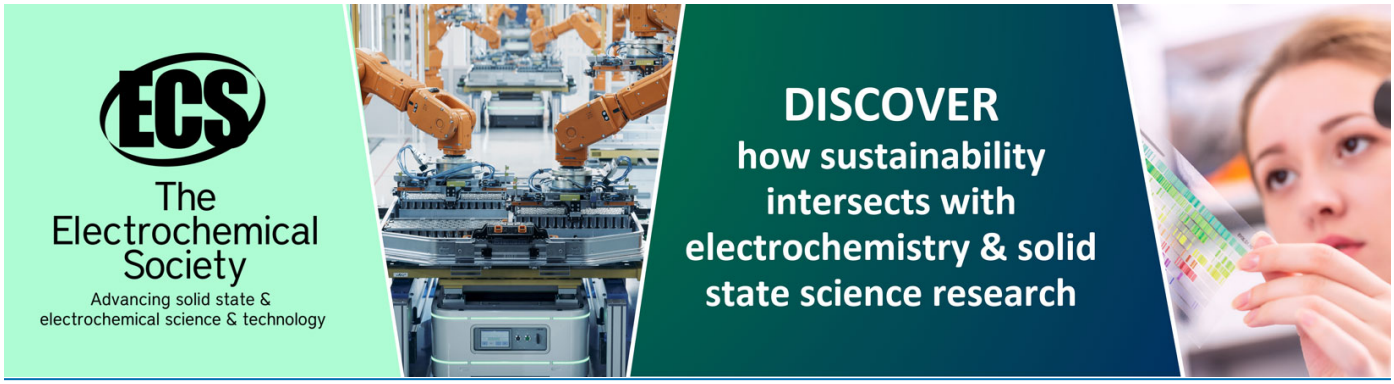
Arjuna Mountain Forest Revegetation to Preserve Areas Around Springs



Arjuna Mountain Forest Revegetation to Preserve Areas Around Springs

M Nugroho[1], Soemarno[2], H Riniwati[3], A Afandhi[4]

[1]Environmental Science Doctoral Program of Brawijaya University Postgraduate Program in Malang, Indonesia
[2]Faculty of Agriculture Brawijaya University in Malang, Indonesia
[3]Faculty of Fisheries and Marine Science Brawijaya University in Malang, Indonesia
[4]Faculty of Agriculture Brawijaya University in Malang, Indonesia

[*]Corresponding author: mtnugroho@gmail.com

Abstract. The objective of the study was to examine the effect of forest revegetation on Arjuna Mount of the preservation of the area around the spring. The research method was quantitative descriptive, by conducting a survey of measurements in the area around the springs. The survey method covers: (1) the measurement of the number and type of plants, the results of their growth (number of plants that live and die), as well as measuring the water discharge of springs; (2) interviews of people living in the vicinity of springs; (3) direct observation of vegetation conditions around Lajer, Dawuan, Sumber Kuning and Watupereng springs in Arjuna Mount. Data were analyzed quantitatively spatially using GIS, ArcView 3.3 programs and Google Earth. The results showed that (1) forest revegetation in Lajer's springs area, the water debit of springs were 10.35 L/s; (2) forest revegetation in Dawuan springs area, the water debit of springs were 25.47 L/s; (3) forest revegetation in Sumber Kuning springs area, the water debit of springs were 10.25 L/s; (4) forest revegetation in the Watu Pereng springs, the water debit of springs were 0.80 L/s.

