The conservation activities and land use changes in the upstream *Bedadung* watershed

J M Petrina*, F K Alfarisy, I Andriyani, L P Suciati

Department Management of Natural Resources and Environmental Science, University of Jember, Jl. Kalimantan No. 37 Kampus Bumi Tegalboto Sumbersari, 68121 Jember, East Java, Indonesia

*Email: jenitramilan@gmail.com

Abstract. *Bedadung* watershed is one of the largest watersheds in Jember Regency. The Bedadung watershed in upstream area is generally hilly with steep slopes, so it is prone to landslides and potential to erosion. The upstream area is a protected forest that functions as a water catchment area, turning into plantation and production forest to become the target of logging and deforestation. Conservation activities in the upstream watershed area is essential in the management of water resources. Natural resource management activities in the upstream area significantly affect the success of efforts to provide water and control water resources downstream damage. This study aimed to identify conservation activities in the upstream Bedadung watershed and the impact of changes in upstream land use on environmental damage. The conservation activities in the Jompo, Antrokan, Rempangan, and Rembangan Sub-watersheds is coffe plantation, cover crop, forestry, terrace, restoration, bush, grassland. The highest increase in land change in the four sub-watersged was irrigated land / field, while the decrease was non-irrigated land. The results of comparisons between the 2001 RBI map with the 2015 Landsat Image show an 8% forest loss and 7% increase in irrigated fields.

1. Introduction

The upstream area of the Bedadung watershed is generally hilly with steep slopes, making it prone to landslides and prone to erosion [1]. The upstream region of the Bedadung watershed occurs illegal logging of protection forest and conversion of forest plants around the Argopuro mountains into plantation crops such as coffee, cacao, and rubber [2]. The Argopuro Mountains as a protected forest are water catchment areas, turned into plantations and production forests, so they become targets of logging and deforestation [3].

The forest area in the upstream Bedadung watershed is only 93.16 km2 or 16.25% of the Bedadung watershed area [1], while according to Law no. 41 of 1999 concerning Forestry states that the minimum forest area in a watershed is 30% of the total area of the watershed. The impact of reduced forest land cover is erosion, flooding, and landslides [4]; Rohman [5] explained that the erosion value in the upstream Bedadung is 92.57 tonnes/ha / year. According to the Ministry of Forestry [6], the erosion value is included in the moderate erosion category. In 2016, the Regional Disaster Management Agency for Jember Regency has 17 sub-districts out of 31 sub-districts in Jember Regency, which are areas prone to floods and landslides during the rainy season. Upstream Bedadung is used as a hydrological function, namely water supply, absorption center, and conservation of water resources. The Bedadung watershed has a role in maintaining biodiversity, economic value, culture, transportation, and tourism

[7]. Activities carried out in the watershed area will affect water flow in the downstream area both in terms of quantity and quality. Land use that does not pay attention to conservation principles results in a decrease in environmental quality [8]. This study purpose (1) to identify conservation activities in the upstream Bedadung Watershed, and (2) to see the impact of land-use change in the upstream Bedadung Watershed Jember Regency East Java.

2. Materials and methods

2.1 Study of research

This research was conducted in a purposive manner in 4 (four) sub-watersheds, namely Jompo, Antrokan, Rempangan and Rembangan. The four sub-watersheds are children of the Bedadung watershed. The reason for choosing the four Sub DAS is because the location was part of the upstream Bedadung watershed and had experienced natural disasters of flash floods and landslides. The map of the research area is presented in Figure 1.

Figure 1. Map of Sub DAS Jompo, Antrokan, Rempangan, and Rembangan.

2.2 Data collection methods

The collection was carried out using the interview method with the help of a questionnaire. and Focus Group Discussion (FGD). The selection of respondents was done intentionally or purposive sampling. The selected respondents are people who are experts in providing information on conservation activities and management of the upstream Bedadung watershed.

