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Integration of Digital Elevation Model (DEM) for Accurate Slope and Contour Maps as Fundamental Data in Spatial Modeling

Nizar [a], Susi Hariyani [b], Puspita Rahmasari [c], Wattini [d], Muhammad Rafani [e], Ely Nurhidayati [f], Iin Arianti [g]*,

[a,b,c,d,e,g] *Politeknik Negeri Pontianak, Jl. Jend. A.Yani, Pontianak 78124, Indonesia*

[f] *Universitas Tanjungpura Pontianak, Jl. Prof. H. Hadari Nawawi Pontianak 78124, Indonesia*

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A B S T R A C T

Flooding is a natural disaster that often occurs and has a significant impact on society and the environment. This can result in economic loss, infrastructure damage, disruption to daily life, and even loss of life. To mitigate the negative impacts of flooding, an in-depth understanding of the potential for flooding in an area is very important. One effective approach is to use spatial modeling to create flood vulnerability models, based on topographic data such as slope maps and contour maps. ALOS PALSAR DEM data, with a spatial resolution of 12.5 meters, offers important advantages in creating slope maps and contour maps for flood potential analysis. As a synthetic aperture radar technology, ALOS PALSAR collects topographic data with high accuracy and wide coverage, even in adverse weather conditions or areas with high cloud cover. Its ability to penetrate clouds makes ALOS PALSAR data more reliable and consistent than optical data, which may be limited by weather conditions. Slope maps show varying degrees of terrain steepness across the study area. Contour lines are successfully created, illustrating elevation changes in the landscape. GIS analysis highlights areas with high slope values and the potential to become flood-prone zones. DEM-derived maps serve as valuable tools for flood vulnerability modeling and risk assessment. Integration of DEM imagery with GIS techniques has proven effective in creating accurate and detailed slope and contour maps. These maps provide important information for identifying flood-prone areas and formulating effective disaster management strategies. This study underscores the importance of terrain analysis in flood vulnerability assessment and emphasizes the usefulness of DEM-derived data for spatial modeling.

Keywords: Digital Elevation Model (DEM), Geographic Information System (GIS), Slope, Contour, Flood Vulnerability.

1. Introduction

Pontianak, a city situated in the province of West Kalimantan, Indonesia, is no stranger to the challenges posed by frequent flooding, particularly during the rainy seasons. These inundations not only disrupt daily life but also pose significant threats to infrastructure and public safety. To address these persistent issues, the creation of accurate slope and contour maps becomes crucial in understanding flood dynamics and vulnerability within the city. This study aims to develop precise slope and contour maps for Pontianak, utilizing advanced modeling techniques based on ALOS PALSAR Digital Elevation Model (DEM) data. The study utilizes data from ALOS PALSAR Digital Elevation Model (DEM), sourced from the Phased Array Type L-band Synthetic Aperture Radar (PALSAR) with a spatial resolution of 12.5 meters. This high-resolution topographical data offers a detailed insight into the terrain characteristics crucial for understanding flood dynamics. The topography of a region plays a crucial role in understanding and assessing flood vulnerability. Accurate maps depicting slope and contour information are essential for identifying areas prone to flooding. In this study, we investigate the application of Digital Elevation Model (DEM) imagery in creating slope and contour maps using Geographic Information System (GIS) techniques.

Through this research, Pontianak can gain valuable insights into its flood-prone areas, enabling informed decision-making processes for disaster preparedness, infrastructure development, and sustainable urban growth. The resulting slope and contour maps will serve as a vital resource in Pontianak's efforts to mitigate the impacts of flooding and create a safer, more resilient city for its residents. The location study like figure 1.