Keywords: revegetation, forest, springs

1. Introduction

The closure of vegetation plays an important role in forest management for the functioning of the hydrological system, especially the effect of sponges capable of holding rainwater and regulating its drainage, thereby reducing the occurrence of flooding and maintaining water flow in the dry season. The hydrological function of the forest will be lost, when vegetation in the higher watersheds was damaged. In tropical forest areas, 90% of farmers in the lowlands depend on the activities of 10% of the people living in the upper reaches of the river. For example, the Ganges river basin, 40 million people living in the Himalayas affect 500 million people in the low lands [2]. Tropical forest vegetation cover can reduce water flow rates by 10-40%, and increase deposit water through litter by more than 4% [5]. In the area of Indonesia's tropical forests and specifically Arjuna Mount, awareness of the importance of vegetation cover and revegetation of forests in achieving sustainable forests was still lacking, so that flooding problems in the rainy season, and no water drought in the dry season always occur every year [3]. There were four key ecological indicators of damage to tropical rainforests, namely: (1) vitality (tree damage and canopy conditions); (2) decreasing forest productivity; (3) low biodiversity; and (4) low

site quality. The four ecological indicators have a close relationship with each other, both separately and together can describe the level of forest destruction [6].

The results of monitoring [8], show that during the last 20 years there has been a rate of forest degradation on Arjuna Mount, some areas of the watershed sub-watershed have decreased springs, this was allegedly related to forest destruction in the recharge area continues to increase. Recharge area damage was caused by land use change, illegal logging, fire and wild sand mining which results in soil damage and increased erosion and sedimentation. The number of dry or dead springs was 30 springs, out of a total of 41 springs. The main cause of dry springs was damage to protected forests and production on Arjuna Mount. Thousands of hectares of Arjuna Mount forests were critical, due to fire and illegal logging. The forest area of Arjuna Mount in the Pasuruan Regency area reaches 12,000 hectares. About 1,500 hectares of them were damaged by fires in 2012. Of the 1,500 hectares burned, only 300 hectares have been rehabilitated. According to the study from the Clinton Foundation, USA in 2011-2012, the rate of forest destruction on Arjuna Mount reached 0.24%, equivalent to 68 ha/year. If this condition continues, it will threaten the supply of clean water for almost 2 million people in Pasuruan Regency, 4.7 thousand hectares of irrigated rice fields and around 500 industries in Pasuruan Regency [9].

Based on some of the facts and problems mentioned above, it was necessary to implement the Revegetation of ArjunaMount for the Preservation of around areasof springs.

2. Method

The method used was descriptive method. While based on the techniques and tools used to research, the author uses the survey method to obtain facts that occur in the research area, namely in the area around the spring of the Kedunglarangan and Gumandar Prigen watersheds, Pasuruan Regency. Data obtained in the field were then processed and analyzed using GIS, ArcView 3.3 and Google Earth programs.

3. Result and discussion

3.1. Water resources of the Kedunglarangan and Gumandar watersheds

The Arjuna-Welirang Mountains (forest status: Great Forest Park) with an area of 27,868 Ha was the largest clean water storage area in East Java, because it was upstream of the Brantas watershed that passes 14 cities or regencies in East Java with a population of around 60% of the total Javanese population East. According to the study from the Clinton Foundation, USA in 2011-2012, the deforestation rate on Mount of Arjuna-Welirang reached 0.24%, equivalent to 68 ha/year due to forest fires, illegal logging, intensive expansion of agricultural land and landslides. Especially on Mount of Arjuna-Welirang in the slopes of Pasuruan Regency, until 2011 there had been a forest fire of 960.8 hectar which caused 12 sources of water to die and only 16 water sources left. During the rainy season, precisely at the beginning of 2012 floods have hit 4 sub-districts in Pasuruan which resulted in the paralysis of the East Java Pantura lane for almost 2 months. While in the dry season last year, between September and November 2011, 38 villages in 10 sub-districts in Pasuruan had experienced drought and lack of clean water. The condition of forest area management was not right, it will threaten the supply of clean water for almost 2 million people in Pasuruan Regency, 4.7 thousand ha of irrigated rice fields and more than 500 industries in Pasuruan Regency.

3.2. Revegetation of Arjunamount forest

One of the multinational companies in Pasuruan Regency that sustainably supports environmental conservation efforts was PT. Sorini Agro Asia Corporindo (Cargill). The company was committed to the environment, and was implemented in the form of education about the importance of sustainable forests while providing assistance and assistance to improve the economy of the community. The success of the forest revegetation program cannot be separated from collaboration with the government, non-governmental organizations and the environmental community, so as to create a program that was right on target, comprehensive and sustainable. One tangible form of corporate support for environmental conservation efforts was the planting of 19,500 trees, in the area around Lajer, Dawuhan, Sumber Kuning and Watu Pereng springs. The total forest revegetation area was 93 hectares, and was carried out for 5 years as explained in Table 1.

