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Detection of Potential Natural Disasters Due to the Rate of Land Change in Sinjai Indonesia Regency with Geospatial Technology

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ABSTRACT

Sinjai, Indonesia Regency is an area that is often hit by floods and landslides, drought, forest fires with the following data: potential natural disasters that often occur in Sinjai Regency are landslides and flash floods. This disaster is the impact of land use change. Landslides and flash floods often occur at the same time, especially if there is heavy rain. The objectives of this study are (1) to evaluate the rate of change in temporal land cover between 2014 and 2019 in Sinjai Regency. 2) To detect the impact of disasters caused by the conversion of land functions in Sinjai Regency. This research uses quantitative methods. This research is closely related to the enumerative induction process (calculation based induction). Based on the results of land cover classification using different image data in the year of updating, this data indicates strongly that in 2014 to 2019 there was a rate of land change which had a major influence on all watershed areas in Sinjai Regency, the impact of the rate of land change can increase the runoff thickness. The greatest rate of change is the change from primary forest to mixed agriculture and a shift in land use due to settlement, opening of new rice fields and other uses which constitute forest conversion. The survey activities conducted by the survey team indicated that mining activities (especially sand mining around the river) led to the opening of some areas that were previously dominated by forest to become type C mining activities, this type of activity is the main cause of runoff when it rains and has the potential erosion that can result in silting, such as that of the Saleo river, which is a tributary of the Garaccing watershed.

1. Introduction

Land is one of the most important and needed resources in supporting the lives of humans and other creatures that exist in this universe. The need for land from time to time is increasing along with the increasing number of human populations on this earth. This is triggered by an increase in the quality and quantity of human life (Nuraeni et al., 2017). This land use is driven by the increasing level of human needs, the need for food, housing needs and other needs that continue to increase. According to (As-syakur, 2011), One of the most vulnerable problems related to land resources is land degradation. Land degradation is a process of decreasing land productivity, either temporarily or permanently. Land that has been heavily degraded and has become critical land covers an area of approximately 48.3 million ha or 25.1% of the total area of Indonesia, this is according to research conducted by (Wahyunto & Dariah, 2014).

When land is used it will affect other resources such as watersheds (DAS). Watershed is a complex ecosystem from upstream to downstream. The largest increase in land use was for agricultural rice fields, moor and gardens. Changes in land cover, especially forest, indicate the ability of watersheds to store water, this is according to research conducted by (Permatasari et al., 2017). Land use greatly affects watershed conditions, when land use is good, the watershed will be well preserved, but when land use is not limited and does not pay attention to environmental problems, this condition will affect watershed conditions. When a watershed is damaged it will have a major impact on humans. Damaged watersheds can result in disasters such as erosion, flooding and landslides, and all of this can result in enormous losses for humans. Changes in land use have a major impact on decreasing water quality, increasing seasonal fluctuations with flood and drought symptoms in the watershed, this is in accordance with the opinion of Parwitan (1999) in (Permatasari et al., 2017).

In order for land use to run according to its desires and designations, it is necessary to have a good land use evaluation, but when we talk about land use it cannot be separated from the picture of something broad, it takes time and a lot of energy. The birth of geospatial technology is one of the answers to this challenge so that land use is right in accordance with its allocation. According to (Baja, 2012) In regional development, land use planning is needed to guide decision makers in an effort to select the appropriate type of land use, determine the optimal spatial location of planned activities, identify and formulate opportunities for land use change, and anticipate the consequences of changes to land use policies. According to (Deptan, 2011) the increasing need for land, as well as the existence of competition between agricultural and non-agricultural land uses, requires appropriate technology to optimize land use in a sustainable manner.

The impact of the increasing rate of land change can result in the emergence of various natural disasters such as landslides, flash floods, extreme weather, forest fires, and drought, this is in accordance with research conducted by (M. L. Hakim, 2010). Sinjai Regency is an area that is often hit by floods and landslides, drought, and forest fires with the following data: potential natural disasters that often occur in Sinjai Regency are landslides and flash floods. This disaster is the impact of land use change. Landslides and flash floods often occur at the same time, especially if there is heavy rain

The existence of satellite images is very helpful for observers and researchers to determine land conditions. Aerial photo interpretation can make it easier to detect, identify and delineate the presence of an area so that it can save time and effort and costs to observe directly the area in question. With the presence of satellite images, we can retrieve data from an area without having to visit that area. In this research, the authors use 3 (three) types of satellite image data, namely Landsat 8 satellite image data with an accuracy of 30 meters, spot images with an accuracy of 1 meter and Dem data with an accuracy of 6x6 m.

Conventionally, the best method for assessing landslide vulnerability is by field survey. However, to detect the potential for landslides in an area that is very likely to consume a lot of time, survey energy and costs, such as in Indonesia which is a developing country, because it experiences many obstacles in which the earth observation network is relatively limited and the many mountainous areas are difficult to reach. The best method to overcome this problem is remote sensing, information obtained through remote sensing is one of the best solutions that can be obtained, as research conducted by (Somantri, 2014), in the Study of Landslide Disaster Mitigation Using Remote Sensing Technology. Remote sensing data that is currently available can provide accurate and useful information on surface features and dynamic processes associated with landslide events (Arbain & Sudiana, 2015).

The purpose of this study is to evaluate the rate of change in land cover temporally between 2014 and 2019 in Sinjai Regency. 2) For the impact of disasters caused by the conversion of land functions in Sinjai Regency. This research uses quantitative research. This research uses quantitative research. According to William (2014), quantitative research is research that starts from a specific plan or a set of detailed questions or hypotheses. This research is closely related to the enumerative induction process (calculation based induction)

2. Materials and Methods

2.1. Types of research

This research is closely related to the enumerative induction process (calculation based induction) or quantitative methods.

