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Land use conversion and its impact on farming community income and environment quality, in Lembah Gumanti District, Solok Regency, West Sumatera Indonesia

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Abstract

This study was aimed to analyze the status of land use in Lembah Gumanti District on three time frames in 2000, 2010, 2020 and analyze the impact of land use on people's income and their environment. This research is a quantitative descriptive study by comparing the recorded data both on secondary data published by public institutions and satellite image data as well as primary data collected during the study. The results showed that there had been significant land conversion on land use status at the three points of the year being compared. A sharp decrease occurred in the area of paddy fields and dry land, while on the other hand there was an increase in the status of land use. Satellite imagery data successfully visualize the reduction in the number of water bodies and vegetation which also supports secondary data. On the other hand, there has been a sharp increase in the number of built-up lands, which may be caused by an increase in economic activity and an increase in the need for housing. Land use seems to have an impact in the form of increasing income and community welfare in Lembah Gumanti District, especially in the 2010 to 2020 period significantly. However, land use seems to have a negative impact on environmental status.

Keywords: Land Use; Socio-Economic; Environment; Satellite Image; Lembah Gumanti

1 Introduction

It is recognized that human intervention in the use of the nature landscape will affect its sustainability. Land use is a dynamic form of intervention [1]. Stated by [2] that land use is related to human activities to fulfill their needs. Population growth is one of the main factors affecting land use. The need for living which increases but is not matched by an increase in the amount of land will cause land use conversion. Changes in land use are changes in development spatial planning and without considering conditions in all aspects and carrying capacity, within a certain period of time can cause negative impacts on land and environmental sustainability.

Each particular land use has economic, social, and environmental value [3]. Management of natural resources for economic purposes often ignores environmental factors. If this is not controlled, it will cause environmental problems. Therefore, there is a need for continuity between land use and the carrying capacity of the land (land capability), so that damage or disaster does not occur [4].

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Lembah Gumanti district is an area that is widely used for land in the agricultural sector. Intensive land management has put massive pressure on the sustainability aspect of its carrying capacity. The increase in population and efforts to improve economic standards have forced the conversion of land use for various agricultural activities and other economic motives. Unfortunately, this practice is not accompanied by conservation efforts or rational use in its management. One of the impacts that are starting to be felt include various landslide disasters due to deforestation and the increasing number of neglected critical lands. The landslide that occurred in Nagari Aie Dingin on 16 December 2006 and 13 January 2014 caused damage to agricultural areas covering an area of 15 hectares. The disaster also caused casualties and damaged houses in 2006 in Nagari Aie Dingin. A publication conducted by [5] explained that 62% of vegetable farming communities in the Gumanti Valley have experienced neurotoxic poisoning, namely diseases caused by the use of various types of pesticides. These phenomena indicate how dynamic land use is, if it is not managed properly, it will eventually have an unwanted impact on the community itself.

With this background, it is necessary to conduct a study entitled "Land Use Dynamics in Lembah Gumanti District, Solok Regency". This study aims i). Mapping land use dynamics in 2000, 2010, and 2020, ii). Does the change in land use provide economic benefits to the community? iii) What are the impacts on the environmental status due to these land use activities?

2 Research methodology

This research is a qualitative descriptive research. This research was conducted in Lembah Gumanti District, Solok Regency, West Sumatra Province, which is located at positions $00^0$48'36" and $01^0$16'4" South Latitude, $100^0$52'37" and $101^0$13’32" East Longitude. Primary data were obtained through questionnaires and interviews from data collected in the field and documentation studies. Secondary data is obtained from administrative maps, maps of land use dynamics 2000, 2010 and 2020 obtained from the Solok Regency Development Planning Agency, as well as Landsat 7 and Landsat 8 images, with a scale of 1:100,000. The data obtained is uploaded through the page http://earttheexplorer.ugs.gov and processed using the program, GIS 10.3. For this purpose, several instruments are provided which include GIS (PC and Arcgis software), HP cameras, computer hardware and software, as well as arc Gis 10.3 and micro software. Meanwhile, population density data were obtained from Lembah Gumanti District in Figures for the Year 2000, 2010 and 2020.