2.3 Data analysis

The formulation of the first problem is to identify conservation activities carried out by communities in the upstream area, using descriptive analysis. Descriptive analysis is research conducted to determine the existence of a variable, either only in one or more variables, without making comparisons and looking for relationships between these variables and other variables [9]. Based on the interviews and the results of Focus Group Discussions (FGD) with respondents, then identification of soil and water conservation activities that have been carried out by the community around the upstream of the Bedadung watershed. The formulation of the second problem sees changes in land use in the Jompo, Antrokan, Rempangan sub-watershed, which is to use a comparison between the 2001 RBI map and 2015 Landsat imagery. GIS is an geographic information system designed to work with spatial data

sources [10]. Spatial data is data that has geographic coordinates. The software used is ArcGIS version 10.4.1

3. Results and discussion

3.1. Conservation Activities in the Jompo, Antrokan, Rempangan, and Rembangan Sub-watersheds

The upstream area of the Bedadung Watershed is sought as a conservation area. The four sub-watersheds, namely the Jompo sub-watershed, the Antrokan sub-watershed, the Rempangan sub-watershed, and the Rembangan Sub-watershed, each have different soil and water conservation activities. According to Fandeli [11], conservation practice contains 7 (seven) criteria, which together provide a basis for the use of natural resources and the environment. The seven standards are:

1. Preservation
2. Restoration
3. Beneficiation
4. Substitution
5. Maximization
6. Reduce, Reused, Recycle, and Recovery
7. Integration

Soil and water conservation activities in each sub-watershed along with 7 (seven) criteria Conservation practices in the use of natural resources and the environment are presented in Table 1.

Table 1. Conservation Activities in the Jompo, Antrokan, Rempangan, and Rembangan Sub-watersheds

No	Sub Watershed	Conservation	Category of conservation						
			Preservation	*Restoration*	*Beneficiation*	*Substitution*	*Maximization*	*Reduce*	*Integration*
1.	Jompo	a. Coffee Plantation	✓		✓		✓		✓
		b. Cover crop	✓	✓					✓
		c. Forestry	✓		✓				✓
2.	Antrokan	a. Terrace of rice		✓					
		b. Using mulch straw						✓	
		c. grassland					✓		
3.	Rempangan	a. Cover crop	✓	✓					✓
		b. Terrace		✓					
		c. Forestry	✓		✓				✓
		d. Coffee Plantation	✓		✓		✓		✓
		e. Restoration		✓		✓			
4.	Rembangan	a. Bush	✓				✓		
		b. Cover crop	✓	✓					✓
		c. Terrace of sugarcane		✓					
		d. Grassland					✓		
		e. Coffee Plantation	✓		✓		✓		✓

Noted:
Given mark (√) for conservation, criteria was selected
Sources: Primer data (2019)

3.2 Soil and Water Conservation Activities in the Jompo Sub-watershed

Conservation activities in the Jompo Sub-watershed were carried out using descriptive analysis. Descriptive analysis is a method used to identify conservation activities that have been carried out by upstream communities and the ecological, social and economic impacts of conservation activities. Besides that, it also describes the disaster vulnerability and institutions that exist in the area. Sub-watershed land conditions in nursing, in the village Klungkung District of Sukorambi, with 12.53 km2 with a height of 300 meters above sea level. The slope of the slope in the Jompo Sub-watershed according to the research results of Suryaningtias [12]. Is in the amount of 0 - 1% with an area of 760.6 ha or 64.50% of the total area of the Jompo Sub-watershed. This means that the higher the value of the slope (LS) with very steep conditions will affect the surface flow velocity of the water splash grains to the more significant water carrying capacity.

The forest area in the upstream area of the Jompo Sub-watershed is a protected area on the slopes of the Argopuro mountain range. The forest area around the slopes of the Argopuro mountain range has a fairly high level of soil fertility. Soil contains organic and mineral matter with an average soil thickness between 20 - 35 cm. Fertile soil conditions encourage people to carry out agricultural businesses that can generate economic value or higher income.

