Map



Source: Data Processing, 2024

This study is situated in Desa Jejangkit Muara, Kabupaten Barito Kuala, Provinsi Kalimantan Selatan. This community possesses significant agricultural potential, particularly due to the existence of peatlands that facilitate irrigation and enhance fisheries development. The village's geographical position in the lowlands adjacent to the Barito River renders it strategic for land rehabilitation and catastrophe mitigation initiatives, including forest and land fires and floods.

RESULTS AND DISCUSSION

1. Introduction and Training of Geographic Information Systems

The Geographic Information System (GIS 1) serves as a training program for members of the Fire Brigade (BPK). This activity includes an introduction and training of Geographic Information Systems, which aims to introduce the basics of GIS, including concepts, components, and their benefits in geospatial analysis and mapping (Cynthia et al., 2024). Participants learn about geospatial data, which consists of spatial and attribute data, and the importance of data integrity and analysis in Geographic Information Systems (GIS). In order to maintain the consistency and accuracy of spatial data, they also learn about coordinate reference systems (Danardono & Fikriyah, 2021). Furthermore, this training imparts knowledge on data representation and the various types of geospatial data, including vector data (points, lines, and polygons) and raster data. (Fikriyah & Furoida, 2021) teach the digitization process, both directly and indirectly, as a technique for transforming analog map data into digitized data.

Table 2. GIS Knowledge and Skills Questions 1

No.	Knowledge
1	Geographic Information System (GIS) is
2	The main components of GIS are
3	Geospatial data includes
4	Coordinate Reference System is used for
5	Digitization is not done directly with
6	Vector data is used for
7	Data representation in GIS makes it easier
8	GIS can be used for
9	Coordinate reference system, namely the geodetic datum for measuring
10	Benefits of Geographic Information Systems
No.	Skills
1	Able to use mapping software well
2	Inputting digital map data into mapping software
3	Perform indirect digitization by scanning analog maps into digital format and converting them to vector data in GIS software.
4	Save the digitized data into the specified folder.