To determine the status of land use, scoring is used based on the type of land cultivated with the standards in table 1

Table 1 Land use scoring

No	Land Use	Score	Weight
1	Lake	0	20%
2	River	0	
3	Forest	1	
4	Plantation	5	
5	Settlement	1	
6	Ricefield	1	
7	Shrubs	9	
8	Moor	5	

Source: Darmawan and Theml, (2008) [6]

3 Results and discussion

3.1 Location's Characteristics

Lembah Gumanti District is one of the sub-districts in Solok Regency, West Sumatra Province which is located between $00^0$48'36" and $01^0$16'4" South Latitude, $100^0$52'37" dan $101^0$13’’32" East Longitude. This sub-district consists of four

nagari, namely Alahan Panjang, Sungai Nanam, Salimpat and Aie Dingin with a total of 68 Jorong (Dusun). The total population of this district is 60,022 people with a total of 15,430 families in 2018 where the number of households in the agricultural sector reached 15,704. Records on geographic and demographic status in Lembah Gumanti Sub-district were not available in 2000, only starting in 2010 some of these data could be found, as well as data for 2020 (Table 2). In 2010 the total area of Lembah Gumanti reached 456.72 km^2, while in 2020 it reached 459.72 km2. An increase of 3 km^2 in Nagari Sungai Nanam was caused by the clearing of new land for agricultural purposes. The population has increased by 8,712 people or an average of 16.98%, with the largest addition to Nagari Alahan Panjang as many as 5,573 people or 37.73% followed by Nagari Salimpat and Aie Dingin by 30.73% and 14.03%. Interestingly, the population growth in Nagari Sungai Nanam was negative during those 10 years. The same pattern is found in the development of population density in the four nagari.

Table 2 Total area and population of Lembah Gumanti District in 2010 and 2020

Nagari	Total Area (km^2)		Population		Density/Km^2	
	2010	2020	2010	2020	2010	2020
Aie Dingin	126.39	126.39	9,499	10,832	75.15	85.70
Salimpat	80.03	80.03	6,082	7,951	76.00	99.35
Alahan Panjang	88.76	88.76	14,770	20,343	166.40	229.19
Sungai Nanam	161.54	164.54	20,959	20,897	129.74	127.00
Jumlah	456.72	459.72	51,310	60,022	112.34	130.56

Source: Lembah Gumanti District in Figures of year 2010 and 2020 [7]

The reduction in the population by 62 people over 10 years is thought to be due to the large number of Nagari Sungai Nanam residents who have migrated out of the nagari. They move or migrate with reasons to seek a better life and economic resources. On the other hand, there was an increase in land area of 3 km^2 in Nagari Sungai Nanam so that the amount of land ownership by the community could be maintained at 0.008 km/person while in other villages the average decreased by 0.001 km/person for 10 years. The highest decrease was found in Nagari Alahan Panjang which was caused by the highest population growth rate of 37.73%.

3.2 Land Use Dynamics

The dynamics of land use in Lembah Gumanti District were studied using two data sources, namely secondary data published by the Central Statistics Agency (BPS) Lembah Gumanti Valley in Figures 2010 and 2020 [7] and primary data from satellite image processing.

The results of secondary data processing from the publication of Lembah Gumanti in Figures are presented in Table 3. Total land use in 2010 covered an area of 45,672 Ha, while in 2020 it was 45,972 Ha. Thus there is an increase in the area of land used by 300 Ha.

Table 3 shows that in general there is a dynamic of land use which is characterized by the conversion activities. The grouping according to its designation into agriculture and non-agriculture shows that the allotment for agriculture for 10 years has increased by 1,715 ha or an increase of 6.20% compared to 2010. On the other hand, the area of land for non-agricultural purposes has decreased by 1,415 ha or by 7.87%.

In total, in all Lembah Gumanti Sub-districts during the last 10 years, there has been an increase in the area of land use with a total area of 300 hectares or about 0.66%. This dynamic is an accumulation of conversions for land use designations, thus the contribution can be in the form of additions or expansions but some have decreased. The decrease in land use occurred for paddy fields (56.81%), vacant land (6.65%), community forests (0.11%), dry land (100%), swamps (100%) and fish ponds (100%). The highest decrease of 100% occurred in the designation of dry land, swamps and fish ponds. Of the three dry lands, the change rate is very significant, namely 1,821 hectares, while the other two are swamps and fish ponds, because the land used since 2010 is relatively small.

