

Analysis Of Vegetation Density In Flood Disaster Using Landsat 8 Imagery In Jember Urban Area 2010-2019 and 2020-2022

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Abstract. Vegetation has an important in human life. Studies related to vegetation can include its density or distribution in the area. To analyze the vegetation density in an area by using Remote Sensing System technology. This study aims to analyze vegetation density in flood disaster using Landsat 8 imagery in the urban area of Jember in 2010-2019 and 2020-2022. The research method used is a quantitative research method. This type of research was chosen because there will be data that needs to be processed using remote sensing techniques, which are also related to numbers. The research object to be studied is vegetation density using Landsat 8-OLI imagery and field survey data. The data collection technique in this study uses the observation method to compare the results of imagery processing on the Envi 4.5 application with direct conditions in the field, then field documentation is carried out. Then the vegetation index method used is the NDVI method (*Normalized Difference Vegetation Index*). The results of the research it is known that the Districts of Patrang, Summersari, and Kaliwates have vegetation land cover that varies from medium to dense vegetation. Kaliwates and Summersari sub-districts have lower vegetation density compared to Patrang sub-district. Land use in this sub-district is also filled with built-up land, furthermore the physical condition in the lowlands and close to the Bedadung River. Therefore, apart from vegetation density, there are other factors that can influence the occurrence of floods.

Keywords: Vegetation, Vegetation Density, NDVI, Flood Disaster

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1. Introduction

Several regions in Indonesia have often experienced flood disasters, one of which is in Jember Regency. Flood disasters in urban areas can usually occur due to lack of vegetation or land cover areas caused by changes in land use. Changes in land use also cause changes in soil structure due to human management, thus affecting soil infiltration capabilities (Hariati, 2022). As is well known, the role of vegetation is very important because vegetation functions as an absorber of water. According to Asdak (2002) in Fauzi, et al (2017) most of the rainwater that falls cannot be retained by vegetation and cannot seep into the ground so that most of the rainwater will become surface runoff. This is what will cause the flood disaster.

The level of vulnerability to flooding in Jember is classified as medium to high with an area of 48,379 Ha for medium classification and 34,198 for high classification in one district which consists of 31 Districts (Alfiah, 2022). In this district, there are several sub-districts that are prone to flooding, namely Kaliwates, Summersari, and Patrang. It is known that in the last three years these sub-districts have experienced flooding almost every year. These three sub-districts are also the core centers of the Jember Regency itself. Which in this case the development process is developing more rapidly in these sub-districts. This also has an impact on land cover or vegetation density in these districts. This vegetation density is one of the indicators of the presence of floods in these three sub-districts. With the decreasing vegetation in these areas, it certainly causes the potential for flood

disasters. Therefore, it is important to study the density of vegetation and compare it in certain periods.

Given the importance of a vegetation condition, the main indicator in this flood problem is to look at the density of vegetation in the area itself. To analyze the level of vegetation density in an area, Remote Sensing System technology and Geographic Information Systems (GIS) can be used using the NDVI method. Remote sensing is the science and art of obtaining information on an object, analyzing data without direct contact with the object (Humam et al., 2020). Satellite imagery is one source of data that can be used in remote sensing. One of the images that can be used is Landsat imagery. Landsat imagery is considered very suitable for research in determining the vegetation density index using the NDVI method in the Jember Regency area.

2. Methods

The location of this research was conducted in three sub-districts located in the center of Jember Regency, namely Summersari, Patrang, and Kaliwates Districts, East Java Province, Indonesia. The type of research in this activity is using quantitative research. The research object to be studied is vegetation density using Landsat 8-OLI imagery data and field survey data. During the field survey, several samples will be taken for the level of vegetation density. The data collection technique used in this research uses the observation method which later functions to compare the results of image processing in the Envi 4.5 application with direct conditions in the field, then field documentation is carried out to support the implementation of research activities, and research team discussion activities to better see developments further research activities.