Table 1. Revegetation of Arjuna mount forest during 2014-2018

No	Springs location	Number of trees	Area (ha)	the percentage of trees living
1	Lajer – Arjuna Mount	3000	10	94%
2	Dawuhan – Arjuna Mount	1500	5	92%
3	Sumber Kuning – Arjuna Mount	5000	25	86%
4	Watu Pereng – Arjuna Mount	6000	34	99%
5	Watu Pereng – Arjuna Mount	4000	19	99%
		19500	93	

Source: [4]

3.2.1. Revegetation of forests I in 2014 Lajer springs area

The first year of forest revegetation program began planting on February 27, 2014, with the purpose of improving the vegetation of around area of Lajer springs, by planting and maintaining plants for 3 years to keep the volume of water flowing and increasing, and preventing landslides and floods. Guidelines for revegetation of the Lajer spring water source area were PP No. 43 of 2008, that revegetation was carried out thoroughly in groundwater basins which include recharge areas and groundwater discharge areas, through (1) protection and preservation of groundwater; (2) preservation of ground water; and (3) quality management and control of groundwater pollution. The decrease in springsdebitwere caused by a reduction in protected areas or water catchment areas due to illegal deforestation and land conversion that results in critical land occurrence and a decline in the quality of water catchment areas (Tjakrawarsa and Handoko, 2013). The result of revegetation phase I was to increase the vegetation cover of 10 hectares of land in the area around Lajer springs, with a total of 3000 trees. 3000 species of plants include: 1000 Bamboo (*Dendrocalamus asper*), 600 Pecan (*Aleurites moluccana*), 400 Kluwek (*Pangium edule*), 300 Kluweh (*Artocarpus communis*), 100 Banyan (*Ficus benyamina*), 500 Durian (*Durio zibethinus*) and 100 Elo (*Ficus glomerata*). Intensive plant maintenance was carried out for 3 years, with 5 nurse farmers from the community around the forest.

Based on verification results in each year shows that in the first year period of 2014 the percentage of living trees was 98%, in the second year of 2015 the percentage of living trees was 96% and in the third year 2016 the percentage of trees the life was 94%. Some factors that influence the percentage of the number of trees that live relatively stable were nurse farmers who directly replace dead plants with other plants, even though the plant species are different, so the number of trees was relatively close to a percentage. While other technical factors that affect the percentage of living trees were relatively stable, among others: (1) treatment of grass cleansing on plants, (2) weeding plants, (3) giving water to plants in the dry season, (3) making bulkhead burn, during the dry season, (4) routine evaluation of plant maintenance from farmers to NGOs, village forest community institutions, companies and the government every month, (5) corporate social responsibility programs for economic empowerment for nurse farmers. The results of verification for 3 years showed that the highest number of plant deaths occurred in durian plants reaching 98.8% (the initial number of plants 500 trees, which lived were 6 trees), the cause of death of durian trees (*Durio zibethius*) was eating animal Porcupines especially new stems who sprouted, so that the corrective action was to replace the types of plants that were resistant to porcupine pests such as Jackfruit, Mahogany, Sengon Buto, Srampang Balong and Segawe plants. The dry season factor during August-November 2014, with temperatures above normal temperature (temperature 37-39◦C), has the potential to cause forest fires.

