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Vegetation analysis of Samin watershed, Central Java as water and soil conservation efforts

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ABSTRACT

Maridi, Agustina P, Saputra A. 2014. Vegetation analysis of Samin watershed, Central Java as water and soil conservation efforts. Biodiversitas 15: 215-223. Samin watershed in Central Java is one of 282 Indonesian watersheds which are in critical condition. Nowadays, the sustainability of forest resources in the upstream of Samin watershed is threatened by exploitation of forest by people. As a result, erosion and sedimentation are occurring in this area that may pose a threat of flooding and landslide. Therefore, we need serious measures to maintain the function of Samin watershed, one of which is through the monitoring of vegetation in watershed. The purpose of this research was to analyze the structure and composition of vegetation in Samin watershed to support soil and water conservation. The survey of vegetation was conducted in 3 areas of Samin watershed based on geophysical conditions namely upstream, midstream, and downstream. At each sampling area, 37 sampling plots were randomly distributed in six observation stations. Vegetation analysis was carried out in both the lower crop community (LCC) and the tree. Results showed that the number of LCC species found in the upstream, midstream, and downstream areas were 21, 34, and 28 respectively. The species diversity indexes of LCC vegetation in the upstream, midstream, and downstream areas were 1.04, 1.34, and 1.23 respectively. Based on this result, LCC vegetation in Samin watershed was categorized in medium condition. The number of tree species found in the upstream, midstream, and downstream areas were 27, 18, and 12 respectively. The species diversity indexes of tree vegetation in the upstream, midstream, and downstream areas were 1.31, 1.15, and 0.97 respectively. Based on this result, the tree vegetation in Samin watershed was categorized in medium condition for the upstream and midstream areas, and low condition for the downstream area. Vegetation in Samin watershed must be preserved in order to maintain the sustainability of Samin watershed.

Key words: Conservation, samin, soil, vegetation, water.

INTRODUCTION

Water is a key to life on earth. According to Eamus (2010) from sub-cellular processes (photosynthesis, enzymatic reactions) to continental-scale processes such as erosion and sedimentation, water is central to ecosystem structure and function. Postel and Thompson (2005) say that a watershed is an area of land that drains into a common water source. Watersheds connect and encompass terrestrial, freshwater, and coastal ecosystems, and they perform a wide variety of valuable services, including the supply and purification of fresh water, the provision of habitat that safeguards fisheries and biological diversity, etc.

Samin watershed is one of watersheds located in the Districts of Karanganyar and Sukoharjo, Central Java, Indonesia. Samin is part of Bengawan Solo watershed (BPDAS 2009). The area of Samin watershed is approximately 20412 ha with 5881 m^3/second for water discharge. It provides the main source of surface water for agricultural irrigation and clean water supply for surrounding communities. Research conducted by Riyanto and Paimin (2011) showed that Samin watershed is one of 282 watersheds which are in critical condition. This can be inferred from the extent of degraded land in Samin watershed, mainly located in upstream area in Karanganyar District. Nowadays, the sustainability of forest resources mainly in the upstream area is threatened by exploitation of forest by people. The notion that forest only provides timber and other physical products causes the unsustainable forest exploitation. Nugraha et al. (2006) stated that regional regulation relating to the exploitation of natural resources in Samin watershed was not enforced well. As a result, there is erosion and sedimentation in Samin that may ultimately pose a threat of floods and landslides. Furthermore, Nugraha et al. (2006) stated that erosion in Samin watershed was great, namely 11483.533 ton/year. The classification of erosion danger levels are: very light (5.409 ha/70.13%), light (3935.364 ha/12.51%), moderate (2187.831 ha/6.76%), severe (2187.831 ha/6.76%), and very severe (1800.882 ha/5.56%). The classification of landslide danger levels are: light (6937.006 ha/21.42%), moderate (21664.015 ha/1%), severe (3081.926 ha/9.52%), and very severe (695.840 ha/2.15%). In addition, Nugraha et al. (2006) also stated that the quality of river water in Samin had exceeded the quality standard in Government Regulation No. 82 the year 2001 about the use of water class I, II, III, and IV, for nitrite and BOD levels.