Conservation activities that have been carried out in the Jompo Sub-watershed are coffee plantations with system agroforestry simple, cover crops with sengon plants, and preserving the forest. Coffee plantation with system agroforestry simple is an agricultural system where trees are planted intercropping. The types of trees planted are also very diverse, with high economic value, such as coconut, rubber, cloves, coffee, cocoa, jackfruit, belinjo, petai, teak and mahogany. A form of agroforestry simple in the Jompo Sub-watershed is intercropping with land belonging to Perhutani. This system requires that forest areas be developed within the framework of the social forestry program of Perum Perhutani. On this land, farmers are allowed to plant coffee plants between the trees in the forest. Farmers take the coffee plant products, but farmers are not allowed to cut down or destroy forests.

Coffee plantations with the system are agroforestry included in the criteria of protection, utilization, maximum in process, and integration in meeting the needs of humans and other creatures. This shows that the conservation of intercropping forest plants with coffee has a positive impact on ecology, society, and economy. Ecologically, it is useful to reduce landslides in hilly areas due to erosion. Socially, the people in the upstream get jobs both as primary and side jobs. In addition to that, the relationship between the coffee farmer groups is getting closer because the Forest Village Community Institution or LMDH is formed. The name LMDH in Klungkung Village is LMDH Anugerah. Economically, the upstream community's income earns additional income from the coffee crop without having to rent land. The cover crop is included in the criteria of protection, restoration, and integration in meeting the needs of humans and other creatures. Ground cover plants (cover crop) is a plant or plant specifically planted to protect the soil from erosion and the threat of damage by or to improve the chemical and physical properties of the soil, making a positive impact on the ecology of the subzone nursing. The ground cover crop in Klungkung Village is a sengon plant. Socially, the community has a job as a sengon seed seller, as a sengon farmer, and as a sengon trader. Economically, people's income can increase from the production of sengon. Sengon trees are used for wood to be sold to local timber entrepreneurs, some are sent to plywood factories in Bangsalsari District, Jember Regency.

Forests include criteria for protection, wise use, and integration in meeting the needs of humans and other creatures. According to Law Number 41 the Year 1999 concerning Forestry, it is an integrated ecosystem in the form of a stretch of land containing biological natural resources that is dominated by trees in their natural environment, which cannot be separated from one another. Forests serve as a store of carbon dioxide, a habitat for animals, a modulator of hydrological flows, a soil preserver, and one of the most critical aspects of the earth's biosphere.

Currently, Perum Perhutani has mobilized local communities around the forest to be invited to conserve the forest. The involvement of local communities in preserving forests has ecological, social, and economic impacts. The environmental impact obtained is the preservation of biodiversity. The financial implications obtained is that the community gets added value from the use of land use rights

from Perum Perhutani. The social impact is to encourage cooperation and coordination of policies and institutions so that the relationship between farmers is getting closer.

3.3. Soil and Water Conservation Activities in the Antrokan Sub-watershed

The land condition in the Antrokan Sub-watershed is precisely in Slawu Village, Patrang District, with an area of 10 km2 with an altitude of 49 masl. According to Fadila [13], the slope of the slope in the Antrokan Sub-watershed is 0-1% with an area of 688,826 ha or 60.78% of the entire Antrokan Sub-watershed area. This means that the higher the value of the slope (LS) will have an effect on the increase in surface flow velocity, the more scattered soil grains, and the greater the water transport energy.

Conservation activities that have been carried out in the Antrokan Sub-watershed include rice terraces, use of mulch with straw limbs, and pasture for animal feed. Is a soil and water conservation building made by excavation and landfilling, forming the main building in the form of a cultivated area, mounds, and water channels that follow the contour and can also be equipped with complementary structures such as water drains (SPA) and waterfalls perpendicular to the contours [14]. The terrace is a mechanical soil and water conservation building designed to shorten the length of the slope and/or reduce the slope of the slope by excavating and landfilling across the slope [15]. The purpose of making a terrace is to reduce runoff and increase water infiltration so that soil loss is reduced. The function of the terraces is to reduce the length of the slope and hold water, thereby reducing the speed and amount of surface runoff, and allowing the absorption of water by the soil, thereby decreasing erosion [16].