3.2.2. Forest revegetation II year 2015 Dawuan springs source area

Based on the results of verification on February 23, 2015 shows that the area of forest rehabilitation in the second period in the area around the Dawuan springswere 15 hectares, with the number of plants was 1500 trees, data on types of plants include Bamboo Petung (*Dendroca-lamus asper*) 300 trees, Candlenut (*Aleurities mollucana*) 500 trees, Banyan (*Ficus benyamina*) 50 trees, Bendo (*Artocarpus elasticus*) 450 trees and Ivory tree 200 trees. The number of nurse farmers who directly carry out and care for plants was 3 people, each of whom receives 6 goats breeding assistance. Plant maintenance was scheduled every 1 week with the main goal of caring for and maintaining plant growth. 3 months after the initial planting, in April 2015 the nurse farmers carried out fertilization and planting dead plants. Based on the results of verification at the planting location around the Dawuan springs, it showed that up to May 30, 2015 the number of dead plants was 103 plants, and the nurse farmers immediately replaced with 140 new plants for planting. The total number of plants from verification in December 2016 was 1537 trees. Some types of plant replacement for revegetation include: Spathodea (*Spathodea campanulata*) 20 trees, mahogany (*Sweetenia mahagoni*) 8 trees, Srikaya (*Annona squamosa*) and jackfruit (*Artocarpus heterophyllus*) 5 trees. Dolezal and Srutek (2002). states that plant growth was influenced by soil factors, climate, microorganisms, competition by other organisms, and was also influenced by available organic substances, humidity and sunlight. Based on the results of the implementation of this second rehabilitation program, researchers measured and verified that Petung bamboo plants were very strong and resistant to be planted in critical areas and with little water, andable to hold water when the rainy season occurs.

Based on the results of observations and measurements show that the number of plant deaths in the second stage rehabilitation program in the Dawuan springs, verification during the first year of 2015 the number of living trees was 1442 trees (96%), in the second year 2016 the number of living trees was 1404 trees (94%), and in the third year verification in April 2017 the number of trees that lived to be 1380 trees or 92% of the initial number of trees planted as many as 1500 trees.

3.2.3. Forest revegetation III year 2016 Sumber Kuning springs area

The third stage of the forest revegetation program was held on March 29, 2016 with a location in the Sumber Kuning spring area. The revegetation area was 25 hectares with a total of 5000 trees, with plants including mountain cypress (*Casuarina junghuniana*) 2000 trees, Kesek 300 trees, Petung Bamboo (*Dendrocalamus asper*) 500 trees, tutup tree (*Mallocus moluccana*) 200 trees, Mlandingan (*Leucaena glauca*) 500 trees, Calliandra (*Calliandra calothyrsus*) 1000 trees and Gmelina (*Gmelina arbora*) 500 trees. Sumber Kuning spring was included in the area of Jatiarjo Village, Prigen Subdistrict, Pasuruan Regency, with different conditions compared to phase 1 and 2 revegetation activities (Lajer and Dawuhan springs). The Sumber Kuning spring was located at an altitude of 2,427 meters above sea level, and the forest area was under the management of the East Java Province Forestry Service. Community forest park of Raden Soerjo. The area was included in the conservation forest status, where there was a community allowed to do forest conservation but cannot take anything inside the forest area. The selection of forest rehabilitation sites in the Sumber Kuning area was to protect upstream springs, which have been damaged by forest fires in November 2015, so that these forests need to be treated and protected from forest fires. If the water discharge in the area of the spring was reduced, then it has an impact on a number of springs under it.

Based on the results of verification on March 29, 2016, the third period of forest revegetation area in Sumber Kuning springs area was 25 hectares, with a total of 5000 trees. The results of planting verification for 2 years showed that in the first year the number of living plants was 4485 trees (90%) and 515 trees died. In the second year of verification in April 2017, the number of living plants was 4303 trees (86%) and the number of plants that died from 2017 to April 2017 was 697. The number of nurse farmers who were directly involved in the management of Sumber Kuning springs forest rehabilitation in the program community empowerment was 5 people.