In this research, quantitative data analysis techniques were used, which are data processing techniques using numbers. In the quantitative data analysis, a radiometric correction will be carried out on Landsat 8-OLI imagery, then a formula will be entered in the available bands, after the process is carried out to supervised classification, then proceed with the vegetation index using the NDVI method, then data analysis is continued with the qualitative method. descriptive which compares the results of image data processing with conditions in the field. In addition, interpretation of remote sensing imagery and field observations is also carried out. Which results will be in the form of a description of the comparison of vegetation density in the three sub-districts of Jember Regency.

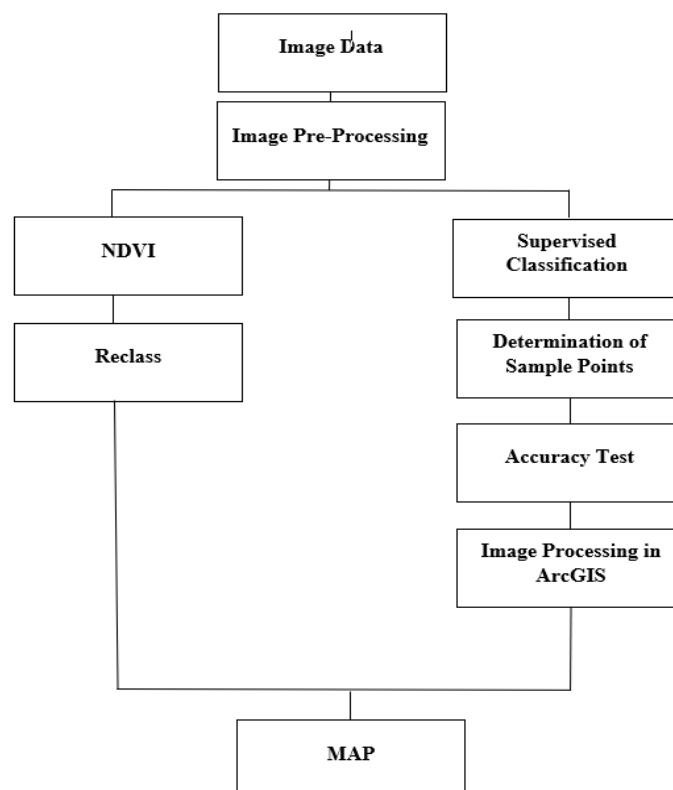


Fig. 1 Flowchart of Vegetation Density Analysis Research Using Image Data Landsat 8 in Part of Jember Regency

3. Results and Discussion

3.1 Results

3.1.1 Vegetation Index Results

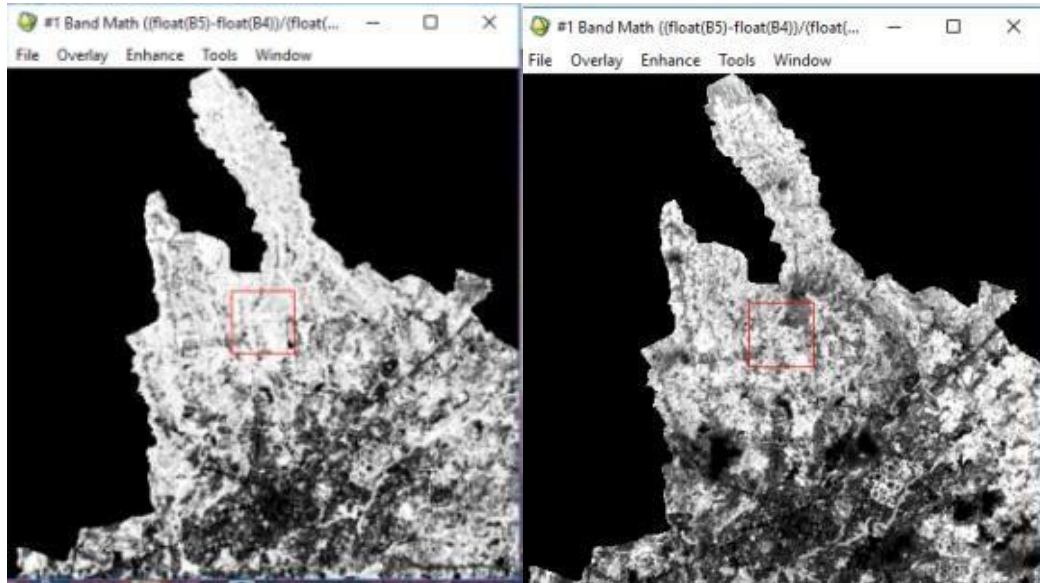


Fig. 2. NDVI Citra results for 2019 and 2021

When using the NDVI method, the colors that appear in the image are black and white, which if examined further, the white to gray color indicates areas that have dense vegetation density. The gray-black color appears to indicate built-up land. This can be adjusted to the condition of the image when viewed from its natural color. The value of the vegetation index of these two images is as follows :

