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Spatial Data Handling System in The Nasai Village Area, South Papua

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ABSRACT: Merauke Regency is one of the districts in the South Papua Province, geographically located between 1370 - 1410 East Longitude and 50 - 90 South Latitude. With an area of up to 45,013.35 km2 or 38.2 percent of the total area of South Papua Province, making Merauke Regency the largest district not only in South Papua Province but also among other districts in Indonesia. Administratively, Merauke Regency has 22 districts. With the expansion of new provincial territories, Merauke Regency became part of South Papua Province along with Boven Digoel, Asmat and Mappi Regencies. This expansion is based on Law No. 14 of 2022. Merauke has 22 districts/sub-districts and 190 villages. The existence of 190 villages means that spatial data collection is still considered a normal thing, even though spatial data collection in an area is very important, especially with current technological advances. Accurate and integrated management of spatial data is important in planning and decision making in a region, especially in the Nasai Village area, South Papua. This research aims to examine a comprehensive spatial data handling system in this area, using Geographic Information System (GIS) technology as a tool. The methods used in this research include identifying needs and problems related to spatial data, collecting spatial and non-spatial data, as well as designing an integrated geographic information system. It is hoped that the results of this research will provide an overview of the current condition of spatial data management in Nasai Village and provide system recommendations that can increase the efficiency and effectiveness of geographic information management in the area.

KEYWORDS: Spatial Data, Geographic Information Systems, Spatial Data and Non-Spatial, Nasai Village

A. INTRODUCTION

Nowadays, geographical information has become an essential element in various aspects of human life, both for work purposes and life planning [1]. Geographic Information System (GIS)-based spatial mapping and analysis has been widely applied in various sectors, including spatial planning [2], natural resource management, and infrastructure development [3][4]. Especially in rural or remote areas, the use of geospatial technology can have a significant impact in accelerating development and improving community welfare [5].

Nasai Village, one of the regions in South Papua Province, faces challenges in managing accurate and integrated geographic data and information. Until now, spatial data in Nasai Village is still managed partially and limitedly, making it difficult for local governments to create comprehensive location-based planning [4]. Therefore, this research aims to analyze the spatial data handling system that can be applied in Nasai Village to support regional planning and development more effectively.

Considering that Merauke is broadly one of the cities located in the southern coastal region of Papua Island with varying heights of up to 8 meters above sea level. Higher and undulating areas are found in the northern part of this district with elevations between 12 and 50 meters above sea level. This low elevation makes Merauke an area with a plain landscape, and Nasai Village in particular is also included in villages that are close to coastal areas and is also a village in an area prone to sea water flood disasters. Global warming, which has had a direct impact on overall climate change on the earth's surface, is clearly visible in this area with the increasingly intensive abrasion process occurring along the coast of Merauke. This abrasion has changed the coastline further inland and has increased the area of Merauke's coastline. On the contrary, with increasing the area of the coastal area has an impact on reducing the area of land.

The abrasion process along the Merauke coast is influenced by erosion caused by sea currents and tides, as well as erosion by rainwater and wind. The shape of Merauke's landscape increasingly supports the abrasion process in this coastal area. The shape of the Merauke coast is almost flat and there are no large differences in elevation in the morphology of the seabed, meaning that the process of transporting material originating from the ocean during high tides is smaller than material transported from land during low tides. The strong winds have also changed the shape of

the sand embankments along the coast. These sand embankments, whether formed naturally (formerly in the payum area) or artificially (during the construction of the Oost and West Polder), have now been completely eroded by coastal currents and winds.

B. LITERATURE REVIEW

Research related to the use of geospatial technology and Geographic Information Systems (GIS) for geographic information management has been widely carried out, both in Indonesia and in various other countries.[1] These studies show that Geographic Information Systems can play an important role in managing spatial and non-spatial data in an integrated manner [1][5]. In relation to sustainable development, Geographic Information Systems can also be used to map various aspects related to sustainability, such as land use, infrastructure and demographic characteristics [1][5].

Research conducted by [6] analyzed the use of Geographic Information Systems in rural development through the E-Monitoring System application in Banyuwangi Regency, East Java. The research results show that Geographic Information Systems can help local governments in monitoring, reporting and utilizing spatial data for more effective decision making.[6]

Meanwhile, research in Koto Gadang, West Sumatra, shows that a Geographic Information System can be developed to manage land, building and residential ownership data in accordance with local customary rules [7].