3.2.4. Forest revegetation IV year 2017 Watu Pereng springsarea

The fourth stage of the forest rehabilitation program was carried out in the spring area of Watupereng, the Gumandar Sub-watershed (watershed) in Jatiarjo Village, Prigen District, Pasuruan Regency on February 21, 2017, with the theme "Caring for the Forest". The area of the forest rehabilitation area was 46 hectares, with the number of trees as many as 8,000 trees, this rehabilitation area was included in the protected forest of the Indonesian state forest company of west Lawang in plot 35. The types of trees planted include petung (*Dendrocalamus asper*), banyan (*Ficus sp*), kluweh (Artocarpus *communis*), pecan (*Ale mollucana*), matoa (*Pometia pinnata*), clove (*Syzygium aromaticum*), soursop (*Annona muricata*), avocado (*Persea americana*), durian (*Durio Zibethinus*) and coffee (*Coffea canephora Pierre*). By implementing this revegation program, Sorini Cargill has been conserving 4 springs (Lajer, Dawuan, Sumber Kuning and Watu Pereng), with a total area of 83 hectares, and 17,500 trees planted and involving 28 forest nurse farmers in the form of a program to empower communities around the forest Through this sustainable forest rehabilitation program, the company was committed to carrying out the obligation to improve the rainwater catchment area that was upstream for water needs for all communities in Pasuruan Regency. The results of tree planting verification show that up to April 2017 the number of living trees was 7958 trees (99%).

3.3. Results of springs preservation

The spring protection method that can be applied one of them was by revegetation technique. One of the protection of springs with revegetation techniques was by planting various types of trees. Protection of springs by revegetation can be done in 2 ways, namely (1) planting around the point of spring (radius 10-15) as spring protection; and (2) planting in the recharge area as spring shed protection. The purpose of planting around the spring was more to protect spring points from all pollutants and damage due to human activities. Whereas planting in the groundwater recharge area was expected to help absorb rainwater into the soil which in the long run can fill aquifers, and not become surface runoff. It was expected that the tree planting will protect springs from pollutants, bacteria and harmful chemicals. Thus the sustainability of the spring will be maintained, so that the quality, quantity and continuity of the water flow were met. The results of measurements of water discharge from each spring source as an indicator that the source of the spring was still sustainable because the condition of the vegetation of the plant was still able to absorb rainwater presented in Table 2.

