

Study of Land Use Change from 1997 To 2014 Using Landsat Data In Bangli Regency

Nuranita Naningsi ^{a*}, Takahiro Osawa ^{b,c}, I Nyoman Merit ^a

^a Graduate Study of Environmental Sciences, Udayana University, Denpasar, Bali 80232, Indonesia

^b Graduate School of Science and Engineering, Yamaguchi University, Ube Shi Tokiwadai 2-16-1, 7550092, Japan

^c Center for Remote Sensing and Ocean Sciences (CReSOS), Udayana University, PB Sudirman Street, Denpasar, Bali 80232, Indonesia

* Correspondence: nuranitananingsi@yahoo.co.id

Received: 7 Februari 2018; Accepted: 30 November 2018; Available online: 1 Desember 2018

Abstract

Bangli Regency is one of Regency in the Bali Province. The total area of Bangli Regency is 52,081 hectares (9.24%) of total area of Bali Province (563,666 ha). The Growth and the development of the region Bangli Regency the positive impacts on the economy of the community, and the negative impacts on the environment. Land use change is one of the negative issue of development Bangli Regency. This study conduted the calculation of land use change from 1997 to 2014 using Landsat data in Bangli Regency. Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI/TIRS imageries were used to determine the land use map based, on using supervised classification method. The field data set the nine classes were classtuded based, on the classification were fresh water, bare land, forest, residential, bushes, irrigated paddy field, non irrigated paddy field, dry land and plantation. There results showed in land use changes from 1997 to 2014 that plantation increased (19,486.33 ha (36.89%)), and residential increased (1,872.00 ha (3.47%)), there is also a vast to reduction in dry land (-10,868.90 ha (-21.21%)), forest (-6,333.34 ha (-12.24%)), irrigated paddy field (-1,619.50 ha (-3.17%)), bushes (-1,637.30 ha (-3.27%)), bare land (-63.00 ha (-0.17%)), non irrigated paddy field (-113.59 ha (-0.26%)) and fresh water (-2.70 ha (-0.05%)). The results accuracy rate was 89.45%. Anlyse of land use showed that the significant decrease of plantation area in Bangli Regency hill due to rapid development of infrastruture of tourism and extensive residential area has increased particularly in sub district of the Kintamani District.

Keywords: *land use change; landsat data; supervised classification.*

1. Introduction

Along with the development of ever increasing population, the need for land to be used as residential and agricultural land so plantations perceived increasing as well. This causes the land conversions, both from agricultural land into residential areas or of forests into plantations and Agriculture (As-syakur et al., 2011). Land use is the end result of any form of intervention human activities to land on the earth's surface that is dynamic and serves to meet the needs of both material and spiritual life according to (Arsyad, 1989).

Bangli Regency is a regency on Bali the area is a plateau, it affects the activity of the population and population density. This activity led to the forest population metamorphoses into agricultural land, both legally and illegally (As-syakur, 2011). The impact of land use change from forest to non-forest and to non- agricultural already benefit both socially and economically (Tang, 2005).

Looking at the above conditions, the need for a strategic and solution for the management classification of land use synergies in accordance with the characteristics of the region. For this study was conducted to find the public perception in the preservation of land use in Bangli Regency using Landsat data.

2. Research Method

2.1 Research Location

This research was conducted in Bangli Regency. It is located in between 808'30 " until 8031'87 " South latitude and between 115027'48 " until 115027'24" east longitude, with an area of 52.081 Ha or 9.25% of the total area of Bali Province (563.666 ha). Bangli Regency has 4 Regional District and 72 villages/wards. Administratively, the study area is at the boundaries of the following: (1) northern part of Buleleng Regency, (2) the eastern part of Karangasem Regency, (3) southern part of Klungkung Regency and, (4) western part of Gianyar Regency and Badung Regency. The study was conducted in Bangli Regency. Location of the study is showed in Figure 1.