Regarding spatial data management in remote areas, research on designing a Geographic Information System for managing mining potential data in Gorontalo Regency underlines the importance of an integrated information system.

1. Spatial Analysis

Spatial analysis is the process of using geographic data to gain deeper insight into the patterns, relationships, and geographic distribution of certain phenomena. This involves the use of statistical, mathematical, and modeling techniques to understand how the phenomenon is related to its geographic space.

In general, spatial analysis involves several steps:

a) Data Collection: The first step is to collect relevant geographic data. This can be spatial data (e.g. maps), attribute data (e.g. demographic data), or both.
b) Data Processing: The data is then processed to prepare it for analysis. This may involve projecting data onto the same coordinate system, merging data from multiple sources, or filtering out irrelevant data.
c) Spatial Analysis: The core process of spatial analysis. This can involve various techniques, such as point analysis, distance analysis, spatial interpolation, cluster analysis, and others. The goal is to identify patterns, trends, and geographic correlations in the data.
d) Interpretation and Visualization: Analysis results are understood and interpreted. This can be done through data visualization using maps, graphs, or other graphics. This helps to understand the analysis findings and make informed decisions.
e) Decision Making: Based on insights from spatial analysis, decisions can be made. This can range from public policy to regional planning to business strategy.

Spatial analysis is used in a variety of fields, including geography, ecology, epidemiology, social sciences, urban planning, and business. This helps in a better understanding of how different phenomena interact in a geographical context, which in turn enables better decision making.

2. Non-Spatial Analysis

Non-spatial analysis is the process of using data that does not have an associated spatial dimension or geographic space. It focuses on data that is more attribute or quantitative rather than geographic. Even though it does not involve geographic space, this analysis is still very useful in providing deep insight into the relationships between various variables.

Following are the general steps in non-spatial analysis:

a) Data Collection: Data is collected from a variety of sources which may include surveys, databases, historical records, or experiments.
b) Data Processing: Data is processed to clean, remove missing values, and format it to suit analysis needs.
c) Statistical Analysis: The data is then analyzed using statistical techniques such as regression, analysis of variance (ANOVA), hypothesis testing, correlation analysis, or principal component analysis (PCA). The goal is to find patterns, trends, or relationships between variables.
d) Interpretation and Visualization: Analysis results are presented and interpreted. This can be done through data visualization using charts, graphs or tables. The goal is to present the analysis findings intuitively so they are easy to understand.
e) Decision Making: Based on the findings of non-spatial analysis, decisions can be made. This can range from business strategy development, policy making, human resource planning, to marketing planning.

Non-spatial analysis is used in a variety of fields, including social sciences, economics, political science, health, and business. This helps in better understanding the relationships between non-geographical variables and making informed decisions based on data. Even though it

does not involve geographic aspects, this analysis remains critical for good decision making in various contexts.

3. Drone Maps

Drone maps are a visual representation of data captured by drones using cameras or other sensors. These maps usually provide a more detailed and accurate view of a particular region than traditionally produced maps. Drone mapping can provide a variety of useful information in a variety of applications, including land mapping, environmental monitoring, infrastructure mapping, and more [8][9][10][11].

Here are some things you can do with drone maps:

a) Land Monitoring and Mapping: Drones can be used to map agricultural land, forests or other land with a high level of detail. It can help in crop planning, natural resource management, and monitoring environmental changes.
b) Infrastructure Mapping: Drone maps can be used to map infrastructure such as roads, bridges, buildings and drainage channels. It helps in planning and maintenance of urban and rural infrastructure.
c) Construction Monitoring: Drones are frequently used in the construction industry to monitor project progress, check site safety, and create topographic mapping before and after construction.
d) Environmental Monitoring: Drones can be used to monitor natural environments such as forests, rivers or beaches to detect changes in the environment or the presence of certain species.
e) Emergency Mapping: In emergency situations such as natural disasters, drones can be used to create maps of affected areas quickly and accurately. This information can help in rescue and recovery efforts.
f) Asset Mapping: Companies can use drones to map their assets such as refineries, oil fields, or wind farms for monitoring and maintenance planning.

Drone maps are usually created using special software that processes images and sensor data from drones to create accurate maps. These maps can be 2D maps or 3D maps depending on the type of data collected by the drone.