The addition of land use for several purposes has increased with a very diverse range, starting from 2.17% to 154.22%. The most significant addition was for the designation of buildings and yards which was 154.22% or an area of 1,425 Ha, while the least addition was for the designation of state forest (2.17%) or an area of 433 Ha. The addition of area for field/huma designation in 2010 experienced a fairly high number of 1,634 Ha or an increase of 78.18% compared to its use in 2010, while the allotment for tegal/garden increased by 809 Ha or by 31.12% compared to the previous year 2010. The very high decrease in the area of vacant land that is not cultivated and other dry lands of 1,012 Ha and 1,821 Ha may be related to the addition of land area designated for buildings and yards. This assumption is supported by the population growth of 8,712 people, which of course requires additional housing and buildings for businesses.

Table 3 Land Use proportion 2010 – 2020 in Lembah Gumanti District

Land Use	**2010 (Ha)**	**2020 (Ha)**	**Change (Ha)**[**)]	**%**
Agriculture				
Rice field	2,042	882	-1,160	-56.81%
Garden	2,600	3,409	809	31.12%
Huma	2,090	3,724	1,634	78.18%
People forest	950	949	-1	-0.11%
State forest	20,000	20,433	433	2.17%
Plantation	0	0	0	-
Other dry land	1,821	0	-1,821	-100.00%
Total Agricultural Sector	27,682	29,397	1,715	6.00%
Non Agriculture				
Swamps	4	0	-4	-100.00%
Meadow	22	22	0	0.00%
Building	924	2,349	1,425	154.22%
Un-used	15,216	14,204	-1,012	-6.65%
Fish pond	3	0	-3	-100.00%
Number of non-agricultural sectors	**17,990**	**16,575**	**-1,415**	**-8.00%**
Total Number	45,672	45,972	300	0.66%

*) Source: Lembah Gumanti District in Figures for 2010 and 2020 [7]; **) A negative number indicates a reduction

To strengthen the data on the dynamics of land use that occurs, an analysis is also carried out by comparing it with satellite image data (Table 4). However, due to the limited data available, the satellite image data only shows 5 status allotments of use, namely, built up land, grasslands, rice fields, bodies of water and vegetation. The change in land use status is shown in Figures 4, 5 and 6.

Satellite image data from the five parameters in general shows a decrease in land use in the interval from 2000 to 2010 by 615 Ha or 2.55%, while between 2010 and 2020 the amount of land used is relatively the same. The changes occurred very small that is only 1 ha. Further detail analysis shows that the use of land for buildings has increased in a very significant number. The satellite image data is in line with the data published in Lembah Gumanti in the previous figure which reached 154.22%. Meanwhile, other land uses such as grasslands, paddy fields, bodies of water, and vegetation in the period 2000 to 2010 declined in the range between 105 Ha to 615 Ha. The highest decrease occurred in the allocation of water bodies, followed by the allocation of rice fields, vegetation and grasslands, as many as 615 Ha, 468 Ha and 105 Ha, and 237 Ha, respectively. In the period 2010 to 2020 the pattern of land use change is much different compared to 2000 to 2010. It was

recorded that only land for vegetation decreased by 2,506 hectares or around 17.90%, while the most significant change was 78.64% used for buildings.

Comparing data obtained from Lembah Gumanti District in Figures and satellite imagery, shows different in the status of the designation. The differences in the data obtained from government agencies (secondary data) and satellite imagery have also been reported by several researchers [8; 9; 10]. In general, the land area that can be mapped by satellite imagery is smaller than the land area presented by secondary data. The secondary data published a figure of 45,972 Ha, while data from satellite imagery is only 23,470 Ha. Thus the data from the satellite imagery only maps about 51.05% compared to the secondary data.