2.2. Materials and tools

The tools needed in this research include: GPS, meter, computer, Arc GIS software, ArcView, Ermapper, printer.
The materials needed in this research are: RepppRots map, administration map, rainfall map, watershed map, geological map, area map, landsat satellite imagery data in 2014 and landsat data in 2019. Spot image data, DEM data.
Time and place of research
The research was conducted in the Sinjai district from June 2019 to August 2020
2.3. Research procedure
1. To classify the type of land cover

a. Land cover classification is a guideline or reference in the interpretation process if the land use mapping data uses remote sensing imagery. The purpose of classification is so that the data is made of information that is simple and easy to understand.
b. The grouping of objects into classes based on similarities in their nature, or the relationship between these objects, is called classification. Land cover classification is a guideline or reference in the interpretation process if the land use mapping data uses remote sensing imagery. The purpose of classification is so that the data is made of information that is simple and easy to understand
2. Test the accuracy of image data

Data validation is to determine the accuracy of the image in classifying the objects identified as land cover types based on the type of land cover used as a reference in the classification system, determining the level of accuracy in image reading using the following equation:

$$K_{chat} = \frac{N.\sum_{k=i}^{ii} - \sum_{k=i}^{ii}(xi*xii)}{(N*N) - \sum_{k=i}^{ii}(xi*xii)}$$

A. Determination of potential disaster areas

The data collection stage begins with the interpretation of the distribution of soil movements including analysis and direct visual interpretation of the soil, then field activities to check the correctness of the results of the analysis such as texture, land cover conditions, slope and depth, this is done directly, and analysis of the vulnerability zone of soil movements with Indirect method, this is in accordance with the method used by (Kumoro, 2010) in his research on "Microzonation of Potential Areas of Soil Movement Based on Remote Sensing and Geographical Information Systems in the Southern Cianjur Region, West Java". In the Landsat and SPOT satellite images used in this study, the appearance of symptoms of ground motion and the potential for flooding is shown by their distinctive shape. Furthermore (Kumoro, 2010), explains that satellite imagery carries several sensor systems simultaneously, while each sensor can produce several image bands.

Each of these bands is the result of a sensor recording with a certain width and sensitivity (the limits or dominance of the electromagnetic wave spectrum). Each band has its own characteristics of sensitivity to certain shapes on the surface of the earth, as argued by (Prahasta, 2008). Although the type / type of landslide cannot always be determined from the image, initial estimates can still be estimated from the shape of the landslide product. Based on the appearance form which is generally very specific in the image above, it is possible to interpret and delineate the area of distribution of ground motion, direction of landslides, fracture patterns and sliding areas in large areas quickly with sufficient accuracy and run off movements when there is an overflow. water.

Then the preparation of the vulnerability zone map using the indirect method, the process is based on the calculation of soil movement density and weight value for each geological unit, slope class and land use unit (on each parameter map) and obtained three types. disaster risk level. For floods and landslides, each of them is categorized as high hazard potential, medium hazard potential and low hazard potential. As explained above, the analysis is indirectly carried out by overlapping maps of the distribution (distribution) of land movements that have occurred with parameter maps (geology, slope, land use), then estimating / calculating using geological unit data. , slope class and land use unit that affect the incidence of ground motion.

3. Result

a. The rate of land cover change is based on reading Landsat satellite imagery

3.1. Image Preliminary Processing (Geometric Correction)

The closure classification is based on the use of Landsat satellite imagery data using RGB composite with the same channel band, namely 1,2,3 and 4,3,2. The type of land cover obtained is the result of land cover interpretation using Landsat TM satellite image data which is the beginning of research with different types of years, namely 2014 and 2019 data. The opinion of (JAUH & NASIONAL, 2015) states that The distance used has been corrected Radiomatically and Geometrically based on the standards set by the institution (Guidelines for Radiomatric Correction Processing and Geometric Sensing Data, Pustekdata-Lapan) Using an unsupervised classification system, the land cover class is obtained as shown in Figure 3.1.,

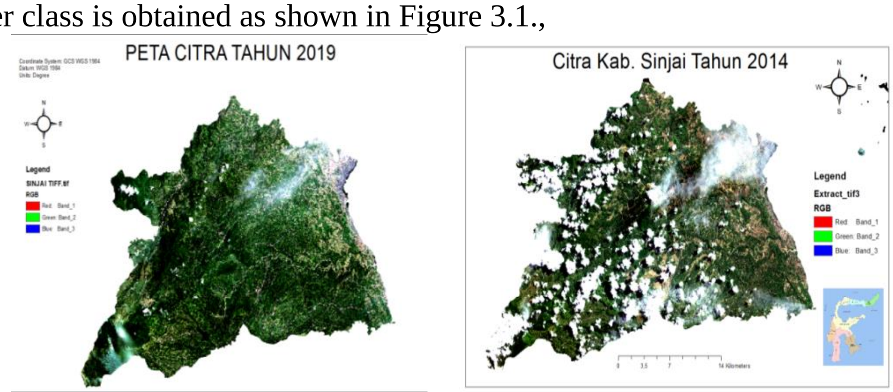

Figure 3.1. 2014 and 2019 Landsat imagery

In the picture above is an image display that has not been classified, consisting of two different years between 2014 and 2019. The image is made in the same composite, namely 4,3,2 and 1,2, and 3, this is a combination of bands for display quality good image, this is in accordance with research conducted by (Sampurno & Thoriq, 2016). From this image data, land cover can be identified based on the TN value of each type of land cover. Before classification, geometric correction is needed. This needs to be done to get the actual pixel value in the right position, this is in accordance with the opinion of Jaya (2010) in Levi (2014). The purpose of geometric correction is to make rectifications (corrections) so that the image coordinates are in accordance with geographic coordinates.