Table 1
Processing Results of the NDVI Method Vegetation Index

| Image | Minimum Value (NDVI) | Maximum Value (NDVI) |
|----------------|----------------------|----------------------|
| Landsat 8 2019 | - 0.088612 | 0.792793 |
| Landsat 8 2021 | - 0.13160 | 1.148387 |

Experiments on images in 2019 for three sub-districts (Patrang, Summersari and Kaliwates Sub-Districts). It is known that the NDVI method is vulnerable to a maximum value of 0.792793 and a minimum value of - 0.088612. Whereas the standard value for the NDVI method should be -1 to 1. Experiment on the second image, namely in 2021 for three sub-districts (Patrang, Summersari, and Kaliwates Sub-Districts). It is known that the NDVI method is vulnerable to a maximum value of 1.148387 and a minimum value of -0.13160.

3.1.2 Accuracy Results

Table 2
Categories of Interpretation of 2019 Landsat-OLI Imagery

| Category | Category Interpretation | | | | | Total |
|---------------|-------------------------|-----------|-------------|------------|------------|-------|
| | Plantation | Farm/Moor | Rice fields | Build Land | Open field | |
| Plantation | 3 | 1 | - | - | - | 4 |
| Moor | 1 | 5 | 1 | - | - | 7 |
| Rice fields | - | 1 | 5 | - | - | 6 |
| Build Land | - | - | - | 8 | - | 8 |
| Open field | - | - | 1 | - | 4 | 5 |
| Totals | 4 | 7 | 7 | 8 | 4 | 30 |

Information :

 Correctly classified pixels/samples  Number of reference/sample pixels

Table 3

Accuracy of 2021 Landsat 8-OLI Imagery Interpretation Results

| Mapping Accuracy | | | | Results Accuracy Interpretation |
|---------------------|----------------|-----------------|----------------|---------------------------------|
| Producer's accuracy | Omission Error | User's accuracy | Omission Error | |
| 3/4= 75% | 25% | 3/4= 75% | 25% | (3+5+5+8+4)/30= 83.33% |
| 5/7= 71.42% | 28.58% | 5/7= 71.42% | 28.58% | |
| 5/7= 71.42% | 29% | 5/6= 83.33% | 16.7% | |
| 8/8= 100% | 0% | 8/8= 100% | 0% | |
| 4/4= 100% | 0% | 4/5= 80% | 20% | |

Table 4

Categories of 2021 Landsat 8-OLI Imagery Interpretation

| Category | Category Interpretation Results | | | | | Total |
|----------------------|---------------------------------|------|-------------|------------|------------|-------|
| | Plantation | Moor | Rice fields | Build Land | Open field | |
| Plantation | 3 | 1 | - | - | - | 4 |
| Moor | - | 6 | - | - | 1 | 7 |
| Rice fields | - | - | 5 | - | 1 | 6 |
| Build Land | - | - | - | 8 | - | 8 |
| Open field | 1 | - | - | - | 4 | 5 |
| Column Totals | 4 | 7 | 5 | 8 | 6 | 30 |

Information :

 Correctly classified pixels/samples  Number of reference/sample pixels

Table 5

Accuracy of 2021 Landsat 8-OLI Image Interpretation Results

| Mapping Accuracy | | | | Results Accuracy Interpretation |
|---------------------|----------------|-----------------|----------------|---------------------------------|
| Producer's accuracy | Omission Error | User's accuracy | Omission Error | |
| 3/4= 75% | 25% | 3/4= 75% | 25% | (3+6+5+8+4)/30= 86.66% |
| 6/7= 85.71% | 14.29% | 6/7= 85.71% | 14.29% | |
| 5/5= 100% | 0% | 5/6= 83.33% | 16.7% | |
| 8/8= 100% | 0% | 8/8= 100% | 0% | |
| 4/6= 66.66% | 33.34% | 4/5= 80% | 20% | |