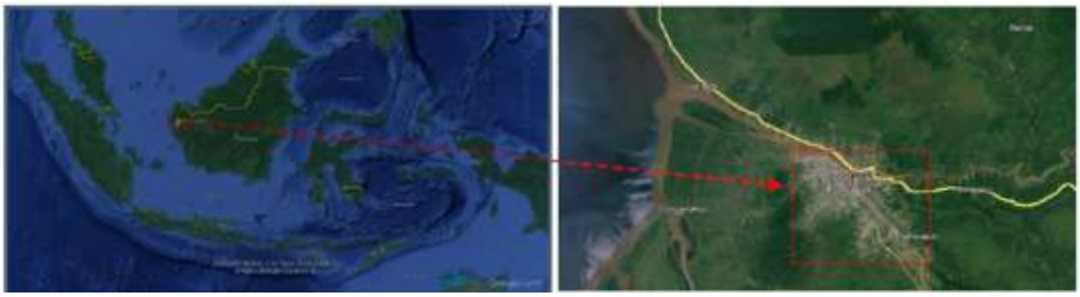

Figure 1

2. Materials and Methods

Data Acquisition: ALOS PALSAR DEM imagery

Pre-processing: The DEM data was pre-processed to remove noise and outliers.

Slope Calculation: Slope was calculated using the difference method in GIS.

Contour Extraction: Contour lines were extracted through interpolation techniques such as spline or kriging.

GIS Analysis: GIS software was utilized to analyze and visualize the slope and contour maps.

The creation of contour maps using ALOS PALSAR data involves a combination of Geographic Information System (GIS) and Remote Sensing techniques. The following are the general steps that can be followed for contour map creation:

a. Data Collection

Obtain ALOS PALSAR DEM image data for the desired mapping area. Ensure that the data has undergone preprocessing and co-registration if necessary.

b. Data Processing in GIS

Import the ALOS PALSAR DEM data into the GIS software you are using.

Check the projection and coordinate system of the DEM data to ensure compatibility with the desired projection for the final map.

c. Preprocessing in GIS

Check the data to remove outliers or invalid values.

Perform interpolation to improve spatial resolution and fill in data gaps within the DEM image.

d. Contour Extraction

Use tools or functions within the GIS software to extract contour lines from the DEM data.

Some GIS software provides automatic tools for this purpose, such as the "Contour" tool in ArcGIS or "Generate Contours" in QGIS.

Determine the desired contour interval, which is the vertical distance between adjacent contour lines.

e. Editing and Correction:

After the contour lines are extracted, check and correct any discrepancies or errors. Ensure that the resulting contours align with the actual topographic features in the field.

f. Visualization and Presentation:

Display the contour map in the GIS software using appropriate symbols, labels, or colors. Add other map elements such as rivers, roads, and boundary lines to provide spatial context.

g. Validation and Verification:

Perform validation by comparing the generated contour map with the original data or other valid data sources.

If necessary, make corrections or refinements to the contour map to ensure accuracy and precision of the map.

By following these steps, a contour map can be effectively created using ALOS PALSAR data and GIS techniques. This process ensures accurate depiction of the terrain's elevation and slope, providing valuable insights for various applications such as flood risk assessment, land use planning, and environmental management.

To validate the accuracy of the newly created slope and contour maps, a comparison will be made with previously established flood vulnerability maps. If areas highly susceptible to flooding are found to coincide with locations of low slope inclinations or flat terrains, it will serve as validation that the interpretation of ALOS PALSAR imagery for creating the slope and contour maps was accurate.

3. Results and Discussions

The slope map revealed varying degrees of terrain steepness across the study area. Contour lines were successfully generated, depicting elevation changes in the landscape. GIS analysis highlighted areas with high slope values and potential flood-prone zones.

The DEM-derived maps serve as valuable tools for flood vulnerability modeling and risk assessment.