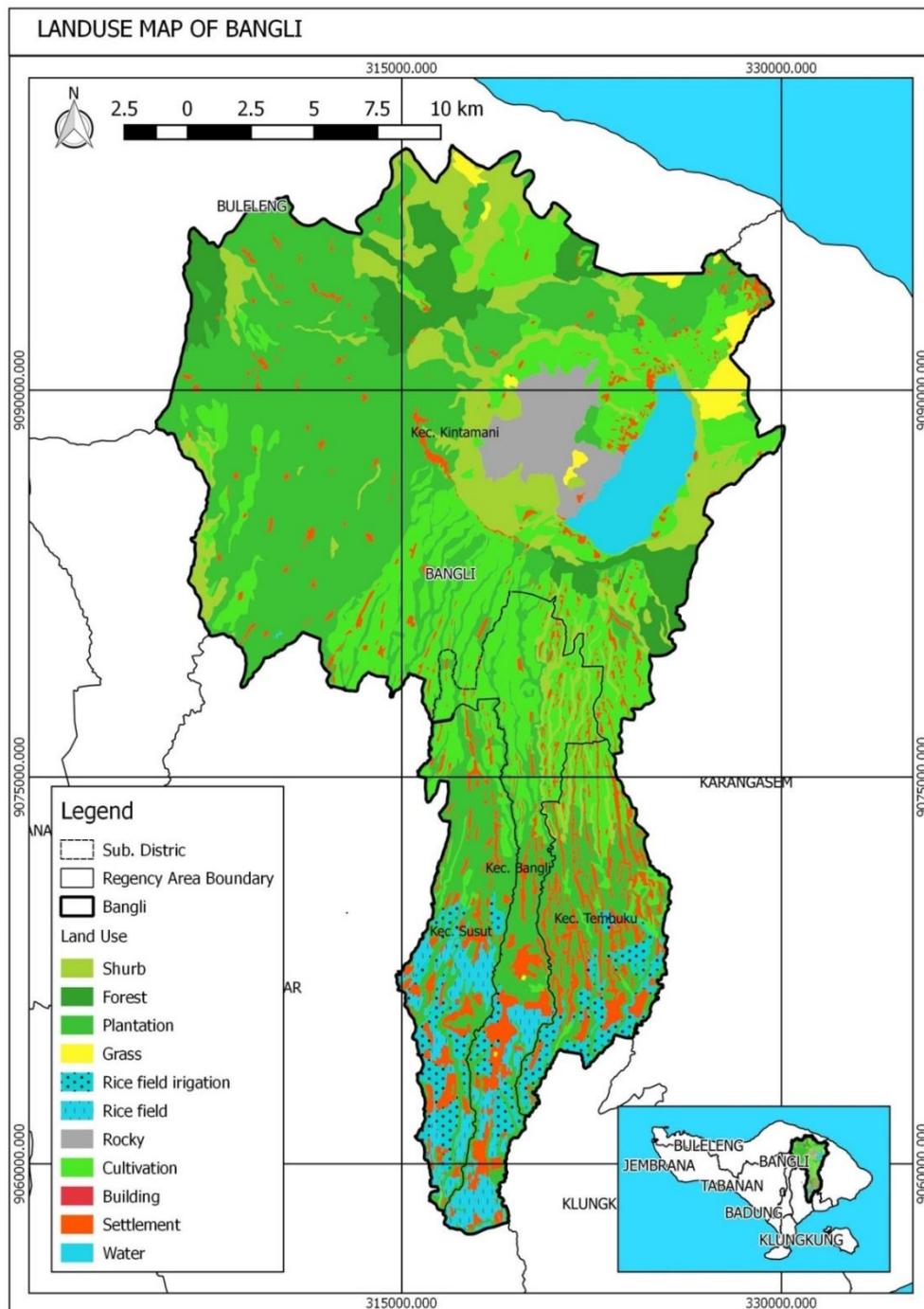


Figure 1. Research Location (RTRW, 2009)

The interpretation of satellite imageries conducted to get land use map. Its took a few step to get land use map, namely: 1). Downloaded Landsat 5 TM imageries acquisition August 19th 1997, Landsat 7 ETM+ imageries acquisition March 21st 2003 and Landsat 8 OLI/TIRS imageries acquisition of July 17th 2014, path 116 row 66 from USGS; 2). Geometric is ageographic position associated with the spatial distribution (spatial distribution); 3). Convert DN value of Landsat Imageries into reflectance value of the surface (radiometric correction); 4). Cropped Landsat Imageries; 5). Created composite RGB of Landsat imageries; and 6). Landsat imageries classification used supervised with maximum llikelihood method.