C. METHOD

This research uses a descriptive qualitative approach to explore the spatial data handling system in Nasai Village, South Papua. Research stages include:

a) Identify needs and problems related to spatial data management in Nasai Village through interviews with stakeholders.
b) Collection of spatial and non-spatial data, including base maps, population census data, and facilities and infrastructure data.
c) Design of an integrated geographic information system to handle spatial data, including database development, user interface, and spatial analysis features.
d) Evaluation and improvement of the geographic information system that has been designed to ensure the sustainability and effectiveness of its implementation in Nasai Village.

D. DISCUSSION AND RESULT

Based on the results of identifying needs and problems, it was found that the handling of spatial data in Nasai Village was still carried out partially and limitedly. Spatial data such as base maps, land use and distribution of public facilities have not been managed in an integrated manner, making the location-based planning process difficult. Apart from that, coordination between local government agencies in collecting and sharing spatial data is also still weak.

To overcome this problem, this research designed an integrated Geographic Information System to handle spatial data in Nasai Village. This system includes several main modules, namely:

a) Spatial and non-spatial data management: This system allows the collection, storage and updating of spatial data regularly, so that the resulting information is always up-to-date.
b) Data visualization: This system provides facilities for mapping and visualizing spatial data, such as the distribution of public facilities, land use, and road networks.
c) Spatial analysis: This system is equipped with spatial analysis features to support location-based planning, such as land suitability analysis, service coverage analysis, and disaster vulnerability analysis.
d) Integration and coordination: This system was built with a data sharing and collaboration mechanism between related agencies, thereby strengthening coordination in handling spatial data.
e) The designed geographic information system prototype has been tested in Nasai Village and shows promising results. The software developed can be operated easily by local government officials, and is capable of producing thematic maps and spatial analysis which are useful for planning and decision making [12][13][14][15].

a. Spatial and non-spatial data management:

Spatial and non-spatial data management are two different approaches to managing data in geographic and non-geographic contexts. Here is an overview of these two types of data and how they are managed

Aspects	Spatial Data	Non-Spatial Data
Location	Geographic location based	Not related to location
Example	Maps, satellite images, GPS data	Customer data, sales transactions, text documents
Management Tools	GIS software (ArcGIS, QGIS), database spatial (PostGIS)	RDBMS (MySQL, PostgreSQL), NoSQL (MongoDB)
Analysis	Analysis spatial, visualisasi Maps	Business data analysis, reports, data warehousing
Application	Urban planning, navigation, natural resource management	CRM, ERP, market analysis, document management

Figure 1. Comparison of Spatial and Non-Spatial Data

b. Data visualization

Data visualization is the process of representing data in visual form such as graphs, maps and diagrams to facilitate understanding and analysis. The main goal of data visualization is to communicate information clearly and effectively through graphical representation. The following is an overview of data visualization.

Data visualization is an important tool in data analysis that helps transform complex data into information that is easy to understand and analyze. By choosing the right type of visualization and using appropriate tools, data visualization can greatly improve data understanding and support better decision making.

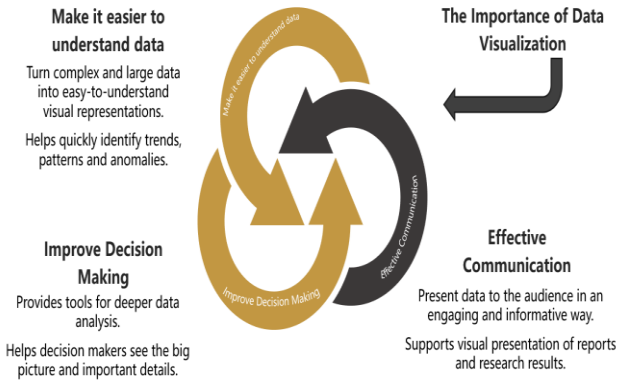

Figure 2. The Importance Of Data

c. Spatial Analysis

Spatial analysis is the process of evaluating geographic data to understand patterns, relationships, and trends related to location. The spatial analysis framework includes several key steps from data collection to decision making [16].

The spatial analysis framework includes various steps from data collection to interpretation of results and decision making. By using the right tools and techniques, spatial analysis can provide valuable insights for planning, management, and decision making in a variety of fields.