The positive impact felt by the community on terraced buildings from the ecological, social, and economic aspects. Ecologically, terracing includes the criteria for recovery because terracing will reduce the rate of erosion on sloping land, thereby minimizing the occurrence of landslides. Economically, terraces have a positive impact on the communities around the Antrokan sub-watershed. By building terraces, people can do farming, so that their income increases. The social impact is that farmers in Slawu Village have a good cooperation. The farmers form farmer groups and there are regular meetings every month. The name of the farmer group in Slawu Village is Sumber Makmur. Field Agricultural Extension officers or PPLs from the Jember Regency Agriculture Service are actively providing counseling to farmer groups. The commodity planted in Slawu Village is a seasonal crop. Like rice and corn. The source of irrigation water comes from the Antrokan Sub-watershed and the distribution of the water is divided by the officer or ulu-ulu water. After every harvest, the farmer is obliged to give part of his crop to the water officer.

The use of mulch with straw waste in Slawu Village includes conservation criteria, namely reducing, reusing, recycling, and restoring land conditions that have been used for farming. The main livelihood of the people of Slawu Village is seasonal farmers. The mulch used is the residue of the rice plants after harvest which has been cut into pieces and then spread evenly over the soil surface. Mulch apart from plant debris, there are other materials such as plastic, stone and sand. The ecological impact from the use of mulch is to reduce erosion by reducing the energy of falling rain to not damage the soil structure, reducing the speed and amount of surface runoff, thereby reducing the draining power of surface runoff. Mulch also reduces the evaporation of water from the soil, thereby increasing groundwater content. The social impact of using mulch is that local people who work as odd jobs can work as agricultural laborers. Economically, the use of mulch from straw waste minimizes costs for land maintenance.

Grasslands are also a conservation activity around the Antrokan Sub-watershed. Grasslands are included in the maximization conservation criteria. This criterion is carried out by using the land as pasture. Ecologically, grasslands have several benefits, such as:

a. Providing a source of food for other living things
b. Maintain ecosystem balance
c. Help overcome air pollution
d. The place where organic waste recycling takes place in the ecosystem
e. Become a source of organic compounds

3.4 Soil and Water Conservation Activities in the Rembangan Sub-watershed, Rembangan
Sub-watershed, to be precise in Sucopangepok Village, Jelbuk District, with an altitude of 487 meters above sea level and has the largest area in Jelbuk District, which is 15.04 km2. According to Suryaningtias [12], the slope in Rempangan Sub-watershed is 0–1% with 865.15 ha or 53.20% of the entire Rempangan Sub-watershed area. This means that the more sloping a land is, the higher the level of erosion produced. Thus the soil will be quickly eroded. The longer the slope, the higher the damage or erosion takes place.

Conservation activities that have been carried out in Rempangan Sub-watershed, Sucopangepok Village, Jelbuk District are planting ground cover, terraces, forests, fields, coffee plantations, and tree planting or reforestation. Ground cover plants are found around the Rempangan Sub-watershed, such as flower plants that we often encounter in the highlands. The names of these plants are Tithonia tagetiflora and Sesbania grandiflora or flower turi. These plants are used by the community to plant hedges in front of local residents' houses. The benefits from the ecological side are to hold or reduce the destructive power of falling raindrops and the flow of water above the soil surface, increase soil organic matter through fallen dead stems, twigs and leaves, and carry out transpiration, which reduces the groundwater content. The benefit from the economic side is that apart from being a beauty, the flowers invite bees to attract bees. There are beekeepers in Sucopangepok Village, the produce of the bee honey is sold to local residents.

Ecologically, terracing includes the criteria for recovery because terracing will reduce the rate of erosion on sloping land, thereby minimizing the occurrence of landslides. Economically, terraces have a positive impact on the communities around the Rempangan sub-watershed. By building terraces, people can do farming, so that their income increases. The social impact is that farmers in Sucopangepok Village maintain close relationships even though there are still no farmer groups there. People who work as farmers usually gather at one of the residents' houses to discuss the commodities to be planted and water distribution during the dry season. The commodity that is grown during the rainy season besides secondary crops is tobacco.

The social impact of the forest around the Rempangan Sub-watershed is that the community participates in preserving the forest by establishing a Forest Village Community Organization or LMDH called Sucopangepok Lestari. The economic impact obtained is that the community gets added value from the use of land use rights from Perum Perhutani. Farmers are given seeds by Perhutani, such as mahogany seeds, fruit crops such as durian, avocado. Farmers are given the obligation to take care of these plants and the results are also farmers.