2.2 Research Scope

This study is about the process of land use changes, includes fresh water, bare land, residential, bushes, irrigated paddy field, non irrigate paddy field, dry land and plantation during 1997- 2014.

2.3 Land Cover Change detection

Landsat data in 1997, 2003 and 2014 were classified the land use by supervise classification with maximum likelihood method to particular nine catelogies, namely : fresh water, bare land, residential, bushes, irrigated paddy field, non irrigated paddy field, dry land and plantation.

2.4 Concept of Research

The concept of research the study is as follows:

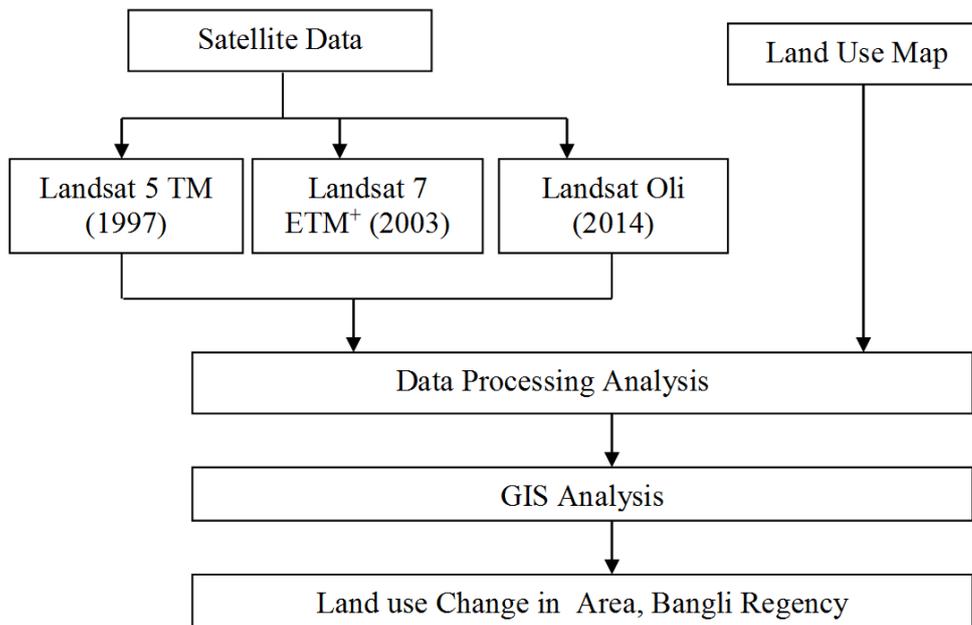


Figure 2. Framework of Research

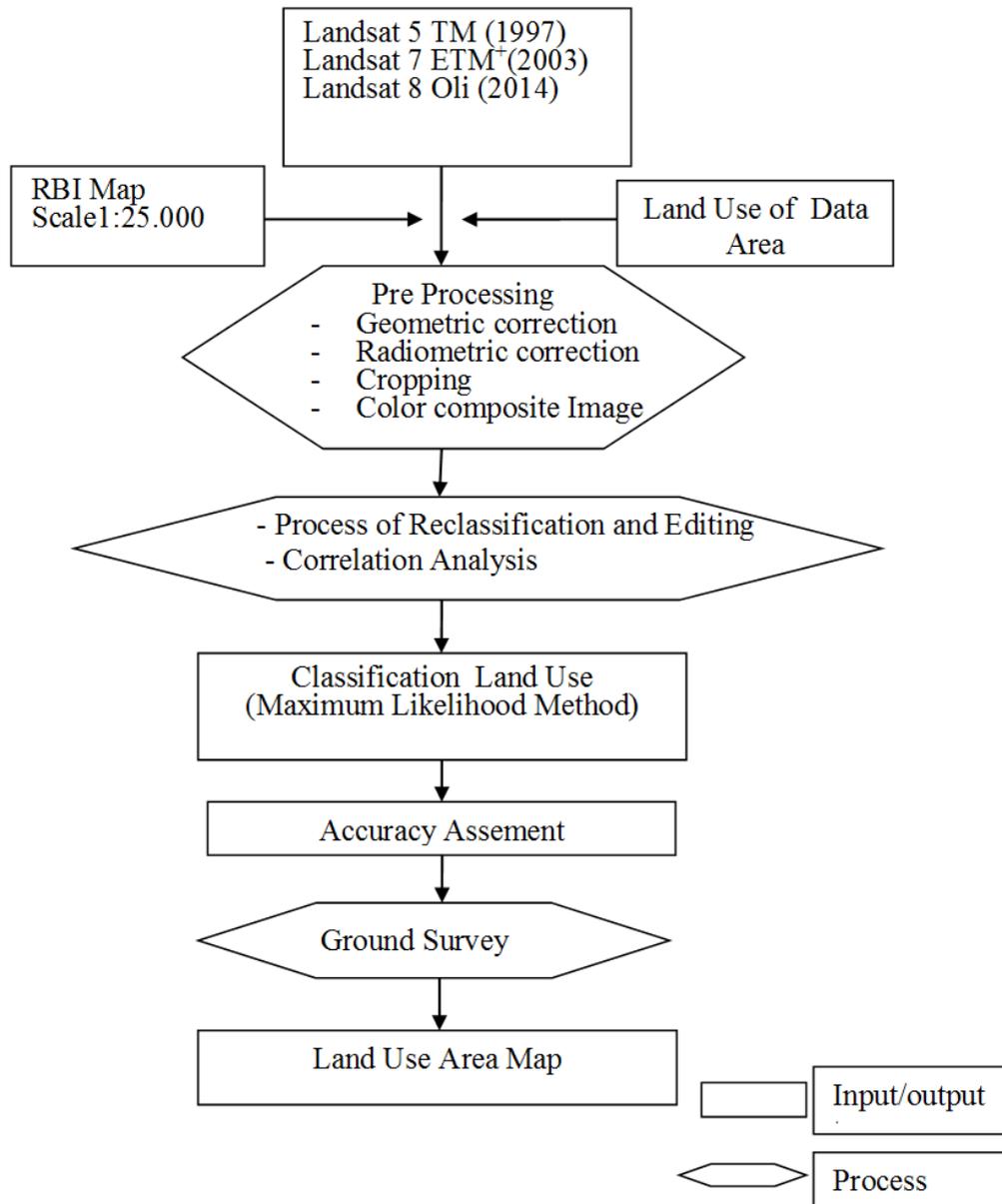


Figure 3. Research procedure

3. Result and Discussion

3.1 Land Use Change detection

The classification results in research location Bangli regency in 1997, 2003 and 2014 with nine categories including fresh water, bare land, residential, bushes, irrigated paddy field, non irrigated paddy field, dry land and plantation land are shown Figure 4.

The total area of Bangli Regency is 52.080.00 ha. Inside, the land use classification for 1997 (figure 3 - a) showed that majority of the study area was fresh water accounting for 1,697.57 ha (3.26%), bare land 1,972.00 ha (3.79%), forest 9,303.34 ha (17.86%), residential 2,702.84 ha (5.19%), bushes 6,277.21 ha (12.05%), irrigated paddy field 3,963.01 ha (7.61%), non irrigated paddy field 1,698.01 ha (3.26%), dry land 23,821.91 ha (45.74%), and plantation 644.11 ha (1.04%) respectively (Table 1).

Land use area and percent coverage for 2003 (figure 3 - b) show that fresh water 1,701.17 ha (3.27%), bare land 1,873.00 ha (3.60%), forest 2,970.51 ha (5.70%), residential 4,474.84 ha (8.59%), bushes 4,648.11 ha (8.92%), irrigated paddy field 2,583.51 ha (4.96%), non irrigated paddy field 1,082.31 ha (2.08%), dry land 13,534.71 ha (25.99%), and plantation 19,211.84 ha (36.89%) respectively (Table 1).