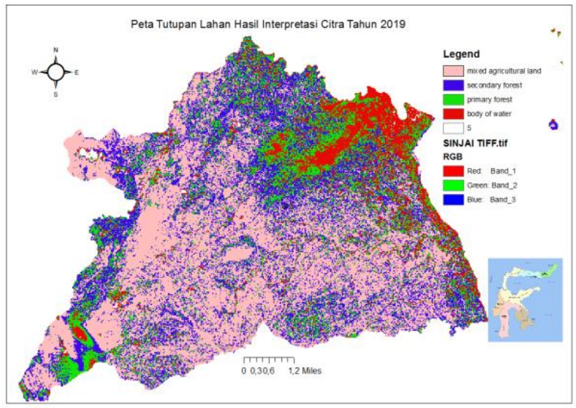

Figure 3.2. Map of 2019 Landsat Image Interpretation Results

The author classifies land cover in Sinjai district with several classes of land cover, namely: settlements, shrubs, swamps, mangroves, dry land, which is land that is not too wide and difficult to distinguish based on pixel perpixel analysis because it uses image data with medium resolution, namely landsat with 30 x 30 meter coverage. We can see the land cover based on the Landsat 8 image interpretation with an unmonitored classification system in table 3.1 below

Tabel 3.1. Klasifikasi penutupan lahan hasil olah citra Landsat 2019

Land Cover Classification	Count	Luas (Ha)
Mixed agricultural land	727.914	65.512,33
Secondary forest	28.498	2.564,88
Primary forest	23.153	2.083,80
Body of water	115.778	10.420,02
Other use	15.766	1.418,97
	911.111	82.000

Source: Data from Landsat image processing in 2019

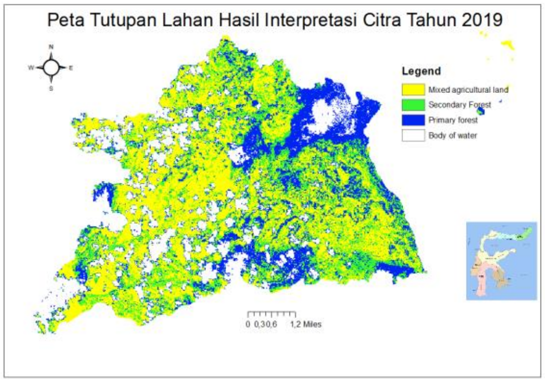

Figure 3.3: Results of interpretation of 2014 Landsat imagery

Table 3.2. Land cover classification resulting from image processing in 2014

Land Cover Classification	Count	Large (Ha)
Mixed agricultural land	731.111	65.800
Secondary forest	30.009	2700,81
Primary forest	23.376	2103,85
Body of water	117.372	10.563,55
ATC	9.244	832
	911.112	82.000

Source: Primary data 2019

Table 3.3. The rate of land change between 2014 and 2019

No	Land cover	years 2014 (Ha)	years 2019 (Ha)	Large change (Ha)
1	Mixed Agricultural land	65.800	65.512,33	287,67
2	Secondary Forest	2.700,81	2.564,88	135,93
3	Primary Forest	2.103,85	2.083,80	20,05
4	Body Of Water	10.563,55	10.420,02	140,53
5	ATC	832	1.418,97	586,97

Source: Primary data 2019 after being processed

Accuracy Evaluation

To find out the level of accuracy of the data from the results of image interpretation, a field check was carried out by taking a sample point of about 20% of the total pixels of 911111 pixels, so that 191 points were obtained which are distribution points for the accuracy test of using image data to evaluate the accuracy level of land cover based on image data in 2019 The overall accuracy test uses the Kappa formula as research conducted by

(Sampurno & Thoriq, 2016). Observation points can be seen in the following table Table 3.4. Number of Ground Check Points for each Land Cover Class for 2019 Landsat 8 imagery.

Tabel. 3.4. Ground Check setiap kelas tutupan lahan

Jenis penggunaan	Jumlah pixel	Luas (Ha)	Jumlah titik
Mixed Agriculture Land	727.914	65.512,33	61
Secondary Forest	28.498	2.564,88	38
Primery Forest	23.153	2.083,80	36
Body Of Water	115.778	10.420,02	31
ATC	15.766	1.418,97	25
Total	911.111	82.000	191

Sumber: Data primer setelah diolah, 2019

4. Discussion

4.1. Klasifikasi land cover

In table 3.1 and figure 3.1, the results of land cover classification in 2019 are presented based on the interpretation of Landsat 8 imagery, the appearance of the land cover type is shown in different colors, according to research conducted by (Sampurno & Thoriq, 2016). Based on table 3.1, the mixed agricultural land cover class is the land cover class with the largest area of 65,512.33 hectares, indicating that in 2019 the largest land cover was mixed agriculture and the number of pixels was 727,913 pixels, primary forest class was the widest land cover class after mixed farming with an area of 2,083.80 Ha with a ratio of 23,154 pixels to the number of pixels, on the display in the image, forest with high density will appear dark green when compared to low-density or secondary forest, this is in accordance with research (Sampurno & Thoriq, 2016). Secondary forest with an area of 2,564.87 hectares with a ratio of the number of pixels of 28,498 pixels is a cover class consisting of several similar vegetation, land cover in the form of bodies of water consisting of water bodies consisting of paddy fields, swamps, rivers and so on covering an area of 10,420, 06 Ha with a pixel count ratio of 115,779 pixels, then other land cover covering an area of 1,418.95 Ha with a pixel number of 15,764 pixels.