Reforestation includes criteria for the conservation of restoration and substitution. The recovery criteria are aimed at increasing the value quality of natural resources and maintaining and maintaining the diversity of resources around the upstream area of the Rempangan Sub-watershed. Substitution in reforestation activities aims to prevent the resources in the region from being in a minus position so that they can still be utilized by the next generation. Reforestation activities in Sucopangepok Village have been carried out by students of the Postgraduate Program at the University of Jember. The activity was carried out in the context of World Tree Planting Day 2019. The activity was carried out on December 23, 2019. There were 10 (ten) kinds of seeds given by residents in Sucopangepok Village to be planted in the upstream area. These seeds are durian, petai, sengon, klengkeng, jackfruit, matoa, breadfruit, avocado, tailings, and guava plants. The total number of seeds that were donated was 3,000 seeds. The seeds were obtained from the Brantas Sampean Watershed and Protected Forest Management Center (BPDASHL).

3.5 Soil and Water Conservation Activities in the Rembangan Sub-watershed, Rembangan
Sub-watershed, to be precise in the Village of Kemuning Lor, Arjasa District, has an area of 10.89 km2 and is located at an altitude of 175.45 masl. According to the results of Suryaningtias [12], the slope slope in Rembangan is 0 - 1% with an area of 394.32 ha or 57.65% of the total area of the Rembangan Sub-watershed. This means that the higher the value of the slope or LS slope with very steep conditions will affect the surface flow velocity of the water splash grains to the greater carrying capacity. The

results of Andriyani's research [17] show that the Rembangan Sub-watershed has undergone significant land-use changes up to 34.6%, which means that the area is experiencing heavy erosion.

The conservation activities in the Rembangan Sub-watershed, Kemuning Lor Village, Arjasa District are shrubs, ground cover crops, terraces, grasslands, and coffee plantations. Shrubs are included in the criteria of preservation and maximization conservation activities. Shrubs are vegetation plants planted along the left and right banks of rivers. Ecologically, bushes function to preserve the function of rivers by holding or capturing eroded soil (mud) and nutrients and chemicals, including pesticides carried from the land. Ground cover plants found around the Rembangan Sub-watershed, such as flower plants that we often encounter in the highlands. The names of these plants are Tithonia tagetiflora and Sesbania grandiflora or flower turi. Tithonia tagetiflora is a wildflower plant whose flowers appear orange like sunflowers, but smaller in size. The terraces in Kemuning Lor Village are planted with crops and sugarcane. The utilization of pasture in the village of Kemuning Lor is used as a livelihood for the surrounding community because most of them are not only farmers but also breeders of goats and dairy cows. Kemuning Lor Village is a tourist area that offers beautiful views. The name of the tour is Rembangan. Visitors can enjoy the beauty of nature, pick chrysanthemums, pick dragon fruit, and enjoy milk from local cattle breeders.

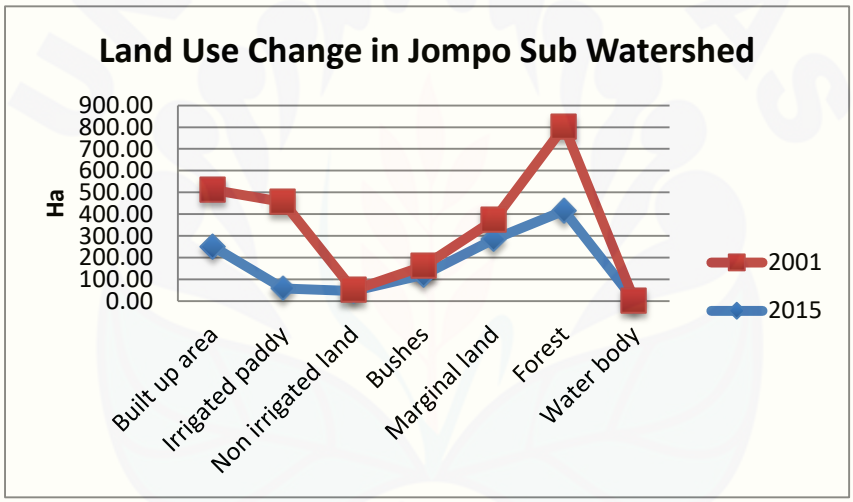

Figure 2. Land use changes in Jompo.