Based on the results of table 2. Categories of 2019 Landsat-Oli Image Interpretation Results. It is known that in this study several categories of land cover classes were used, such as plantations, fields/moors, rice fields, built-up land, and open land. With sample points taken from the land cover class, namely 30 sample points. As for plantations, four sample points were taken and the three sample points showed the correct results. Furthermore, seven sample points were taken from the fields/moors, which of the seven sample points had the correct classification of objects, namely five sample points. Then the rice fields take sample points, namely six points and the correct one shows five sample points. The built-up area takes eight sample points, of which all the objects in the image are classified correctly. Lastly, open land took five sample points and the correct ones were four sample points.

Based on the result of Table 3. The accuracy of the results of the 2019 Landsat 8-OLI imagery interpretation is known that the calculation of the accuracy of the results of the interpretation performed showed a result of 83.33%. This is calculated from the correctly classified pixels/samples divided by the number of sample points taken from this study.

Based on the results of table 4. Interpretation of Landsat-Oli Imagery Results for 2021. It is known that in this study several categories of land cover classes were used, such as plantations, fields/moors, rice fields, built-up land, and open land. With sample points taken from the land cover class, namely 30 sample points. As for plantations, four samples were taken, of which three sample points showed the correct results. Furthermore, seven sample points were taken from the fields/moors, which of the seven sample points had the object classified correctly, namely six sample points. Then the rice fields take sample points, namely six points and the correct one shows five sample points. The built-up area takes eight sample points, of which all the objects in the image are classified correctly. Lastly, open land took five sample points and the correct ones were four sample points. Errors in pixels or sample points occur when objects cannot be classified correctly in the image and in the field.

Based on the result of table 5. Accuracy of the results of the 2021 Landsat 8-OLI image interpretation. It is known that the calculation of the accuracy of the interpretation results carried out shows a result of 86.66%. This is calculated from the correctly classified pixels/samples divided by the number of sample points taken from this study.

3.2 Discussion

3.2.1 Analysis of Differences in Vegetation Density Landsat 8-OLI Imagery

By using Normalized Difference Vegetation Index(NDVI) which describes the level of greenness of a plant will be the basis for the classification of vegetation in an area by calculating data obtained from near infrared calculations with red reflected by plants so that the density of vegetation will be very dense in the Jember Regency area which is detected as land that has very dense vegetation. meeting, meeting, and being. Based on the data analysis that has been carried out, the results obtained are density values with regional NDVI variations. Part of Jember Regency in 2019 and 2021 consists of very dense vegetation, not dense vegetation, medium vegetation, dense vegetation, and very dense vegetation. Then, for the results of regional land cover. Parts of Jember Regency in 2019 and 2021 consist of plantations, rice fields, dry fields or fields, built-up land and open land.