Table 4 Land use in 2000, 2010 and 2020 based on satellite image data

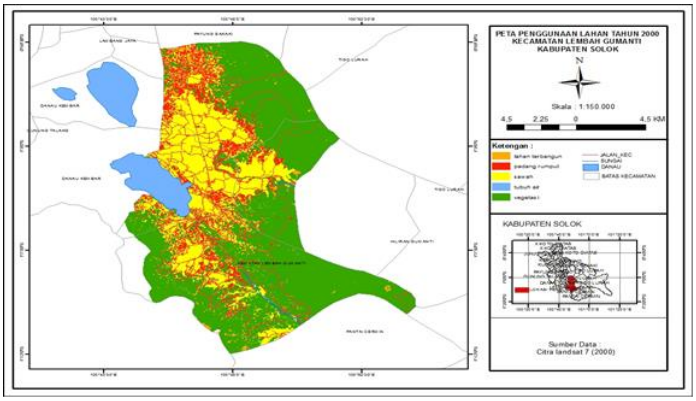
Land Use	Total Area (Ha)						
	2000	**2010**	**Change**	**%**	**2020**	**Change**	**%**
Building	861	1,671	810	94.08%	2,985	1,314	78.64%
Meadow	2,212	2,107	-105	-4.75%	2,464	357	16.94%
Rice field	6,171	5,703	-468	-7.58%	6,534	831	14.57%
Water body	622	7	-615	-98.87%	10	3	42.86%
Vegetation	14,220	13,983	-237	-1.67%	11,477	-2,506	-17.92%
Amount	24,086	23,471	-615	-2.55%	23,470	-1	0.00%

Source: Primary data processed by satellite image

The difference in data acquisition occurs because the data mapped by satellite imagery is more general than the data obtained from secondary data. Several parameters such as forest, grass fields, rice in wet and dry land, as well as gardens and horticultural crops cannot be distinguished specifically because the parameters are only based on vegetation indicators [9]. Another drawback can be caused by weather conditions when taking satellite images. Cloudy weather will cause the captured image to be unrealistic and can be a source of bias in the resulting area figures. However, it should be kept in mind that the actual satellite image data more accurately describes the actual real conditions by using the variable criteria set previously, if the weather conditions are really ideal. On the other hand, secondary data collected by governmental agencies also has a large potential for bias, because the data is obtained based on a sampling of personal confessions and respondents and often has the possibility of "political" interests. Continuity of data collection may also be a contributor to the difference between the numbers produced by those two methods, in addition to differences in variables and other sampling methodologies. Although the data displayed in the two methods above are different, the information provided brings the same conclusion, where changes in land use status in the same aspect remain consistent between the two data used.

The dynamics of land use which includes the addition, reduction and conversion of allotment of use is a natural occurrence in a residential location. The need for additional space for residence, business and various activities has even occurred since the existence of humans on the earth's surface. In this study, there was an increase in the area allocated to the agricultural sector by 1,715 Ha or about 6.20%, while the non-agricultural sector decreased in land area by 1,415 Ha or (7.87%) and an increase in land use area of 300 Ha for 10 years.

The increase in land use for the agricultural activities and the decrease in land use for the non-agricultural sector seem to be a natural necessary in order to meet the needs of housing and economic activity. This is quite reasonable if it is related to the population growth in Lembah Gumanti Subdistrict for the last 10 years by 8,712 people (16.98%) or an average of 1.698% per year. In this regard, of course, it is necessary to ask questions, how far this population growth can still be supported by the availability of available land. Is the change in land use able to contribute to improving welfare? To answer this question, it is necessary to study the impact of land use on the income of the community.



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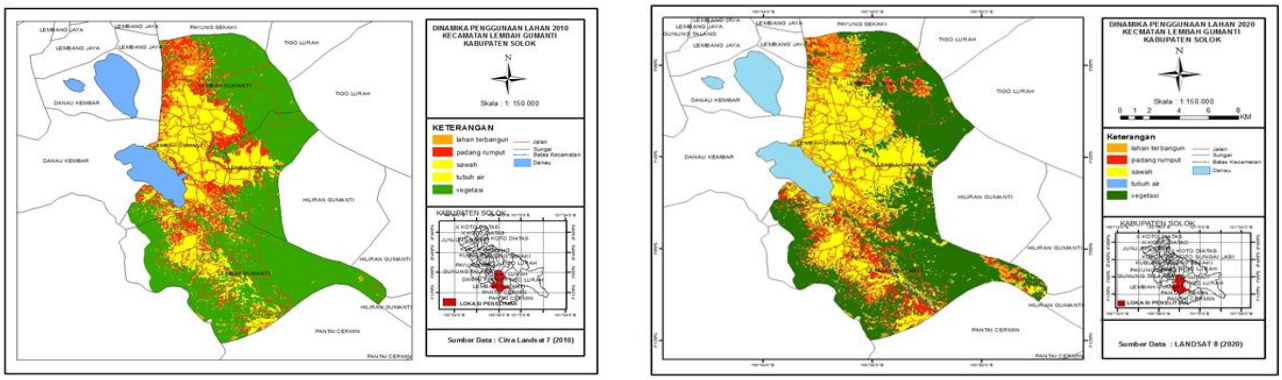