Based on this interpretation, this condition indicates that the condition of forest cover is still relatively stable, the problem of natural conditions is one of the control factors, but there are several areas that experience problems related to land conversion, especially in the districts of West Sinjai, Sinjai Borong and parts of Central Sinjai. In table 3.2. presents the results of land cover classification in 2014 based on the interpretation of Landsat 8 imagery, with mixed farming class being the largest land cover with an area of about 65,800 hectares with a ratio of the number of pixels of 731,113 pixels, secondary forest with 30,009 pixels with an area of 2,700.82 hectares, Primary forest with 23,375 pixels with an area of about 2,103.86 hectares, a body of water with 117,373 pixels in an area of 10,563.56 hectares, according to the results of research conducted by (Derajat et al., 2020). that if we look at the two land cover maps above, there are differences in the area of land cover classification, this is because the size of the object can experience over segmentation or under segmentation.

Based on the results of land cover classification using different image data in the year of updating, this data indicates strongly that in 2014 to 2019 there was a rate of land change which had a major influence on all watershed areas in Sinjai Regency, the impact of the rate of land change. can increase the thickness of the runoff, according to the research conducted by (Yudha et al., 2013). The greatest rate of change is the change from primary forest to mixed agriculture and the existence of a shift in land use due to settlement, opening of new rice fields and other uses which constitute forest conversion. The survey activities conducted by the survey team indicated that mining activities (especially sand mining around the river) led to the opening of part of the area that was previously dominated by forests to mining type C activities, this kind of activity is the main cause of runoff when it rains and has the potential erosion that can result in silting, such as that which occurred in the Saleo river, which is a tributary of the Garaccing watershed, as a research conducted by (Salim et al., 2019), which states that a decrease in forest cover can increase discharge and surface flow, conversely increase forest cover will increase soil infiltration and evapotranspiration. The results of the interpretation of the image for the 2019 recording year, mixed gardens in Sinjai Regency were 65,512.34 hectares, while for the 2014 recording year the area of land cover included in the mixed garden category was 65,800 hectares. Based on these data, there was a reduction in mixed agricultural land by around 287.67 for 5 years. The spatial position of the interpretation of Landsat 8 satellite imagery can be seen in Figure 3.3.

4.2. Accuracy Evaluation

Reference data and results of field checks are used as references in testing the accuracy of interpretation of satellite image data. The contingency matrix, used as a method for analyzing the accuracy of the interpretation of satellite image data, in the following table shows the overall accuracy value of 78%, the accuracy results with the overal system are also carried out by. These results indicate that the pixels in the sample area are well classified, with an accuracy rate of above 84%, this is in accordance with the opinion of (CARPER et al., 1990), *dalam* Amalia, 2013). The Sinjai Regency statistical data in 2018 figures is used as a reference in evaluating the accuracy of the 2019 interpretation results.

Although the level of accuracy obtained is in the high category, we still pay attention to errors in the classification for these classes, this error can occur due to the image conditions used, such as there are clouds, the similarity in reflectance of the pixels as is the case in forest classes secondary with a uniform garden cover such as plantation plantations, water bodies with other uses such as swamps or rice fields, shrubs and open land and savanna, this is in accordance with research conducted by (N. I. A. Hakim et al., 2019). Atmospheric conditions, changes in water content, differences in the angle of the sun and different topographical influences such as those that occur in forest classes which reflect the same reflectance as cloud shadows are other factors that cause misclassification. The difference in this condition occurs because the difference in the recording time date of the two best recording time images for Sinjai district is September and October because these two months are dry months and Sinjai Regency has high rainfall and clouds, even certain seasons of September and October are often washed down. rain.

Table. 3.5. The test matrix for the accuracy of Landsat imagery in 2019

	MAL	SF	PF	BOW	ATC	Total	User Acuracy
MAL	53	3	0	2	2	62	89%
SF	0	31	4	2	2	37	77%
PF	0	3	27	2	4	36	75%
BOW	2	1	1	25	2	31	80%
ATC	1	2	1	1	20	25	80%
Total	57	39	33	32	30	191	
Producer	94%	76%	81%	78%	66%		
Overal	81,69%						

MAL = Mixed Agriculture Land, SF= Secondary Forest, PF= Primary Forest, BOW = Body Of Water, ATC = Other Use Land

Sumber: Data primer 2019

$$K_{chat} = \frac{N.\sum_{k=i}^{ii} - \sum_{k=i}^{ii}(xi*xii)}{(N*N) - \sum_{k=i}^{ii}(xi*xii)}$$

$$K = \frac{(191*155)-((57*61)+(37*38)+(33*36)+(32*31)+(30*25))}{(191*191)-((57*61)+(39*38)+(33*36)+(32*31)+(30*25))}$$

$$Kchat = \frac{(29796)-((3477)+(1482)+(1188)+(992)+(750))}{(36481)-((3477)+(1482)+(1188)+(992)+(750))}$$

$$Kchat = \frac{(29796)-(7889)}{(36481)-(7889)}$$

$$Kchat = \frac{21908}{28592}$$

K_{chat} = 76,63%

Land Use

The large rate of land change occurred in South Sinjai and North Sinjai Districts, this was due to the very rapid development in the two Districts. Many areas in the two subdistricts have been developed as residential areas. The existence of increasingly limited land in South Sinjai District has led to the expansion of residential areas to South Sinjai District, where land availability is still quite wide, this is in accordance with research conducted by (Kusrini et al., 2011). The development of settlements in this area occurred rapidly so that land use was very dynamic, especially the change of non-developed land (mixed agriculture and forest) to developed land, within the last 5 years.