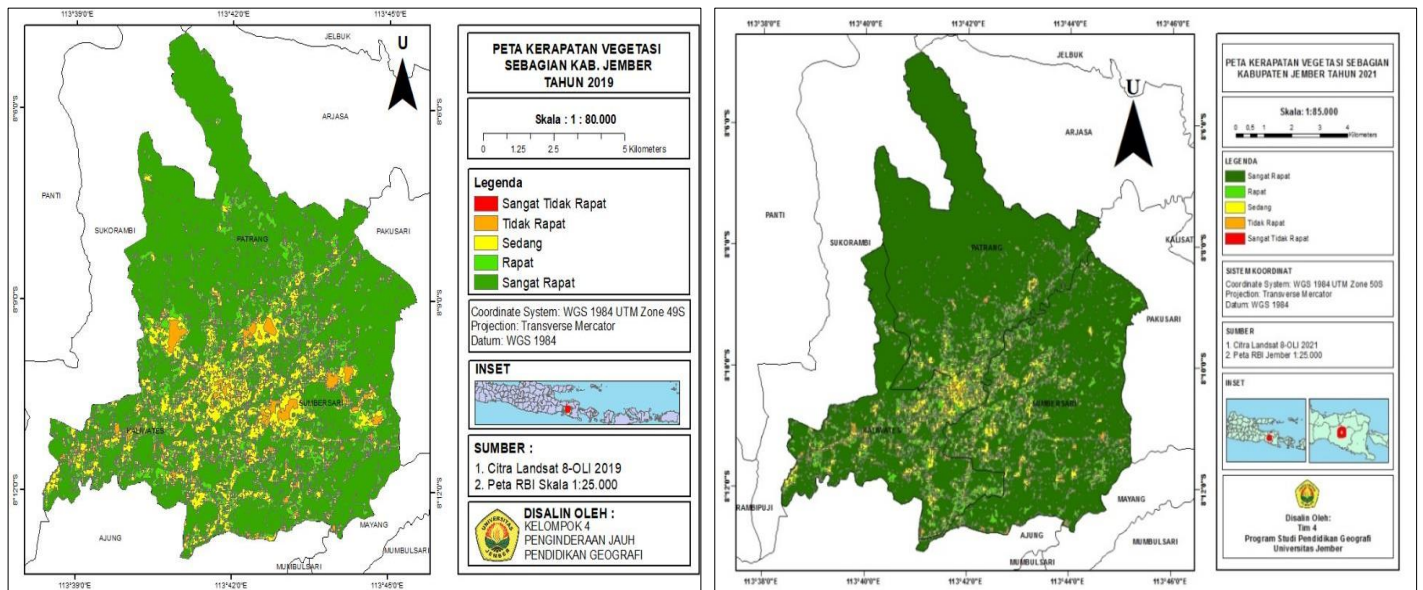


Fig 3. Vegetation Density Map of Part of Jember Regency in 2019 and 2021

The difference between the Vegetation Density Map of Part of Jember Regency in 2019 and the Vegetation Density Map of Part of Jember Regency in 2021 is that the Partial Vegetation Density Map of Jember Regency in 2019 is dominated by very dense vegetation density, then followed by yellow color on the map that dominates the second, namely vegetation with categories currently. Vegetation with this dense category is found in the District of Patrang. Then for vegetation with this medium category which the most commonly found when viewed from the map is in the Summersari District area and dense vegetation density is also in the Summersari District and Kaliwates District areas.

The 2021 Jember Regency Partial Vegetation Density Map is also dominated by very dense vegetation density. Then this dense vegetation density is most commonly found in the Patrang District area. The difference between the Vegetation Density Map for Part of Jember Regency in 2019 and the Vegetation Density Map for Part of Jember Regency in 2021 is very clear. In fact, in 2021 it can be seen on the map that very dense vegetation density and dense vegetation density dominate more. It has been previously explained that the current Jember Regency Government, especially the Jember Regency Environmental Service, has initiated the ideaGreen City or the Green City and you can see the difference in 2019 and 2021, that the Jember Regency Government has already implemented the program.

Very rapid infrastructure development resulted in the closing of green land or vegetation areas. Of course this will have an impact on decreasing the quality of the environment if the allocation of vegetation and land use space is not implemented properly. Unstructured clearing of vegetation can cause a lot of damage and problems in the area, such as erosion, flooding, drought, increasing temperature and decreasing ecosystems. In the Jember Regency area itself, especially in the 3 sub-districts studied by the researchers themselves, which are the downtown areas of Jember Regency including Summersari District, Kaliwates District, and Patrang District.