Based on this fact, it will require serious measures by local community in Samin watershed, local government, or environmental experts to preserve the function of Samin watershed. The function of watershed is complex and affected by several factors, namely vegetation, topography, soil, and residential (Triwanto 2012). Furthermore, Triwanto (2012) states changes in one factor will affect watershed ecosystem and can reduce the watershed function. Ecosystem goods and services provided by healthy watersheds, according to Postel and Thompson (2005), are water supplies for agricultural, industrial, and urban-domestic uses, water filtration, flow regulation, flood control, erosion and sedimentation control, fisheries, timber and other forest products, recreation/tourism, habitat for biodiversity preservation, climate stabilization, and others.

One effort to maintain the function of Samin watershed is water and soil conservation. Water and soil conservation in Samin watershed can be done by monitoring the condition of vegetation in Samin watershed.

Vegetation is a whole plants that live together in such area which interact to each other and to their environment (Mueller-Dumbois and Ellenberg 1974; Susanto 2012). Parejiya et al. (2013) say that vegetation of a region is a function of several factors such as time, altitude, slope, latitude, aspect, rainfall. Variation in species diversity along environmental gradient is a major topic of ecological investigation and has been explained by reference to climate, productivity, biotic interaction, habitat heterogeneity, and history.

Vegetation, according to Marsono (2008), has an important role because it serves as hydrological regulation, flood control, and drought mitigation. Wang et al. (2013) state that forest plays an important role in controlling runoff overland flow through its effect on hydrological processes such as precipitation, interception, and evapotranspiration, affects soil properties, and modify the amount of rain water that will go into the soil through infiltration. In addition, Zheng et al. (2007) add that vegetation canopy can intercept droplets of rain that falls on it, hold it over the canopy and then release it on the ground or let it flow through the stem, thereby reducing its kinetic energy when it falls on the ground. Vegetation cover is a crucial factor in influencing erosion (Yan et al. 2011). Increased vegetation cover may increase the accumulation of litter on the soil surface to control soil erosion occurrence of a maximum of 75%. Vegetation root systems can significantly improve the stability of the soil and act as anti-erosion agent (Zheng et al. 2007).

The role of vegetation for water and soil conservation is largely determined by the structure and composition. Vegetation structure, according Arrijani (2006), is an organization in the space where the individuals form a stand or extension of stands type forming an association as a whole. The structure and composition of vegetation in an area are affected by ecosystem components that interact with each other, so the vegetation that grows naturally in the region is the result of the interaction among environmental factors and may change due to anthropogenic influences. Monitoring the structure and composition of vegetation in Samin watershed can be done by vegetation analysis. Analysis of vegetation, according to Susanto (2012) and Ardhana (2012), is a way of studying the composition and structure of vegetation types. Whittaker (1976) also mentions that the vegetation analysis is an approach and an introduction to a community using ecological approaches that encompass physical, chemical and biological factors affecting community attributes such as species density, distribution, as well as the diversity of its constituent species.

The objective of this research was to analyze the structure and composition of vegetation in Samin watershed Karanganyar District, Central Java to support water and soil conservation. The results of this research are expected to be a material consideration in determining soil and water conservation to maintain the condition of Samin watershed and encourage local community to behave conservatively.

MATERIALS AND METHODS

Study sites

This research was conducted from March to April 2014 in Samin watershed, Karanganyar, Central Java, Indonesia. Samin watershed geographically extends from east to west. Its upstream area is on the slopes of Mount Lawu and downstream area is in Sukoharjo rice fields, covering a total area of 37302.5 ha. Administratively, Samin watershed is located in two districts namely Karanganyar and Sukoharjo, Central Java Province, Indonesia. The length of this watershed, according Riyanto and Paimin (2011), reaches 39.5 km and an average width 7 km. Samin watershed in the Karanganyar District includes five sub-districts, namely: Tawangmangu, Matesih, Jumantono, Jumapolo, and Jatiyoso. While that in Sukoharjo District includes three sub-districts, namely Bendosari, Mojolaban and Polokarto.

Procedure

Pre research (survey)

The field survey was conducted to determine the condition of the study site, soil characteristics, slope, and other information relating to the condition of the Samin watershed. Several kinds of maps reviewed for this study were topographic maps, land use maps, administrative maps, Samin Watershed map. Those maps were used to determine the location of the study area and the determination of the sampling unit.