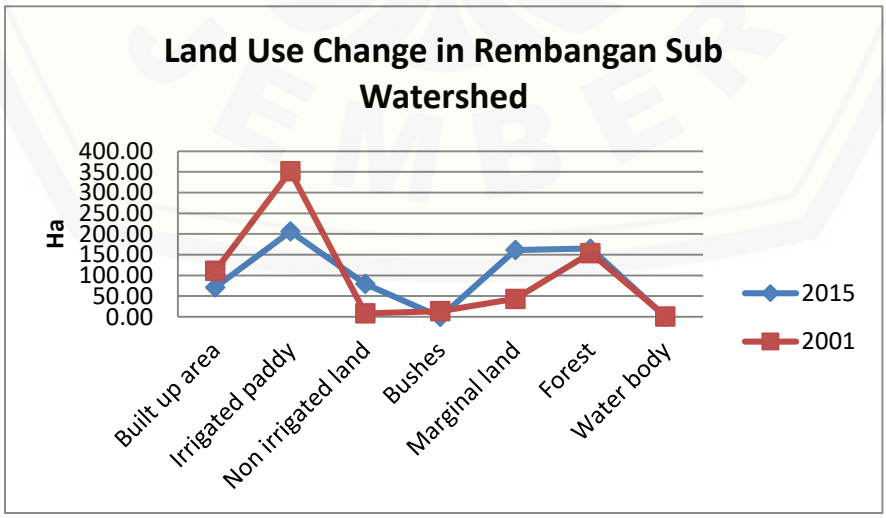

Figure 3. Land use changes in Rembangan.

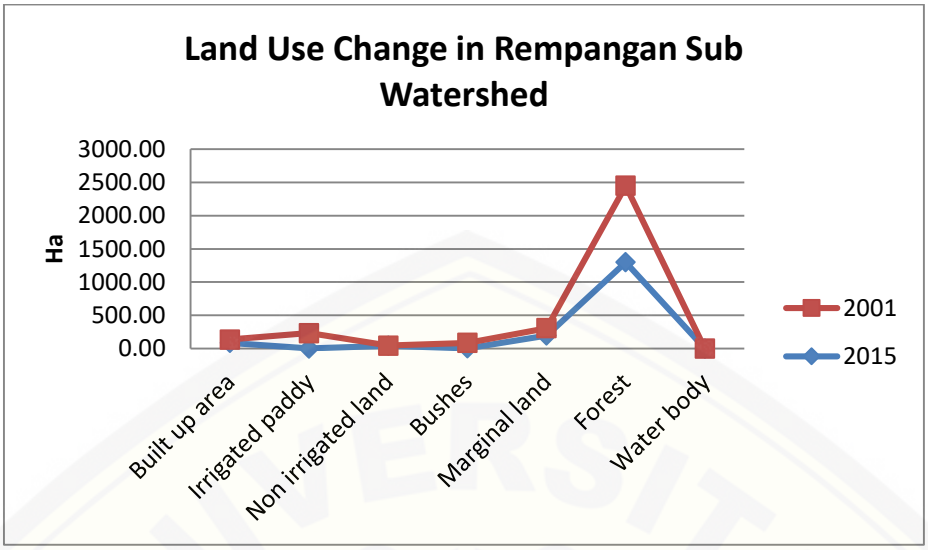

Figure 4. Land use changes in Rempangan.