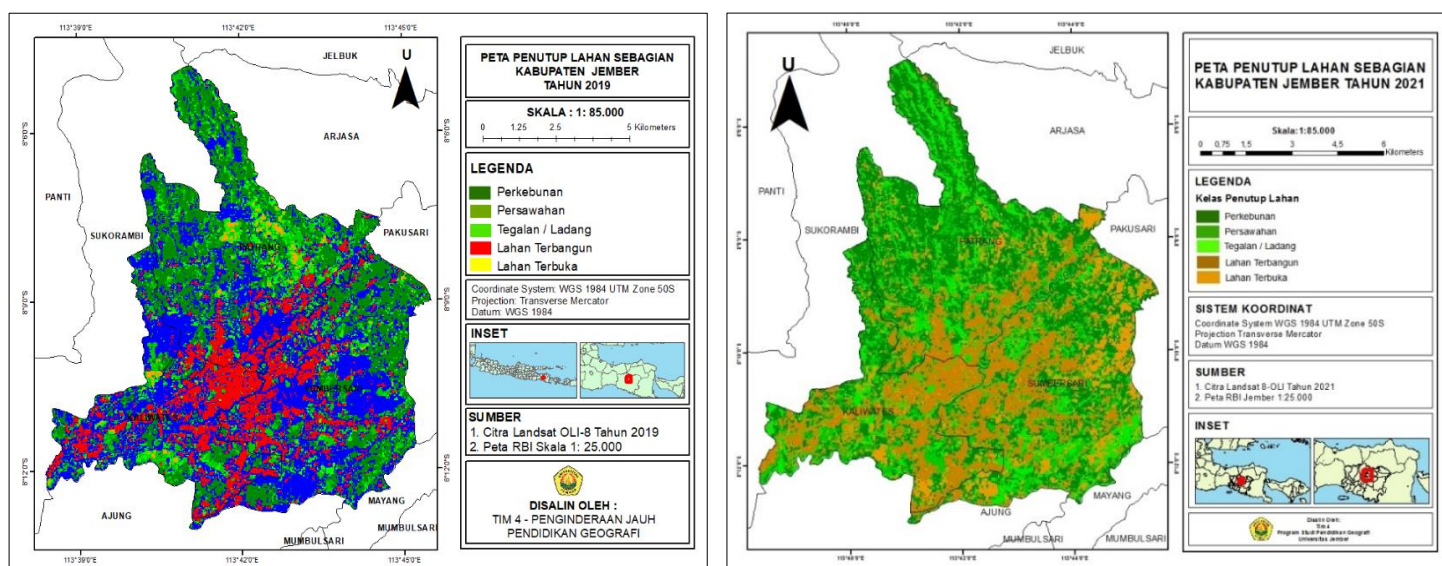


Fig 4. Land Cover Map of Part of Jember Regency in 2019 and 2021

Then compare or analyze the differences in land cover for parts of Jember Regency in 2019 and 2021 based on the 2019 and 2021 Partial Land Cover Maps for Jember Regency. located in Kaliwates District, Summersari District, and Patrang District. Built-up land is often found around roads with easy accessibility, namely in the Kaliwates District and the District Summersari. Then, dry fields or fields as well as open land are often found in Patrang District.

Furthermore, in the 2021 Partial Land Cover Map for Jember Regency, the land cover in Jember Regency in the research area is dominated by dry fields or fields as well as built-up land. Moor fields or fields are often found in Kaliwates, Summersari, and Patrang sub-districts. Then, for self-built land based on research studies, it is often found in Kaliwates and Summersari Districts. For the Jember Regency area itself, land cover is dominated by paddy fields, and dry fields or fields, plantations as a result of which there is a lot of vegetation land in Jember Regency, and this can have an effect on improving environmental quality, especially in the research area of study.

3.2.2 Effect of Vegetation Density on Flood Disasters

Jember Regency as a research area itself has several points as city centers namely Summersari District, Kaliwates District, and Patrang District. In this case, for example, Summersari District, where this sub-district is the center of industry and education which has a height of about 90 meters above sea level, thus it can be concluded that the community activity center in this district is classified as lowland with a range of vegetation that is categorized as quite medium and dense in certain areas. This was proven from the results of the accuracy test, there was a lot of vegetation found in the Summersari area, to be precise, on Jalan Kalimantan, which is also the city center of Jember Regency, that vegetation in the form of trees that adorned the road in Kalimantan was found. This was also supported by the existence of a program Green City or the Green City which was initiated by the Environmental Service and the Jember District Government in creating a beautiful and pollution-free city.