B C

Figure 1 Land use map change in 2000 (A), 2010 (B) and 2020 (C) based on satellite image

3.3 Impact of Land Conversion on Income

Table 5 shows an increase in food crop production from 2000 to 2010 by 295.91%, but between 2010 and 2020 there was a decrease of 49.31%. Production of vegetable crops in the range of 2000 to 2010 decreased by 97.13% but increased very rapidly in 2020 by 20199.60%. The same condition is of fruit crops, which in 2000 to 2010 increased by 807.37% and continued to increase until 2020 by 153.40%. For plantation crops, there was a decrease in production from 2000 to 2010 by 19.03% and continued to decline between 2010 and 2020 by 15.24%. These data indicate that there is a change in the orientation of the types of crops being cultivated. In 2000 the vegetable crops cultivation was the most dominating amount, so in 2010 the food crop cultivation was the dominant one. In the range of 2010 to 2020, the growth of production of food crops and plantations had a negative growth, while the growth of production of vegetable crops increased very rapidly and was followed by the production of fruit crops.

To see the impact of changes in land use on income, an analysis was carried out on the total production of agricultural products in the Lembah Gumanti District. Unfortunately, in 2000 and 2010, not all data on agricultural product production were available, so it was as if some agricultural commodities were not produced in the second span of the year. In addition, exact data on the components of the selling price at the farm level for each commodity are also not fully available, so the selling price at the producer farm level is taken based on the estimated national average price. The production value is obtained by multiplying the total production by the selling price per kg of product. The results of processing income data including the average income per Farmer Household in the three analyzed years are presented in Table 5 and Figure 2.

Table 5 Production of agricultural commodities, price per Kg, production value and total income obtained by the community during 2000, 2010 and 2020

Year												
	2000				2010				2020			
Commodities	Production (ton)*)	Price/Kg (Rp.)**)	Production value (Rp.)***)	Income (Rp.)****)	Production (ton)*)	Price/Kg (Rp.)**)	Production value (Rp.)***)	Income (Rp.)****)	Production (ton)*)	Price/Kg (Rp.)**)	Production value (Rp.)***)	Income (Rp.)****)
Food Crop												
Paddy	1,452.00	981.52	1,425,167,040.00	423,987,194.40	3,040.10	3,547.93	10,786,061,993.00	3,208,853,442.92	5,819.60	5,566.61	32,395,443,556.00	9,637,644,457.91
Corn	177.00	1.028.65	182,071,050.00	54,166,137.38	0.00	2,933.00	0.00	0.00	81.90	3,800.00	311,220,000.00	92,587,950.00
Cassava	367.00	421.00	154,507,000.00	45,965,832.50	539.60	1,928.00	1,040,348,800.00	309,503,768.00	594.00	2,600.00	1,544,400,000.00	459,459,000.00
Sweet Potato	1,467.00	610.19	895,148,730.00	266,306,747.18	10,130.80	2,611.74	26,459,015,592.00	7,871,557,138.62	454.20	3,900.00	1,771,380,000.00	526,985,550.00
Vegetable												
Onion	0.00	0.00	0.00	0.00	751.00	11,757.00	8,829,507,000.00	2,771,582,247.30	72,292.10	16,125.00	1,165,710,112,500.00	365,916,404,313.75
Garlic	0.00	0.00	0.00	0.00	0.00	12,278.00	0.00	0.00	158.60	26,568.00	4,213,684,800.00	1,322,675,658.72
Cabbage	27,858.00	1,250.00	34,822,500,000.00	10,930,782,750.00	66.00	2,000.00	132,000,000.00	41,434,800.00	47,310.20	3,500.00	165,585,700,000.00	51,977,351,230.00
Red Chilli	965.00	5,860.00	5,654,900,000.00	1,775,073,110.00	262.50	16,343.00	4,290,037,500.00	1,346,642,771.25	16,719.90	34,533.33	577,393,824,267.00	181,243,921,437.41
Cayenne Pepper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	205.90	27,583.34	5,679,409,706.00	1,782,766,706.71
Spring Onion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,764.40	17,525.00	65,971,110,000.00	20,708,331,429.00
Tomatoe	1,319.00	4,225.67	5,573,658,730.00	1,749,571,475.35	77.00	6,776.01	521,752,770.00	163,778,194.50	53,235.10	8,645.79	460,259,495,229.00	144,475,455,552.38
Potatoe	10,182.00	7,565.35	77,030,393,700.00	24,179,840,582.43	0.00	0.00	0.00	0.00	29,521.30	15,598.00	460,473,237,400.00	144,542,549,219.86
Carrot	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10,632.20	11,667.00	124,045,877,400.00	38,938,000,915.86
Fruits												
Avocado	0.00	0.00	0.00	0.00	137.00	20,000.00	2,740,000,000.00	1,480,970,000.00	1,744.00	28,500.00	49,704,000,000.00	26,865,012,000.00