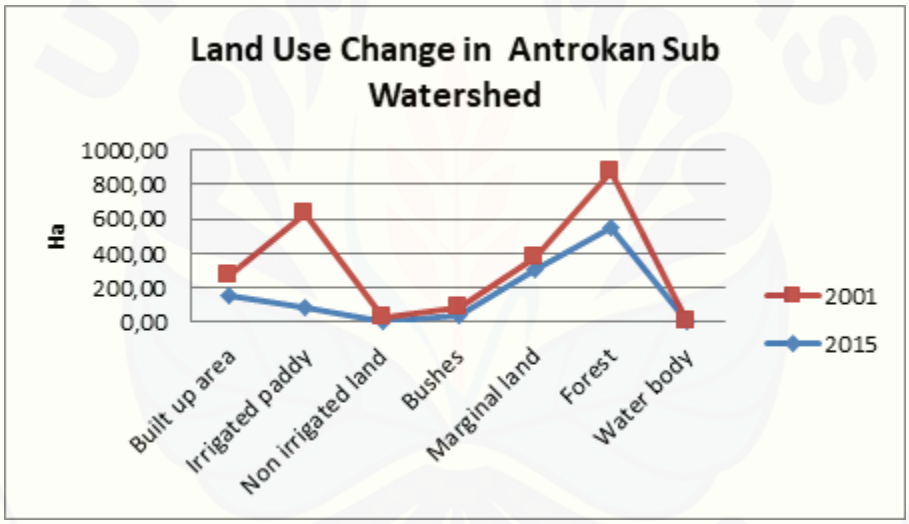

Figure 5. Land use changes in Antrokan.

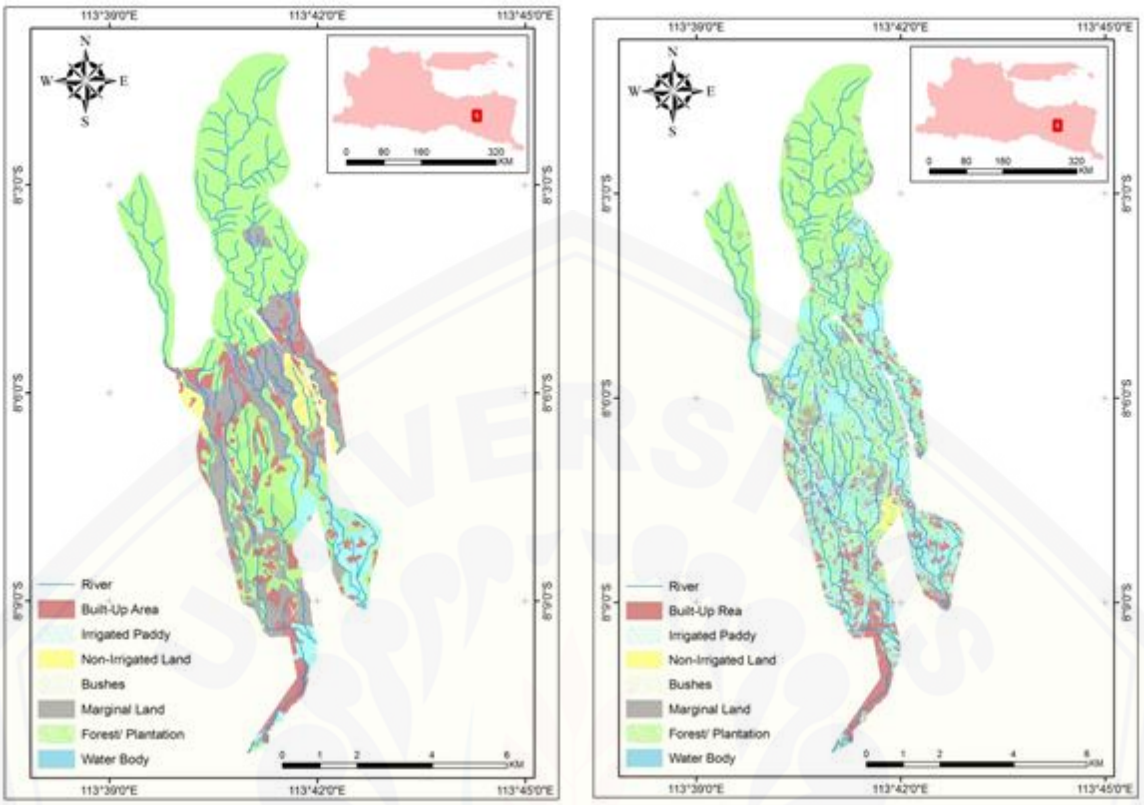

Figure 6. Map of Land Use Change in 2001-2005.