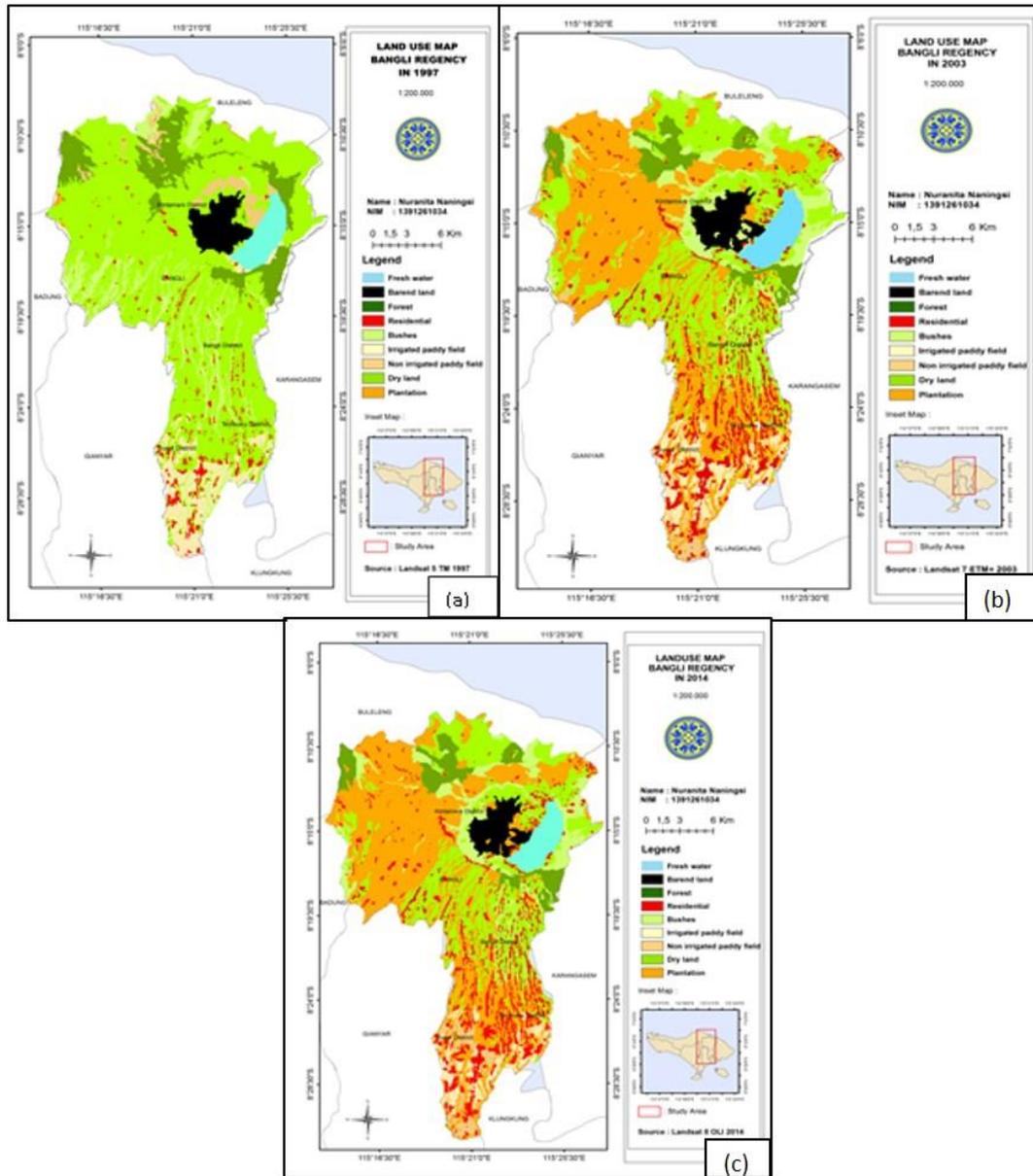


Figure 4. Land Use Map Bangli Regency in 1997 (a), 2003 (b) and 2014 (c)

Land use area and percent coverage for 2014 (figure 3 - c) also shows that fresh water 1,694.87 ha (3.25%), bare land 1,909.00 ha (3.67%), forest 2,970.00 ha (5.70%), residential 4,574.84 ha (8.66%), bushes 4,639.91 ha (8.79%), irrigated paddy field 2,343.51 ha (4.44%), non irrigated paddy field 1,584.42 ha (3.00%), dry land 12,953.01 ha (24.53%), and plantation 20,130.44 ha (38.13%) respectively Table 1. Most portion of the land use class was during this period.

Figure 5 showed land use change from 1997 to 2014. The conjunction (Table 1) showed the total amount of fresh water in 1997 was 1,697.57 ha or covered 3.26% of the total study area. However, this land use category was increased to 1,701.17 ha (3.27%) in 2003 continued to reduce to 1,694.87 ha (3.25%) in 2014.