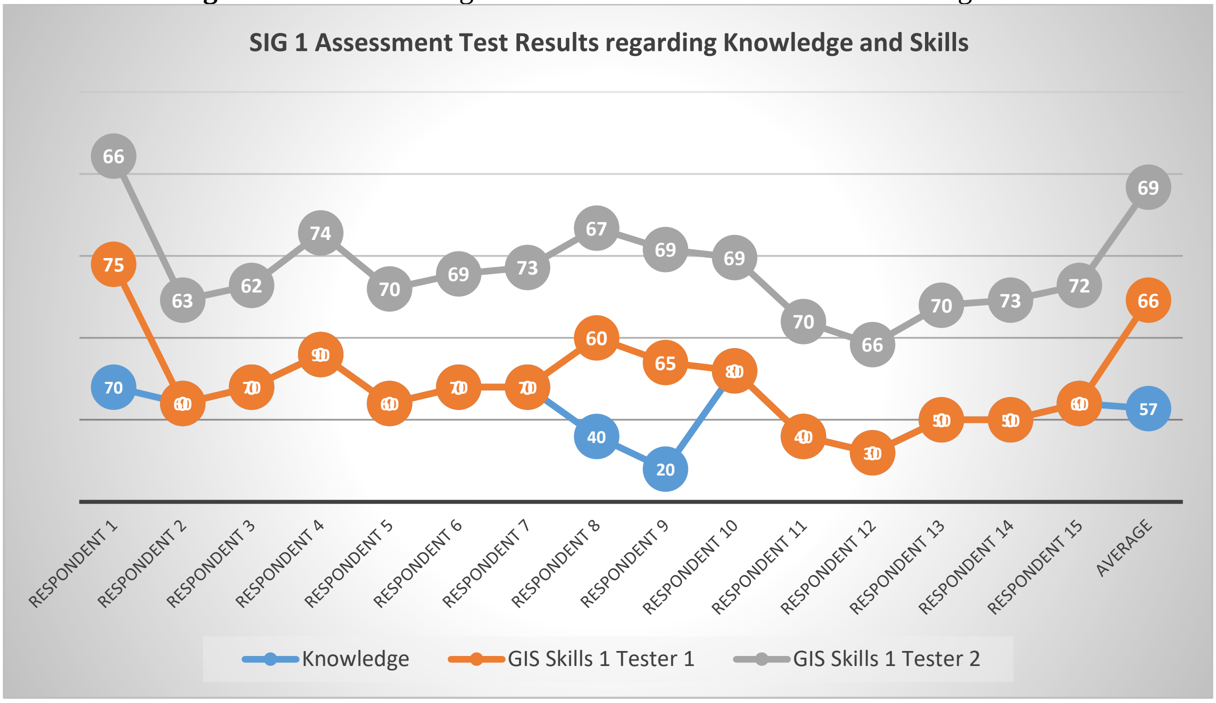
Source: Data processing, 2024

Table 3. SIG 1 Assessment Test Results regarding Knowledge and Skills

Name	Knowledge	GIS Skills 1	
		Tester 1	Tester 2
Respondent 1	70	75	66
Respondent 2	60	79.75	63
Respondent 3	70	66.25	62
Respondent 4	90	82.25	74
Respondent 5	60	56.25	70
Respondent 6	70	63.75	69
Respondent 7	70	51.25	73
Respondent 8	40	60	67
Respondent 9	20	65	69
Respondent 10	80	67.5	69
Respondent 11	40	68.75	70
Respondent 12	30	53.75	66
Respondent 13	50	62.5	70
Respondent 14	50	77.25	73
Respondent 15	60	67.5	72
Average	57	66	69

Source: Data processing, 2024

Figure 4. GIS Knowledge and Skills Assessment Test Results Diagram 1



Source: Data processing, 2024

Based on the data in Table 3, the results of the first examiner's assessment of knowledge and skills show varying values among the 15 respondents. The average knowledge of the respondents is 57. The table's data also reveals that only 9 respondents scored above 50, indicating an adequate level of understanding. There were 6 respondents who scored 50 or below, which may indicate they had trouble understanding the material.

Only one participant, the 4th respondent, achieved a score of 90 in the respondents' knowledge test, correctly answering 9 out of 9 knowledge questions, with the exception of one incorrect response, a question about indirect digitization. Respondent 9 had the lowest score, answering only two questions correctly. These inquiries pertain to the coordinate reference system employed for which purpose and the manner in which data representation in GIS facilitates the process for which purpose. The average results in GIS knowledge suggest that the majority of participants possess a sufficient level of comprehension. The average score for skills was 66, indicating that the knowledge comprehension of the participants was surpassed by their skill abilities. This data indicates that all respondents obtained scores exceeding 50, indicating that they have a sufficient understanding of the material they have studied. The second examiner's findings suggest that the post-test of knowledge and abilities resulted in scores that varied among the 15 respondents.The average result for the skill aspect was 69, indicating a higher skill ability compared to the knowledge aspect. Given that skills often necessitate direct experience and consistent practice, this figure demonstrates the respondents' superior ability to apply learned material in practice. Based on these data, as many as 15 respondents managed to get a score above 50, indicating that they have a fairly adequate mastery of skills.

This success not only reflects theoretical understanding but also the ability to adapt and apply this knowledge in real situations (Darmayanti, n.d.). This is important to ensure that participants not only remember the information but can also integrate it into relevant practical actions.

Figure 5. Introduction to Geographic Information Systems

Source: Anastasya Rosyidah An-Nafi, 2024

Figure 6. GIS Testing 1

Source: Anastasya Rosyidah An-nafi, 2024

2. Map Making and Layout Design

(Erkamim et al., 2023) designed this training to provide an in-depth understanding of simple yet informative layout design. In this session, participants will learn about the basic principles needed to create maps that are not only clear but also simple to interpret for a variety of audiences. The main focus of the training includes effective visualization techniques, as well as the importance of using the right color and typography in conveying information. The training will also introduce participants to the concept of visual hierarchy, enabling them to organize information in a way that enhances comprehension.

In addition, this training emphasizes the importance of selecting graphic elements that support information. Every element used, from icons and symbols to illustrations, must have a clear and relevant function in the context of the entire map. We will also teach participants how to avoid common design mistakes, enhancing the effectiveness of their work in conveying messages.

With a strong understanding and honed skills, participants are expected to be able to face various challenges in map design and make significant contributions in this field. This training will be the first step for participants to develop their abilities and explore further their potential. In addition, the skills acquired during this training will open up new opportunities for participants to innovate and create more effective design solutions, which in turn can improve the quality of information conveyed through maps. Thus, it is expected that participants can become reliable and creative professionals, ready to contribute to projects that require quality map design.