Banana	33.93	2,190.00	74,306,700.00	40,162,771.35	293.70	4,961.00	1,457,045,700.00	787,533,200.85	107.20	8,250.00	884,400,000.00	478,018,200.00
Passion Fruit	7.93	11,528.00	91,417,040.00	49,410,910.12	328.50	22,000.00	7,227,000,000.00	3,906,193,500.00	0.00		0.00	0.00
Guava	2.43	6,573.00	15,972,390.00	8,633,076.80	0.00	0.00	0.00	0.00	9.90	13,850.00	137,115,000.00	74,110,657.50
Orange	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	53.50	9,327.35	499,013,225.00	269,716,648.11
Jackfruit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10	18,900.00	115,290,000.00	62,314,245.00
Papaya	4.58	1,500.00	6,870,000.00	3,713,235.00	0.00	0.00	0.00	0.00	3.10	3,000.00	9,300,000.00	5,026,650.00
Dutch Eggplant	34.80	15,000.00	522,000,000.00	282,141,000.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
Plantation												
Cinnamon	190.00	45,000.00	8,550,000,000.00	3,131,865,000.00	334.56	65,000.00	21,746,400,000.00	7,965,706,320.00	0.00		0.00	0.00
Sugarcane	0.00	0.00	0.00	0.00	156.98	546.00	85,711,080.00	31,395,968.60	196.00	865.00	169,540,000.00	62,102,502.00
Coffee	505.00	10.350,00	5,226,750,000.00	1,914,558,525.00	110.03	14,217.00	1,564,296,510.00	573,001,811.61	313.00	22,611.00	7,077,243,000.00	2,592,394,110.90
Clove	0.00	0,00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	58,000.00	52,200,000.00	19,120,860.00
Rubber	45.00	28.500,00	1,282,500,000.00	469,779,750.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
Coconut	3.00	3.100,00	9,300,000.00	3,406,590.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
Jumlah			141,517,462,380.00	45,329,364,687.49			86,879,176,945.00	30,458,153,163.66			3,124,002,996,083.00	992,051,949,295.12
Average Income /Farmer's Household				3,007,122.51				2,020,575.37				65,812,123.48
Average Income /Non Farmer's Household /Month				250,593.54				168,381.28				5,484,343.62

*) Production value is processed from BPS data and Lembah Gumanti District in Figures [7]; **) Price / kg is determined based on the market price in each year; ***) Production value is the rupiah value of each commodity x price per kg of each plant x 100; ***) Income is obtained by multiplying the Production Value by the R/C Ratio of each agricultural product which is determined from the average of each commodity group