Land closure, especially in South, East, West and Borong Sinjai sub-districts and land use is dominated by mixed agriculture (seasonal crops, plantations and dry land agriculture) as well as conditions of land use change from primary forest to agricultural land and rice fields, as well as a change of function from Productive agriculture becomes residential land (based on the author's observations, there are several productive rice fields converted into settlements), this indicates that it is one of the causes of landslides apart from its own natural conditions. The results of the previous author's research (Muhlis & Muhtar, 2019), this condition shows that the availability of protected forest land is decreasing due to land use that is not in accordance with its designation, along with the high demand for housing as a result of an increase in population. Likewise in the Sinjai district, where some of the land uses in the highland areas are scattered in the Districts of South Sinjai, West Sinjai, Central Sinjai, Sinjai Borong, East Sinjai, Bulupoddo is dominated by mixed agricultural land, this is also in accordance with the research conducted. by (Nuraeni et al., 2017).

Change in land cover is a transitional process, such as agricultural land that does not immediately change into built-up land but into grass / empty land or shrubs. temporal rate of land cover change. The change in cover in Sinjai Regency based on reading satellite images, namely. Mixed agricultural land has increased in area based on data from Landsat satellite imagery in 2014 and 2019 covering an area of 287.68 hectares (2014 covering an area of 65,800 hectares and 2019 with an area of 65,512.34 hectares) see table 3.3. Secondary forest is the land cover with the largest decrease, which is an area of 135.93 hectares. Meanwhile, many plantations have decreased due to their strategic presence in the plan and landslides that often occur in several areas due to land use changes due to the causes of land use.

Based on the analysis of image data between 2014 and 2019, there was a change in the area for water bodies covering an area of 140.534 hectares. In the classification based on the Landsat 2019 satellite imagery, the body of water consists of swamps, rivers, irrigation rice fields scattered throughout the Districts in Sinjai Regency. This change occurred due to the change in land use from swamps to gardens, and rice fields to gardens and settlements, and so on. Irrigation rice fields in North Sinjai Subdistrict are not very wide, distributed in the outskirts of South Sinjai District, especially around villages. The change in irrigated rice fields was partially turned into empty land and scrub before turning into a settlement. Agricultural land area has decreased in general, including rainfed rice area has decreased by 141 Ha (part of water body) and field moor area has decreased by 287.68 Ha (part of mixed farming). Rice fields are believed to be able to prevent or defend the environment from damage because they are able to hold water, function as DAM, and reduce erosion as well as forest functions that can preserve nature and climate stability.

Changes in land cover are a serious problem in threatening natural disaster processes, such as paddy fields into settlements and primary forests to secondary forests, plantations, this conversion of functions can threaten the loss of soil productivity and environmental sustainability. Figures 3.2 and 3.3 show that the area of swamps has decreased based on the interpretation of satellite images from 2014 and 2019 (part of the water body), the biggest problem that arises is the deepening of the swamps due to human activities that violate environmental ethics and naturally the swamps also experience silting due to the sedimentation process. . A lot of surface flow flows and enters the swampland while carrying material and soil, this occurs during the rainy season. This silting occurs because the rain catches are decreasing and the river has reduced its function due to human activities. Most of the swamps are used as settlements, so that many developers expand the residential area by confining the swamp. In addition, most of the swamplands (including fishponds and thatch plantations) are deliberately filled with soil material to be used as a residential area, especially in the area of North Sinjai District. Water bodies are in the form of ponds (swamps, rice fields) and rivers with a relatively fixed area.

4.3. Land cover change

Change in land cover / use as a process of change from previous land cover / use to other land cover / use which can be permanent or temporary, and is a logical consequence of growth and transformation of changes in the social economic structure of a developing community, this is in accordance with the opinion stated by Yulita (2011). Land cover is a term related to the types of appearances that exist on the surface of the earth. Whereas land cover change is the state of a land that changes at different times based on changes in time or changes in land conditions from time to time due to human activities. We can observe the analysis of the rate of change in watershed land cover in Sinjai Regency between 2014 and 2019 based on the change matrix as shown in table 3.3.

Information on the area and form of changes from a certain land cover class to another land cover class as well as errors in the cover change analysis are made in the form of a matrix, this matrix that provides information on the accuracy of data use. From the cover data for 2014 and cover in 2019, it provides an overview of the area based on image reading and the quality of the resulting data. The classification results for land cover in Sinjai Regency between 2014 and 2019 produce data on the area of each class that can be compared against the time of taking the image.

In the 2014-2019 period, the mixed agricultural land cover class experienced a significant change, namely an area of 287.67 Ha and based on the interpretation of satellite imagery the authors made 4 types of cover classifications. In the classification of land cover, the authors make 4 types of land cover that have decreased in area, namely primary forest cover class, secondary forest, and water bodies and mixed agriculture, we can see this information in the description of table 3.3 above. On the other hand, the land cover classes that experienced an increase in area were mixed farming classes due to the conversion of function from secondary forest and an error in image reading when land cover classification was carried out.