Table 4. GIS Knowledge and Skills Questions 2

No.	Knowledge
1	The definition of a map is
2	Thematic maps focus on
3	Map scale is used for
4	The legend on the map works for
5	Topographic maps are usually used for
6	The first step in making a map is
7	The most important elements in a map layout include
8	A map designed to display information or themes of a geographic area.
9	The first step in designing a layout on a map
10	The following is not an example of a thematic map.
No.	**Skills**
1	Define geographic coordinate systems and projection systems to determine locations on a map.
2	Inputting vector data (digitized shapefiles) into Arcgis 10.8 software
3	Able to set sub-district boundary symbology
4	Able to set paper size for layout

5	Able to determine the layout of map elements, such as the placement of the title, scale, legend, and wind direction.
6	Able to set Grid on map
7	Able to do finishing map making with layout design.

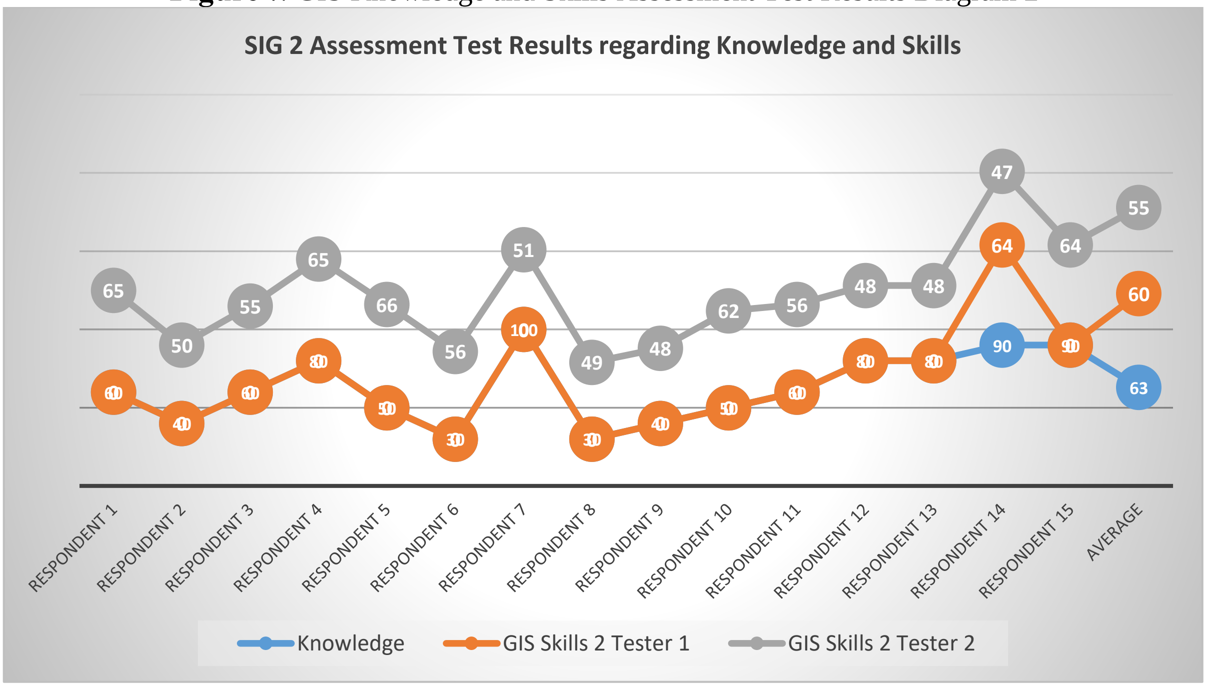
Source: Data processing, 2024

Table 5. SIG 2 assessment results regarding Knowledge and Skills

Name	Knowledge	GIS Skills 2	
		Tester 1	Tester 2
Respondent 1	60	61.29	65
Respondent 2	40	57.86	50
Respondent 3	60	63.29	55
Respondent 4	80	64.29	65
Respondent 5	50	62.71	66
Respondent 6	30	59.14	56
Respondent 7	100	49.86	51
Respondent 8	30	64.29	49
Respondent 9	40	65.71	48
Respondent 10	50	61.14	62
Respondent 11	60	52.29	56
Respondent 12	80	63.29	48
Respondent 13	80	59.29	48
Respondent 14	90	64	47
Respondent 15	90	58.71	64
Average	63	60	55

Source: Data processing, 2024

Figure 7. GIS Knowledge and Skills Assessment Test Results Diagram 2



Source: Data processing, 2024

Based on Table 5, the assessment results from the first examiner showed that there was a significant variation in the knowledge and skill scores of GIS 2 among the 15 respondents. The respondents achieved an average knowledge score of 63, with the highest score being 100 and the lowest being 30. Of the total respondents, there were 9 people who achieved a score above 50, which indicates adequate understanding of the material, and there were 6 respondents who obtained a score of 50 and below.