4. Conclusions

The Conservation Activities in the Jompo, Antrokan, Rempangan, and Rembangan Sub-watersheds is coffee plantation, cover crop, forestry, terrace, restoration, bush, grassland. The highest increase in land change in the four sub-watersged was irrigated land / field, while the decrease was non-irrigated land

References

[1] Fauzi, Randhea Giarkenang Nur., Dwiyono Hari Utomo., Didik Taryana. 2018. Pengaruh Perubahan Penggunaan Lahan Terhadap Debit Puncak Di Sub DAS Penggung Kabupaten Jember. *Jurnal Pendidikan Geografi.* 23 (1): 50-61.

[2] Wardhono, Adhitya., dan M Rondhi. 2010. Perhitungan Kerusakan Dan Kerugian Dalam Perspektif Ekonomi Dan Sosial Dengan Metode ECLAC Bencana Banjir Bandang Panti Kabupaten Jember. Prosiding.

[3] Puspitaningrum, D. 2011. Pelembagaan Program Pengelolaan Sumberdaya Hutan Bersama Masyarakat (PHBM) Dan Dampaknya Bagi Masyarakat Desa Hutan. *J-SEP*. Vol 5 (3): 1-14.

[4] Rosyidie, Arief. 2013. Banjir : Fakta dan Dampaknya, serta Pengaruhnya dari Perubahan Guna Lahan. Vol 24 (3) : 241-249.

[5] Rohman, Moh Kholilur. 2018. Pengaruh Perubahan Tata Guna Lahan Terhadap Erosi Menggunakan Metode Universal Soil Loss Equation (USLE) Di DAS Bedadung. *Skripsi.* Jember: Universitas Jember.

[6] Kementerian Kehutanan. 2013. *Petunjuk Teknis Penyusunan Data Spasial Lahan Kritis*. Jakarta: Kementerian Kehutanan.

[7] Suparmoko., Dadang Sudirman., Yugi Setyarko., Haryo Setyo Wibowo. 2014. *Valuasi Ekonomi Sumberdaya Alam dan Lingkungan*. Yogyakarta: BPFE Yogyakarta.

[8] Arsyad, S dan Ernan Rustiadi. 2008. *Penyelamatan Tanah, Air, dan Lingkungan*. Bogor: Crestpent Press.
[9] Sugiyono. 2009. Metode Penelitian Kuantitatif, Kualitatifdan R&D, Bandung: Alfabeta.
[10] Indarto. 2013. Sistem Informasi Geografis. Yogyakarta: Graha Ilmu.
[11] Fandeli, Chafid. 2012. *Bisnis Konservasi Pendekatan Baru dalam Pengelolaan Sumberdaya Alam dan Lingkungan*.Yogyakarta: UGM Press.
[12] Suryaningtias, S. 2019. Penentuan Tingkat Bahaya Erosi di Sub DAS Rembangan, Sub DAS Rempangan, dan DAS Sub DAS Jompo Kabupaten Jember. *Skripsi*. Jember: Universitas Jember.
[13] Fadila, Yaumil Zahro. 2019. Pengaruh Jenis Tanah Terhadap Erosi Pada Sub DAS Kemuning, Bintoro, Dan Antrokan Kabupaten Jember. *Skripsi*. Jember: Universitas Jember.
[14] Yuliarta. 2002. *Teknologi Budidaya pada Sistem Usaha Konversi.* Jakarta: Grafindo
[15] Sukartaatmadja. 2004. *Konversi Tanah dan Air*. Bogor: IPB Press.
[16] Arsyad, S., 1989. *Konservasi Tanah dan Air*. Bogor: IPB Press.
[17] Andriyani, I., Wahyuningsih, S., & Arumsari, R. S. (2020). Penentuan Tingkat Bahaya Erosi Di Wilayah Das Bedadung Kabupaten Jember. *Jurnal Ilmiah Rekayasa Pertanian Dan Biosistem*, *8*(1), 1–11.