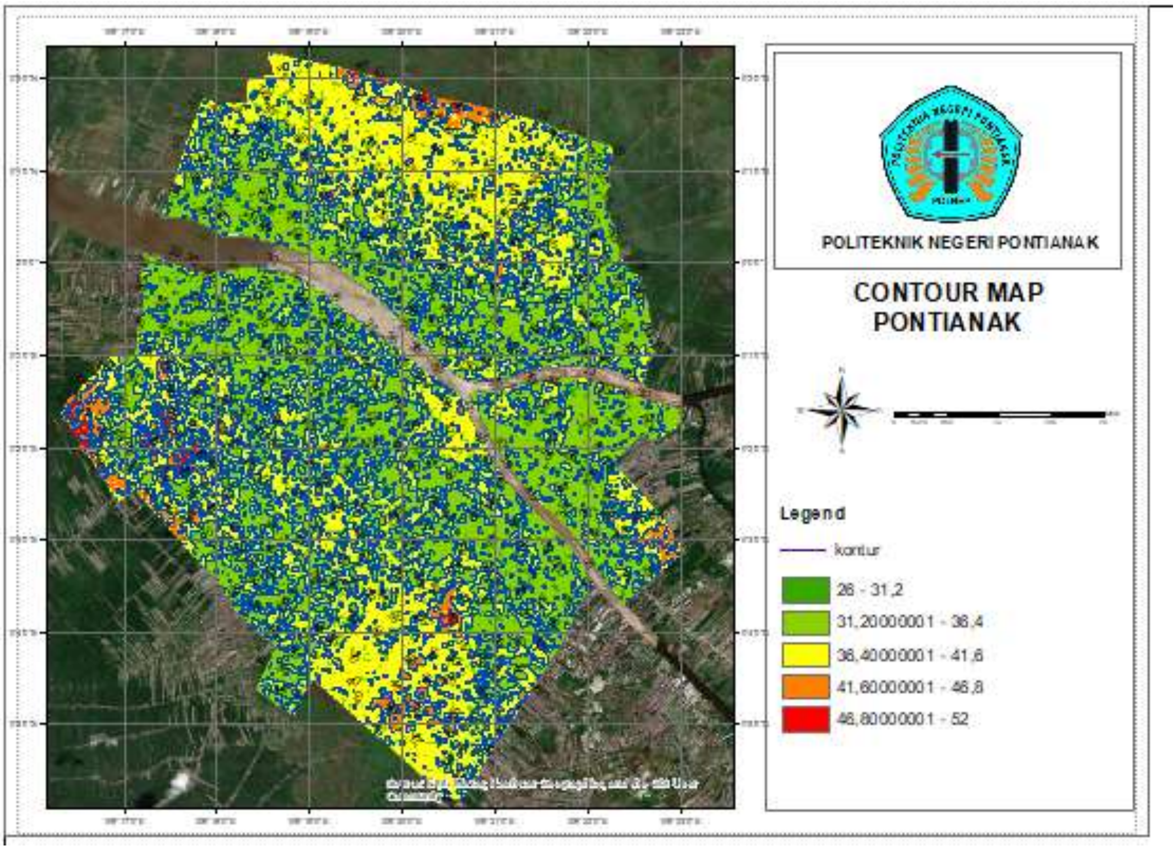

Figure 2. Contour Map

Pontianak contour map that is interpreted ranges from 26 to 52 m, because the contour interval is 5 m, The there are 231 which have a contour of 30 m out of 2282 data. There are 1571 locations with a 35m contour and 411 with a 40m contour, 64 with a 45m contour and 5 locations (data) with a 50m contour. The rest are in contours ≤ 30 m and ≥ 50 m. So, this shows that in Pontianak City there are very few areas with a height of 50 m, namely only 5 locations as in Figure 1.

The main steps in creating a slope inclination map from a Digital Elevation Model (DEM) involve utilizing the "Slope" command in the Spatial Analyst toolbox, selecting either degrees or percent as the slope unit. Generally, slope inclination maps are created using percent units. Following this, the data is then subjected to a reclassification process using the "Reclassify" menu to categorize the slopes according to commonly used classifications.