Only one participant, the 7th respondent, achieved a score of 100 in the respondents' knowledge test, answering all questions correctly. Respondents 6 and 8 received the lowest scores, correctly answering only 3 questions. The average results in SIG 2 knowledge indicate that most participants have a sufficient level of understanding.

Participants achieved an average skill score of 60, which was slightly lower than their knowledge score. The large variation in skill scores, with the highest score being 65.71 and the lowest being 49.86, indicates challenges in the technical application of the material. Based on the data, as many as 14 respondents managed to get a score above 50. On the other hand, only one participant got a score below 50. The second examiner's assessment revealed an average skill score of 55, with only 9 respondents scoring above 50, suggesting further improvement in the participants' mastery of material application skills. On the other hand, there were also 6 participants who scored less than 50.

The purpose of this training is to assess how well members of the Fire Brigade (BPK) understand how to use mapping software for mapmaking and layout design. Evaluation will be conducted after the training, with the following assessment criteria: if the evaluation score ranges between 80 and 100, the participant is considered very good; if the evaluation score ranges between 70 and 79, the participant is considered good; if the evaluation score ranges between 56 and 69, the participant is considered sufficient; and if the evaluation score is less than or equal to 55, the participant is considered lacking. The results of this evaluation will provide a clear picture of the participants' understanding after attending the training.

Significant variations in knowledge and skills scores reflect differences in respondents' abilities to understand theory and apply it practically. Large differences in knowledge scores, ranging from 30 to 100, indicate uneven understanding of basic GIS concepts among participants. People with relevant educational backgrounds or experiences understood the material better than those learning it for the first time. Meanwhile, lower skill scores compared to knowledge indicate challenges in technical mastery. Common technical barriers include using ArcGIS software, symbol selection, and optimal map layout settings.

Some of the main factors that influence these results include the level of technological literacy, previous practical experience, and the motivation of participants to learn during the training. Respondents who are familiar with GIS software or have technical experience are more likely to achieve better results in knowledge and skills. Additionally, the results are also influenced by the level of active participation during the training, with participants who actively participate in discussions and exercises demonstrating superior results.

These results support constructivist learning theory, which states that learning is most effective when individuals can relate new knowledge to prior experiences and knowledge. Participants with a strong initial foundation are more likely to understand and apply training materials.In contrast, participants without experience require a more contextual learning approach. Visual perception theory, which asserts that effective organization of information can enhance participants' comprehension and retention, also finds relevance in the concept of visual hierarchy teaching.

The findings of this investigation have significant practical and theoretical implications. In order to accommodate a wide range of learning requirements, it is advisable to prioritize an adaptive training approach. In order to optimize the delivery of material, it is effective to segment participants according to their initial experience level.The material can be more effectively delivered by segmenting participants based on their initial experience level. In practice, the skills of participants can be substantially enhanced through simulation-based training and case studies that are pertinent to their professional environment. Constructive feedback, personal coaching, and additional intensive practice sessions are also required to assist low-scoring participants in enhancing their performance.

Figure 8. GIS Training 2

Source: Anastasya Rosyidah An-nafi, 2024

Figure 9. GIS Testing 2

Source: Anastasya Rosyidah An-nafi, 2024

Through a practical approach that includes case studies and hands-on exercises, it is hoped that participants will not only understand the theory but will also be able to apply it in real projects (Rorong & Fathonah, 2020). This is crucial as it enables them to create maps that are not only visually appealing but also functional and easy to understand for various groups, including professionals, students, and the general public. In practice, instructors and their peers will provide participants with the opportunity to work in groups, share ideas, and receive constructive feedback.

3. Landsat 8 Image Processing and Thematic Map Data Using NBR and Overlay Methods

The 3rd Geographic Information System (GIS) training focused on image processing and spatial analysis using Landsat 8 satellite imagery and thematic maps. Participants in this training, specifically the Fire Brigade Group (BPK), learned about the Normalized Burn Ratio (NBR) method for forest and land fire hazard analysis and the overlay method for spatial data integration (Dini et al., 2022).