For forests, the area has decreased considerably. This decrease was due to the fact that during 2014-2019 the forest area had been converted into other forms of land cover and there were several landslides in the forest area. The decline in forest cover with an area as follows, the largest area occurred in forest land cover, experiencing a decrease in area of 135.93 (Ha) secondary forest (2014 covering an area of 2,700.81 Ha and in 2019 an area of 2,564.88 Ha). This decrease was due to the conversion of forest to mixed agriculture of around 45 Ha, namely 75 Ha (statistical data) in 2014, then 30 Ha (statistical data) turned into primary forest such as pine forest which is spread in the Districts of South Sinjai and Central Sinjai, 20 Ha (data statistics) to open land and 78 Ha (statistical data) turned into mixed and dense gardens which turned into swamps and dry land overgrown with reeds.

The land cover area data for mixed agriculture in 2014 was 65,800 ha, to 65,512.33 ha in 2019, this shows that this shows that the largest increase in area occurred in mixed agricultural cover, we can see this in table 3.3.,. The occurrence of this addition is due to the conversion of several types of land use into other mixed agriculture, for example mixed plantations, Ha from primary forest, 80 Ha from rice fields, 51 Ha from mixed gardens and 26 Ha from other uses that are not defined in the image data classification.

This condition is understandable, one of the factors that has resulted in the increase in land cover for agriculture is because nearly 80% of the population of Sinjai Regency are farmers, which we can see in statistical data, (2018), so it is very possible to have a large enough land conversion to become land. agriculture. However, from an ecological point of view, the large area opened up due to agricultural activities needs serious attention given the vital function of forests for soil and water conservation in these locations. In addition, it is clear that there has been no effort from the government to carry out revegetation activities in the locations that have been opened. Open land and built-up land / settlements to return to forest land are very unlikely to be realized because it takes a long time and is expensive to return to the forest, this is in accordance with the opinion (Puspaningsih, 2011). The time needed to reach a stable forest from the first planting to the formation of a stable forest takes 75 years.

The condition of land cover changes, especially those with forest status, must receive serious attention, considering that the forest's function is very vital to the conservation of soil and water in that location and is even a buffer for ecosystem life. In addition, it is clear that there has not been any effort from the government to carry out revegetation activities in locations that are included in areas that must be stabilized or their position as protected forests. Open land and built-up land / settlements to return to forest land are unlikely to be realized because it takes a long time and is expensive to return to the forest. The time needed to reach a stable forest from the first planting to the formation of a stable forest takes 75 years, this is in accordance with the opinion expressed by (Puspaningsih, 2011).

The use of mapped land is intended as a source of information and influence for areas that are often affected by landslides or other natural disasters. Residential areas, protected forest areas, and so on are areas that can be affected by landslides. This map can also be used as a guide for further analysis to determine the location of evacuation if landslides occur in residential areas and provide directions for environmental conservation and saving actions. In Figure 4.2. The following shows the distribution of land use in Sinjai Regency

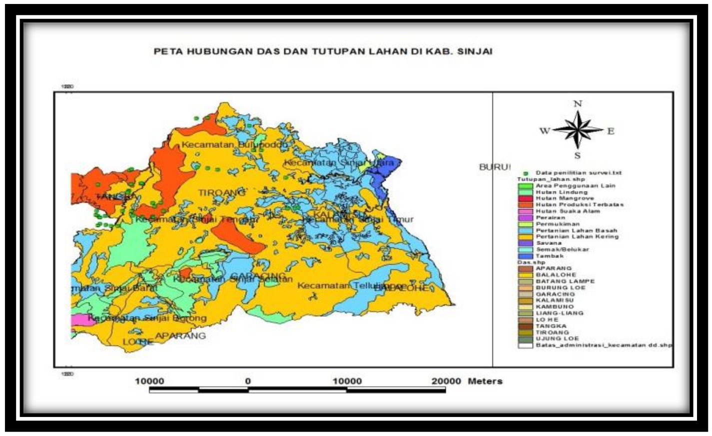

Figure 4.2. Distribution of land use in Kab. Sinjai in 2019

In Sinjai District, some dry land agricultural areas are neglected so that they are overgrown with shrubs. There are many moorlands in the West Sinjai District. Shrubs are often found in the West Sinjai Subdistrict. Shrubs are dry agricultural areas that have not been cultivated for a long time so that they are overgrown with shrubs, or shrubs are often found to be allowed to grow with fruit trees or plantation crops. Mixed dry agricultural land is the most extensive land use in Sinjai Regency. This land use occupies 77% of the total land use area of Sinjai Regency. The proportion of the area of mixed dry agricultural land is mostly found in Sinjai Selatan, Sinjai Tengah and Tellulimpoe Districts. Rice fields occupy 14% of the total land use area. Rice fields are scattered throughout the sub-district.

Secondary forest occupies an area of about 6.22% of the total area of Sinjai Regency. Secondary forests are scattered locally in almost the entire area of Sinjai Regency, especially in West Sinjai, South Sinjai, Central Sinjai and Sinjai Borong Districts. Mangrove forests can be found in the districts of East Sinjai and North Sinjai Districts, this land use area is around 0.07% of the total area of Sinjai Regency. Settlements are scattered along the main road. Settlements are not well identified in the Landsat ETM + imagery because of the relatively narrow built-up area. The use of scrub land occupies about 2.34% of the total area of Sinjai Regency. Shrubs / shrubs are generally in the form of vegetation that grows in areas that are formerly cultivated and are allowed to grow freely. Some shrubs / shrubs occupy the former reforestation area that was burnt. Bush / shrubs are often found in areas including Sinjai Regency, the area of this land use is 1,948 ha.