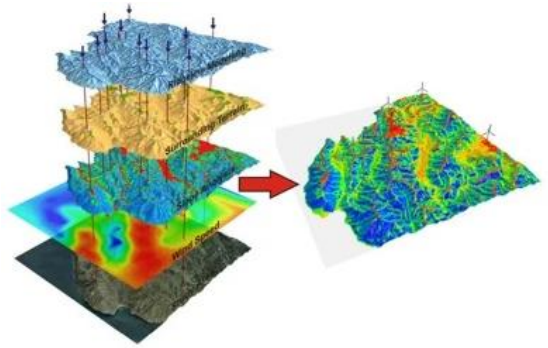

Figure 3. Spatial analysis to understand geographic questions

d. Integration and coordination

Integration and coordination are two key concepts in organizational and system management, which help ensure that the various parts of a system or organization work together effectively and efficiently.

Integration and coordination are two important processes that complement each other in organizational and system management. Integration ensures that various components can work together as a single unit, while coordination organizes and manages activities to achieve common goals. These two concepts together help improve organizational efficiency, performance and responsiveness.

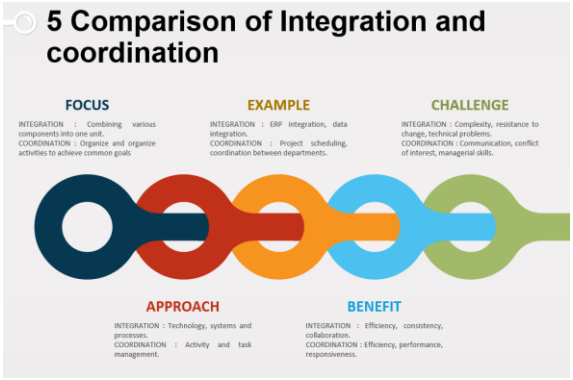

Figure 4. Comprasion of Integration and Coordination.

Results of mapping of Nasai village

In this research, aerial photography was taken using the DJI Phantom 4 Pro drone. The use of the DJI Phantom 4 Pro is considered to be effective for obtaining aerial photography data so that it can be used in mapping areas. The following is an explanation of how this drone is used for taking aerial photos and area mapping training:

a) Drone Specifications: DJI Phantom 4 Pro is a drone equipped with a 20-megapixel 1-inch camera that can record 4K/60fps video and Burst Mode at 14 fps. The drone is also equipped with a FlightAutonomy system that includes dual rear vision sensors and an infrared sensing system for 5-way obstacle sensing and 4-way obstacle avoidance.

b) Use in Mapping: The DJI Phantom 4 Pro drone is used to take aerial photos which are then processed using the Structure from Motion (SfM) method to create orthophoto maps. This map can be used as a basis for creating more detailed and accurate line maps.
c) Advantages: This drone has an obstacle scanning sensor which allows the pilot to avoid objects in front of the aircraft. In addition, this drone is also equipped with an OcuSync HD transmission system that supports automatic dual frequency band switching and connects to DJI Goggles RE wirelessly.
d) Use in Research: The DJI Phantom 4 Pro drone has been used in several studies, such as for identifying administrative boundaries and creating topographic maps. The research results show that the resulting aerial photos have high spatial resolution and can be understood by all parties involved in defining administrative boundaries.
e) Advantages in Mapping: Using the DJI Phantom 4 Pro drone in mapping areas has several advantages, such as being able to produce clear and detailed aerial photos, and can be used over large areas in one flight. However, the downside is that the drone's battery can fly for 60 minutes, so it requires several flights to cover a large area.

In synthesis, the use of the DJI Phantom 4 Pro drone in taking aerial photos and training on area maps is very effective because of its technological specifications which enable clear and detailed aerial photos to be taken, as well as the ability to avoid objects in front of the aircraft.

Figure 5. Taking Aerial Photos of Nasai Village as a Whole

Figure 6. Taking Aerial Photos in Nasai Village Specifically for Expansion

E. CONCLUSION

This research shows that Geographic Information Systems can play an important role in handling spatial data in remote areas such as Nasai Village, South Papua. An integrated and technology-based system can assist local governments in collecting, managing and utilizing spatial data to support more effective and targeted regional planning and development. Through this research, it is hoped that it can provide input for local governments and other stakeholders in developing a more comprehensive and sustainable spatial data management system in remote areas.

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