The NBR method involves using the near-infrared (NIR) and shortwave-infrared (SWIR) channels on Landsat 8 to distinguish burned areas, with steps such as raster data processing and hazard map classification (Fitria, 2023). Additionally, they receive training to generate flood-prone maps by overlaying various geographic parameters, including slope, elevation, soil type, rainfall, land use, and river density (Natannael et al., 2024). Each parameter is given a weight according to its influence on flood potential, and the results are integrated to form a comprehensive flood vulnerability map.

Table 6. GIS Knowledge and Skills Questions 3

No.	Knowledge
1	What is the main purpose of the Normalized Burn Ratio (NBR) method…
2	Landsat 8 is equipped with what sensor is used to capture electromagnetic wavelengths…
3	The spatial resolution of Landsat 8 imagery is…
4	What is the main function of the overlay procedure in Geographic Information Systems (GIS)…
5	Which parameters influence the flood vulnerability of an area…
6	What is meant by flow density...
7	What methods are used in making NBR maps…
8	The altitude of an area affects the possibility of…
9	What is meant by weighting in flood vulnerability analysis…
10	The initial step in disaster analysis using the NBR method is…
No.	Skills

1	Inputting Landsat 8 satellite imagery data with band 5 (NIR) and band 7 (SWIR) for NBR analysis.
2	Change the coordinate system on both bands to match the basemap being used.
3	Cutting satellite image data with Jejangkit Muara village boundaries to focus on the analysis area.
4	Using “Raster Calculator” to calculate NBR value from processed raster data.
5	Set the display of analysis results with the appropriate symbol classification.
6	Application of overlay method to merge maps.
7	Flood Vulnerability Score Calculation and Reclassification.
8	Interpretation of NBR map results and overlays.

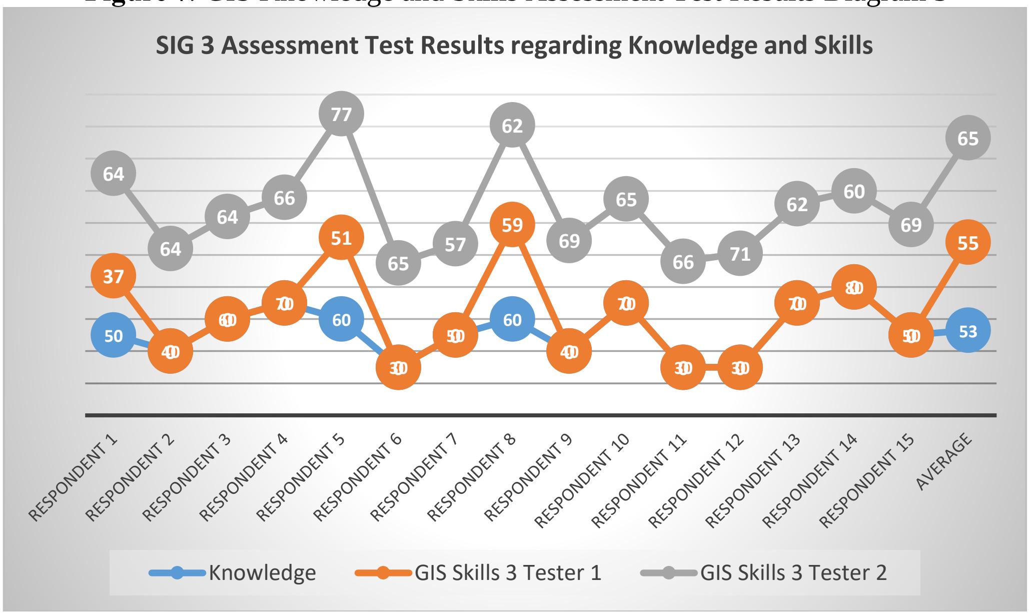
Source: Data processing, 2024

Table 7. SIG 3 assessment results regarding Knowledge and Skills

Name	Knowledge	GIS Skills 3	
		Tester 1	Tester 2
Respondent 1	50	37	64
Respondent 2	40	51.75	64
Respondent 3	60	52.75	64
Respondent 4	70	57.75	66
Respondent 5	60	51	77
Respondent 6	30	58.75	65
Respondent 7	50	57.13	57
Respondent 8	60	59	62
Respondent 9	40	53.63	69
Respondent 10	70	56.25	65
Respondent 11	30	57.88	66
Respondent 12	30	54.25	71
Respondent 13	70	55.13	62
Respondent 14	80	59.88	60
Respondent 15	50	62.25	69
Average	53	55	65

Source: Data processing, 2024

Figure 7. GIS Knowledge and Skills Assessment Test Results Diagram 3



Source: Data processing, 2024

The average knowledge level of 15 respondents was 53, as indicated by the data in Table 7. Only seven of the respondents achieved a score greater than 50, suggesting that their knowledge is deemed sufficient. In contrast, 8 respondents had knowledge scores below 50, suggesting that the majority of participants have not achieved the anticipated level of knowledge.