During 1997 – 2014 in Bangli regency land use change detection (Table 2) shows the total area of Bangli regency is 52,080.00 ha. shows the total area of Bangli Regency is 52,080.00 ha. The percentages of land use change for 1997 - 2003 are fresh water (3.60 ha (0.01%)), bare land (-99.00 ha (-0.19%)), forest (-6,332.83 ha (-12.16%)), residential (1,772.00 ha (3.40%)), bushes (-177.69 ha (-3.13%)), irrigated paddy field (-1,379.50 ha (-2.65%)), non irrigated paddy field (-64.29 ha (-1.18%)), dry land (-10,287.20 ha (-19.75%)), and plantation (18,567.73 ha (35.65%)).

Table 1. Land Use classes, area and percent coverage change in Bangli Regency from 1997 to 2014

No	Class name	1997		2003		2014	
		ha	%	ha	%	ha	%
1	Fresh water	1,697.57	3.26	1,701.17	3.27	1,694.87	3.25
2	Bare land	1,972.00	3.79	1,873.00	3.60	1,909.00	3.67
3	Forest	9,303.34	17.86	2,970.51	5.70	2,970.00	5.70
4	Residential	2,702.84	5.19	4,474.84	8.59	4,574.84	8.66
5	Bushes	6,277.21	12.05	4,648.11	8.92	4,639.91	8.79
6	Irrigated paddy field	3,963.01	7.61	2,583.51	4.96	2,343.51	4.44
7	Non irrigated paddy field	1,698.01	3.26	1,082.31	2.08	1,584.42	3.00
8	Dry land	23,821.91	45.74	13,534.71	25.99	12,953.01	24.53
9	Plantation	644.11	1.04	19,211.84	36.89	20,130.44	38.13
	Total Area	52,080.00	100.00	52,080.00	100.00	52,080.00	100.00

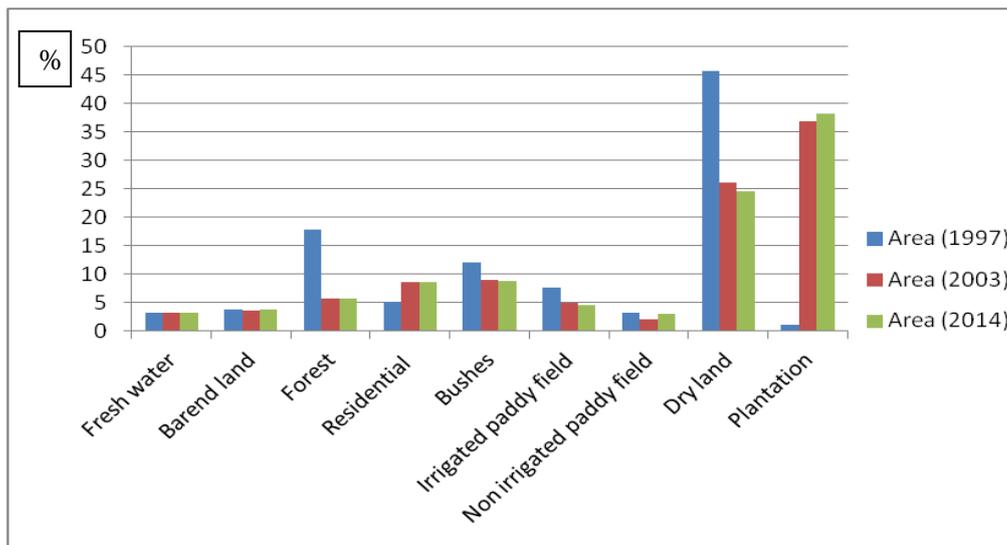


Figure 5. indicated land use change detection in Bangli Regency from 1997 – 2014 is represented Table 1 data

The are percentages of land use change for 2003-2014 are fresh water (-6.30 ha (-0.06%)), bare land (36.00 ha (0.02%)), forest (-0.51 ha (-0.08%)), residential (100.00 ha (0.07%)), bushes (-8.20 ha (-0.14%)), irrigated paddy field (-240.00 ha (-0.52%)), non irrigated paddy field (502.11 ha (0.92%)), dry land (-581.70 ha (-1.46%)), and plantation (918.90 ha (1.24%)). Most portion of the land use change class was during this period.