Determination of sampling units

Based on a total area of 37 ha watershed Samin, a total of 37 points were sampled randomly from 6 observation stations located according to the biophysical characteristics of the Samin watershed area, namely upstream (2 stations), middle (2 stations), and downstream (2 stations).

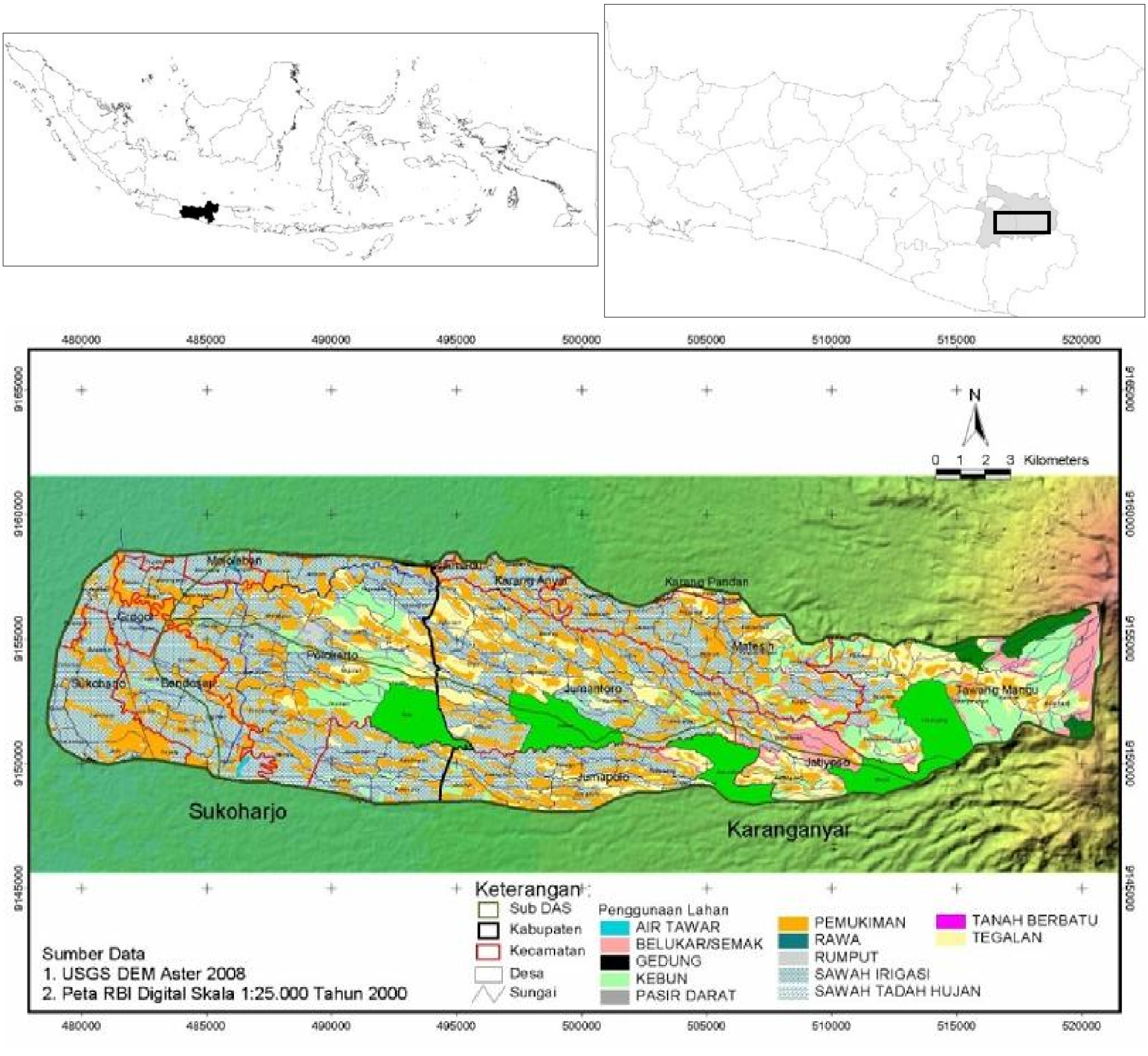

Figure 1. Map of Samin watershed, Central Java, Indonesia (Riyanto and Paimin 2011).