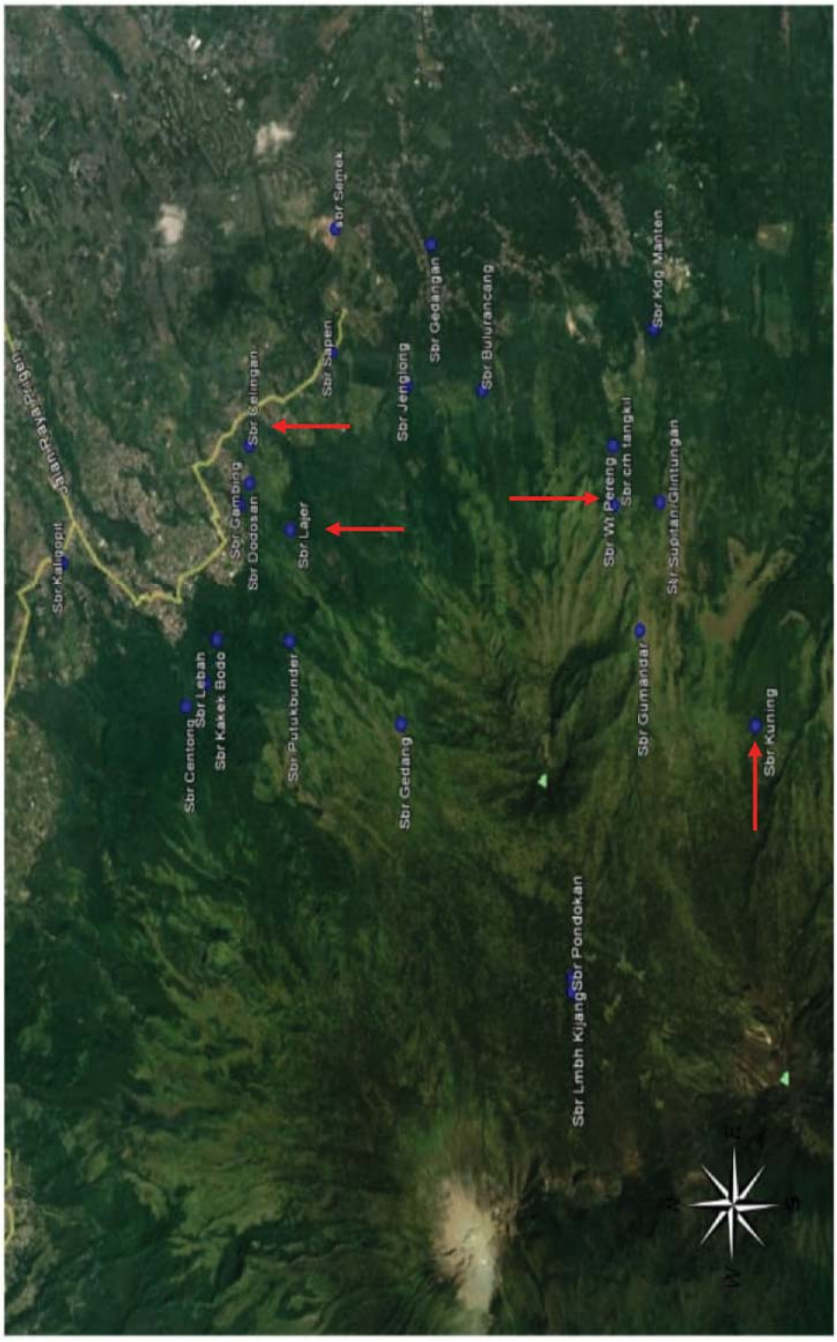


Figure 1. Map of the location of springs in the forest area of ArjunaMount

Table 2. *Condition of springs in conservation and forestry areas of Arjuna mount, Pasuruan East Java*

NO	Springs name	Location	Village	Elevation (meters above sea level)	Coordinate	Water discharge (liter/second)
1	Lembah Kijang	Pecalukan	Pecalukan	2484	07°44' 36,8" LS 112°35'46" BT	2.08
2	Gumandar	Gumandar	Dayurejo	2100	07°42' 30,3" LS 112°36' 35,8" BT	21.05
3	Sumber Kuning	Sumber kuning	Jatiarjo	1960	07°45' 54" LS 112° 37'07,6" BT	10.25
4	Putu Bunder	Putuk bunder	Dayurejo	1119	07°42' 36,7" LS 112°37' 30,6" BT	14.16
5	Sumber Gedang	Pecalukan	Pecalukan	1900	112°37' 04,1" BT 07°43'26,1" LS	4.70
6	Pondokan	Pecalukan	Pecalukan	1700	112°35" 41,8' BT 07°44' 36,8" LS	2.08
7	Bulurancang	plot 42C	Dayurejo	832	07°44'00,1" LS 112° 39'03,1" BT	1.37
8	Jenglong	plot 43	Dayurejo	792	07°43'26.56"LS 112° 39'4.19" BT	3.27
9	Supitan	plot 31	Jatiarjo	1172	07°45'17,7" LS 112° 38'23,8" BT	1.50
10	Kedungmanten	plot 35	Jatiarjo	837	07°45'16,0" LS 112° 39'26,9" BT	no water
11	Curah Tangkil	plot 36	Dayurejo	1026	07°44'57,6" LS 112° 38'43,7" BT	dry
12	Watu Pereng	plot 35	Dayurejo	1159	07°44'57,6" LS 112° 38'22,1" BT	0.80
13	Gumer/Semek	Taman Dayu area	Dayurejo	550	07°42'52.95" LS 112°40'2.70" BT	0.19
14	Sapen	plot 43a	Ledug	648	7°42'52.68" LS 112° 39'16.17" BT	0.49
15	Lajer	plot 51g	Ledug	925	07°42'35,7" LS112° 38'11,0" BT	10.35
16	Sumber Gambing	plot 50a	Ledug	652	07°42'12,7" LS 112° 38'19,7" BT	28.86
17	Centong	plot 54b	Pecalukan	948	07°41'50.83"LS 112° 37'5.57"BT	no water
18	Kakek Bodo	plot 53e	Tretes	1100	7°42'3.64" LS112° 37'29.83" BT	1.89
19	Sumber Lebah	plot 53a	Pecalukan	946	07°41'59,0" LS 112° 37'14,0" BT	0.54
20	Sumber Kali Gopit	plot 3f	Lumbang	572	07°40'51,7" LS112° 37'56,7" BT	36.58
21	Celingan	plot 43d	Ledug	596	07°42'16,1" LS 112° 38'41,3" BT	4.03
22	Dodosan	plot 42	Ledug	639	07°42'16,7" LS 112° 38'27,5" BT	3.67
23	Dawuan	plot 51	Ledug	652	07°42'11,3" LS 112° 38'20,3" BT	25.47
24	Sumber Gedangan	Tegal Gamoh	Dayurejo	600	7°43'36.47" LS 112° 39'57.15" BT	dry