On the other hand, the existence of this program with dense vegetation in certain areas also invites frequent disasters, moreover, this research area also examines three large sub-districts in the central region of Jember Regency, namely Patrang, Kaliwates, and Summersari Districts. The three sub-districts have their own regional characteristics, such as the Summersari sub-district which has a variety of scattered vegetation densities as well.

Two locations with different heights such as the Kalimantan road area itself has around 90 meters above sea level while the Bengawan Solo road, Brantas road and several other roads appear lower than this Kalimantan road. This difference in height causes flooding which direction from west, east, north, south all gathers in the lowest areas, moreover in the Brantas area it is also very dense with built-up land with lots of vegetation which when found is already rare, while in the vicinity of the area, long across, namely the Bededung River which has recently shown overflowing activity due to the high intensity of rain due to the fact that it has entered the rains with the presence of water catchment areas that are almost sparse and the loss of vegetation cover (Nalurita, 2022). Apart from that, there are other factors that cause flooding and generally occur in the lowest areas as well as in the river area by looking at how steep the slopes are in the Brantas area, because basically it will easily erode the flow area.

in that region. Vegetation is another factor when the intensity of the rainwater that falls increases, because the water infiltration area into the ground has begun to decrease due to the large amount of built-up land area in this lowest area or Brantas. because basically it will be easy to erode the flow area. When the area is very easy to penetrate, so there will be a high level of flooding in the area. Vegetation is another factor when the intensity of the rainwater that falls increases, because the water infiltration area into the ground has begun to decrease due to the large amount of built-up land area in this lowest area or Brantas. because basically it will be easy to erode the flow area. When the area is very easy to penetrate, so there will be a high level of flooding in the area. Vegetation is another factor when the intensity of the rainwater that falls increases, because the water infiltration area into the ground has begun to decrease due to the large amount of built-up land area in this lowest area or Brantas.

According to Marom (2019) there are several vegetation criteria in the form of trees with height parameters which are an important aspect in preventing flood disasters, trees that have a canopy or tree canopy with a high enough height which is far and rare and the second level has a height of 15- 30 m, and the third level with a height of 5-15 m. Based on field accuracy tests and observations confirming the existence of land use classes in the three sub-districts, it was found that vegetation in the form of trees with these criteria was very much found in areas along the main roads of the city of Jember Regency with varying heights, which was also in accordance with the program of the Government and related agencies, namely Green City.

In other usage classes it is also quite dominated by rice fields and moor areas which are generally located on the outskirts of the Bededung river which is quite far from the Brantas area with a minimal level of flood disaster, namely in Patrang District, according to the results of interviews with local residents in the area explained that Patrang District itself is an area at the foot of Mount Argopuro with lowlands or areas the settlement has a height of up to 100 meters above sea level. Along the way across the area of Patrang District is also a mountainous area with a fairly high level of vegetation density which is dominated by rice fields and plantations as well as a low level of flood disaster due to the dominance of water catchment areas which allows when it rains there is very little standing water in the area.

4. Conclusion

The difference between the Vegetation Density Map for urban area of Jember Regency in 2019 and the Vegetation Density Map for urban area of Jember Regency in 2021. In fact, in 2021 it can be seen on the map, that very dense vegetation density and dense vegetation density dominate more. This can happen because the current Jember Regency Government, especially the Jember Regency Environmental Service, has initiated the idea Green City and see the difference in 2019 and 2021 and this can affect the improvement of environmental quality, especially in the research area studied.. While the land cover in these three sub-districts, in the research area, there are plantations, field, rice fields, built-up land, and open field. For the Patrang District area, land cover is dominated by plantation land, rice fields, and dry fields or fields, as a result there is a lot of vegetation land in Jember Regency. As for the Summersari District and Kaliwates District, that land use is dominated by built-up land, both for residential, government building, and commercial land use.

Based on the results of an analysis of vegetation density, in this case it is known that several sub-districts in the center of Jember Regency, such as Patrang, Summersari, and Kaliwates sub-districts, have land cover for vegetation that varies from medium to dense vegetation. Land use at several points has also been filled with built-up land, then the physical condition of being in the lowlands and near the Bedadung River is a factor why floods still occur in several areas in these three sub- districts. So in this case, apart from vegetation density there are also other factors that can influence the occurrence of a flood disaster.

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