Vegetation sampling

Vegetation analysis was conducted to know the type and composition of the vegetation in Samin watershed. We calculated the importance value index (IVI) which consists of several parameters, namely density, dominance and basal area, frequency, and canopy area. We also determined the diversity index to know the general condition of community. The steps carried out at this stage were as follows: (i) The sampling sites were selected in accordance with the result of first step. (ii) At each sampling point, vegetation analysis was conducted both for tree and LCC vegetation. Vegetation analysis was conducted using Point Center Quarter (PCQ) method, namely dividing the points into four quadrants with two imaginary lines perpendicular to each other, one of which was directed using a compass (Widoretno 2011; Mitchell 2007). At each sampling quadrant, measurement was done to the tree nearest to the point to determine its distance from the point, the trunk circumference (to determine the basal area), canopy area, and the height of the tree. Vegetation sampling for LCC community was done in each quadrant by making plots measuring 1x1 m^2 to record the species, the number, and coverage of each species (Widoretno 2011). (iii) The results of enumeration and measurement were recorded on the observation table and the species of trees and LCC were identified.

Data analyses

Data were analyzed quantitatively to determine the vegetation parameters and qualitatively to describe the relationship between the result of vegetation analysis and vegetation's ability to sustain Samin watershed. Method of data analyses were done following Whittaker (1975), Widoretno (2011) and Mitchell (2007) as follows.

Density

Trees vegetation

Mean distance = D

$$D = \frac{\text{Total dista}}{\sum \text{Total quai}}$$

Density per 100 m^2

$$\text{Density per 100 m}^2 = \frac{\text{Main d}}{\text{D2}} \text{ X correction factor}$$

Absolute density of each type (ADs)

$$\sum \text{ in the quarter} = \frac{\sum \text{Species}}{\sum \text{Total qua}}$$

ADs = ∑ in quarter x D

Relative density (RDs)

$$RDs = \frac{\text{ADs}}{\sum \text{Total}} \text{ X } 100\%$$

Lower Crop Community (LCC)

Absolute density (ADsi)

$$ADsi = \frac{\sum \text{Individual of spe}}{\sum \text{Total of area}}$$

Relative density (RDsi)

$$RDs = \frac{\text{AD (i)}}{\text{AD total of all spe}} \text{ x } 100\%$$

Frequency

Tree vegetation

Absolute frequency (AF)

$$AF = \frac{\sum \text{sampling points where X species fc}}{\sum \text{Sampling Points}}$$

Relative frequency (RF)

$$RF = \frac{\text{AF}}{\sum \text{Tota}} \text{ X } 100\%$$

Lower Crop Community (LCC)

Absolute frequency (AFi)

$$AFi = \frac{\sum \text{Total plots where X species fc}}{\sum \text{Total plot}}$$

Relative frequency (RFi)

$$AFi = \frac{\text{Absolute frequenci (i)}}{\text{Total absolute frequency of all spe}} \text{ x } 100\%$$

Dominance and wide of Basal Area

Tree vegetation

Basal area (BA) = ¼ πD^2 /

$$\text{Main BA of X species} = \frac{\text{Total BA X species}}{\sum \text{Individuals of X spe}}$$

Relative basal area (RBA)

$$RBA = \frac{\text{BA}}{\sum \text{Tota}} \text{ X } 100\%$$

Lower Crop Community (LCC)

Absolute dominance of I species (i)

$$ADmi = \frac{\sum \text{Coverage of specie}}{\text{Total plot area}}$$

Relative dominance (RDi)

$$RDmi = \frac{\sum \text{Absolute dominance of i spe}}{\sum \text{Total absolute dominanc}}$$

Tree vegetation canopy area

Canopy area = distance of West-East (BT) x Distance of North-South (US) x π

Relative canopy area (R Canopy A)

$$\text{R Canopy A} = \frac{\text{Canopy A}}{\sum \text{Total Cano}} \text{ X } 100\%$$

Tree vegetation

Importance value index (IVI)

IVI = RDs +RF + RBA + R Canopy A

Lower Crop Community (LCC)

IVI = RDs + RF + RDm

Diversity Index

Species diversity and stability of community was analyzed using Shannon-Weiner index (Barbour 1987) as follows:

$$H' = -\sum 1 \frac{ni}{N} \log \frac{ni}{N}$$

Where:
H' = Shannon-Weiner diversity index
ni = Number of individuals of i species
N = Total number of individuals of all species

Interpretation was based on Fachrul (2007) which defines: (i) the value of H '> 3 indicates a high diversity; (ii) the value of H ', 1 ≤ H' ≤ 3 shows medium diversity; and (iii) the value of H '<1 indicates low diversity.