4.5. Potential disaster

Potential disaster in Sinjai Regency

Peta sebaran longsor

Figure 4.4. Landslide distribution map in Sinjai Regency.

In figure 4.4. is a landslide hazard map produced by the WLC method with weighting with three classes, namely low landslide hazard, moderate landslide hazard, high landslide hazard. The figure shows the distribution of landslide-prone areas explicitly based on the criteria of each landslide class, this is based on data on slope, soil texture and rainfall. The distribution of landslide areas with high landslide hazard categories on the map is symbolized by yellow, in three sub-districts, namely West Sinjai District, Sinjai Borong District, Central Sinjai, Part of South Sinjai District including Palangka Village and Polewali Village, For the Tellu Limpoe District it covers some Samaturue Village, Saotengnga Village, Lembang Lohe Village, Sukamaju Village. The East Sinjai area is scattered in Panaikang Village, Sanjai Village, Bongki Lengkese Village. These areas are prone to landslides based on natural factors weighted based on the value of rainfall, slope and soil texture or soil properties, because the areas are scattered in the West Sinjai, Sinjai Borong, Central Sinjai and Palangka and Polewali areas in South Sinjai. needs serious attention, especially in terms of land conversion. These areas are areas with an average slope level of above 45% and need to be used as protected areas, but they are mostly used as arenas for agriculture and plantations so that the potential for landslides is high.

For areas with a moderate landslide hazard category, we can see the map with the distribution in blue, see Figure 4.4. These areas are scattered in Sinjai Tengah Subdistrict in Gantarang Village, Kompang Village, Saohiring Village, Bulu Tellue, for Sinjai Borong there are Pasir Putih Sub-district, Kassi Buleng Village, for South Sinjai District spread in Puncak Village, Part Songing Village, As an area Sangiasserri Village, Part Alenangka Village, part Talle Village, and part Aska Village. The East Sinjai area includes Lengkese and Biringere Villages, for the Sinjai Bulupoddo area, it is scattered in the Villages of Lamatti Riaja and Lamatti Riawang and some of the Lamatti Rilau. For landslides with a low category, it is shown in red on the map, the distribution is spread over East Sinjai District and spread over Kaloling and Biringere Villages.

The map is generated based on weighting with rainfall maps and volcanological data, this is in accordance with the research that has been carried out by (Arbain & Sudiana, 2015), The second landslide hazard map was produced by the WLC method with weighting from the Directorate of Volcanology and Geological Disaster Mitigation (DVMBG). The most dominant landslide prone areas in Sinjai Regency are in West, Central Sinjai and Sinjai Borong Districts. The making of this landslide distribution map focuses on rainfall, soil type and elevation, so that the three sub-districts have a higher potential for landslides due to high rainfall around 3500-4000 mm / year, this is in accordance with research conducted by (Arbain & Sudiana, 2015).

Based on the map of the distribution of areas in several sub-districts which are the distribution of landslides with the category of high-level landslide hazard, it can be concluded that rainfall has a very large effect, West Sinjai and Sinjai Borong and Central Sinjai Districts are the centers of landslide distribution with high-level potential hazards. This sub-district has an average annual rainfall of 3000, 3500 to 4000 mm / year, this is in accordance with the research conducted by (Arbain & Sudiana, 2015), which is that if you look at the annual landslide hazard map, it can be seen that rainfall has an effect on tendency of landslides in an area. Areas that have a high average and standard deviation of rainfall will have a higher risk of landslides. Because the rainfall value is dynamic, landslide susceptibility can vary from year to year.

Based on the results of field monitoring conducted by the research team, it can be concluded that the main factors affecting the potential for landslides in the Sinjai district are slope slope, soil texture, elevation, land cover and high rainfall, such as research conducted by (Arbain & Sudiana, 2015). Looking for category boundaries that have experienced drastic changes / sharp changes in the histogram from the landslide hazard value is one of the best ways to determine the classification for determining the level of landslides in the area.

In the map display, the level of landslide vulnerability in Sinjai Regency is divided into 3, namely high-level landslide hazard potential, medium-level landslide potential and low-level landslide hazard potential. With this scoring system, the fluctuation of the distribution of landslide prone areas in Sinjai Regency can be seen. Figure 4.4. shows the distribution of landslide hazard categories during 2014-2019. Of all the areas that have a high potential for landslide hazard, about 70% of the area is spread across the districts of West SInjai, Sinjai Borong and Central Sinjai. The distribution of landslide prone areas from year to year has a pattern that tends to follow the rainfall value, the higher the rainfall in an area, the higher the potential for landslides.

Rainfall is one of the triggers for landslide hazards, this is in accordance with the opinion of (Arbain & Sudiana, 2015) which states that, apart from being the main triggering factor for landslides, the value of rainfall can also be used to predict the pattern of future landslides in an area. . As a result of the high percentage of landslide-prone areas in the region, the quality of the landslide hazard maps obtained in this study is highly dependent on the accuracy and scale of the geospatial data information used, as well as data on landslides that have occurred as comparative data. More than that, this landslide-prone map also requires validation of the data in the field, so that its accuracy can be further improved, so that researchers carry out ground truth or direct observations in the area that is the object of research. The landslide hazard map from this study can be updated at any time in order to get updated data and also need to enter geospatial data as a comparison and data development model. MODIS land cover data and rainfall data from TRMM are data that can be used as data for updating this landslide hazard map which can also be done dynamically, considering that some of the input data used are also updated periodically. Thus, it can be expected that the accuracy of the landslide hazard map for the Sinjai Regency area will increase over time.

