DETECTION OF FLOOD IMPACTED AREAS IN EAST NUSA TENGGARA USING SENTINEL-1 IMAGERY

Bagas Aryasetab*

1 Department of Civil Engineering, Engineering Faculty, University of Pembangunan Nasional “Veteran” Jawa Timur, Indonesia

*Corresponding Author: aryasetabagas.ts@upnjatim.ac.id

Abstract
Flash Floods in East Nusa Tenggara occurred on April 4th, 2021. These Flash Floods are scattered from East Flores Regency, Lembata Regency, Alor Regency, Malacca Regency, Sabu Raijua Regency, Kupang City, Kupang Regency, and Ende Regency. The cause of these Flash Floods is the high intensity of rain caused by the tropical cyclone Seroja. Mapping of flood locations plays an important role in prevention and mitigation efforts. In this study, InSAR data processing was carried out from the Sentinel 1A satellite to find flood-affected locations in East Nusa Tenggara. 32 images of Sentinel-1 were processed before and 31 images after the Flash Floods incident. The method used is the classification method using cloud computing, Google Earth Engine. The results show that the flood-affected areas can be detected based on a lower pixel value (indicating a very small signal backscatter value), then compared to the conditions before the flood. The four sample points identified, namely points A, B, C, and D each have pixel values of -8.58, -9.99, -12.43, and -9.29 for the VV polarized image, respectively. For VH polarized image is -17.35, -17.96, -17.84, and -14.22, respectively.

Keywords: flash flood, east nusa tenggara, sentinel-1, insar, google earth engine

INTRODUCTION

On Sunday, April 4th, 2021, there was a Flash Floods in East Nusa Tenggara. Flash floods in East Nusa Tenggara are scattered from East Flores Regency, Lembata Regency, Alor Regency, Malacca Regency, Sabu Raijua Regency, Kupang City, Kupang Regency, and Ende Regency. The cause of this Flash Floods is the high intensity of rain caused by the tropical cyclone Seroja. According to the National Disaster Management Agency (BNPB), this Flash Floods is the worst natural disaster in the last 10 years in East Nusa Tenggara [1] [2]. Meanwhile, according to Regional Disaster Management Agency (BPBD) East Nusa Tenggara as of April 28th, 2021, it has been recorded that the resulting impact is 182 people who have died in 10 districts and cities in East Nusa Tenggara [3]. Meanwhile, 47 missing people are still in search. In addition, a total of 1992 houses and 87 public facilities were affected [4].

Mapping of flood locations plays an important role in prevention and mitigation efforts. In the last few decades, remote sensing technology has been developed very rapidly. Not only the spatial resolution is increased, but the temporal resolution has also been improved. That way, efforts to monitor the earth’s surface can be done better. Several studies have shown that the use of InSAR technology to map and monitor floods includes coherent techniques [5] [6] [7] [8], Normalized Difference Ratio (NDR) technique [9], naked eye identification by relying on a Grayscale visualization which is based on the backscatter signal pixel coefficient [10], Quasi-Persistent Scatterers (Q-PS) [11] and so forth.

In this study, InSAR data processing obtained from the Sentinel 1A satellite was carried out to obtain flood-affected locations in East Nusa Tenggara using a classification technique based on the backscatter signal pixel coefficient. The results are expected to become a reference for policymakers as well as a preliminary study for other researchers.

RESEARCH METHOD

A. Data
The research area covers the entire province of East Nusa Tenggara. The data used are data before and after the occurrence of Flash Floods in East Nusa Tenggara on April 4th, 2021. Sentinel-1 images that are processed are 31 images before and 32 images after the Flash Floods incident. The image used is IW mode with VV and VH polarization. The entire image has ascending orbit with a resolution of 10 meters.
B. Methodology

The method used is the backscatter signal pixel coefficient classification method using cloud computing, Google Earth Engine. The processing flow diagram can be seen in Figure 1. The first process is done by defining the Region of Interest (ROI) by drawing a line manually through the Google Earth Engine website. The ROI area covers the entire province of East Nusa Tenggara (figure 2). After that, the Sentinel-1 data filtering process is carried out. The first filter is used to select the Sentinel-1 product type (mode, polarization, orbit, and resolution). The second filter is a filter based on date. In this study, 32 images were filtered before Flash Floods started on February 12th, 2021 to March 12th, 2021. For the images after Flash Floods incident, there were 31 images from April 5th, 2021 to April 30th, 2021.

Then, data identification was carried out to see the image quality and identifying the flood manually. If it is appropriate enough, the next step is to produce a mosaic. After that, the Sentinel-1 data mosaic process was carried out. The mosaic process is a process of combining several Sentinel-1 data before the flood and after the flood for each channel (VV and VH). After this process, the entire InSAR imagery coverage in the study area will be seen (Figure 3).

The next process is to display RGB colors for easier analysis. This process is done by adding images before the incident (R), after the incident (G), and before the incident (B). The results can be seen in figures 4 and 5. Reddish color (pink) indicates inundated (flood) areas. Then applying a speckle filter of 50 to provide a smooth effect on the image to reduce the noise effect (salt and paper effect) to facilitate classification. However, this process will reduce the image resolution. The figure 6 and 7 are the comparison between before and after applying speckle filter.
The next step is to calculate the difference between before and after the flood. Areas in white indicate areas that are flooded. In this process, an inspection is carried out by looking at and comparing the pixel values before and after the incident. The results of this difference can be seen in Table 1. For the sample, 4 points were taken. Points A and B are located in the Lalatan and Laau areas (Sumba Island). Points C and D are located in Makitoenggoeng and Pugubengo (Flores Island). According to BNPB data, the four points were confirmed to have been affected by Flash Floods.

<table>
<thead>
<tr>
<th>Point</th>
<th>Coordinate</th>
<th>Pixel before flood</th>
<th>Pixel after flood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Longitude</td>
<td>Latitude</td>
<td>VV</td>
</tr>
<tr>
<td>A</td>
<td>120.2041</td>
<td>-9.7734</td>
<td>-2.79</td>
</tr>
<tr>
<td>B</td>
<td>120.1379</td>
<td>-9.8211</td>
<td>1.84</td>
</tr>
<tr>
<td>C</td>
<td>121.2465</td>
<td>-8.4963</td>
<td>0.23</td>
</tr>
<tr>
<td>D</td>
<td>121.2673</td>
<td>-8.5564</td>
<td>6</td>
</tr>
</tbody>
</table>

The final step is to carry out the final classification by applying a threshold. The threshold selected is 1.25. This means that values above 1.25 represent flooded areas (areas in blue). The final result is a final map of the classification in Figures 10 and 11. There are several errors in classifying the flooded area as shown in Figure 11 on the right side of the figure. This can be caused by poor image quality.
Figure 11. Final Classifications of Points C and D

CONCLUSION

From this research, it can be concluded that InSAR satellite technology can be used for various things, one of which is to map flood-affected areas. This research uses a classification technique based on the backscatter signal pixel coefficient. The results show that the area after being affected by the flood has a lower pixel value than before it was impacted. From the four points, namely A, B, C, and D, the pixel values obtained after Flash Floods event for VV were \(-8.58, -9.99, -12.43\), and \(-9.29\), respectively. Whereas the pixel values for VH were \(-17.35, -17.96, -17.84\), and \(-14.22\), respectively. In the future, processing Sentinel-1 imagery could be also done by using Descending mode as a comparison and a more comprehensive result.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to the Department of Civil Engineering UPN “Veteran” Jawa Timur for providing me with all the facility that was required.

REFERENCES