RESULTS AND DISCUSSION

Composition of vegetation in Samin watershed

Upstream area

In the upstream area, there were 21 species of LCC belonging to 10 families with 2640 number of individuals. The Importance Value Indexes (IVI) for LCC species in the upstream area are shown in Table 1. The species with the greatest IVI were *Mimosa pudica* (56.24), *Ageratum conyzoides* (45.34), and *Tridax procumbens* (37.23) while the species with the lowest IVI was *Curcuma zedoaria* (0.60).

In the upstream area, there were 27 tree species belonging to 16 families. The IVI of tree species in the upstream area are presented in Table 2. The tree species with the greatest IVI were *Tectona grandis* (78.57), *Delonix regia* (59.74), and *Swietenia mahagoni* (38.16) while the species with the lowest IVI was *Persea americana* (4.88). Tree species in the upstream area had canopy area ranging from 31 to 430 m^2 while the height of trees ranged from 5.50 to 15.50 m.

Midstream area

In the midstream area there were 34 species of LCC belonging to 14 families with 2827 number of individuals. The Importance Value Indexes (IVI) for LCC species in the midstream area are shown in Table 3. The species with the greatest IVI were *Oplismenus burmanii* (39.01), *Axonopus compressus* (19.73), and *Chloris barbata* (18.49) while the species with the lowest IVI was *Cyperus globusus* (1.84).

In the midstream area there were 18 tree species belonging to 9 families. The IVI tree species in the midstream area are presented in Table 4. The tree species with the greatest IVI were *Tectona grandis* (71.61), *Swietenia mahagoni* (43.54), and *Cassia siamea/*cassia (36.72). Tree species in the midstream area had canopy area ranging from 102 to 470 m^2, while the height of trees ranged from 3.38 to 11.25 m.

Downstream area

In the downstream area there were 28 species of LCC belonging to 14 families with 3302 number of individuals. The Importance Value Indexes (IVI) for LCC species in the downstream area are shown in Table 5. The species with the greatest IVI were *Oplismenus burmanii* (34.49), *Ageratum conyzoides* (26.53), and *Chloris barbata* (18.10) while the species with the lowest IVI was *Phyllanthus reticulatus* (1.01).

Table 1. LCC species found in upstream area of Samin watershed

Name of species	RDs	RDm	RF	IVI	Rank
Ageratum conyzoides	13.90	17.09	14.34	45.34	2
Axonopus compressus	4.24	3.85	4.26	12.36	8
Chloris barbata	1.74	3.19	2.71	7.65	14
Colocasia esculenta	0.23	1.46	1.94	3.62	17
Curcuma zedoaria	0.08	0.14	0.39	0.60	21
Cynodon dactylon	1.93	2.31	3.49	7.73	12
Digitaria sanguinalis	6.17	5.70	8.53	20.40	4
Elephantopus scaber	1.74	2.34	2.71	6.80	15
Euphorbia hirta	3.67	7.02	8.53	19.22	5
Fimbristylis schoenoides	1.63	2.39	1.94	5.96	16
Galinsoga parviflora	6.63	4.40	6.20	17.23	6
Hyptis brevipes	1.93	2.31	3.49	7.73	13
Lantana camara	0.30	0.69	0.78	1.77	19
Mimosa invisa	1.97	3.41	4.26	9.65	10
Mimosa pudica	24.51	23.20	8.53	56.24	1
Pennisetum purpureum	9.39	2.89	3.88	16.16	7
Phyllanthus urinaria	2.27	3.28	3.10	8.65	11
Sida rhombifolia	0.23	0.69	1.94	2.85	18
Sonchus arvensis	0.30	0.69	0.78	1.77	20
Tridax procumbens	15.61	9.22	12.40	37.23	3
Wedelia montana	1.52	3.72	5.81	11.05	9
Total	100	100	100	300	