Determination of Geospatial Flood Vulnerability Level

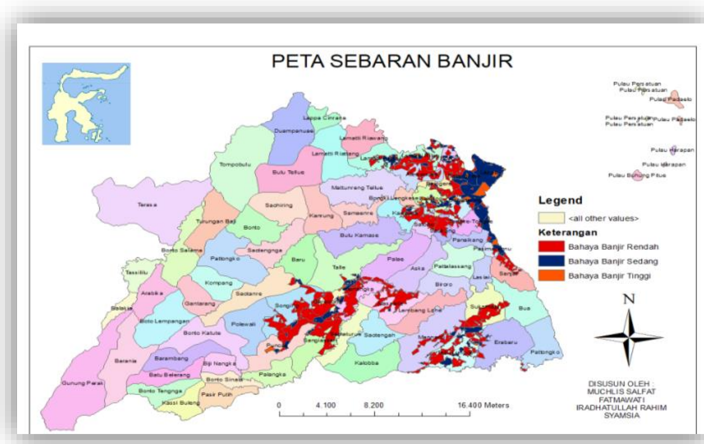

Figure 4.5. Map of the potential distribution of flooding in Sinjai Regency

Based on the map of the distribution of bulk data on a map with a scoring system, the researchers made 3 classes of land cover, namely, high flood hazard is symbolized by red red, for the class of potential flood hazard is being symbolized in yellow, for low potential flood potential class is symbolized in purple. These observations are an overlay of a rainfall map and a map of slope and land cover. Processing involves DEM data generated from SRTM radar images which is data on the earth's surface, from this information analysis is carried out, this is in accordance with research conducted by (Mahfuz, 2016), which aims to produce high-class maps and slope class maps.

In determining flood vulnerability, two phases of geospatial based data analysis were carried out. This analysis provides an overview of the potential for flooding in the study area. At the data processing stage, the data analysis stage is carried out, which can provide a clear picture with clear information through reading the map, which is divided into two stages, namely attribute analysis and spatial analysis, these analyzes have their respective functions in making flood hazard maps. according to the ranking score. At the attribute analysis stage, a spatial-based data analysis was carried out, namely scoring and weighting with a large system, the two processes were carried out after the value classification process in each variable. Whereas at the spatial analysis stage, analysis is carried out related to vector and raster data, this analysis is the result of interaction or a combination of several maps using the overlay method, this is in accordance with research conducted by (Mahfuz, 2016)

The distribution of areas with the potential for flooding is as follows, for the category of flooding with low hazard potential, on the map it is symbolized in green, spread over several Districts, for South Sinjai Subdistrict it is in Puncak Village, Songing Village, Gareccing Village, Alenangka and Sangiasserri Villages. The Tellu Limpoe Subdistrict is scattered in Massaile Village, Mannanti, Tellu Limpoe, Sukamaju. For the area of East Sinjai District, it includes the villages of Sanjai, Salohe, Saukang, Kampala. For North Sinjai includes Biringere and Bongki. Bulupoddo District includes Alewanuae Village. These areas are areas with flat topography and are in the highlands.

The distribution of areas with the potential for flooding with moderate hazards is symbolized by yellow. For the area of South Sinjai District, it is located in Puncak, Songing, Gareccing, and Talle Villages. The Tellu Limpoe Subdistrict includes Tellu Limpoe and Sukamaju Villages. The East Sinjai Region includes the villages of Pasimarannu, Panaikang, Tongke-tongke, Samataring, Kaloling. The North Sinjai District includes Balangnipa, Lappa and Bongki. The Bulupoddo District includes Lamatti Rilau and Lamatti Riaja

The distribution of areas with high potential is symbolized by red, spread over several districts, including: for South Sinjai, areas with high potential for flooding include Puncak and Talle Villages. For the East Sinjai region that has the potential for flooding with a high risk, namely Pasimarannu, Panaikang, Samataring and Kaloling. For North Sinjai includes Lappa and Balangnipa. Based on the observation map, it can be concluded that the areas that are flood centers with high potential are North Sinjai and East Sinjai Districts, this is due to the low regional conditions and lack of water absorption areas due to damaged upstream watersheds such as the Tangka and Garaccing DAS. and Kalamisu.

Flood distribution data is obtained based on research using satellite image data and DEM, with image data researchers can identify flood inundation on remote sensing images on the blue, infrared and microwave spectrum, this is in accordance with research conducted by. In the blue spectrum other than the inundation area, the depth of the inundation can be interpreted. In infrared, the boundaries of inundated and dry land are very clearly presented, so that delineation of areas affected by disaster and those that cannot be carried out. Inundation turbulence (calm, turbulent) can be traced on images recorded with microwaves, for example in the C band (3.25cm). With these observations, the size / size of the floods that arise can be estimated.

5. Conclusion

1. Change in land cover / use as a process of change from previous land cover / use to other land cover / use which can be permanent or temporary, and is a logical consequence of growth and transformation of changes in the social economic structure of a developing community.
2. Based on this interpretation, this condition indicates that the condition of forest cover is still relatively stable, the problem of natural conditions is one of the control factors, but there are several areas that experience problems related to land conversion, especially in the districts of West Sinjai, Sinjai Borong and parts of Central Sinjai

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