The next step involves converting the raster slope layer into a vector polygon layer using the "Conversion Tools" toolbox. The final steps include editing attributes and adding text such as a database for slope classifications and hypsography (the landform's shape)

The final step is validation of the contour and slope maps. Validation of this map uses the Pontianak City Flood Hazard map. The method used is to match the contour map and slope slope to the flood vulnerability map which is adjusted to the level of vulnerability. The flatter a location is on the slope map, the more vulnerable the location is on the flood vulnerability map.

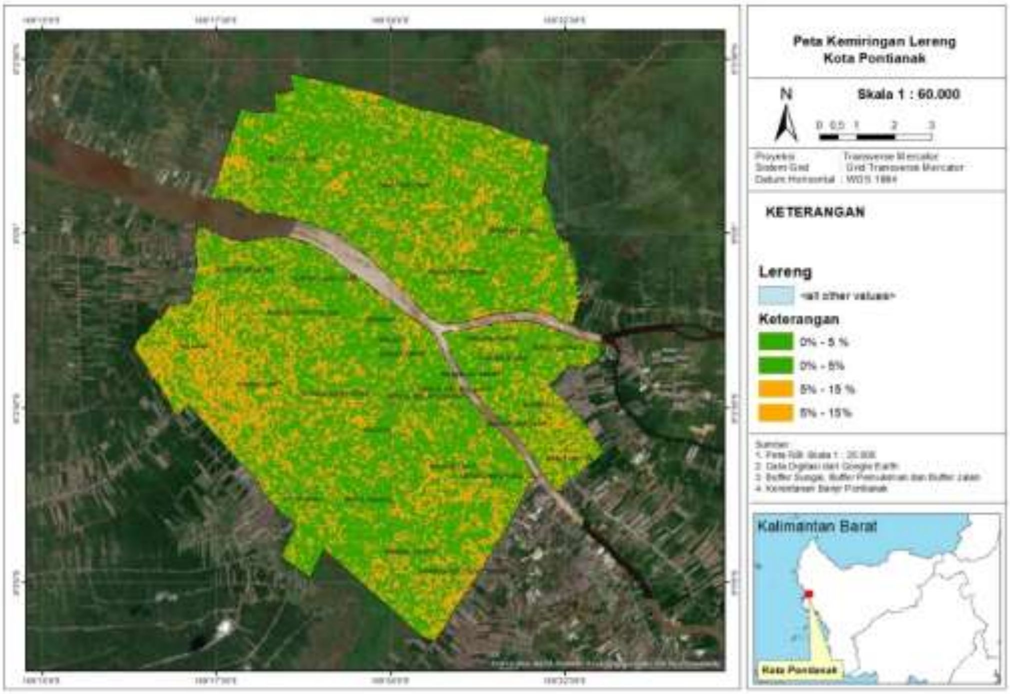

Figure 3. Slope Map

Based on the slope map in Figure 2, Pontianak City only consists of 2 slope classes, namely 0 – 5% flat category and 6 – 15% sloping category. Based on the slope map in Figure 20, Pontianak City is dominated by areas with a slope class of 0 – 5% covering an area of 72 km2 or 66.7% and areas with a slope class of 6 – 15% covering an area of 36 km2 or 33.3%. This shows that Pontianak City is a city located in a flat area.

4. Conclusions

Based on the validation results, it shows that the accuracy of the Pontianak City Contour Map and Pontianak City Slope Map regarding Pontianak City's Flood Vulnerability is 100%, this indicates that this map has a very good level of accuracy and can be used as a data base for further research development. The integration of DEM imagery with GIS techniques proved effective in creating accurate and detailed slope and contour maps. These maps provide essential information for identifying flood-prone areas and formulating effective disaster management strategies. The study underscores the significance of terrain analysis in flood vulnerability assessment and emphasizes the utility of DEM-derived data for spatial modeling.

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