Based on the respondents' knowledge, there was only one participant who achieved a score of 80, which was the 14th respondent, who correctly answered eight knowledge questions. The lowest scores were achieved by respondents 6, 11, and 12, who correctly answered only three questions. The results of the level of comprehension of knowledge in SIG 3 are still relatively low (Aji & DPA, 2020).

Figure 8. GIS Training 3

Source: Anastasya Rosyidah An-nafi, 2024

Figure 9.GIS Testing 3

Source: Anastasya Rosyidah An-nafi, 2024

The average score for the skills component of the first examiner's examination was 55. Among the 15 responses, 14 participants attained a score exceeding 50. One respondent received a score below 50. Additionally, the second examiner's evaluation yielded a score of 65, signifying that 15 respondents attained a score beyond 50. The proficiency of Fire Brigade (BPK) members in image processing mapping software and geographical analysis is assessed using skill achievement indicators. If the evaluation value is between 80 and 100, it is excellent; if it is between 70 and 79, it is good; if it is between 56 and 69, it is adequate; and if it is 55 or lower, it is deficient. The findings classify the comprehension levels of Fire Brigade (BPK) members according to their competencies, revealing that 60% exhibit a satisfactory degree of understanding. Fifteen responders participated in the training, comprising members of the Fire Brigade (BPK) in Jejangkit Muara.

Based on training result data, the increase in participants' skills in using Geographic Information Systems (GIS) demonstrates the implementation of adult learning theory, which emphasizes practice-based learning and direct relevance to participants' needs. The higher average skills compared to the average knowledge in GIS 1 (66 compared to 57) and GIS 2 (60 compared to 63) reflect that the practice-based training approach is effective in supporting direct application understanding. The literature review explains the GIS concept as a tool that analyzes spatial data to support location-based decision-making (Adil & Triwijoyo, 2021). The success of participants in digitizing, managing raster data, and designing layout maps emphasizes the relevance of GIS as a technology that enables disaster vulnerability analysis and risk mitigation with an accurate scientific approach. In addition, these results are also in line with disaster mitigation theory, which states the importance of using technology to identify and reduce disaster risks through structured spatial data processing (Danardono & Fikriyah, 2021).

CONCLUSION

Through various stages of counseling, training, and simulation for the community in Desa Jejangkit Timur and Desa Jejangkit Muara, the Geographic Information System (GIS)-based training program has succeeded in improving participants' understanding and skills in identifying disaster-prone areas and taking the necessary mitigation steps. The evaluation revealed a significant improvement, particularly in the creation of disaster-prone maps that indicate the risk of forest and land fires (karhutla) and flooding in Desa Jejangkit Muara.

The training program includes three main modules, namely GIS 1, GIS 2, and GIS 3. GIS 1 introduces participants to the fundamentals of GIS, covering basic concepts, geospatial data, and digitization processes. GIS 2 involves training in thematic map making and map layout design, while GIS 3 focuses on satellite image processing using the Normalized Burn Ratio (NBR) and overlay methods for flood vulnerability analysis.

The practice-based training method has proven effective, with participants showing higher skill improvements compared to theoretical knowledge. The average skill score demonstrates this, surpassing the average knowledge across the three modules.

Quantitatively, the average knowledge score of participants was 57 in SIG 1, 63 in SIG 2, and 53 in SIG 3. Meanwhile, the average skill score of participants reached 66 and 69 in SIG 1, 60 and 55 in SIG 2, and 55 and 65 in SIG 3. These results indicate that although there is variation in the initial knowledge level of participants, practice-based training is able to significantly support the mastery of technical skills. The distribution of participants' skill scores after training shows that the majority are in the "sufficient" to "good" category.

However, several obstacles are still faced, such as limited resources and differences in participants' initial understanding. This indicates the need for further development in the use of information technology, including a more adaptive training approach, segmentation of participants based on experience level, and increased intensive practice sessions.

Thus, this GIS training not only provides direct benefits in building the capacity of local communities but also becomes a relevant practice-based learning model to be applied in other areas.

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