The are percentages of land use change for 1997-2014 are fresh water (-2.70 ha(-0.05%)), bare land (-63.00 ha (-0.17%)), forest (-6.333.34 ha (-12.24%)), residential (1,872.00 ha (3.47%)), bushes (-1,637.30 ha (-3.27%)), irrigated paddy field (-1,619.50 ha (-3.17%)), non irrigated paddy field (-113.59 ha (-0.26%)), dry land (-10,868.90 ha (-21.21%)), and plantation (19,486.33 ha (36.89%)). Most portion of the land use change class was during this period.

In the whole period, within 17 years from 1997 to 2014, the total increase in a value of residential reached 3.47 % (1,872.00 ha). At the same time, dry land decrease about -21.21 % (-10,868.90 ha). Fresh water decreased by -0,05 % (-2.70 ha). Overall it can be concluded that within 17 years there was an increase of residential of 3.47 % coupled

with the reduction of dry land by -21.21 %. There was a difference in value between the dry land and residential by 17.74 %. The difference was caused by the change of dry land into fresh water.

Table 2. Land Use change , area and percent coverage change in Bangli Regency from 1997 to 2014

No	Class name	Land Use Change 1997-2003		Land Use Change 2003-2014		Land Use Change 1997-2014	
		ha	%	ha	%	ha	%
1	Fresh water	3.60	0.01	-6.30	-0.06	-2.70	-0.05
2	Bare land	-99.00	-0.19	36.00	0.02	-63.00	-0.17
3	Forest	-6,332.83	-12.16	-0.51	-0.08	-6,333.34	-12.24
4	Residential	1,772.00	3.40	100.00	0.07	1,872.00	3.47
5	Bushes	-177.69	-3.13	-8.20	-0.14	-1,637.30	-3.27
6	Irrigated paddy Field	-1,379.50	-2.65	-240.00	-0.52	-1,619.50	-3.17
7	Non irrigated paddy field	-64.29	-1.18	502.11	0.92	-113.59	-0.26
8	Dry land	-10,287.20	-19.75	-581.70	-1.46	-	-21.21
9	Plantation	18,567.73	35.65	918.90	1.24	19,486.33	36.89

Spatial changes in land use of Bangli Regency is increasing the area of the residential and plantation followed a reduced area of the dry land and irrigated paddy field, as well as the type of forest land use into plantation. Land use map of Bangli in 1997, 2003 and 2014 is shown in Figure 5.5.

Land use change in Bangli Regency mostly due to increasing in population and also due to increased economic growth (As-syakur, 2011). According to the Central Bureau of Statistics of Bangli Regency (2009), Bangli Regency grew as many as 213,823 people during the years from 2003 to 2008. The structure of the economy of a region describes how big the reliance area against the ability of the production of each sector of the economy. During the period 2004 – 2008 the economic structure is not much experienced a shift, with the support of tourism sector of tertiary accounted for of 51.16% and in 2008 decline when in compare in 2004 its contribution amounted to 51.70%. Although this sector is highly vulnerable to a wide range of issues.

Land use change is one of the phenomena that occur in a lively enough land use. It is given the higher and increasing pressure needs and the demand for land, both from the agricultural sector as well as from nonagricultural sector result population and development Activities (Nuarsa et al., 2018). Bangli Regency is Regency in the Bali Province who experienced the phenomenon of land use Changde (As-syakur, 2011). The Provincial Government has made local Spatial Plan Area about the rules of use of space, including the anticipation towards the conversion of agricultural land. However, its implementation is still weak. Directional land logging and integrated It is followed by the preparation of policy strategies controlling land use change the holistic need immediate and comprehensive embodied. It is a time the accuracy of collection and the presentation of data so the attention of the parties concerned. In line with the decentralization and regional autonomy local government party, regional authorities should initiate the creation of a comprehensive map of the village of by involving several parties facilitated Government-NGO/LSM (Lembaga Swadaya Masyarakat) and while accompanied by an understanding of the importance of the supply of data and information.