Source: [4]

4. Conclusion

Forest revegetation for the preservation of the springs area sub-watersheds Kedunglarangan and Gumandar Arjuna Mount, Prigen Pasuruan of east Java through a sustainable forest management system involving donor agencies, environmentalists, forest village community organizations, Indonesian state forest company and communities around the forest with a percentage rate of live plants were as follows: (1) forest revegetation in Lajer's springs area, the number of trees 3000, with an area of 10 hectares, the percentage of trees living 94%, and the water debit of springs were10.35 liters/second; (2) forest revegetation in Dawuan springs were the number of trees 1500, with an area of 15 hectares, the percentage of trees living 92%, and the water debit of springs were 25.47 liters/second; (3) forest revegetation in Sumber Kuning springs area, the number of trees 5000, with an area of 25 hectares, the percentage of living trees 86%, and the water debit of springs were 10.25 liters/second; (4) forest revegetation in Watu Pereng springs area, the number of trees was 8000, with an area of 46 hectares, the percentage of trees living was 99%, and the water debit of springs were 0.80 liters/second.

References

[1]. Dolezal, J. and M. Srutek. 2002. Altitudinal changes in composition and structure of mountain-temperate vegetation: A case study from western carpathians. *Journal of plant ecology* 158(16): 201-221.

[2]. Mac Kinnon, K. 1992. Nature's treasurehouse-the wildlife of Indonesia. Jakarta: PT. Gramedia pustaka utama.

[3]. Permadi P., Lelana N.E, Anggraeni I., and W. Darwiati, 2012. Seminar formulation. Inside: national seminar on forest health and forest utilization for forest productivity. June 14, 2012. Bogor. Indonesia. R and D center for increasing forest production. Page 1-2

[4]. PT. Sorini Agro Asia Corporindo, 2017. Forest rehabilitation program for illegal sub-watersheds. Prigen Pasuruan

[5]. Soemarwoto, O. 1991. Indonesia in the arena of global environmental issues. PT. Gramedia pustaka utama. Jakarta

[6]. Supriyanto, Stolte K.W., Soekotjo and A.N. Ginting, 2001. Forest health monitoring plot establishment. In: Forest health monitoring to monitor the sustainability of Indonesian tropical rain forest. Volume I, Japan (JP): ITTO and Bogor ID: SEAMEO-BIOTROP

[7]. Tjakrawarsa G. and C. Handoko, 2013. Study of springs protection techniques on Lombok Island: acase study in KHDTK Rarung (study of technique protection of springs at Lombok Island case study at the Rarung research forest). *Indonesian center for forestry technology research institute for forest rehabilitation Journal* Vol. 1 No. 1, September 2013: 1-15

[8]. USAID. 2008. Nanggroe Aceh Darussalam Environmental services program. Aceh. In. http://www.esp.or.id/wp-content/uploads/pdf/fs/nad-id.pdf. Retrieved 11 August 2009

[9]. Wiyono, A. 2008. Preservation of the R. Soerjo grand forest park to maintain water supply and biodiversity. Kaliandra sejati foundation, Gamoh village, Dayurejo village, Prigen, Pasuruan. USAID