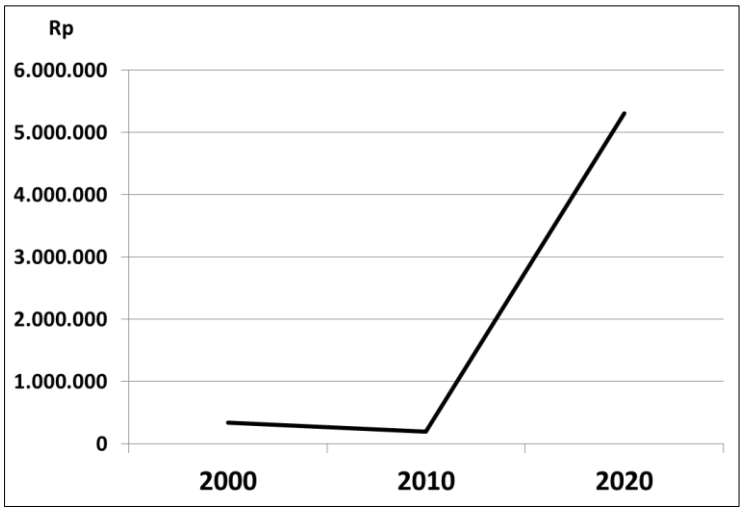


Figure 2 Average monthly income of farmers' households in the years 2000, 2010 and 2020

The increase in the average household income of farmers over the three time points shows a fairly large dynamic. In the period from 2000 to 2010 there was a decline in farmer household income by 43%. Meanwhile, in the period from 2010 to 2020, the income of farmer households increased in a very significant number, up to 2.646%.

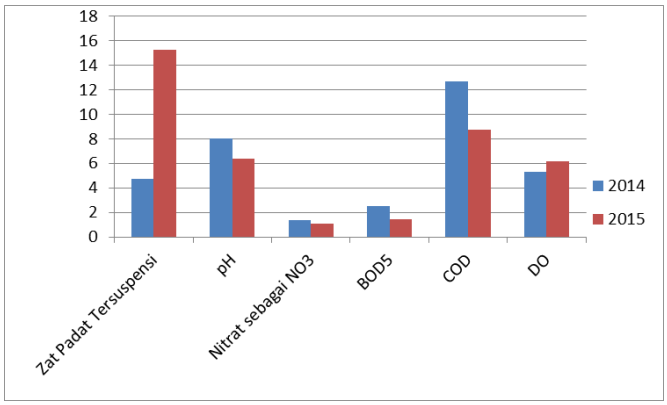
The data in Figure 2 and Table 5 are interesting to observe in terms of land use dynamics. Changes in land use in the agricultural sector increased in area of 1715 Ha which came from the conversion of other land use allocations to the agricultural sector and an additional 300 Ha of new land use. The increase in land use for the agricultural sector by 1,715 ha succeeded in increasing the average income of a farmer's household from Rp. 168,381,28,- per month to Rp. 5,484,343.62,- per month or around 2.646%. Thus, the increase in household income per year is Rp. 531,596.234 in average. However, the results of this calculation still need further scrutiny. Whether it is claimed that the figures achieved are a direct result of the expansion of land for agriculture or there are other factors that have contributed to the increase in these figures, a more analytical study should be undertaken. Some of the possibilities for this very large income difference could be the result of several factors, including i). The unrepresentative data of agricultural production in 2010. This unrepresentativeness may be caused by incomplete documentation of data recording both types of commodities and the amount of production produced by each agricultural commodity in 2010, as well as in 2000. ii). Indeed, there will be an increase in the price of agricultural commodity prices in 2022. In Table 5, the average increase in the price of agricultural commodities is 58.8%. Although the price increase is not so significant as a contributor to the increase in income, it is likely that these factors have played a role.

3.4 The Impact of Land Use on the Status of the Waters of Danau Diatas

The analysis of the impact of land use on environmental status was studied using data on trends in changes in the physical and chemical properties of Danau Diatas and the general health status of the community in Lembah Gumanti District. Unfortunately, detailed data every year on the two groups of variables is not available. Changes in the physical and chemical properties of the above lake conditions therefore can only be analyzed using 2014-2015 data published by the West Sumatra Provincial Environment Agency [11]. The data on the status of the physical and chemical properties obtained are shown in Figure 3. Figure 3 shows that of the 9 observed parameters, 3 parameters, namely suspended solids and coliform content, increased very significantly, while the DO value increased but not significantly. Six parameters namely pH value, Nitrate as NO_3, BOD5 and COD, ammonia as N and Phosphate as P decreased.