4. Conclusion and Suggestion

4.1 Conclusion

1. Land use classification map in Bangli Regency was created in 1997, 2003 and 2014 with nine categories. Such as fresh water, bare land, forest, residential, bushes, irrigated paddy field, non irrigated paddy field, dry land, and plantation. Overall accuracy assessment in 2014, overall accuracy was 89.45%.
2. The total area of Bangli Regency is 52.080.00 ha. The land use, percent coverage for 1997 fresh water (3.26%), bare land (3.79%), forest (17.86%), residential (5.19%), bushes (12.05%), irrigated paddy field (7.61%), non irrigated paddy field (3.26%), dry land (45.74%), and plantation (1.04%). They are fresh water (3.27%), bare land (3.60%), forest (5.70%), residential (8.59%), bushes (8.92%), irrigated paddy field (4.96%), non irrigated paddy field (2.08%), dry land (25.99%), and plantation (36.89%) in percent coverage of 2003. Finally for 2014 are fresh water (3.25%), bare land (3.67%), forest (5.70%), residential (8.66%), bushes (8.79%), irrigated paddy field (4.44%), non irrigated paddy field (3.00%), dry land (24.53%), and plantation 38.13%. Most portion of the land use class was during this period.
3. During the period 1997 - 2014, the biggest change occurred in plantation reached 19,486.33 ha (36.89%). Subsequent changes occurred in the function of residential/urban growth increased 1,872.00 ha (3.47%). Besides the addition, there is also a vast reduction in dry land 10,868.90 ha (21.21%), in the forest area of 6,333.34 ha (12.24%), irrigated paddy field 1,619.50 ha (3.17%), bushes 1,637.30 ha (3.27%), bare land 63.00 ha (0.17%), non irrigated paddy fields 113.59 ha (0.26%) and fresh water 2.70 ha (0.05%).

4.2 Suggestion

1. For researchers, the use of Landsat image as a source of data in order to make the Land use areas. Image interpretation technique can give sufficient information about the extent of the area, because the accuracy that obtained is good enough.
2. It is needed to carry out further research using a new image to compare the accuracy obtained and the changes land use areas and to compare the land use change and correlation analysis.

References

- Arsyad, S. (1989). *Soil and Water conservation*. Bogor, Indonesia: IPB Press.
- As-syakur, A. R. (2011). Perubahan penggunaan lahan di Provinsi Bali. *ECOTROPIC: Jurnal Ilmu Lingkungan*, **6**(1), 1-7.
- As-syakur, A. R., Suarna, I. W., Adnyana, I. S., Rusna, I. W., Laksmiwati, I. A., & Diara, I. W. (2010). Studi perubahan penggunaan lahan di DAS Badung. *Bumi Lestari Journal of Environment*, **10**(2), 200-207.
- Central Bureau of Statistics of Bangli Regency. (2009). *Bangli Regency in Figures 2009*. Bangli, Indonesia: Statistics Bangli Regency.
- Jensen, J. R. (2000). *Introductory Digital Image Processing: A Remote Sensing Perspective*. (2nd ed.). New Jersey, USA: Prentice Hall.
- Kalnay, E., & Cai, M. (2003). Impact of urbanization and land-use change on climate. *Nature*, **423**(6939), 528.
- Kodoatie, R., & Sjarief, R. (2005). *Integrated Water Resources Management*. Yogyakarta, Indonesia: Publisher Andi.
- Lillesand, T. M., & Kiefer, R. W. (1994). *Remote Sensing and Image Interpretation*. (3rd Edition). New York, USA: John Wiley and Sons.
- Lillesand, T. M., Kiefer, R. W., & Chipman, J. (2007). *Remote Sensing and Image Interpretation*. (6th Edition). New York, USA: John Wiley and Sons.
- Lillesand, T. M., Kiefer, R. W., (1990). *Remote Sensing and Image Interpretation* (2nd edition). Dalam Dulbari, Suharsono, P., mHartono, Suharyadi,. (Terj.), *Penginderaan jauh dan interpretasi citra*. Yogyakarta, Indonesia: Gadjah Mada University Press. (Buku asli diterbitkan 1998).

- Nuarsa, I. W., As-syakur, A. R., Gunadi, I. G. A., & Sukewijaya, I. M. (2018). Changes in Gross Primary Production (GPP) over the Past Two Decades Due to Land Use Conversion in a Tourism City. *ISPRS International Journal of Geo-Information*, **7**(2), 57.
- Tang, Z., Engel, B. A., Pijanowski, B. C., & Lim, K. J. (2005). Forecasting land use change and its environmental impact at a watershed scale. *Journal of environmental management*, **76**(1), 35-45.

© 2018 by the authors; licensee Udayana University, Indonesia. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (<http://creativecommons.org/licenses/by/4.0/>).