The increase in the amount of suspended solids or also known as total suspended solids (TSS) in 2015 reached 221% compared to 2014. The amount of suspended solids describes solid particles originating from land which can be in form of particles (soil, mud or sand) carried by erosion including also the number of microorganisms (plankton). Increasing the TSS value will have consequences on the amount of sunlight penetration needed by flora and fauna below the water surface [12], 2010). Reports in 2019 by a media had published the phenomenon of the waters of Danau Diatas which was cloudy and smelly which lasted for more than 2 months [13]. However, the worrying parameter is the coliform content which has increased by more than 285%, from only 14 MPN per 100 ml to 53.95 MPN per 100 ml. This value has exceeded the normal threshold (ABN) for water quality in accordance with the provisions in the Minister of Health of the Republic of Indonesia Number 32 of 2017 which is 50/100 ml. The high coliform content in 2015 indicates the impact of accumulation received by Danau Diatas due to increased human activities both in land use such as the use of

fertilizers, organic waste flowing through rivers, as well as other human activities such as the disposal of organic waste and feces produced by humans [14].



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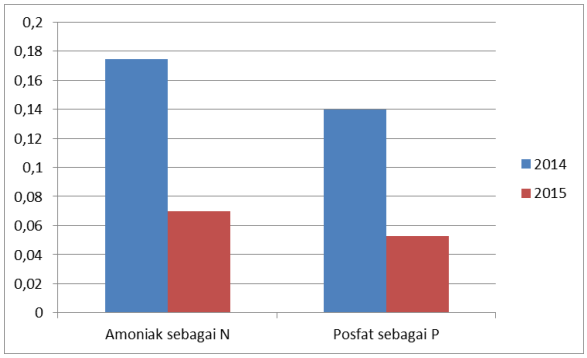

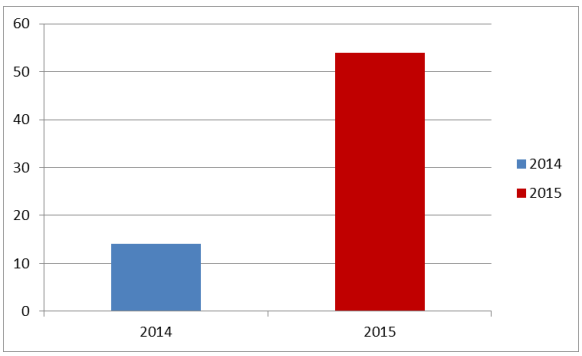

B C

Figure 3 The dynamics of physical and chemical properties of the waters of Danau Diatas, in 2014 and 2015. Panel A; parameters of Suspended Solids, pH, Nitrate as NO_3, BOD5, COD, and DO. Panel B: ammonia content as N, Phosphate as P and Panel C, Dynamics of coliform content

Parameters indicating the health of waters that are also interesting to study are the content of nitrates and phosphates. Nitrates and phosphates are a source of nutrients used by diatoms and plankton (phytoplankton and zooplankton), which serve as food for larger lake biota such as fish and others and at the same time become an indicator of the fertility of a waters [15]. In 2014, the nitrate content in Danau Diatas reached 0.17 mg/L, while in 2015 it was 0.07 mg/L or decreased by 60% in just 1 year. Thus, the fertility level of the waters of Danau Diatas has decreased from the oligotropic group (weak fertility) to worse condition according to the criteria proposed by [16]. The same pattern was also found for the phosphate content, which decreased even to 62% from 0.14 mg/L (low fertility) to 0.05 mg/L in 2015. These two parameters indicate a tendency to worsen the fertility of the waters of Danau Diatas. Additionally, community health status in the area should be considered as serious concern. Reported by [5] that 62,7%) vegetable farmer sprayer in the area have experienced the neurotoxic symptom. However, more comprehensive and representative data is needed to support this claim. A more systematic study over a time span of at least 5 years may provide a more valid picture of water conditions as a result of land use change in Lembah Gumanti district.

4 Conclusion

- In the range of 2010 to 2020 there was a change (conversion) of land use for the agricultural sector of 1,715 Ha or 6% of the total cultivated land, while the addition of land area reached 300 Ha or 0.66%.
- The change in land use is proven to have an increasing impact on the average income of farmers which reaches 2.646% or with an average value of an increase in income of Rp. 531,596, 234 annually.
- On the other hand, changes in land use have an impact on decreasing public health and environmental quality which is characterized by a decrease in water quality in Lake Above as an accumulation zone of the impact of agricultural activities in the area above it.

Compliance with ethical standards

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Disclosure of conflict of interest.

All authors declare that there is no conflicts of interest in this manuscript.

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