Table 2. Tree species found in upstream area of Samin watershed

Name of species	Relative basal area	Relative canopy area	Relative Freq.	Relative Density	IVI
Albizia falcata	0.98	0.56	2.17	2.08	5.80
Altingia excelsa	1.60	1.94	4.35	4.17	12.06
Anacardium occidentale	2.24	2.36	2.17	2.08	8.85
Artocarpus integra	1.83	1.85	2.17	2.08	7.93
Cassia siamea	7.13	6.15	4.35	4.17	21.79
Casuarina equisetifolia	0.38	0.56	2.17	2.08	5.19
Ceiba pentandra	0.91	1.02	2.17	2.08	6.19
Cocos nucifera	0.66	0.68	2.17	2.08	5.60
Cordyline fruticosa	0.47	0.68	2.17	2.08	5.41
Dalbergia latifolia	7.06	6.82	6.52	6.25	26.65
Delonix regia	15.57	18.63	13.04	12.50	59.74
Dimocarpus longan	1.83	1.40	2.17	2.08	7.48
Durio zibethinus	1.50	1.40	2.17	2.08	7.15
Guazuma ulmifolia	4.17	3.71	4.35	4.17	16.39
Hibiscus tiliaceus	1.87	1.45	2.17	2.08	7.58
Leucaena glauca	0.66	1.01	2.17	2.08	5.92
Melia azedarach	1.97	1.86	2.17	2.08	8.09
Muntingia calabura	1.59	1.45	2.17	2.08	7.30
Musa paradisiaca	0.66	0.70	2.17	2.08	5.61
Parkia speciosa	2.46	1.89	2.17	2.08	8.60
Persea americana	0.29	0.33	2.17	2.08	4.88
Pinus merkusii	2.06	0.63	4.35	4.17	11.20
Pometia pinnata	1.97	1.40	2.17	2.08	7.63
Samanea saman	4.29	4.28	2.17	2.08	12.83
Swietenia mahagoni	8.42	8.45	10.87	10.42	38.16
Syzygium aromaticum	1.68	1.45	2.17	2.08	7.39
Tectona grandis	25.76	27.35	10.87	14.58	78.57
Total	100	100	100	100	400

Table 3. LCC species found in upstream area of Samin watershed

Name of species	RDs	RDm	RF	IVI	Rank
Acalypha indica	2.02	2.77	3.91	8.69	13
Ageratum conyzoides	5.59	3.82	8.33	17.74	4
Amaranthus spinosus	1.06	2.33	1.56	4.95	24
Axonopus compressus	11.14	5.46	3.13	19.73	2
Borreria ocymoides	2.65	1.98	2.08	6.72	16
Canna indica	0.53	0.71	0.78	2.02	33
Chloris barbata	7.61	5.16	5.73	18.49	3
Clitoria ternatea	0.88	1.15	1.30	3.34	30
Cyperus globusus	0.35	0.71	0.78	1.84	34
Digitaria sanguinalis	3.15	4.35	5.21	12.70	5
Euphorbia hirta	1.24	1.07	1.30	3.61	28
Fimbristylis globulosa	4.07	2.83	3.13	10.02	12
Fimbristylis schoenoides	3.15	3.54	4.43	11.11	11
Flemingia lineata	4.42	3.23	4.17	11.82	10
Galinsoga parviflora	1.59	1.76	3.91	7.26	15
Imperata cylindrica	2.65	5.16	4.69	12.50	8
Indigofera suffruticosa	1.59	2.33	2.34	6.26	17
Ipomoea batatas	0.42	2.73	2.08	5.24	23
Ipomoea crania	1.06	2.53	2.34	5.93	19
Kyllinga monocephala	3.47	2.41	1.82	7.70	14
Mimosa pudica	4.42	3.54	4.69	12.65	6
Ocimum gratissimum	0.81	1.70	2.08	4.60	25
Oplismenus burmanii	16.09	17.19	5.73	39.01	1
Panicum barbatum	4.07	3.84	4.69	12.60	7
Passiflora foetida	0.71	1.52	1.30	3.53	29
Pennisetum purpureum	5.31	2.93	4.17	12.40	9
Phyllanthus urinaria	1.59	1.21	3.13	5.93	20
Portulaca oleracea	0.71	1.31	2.08	4.10	27
Ruellia tuberosa	0.64	0.91	0.78	2.33	32
Sida rhombifolia	1.24	1.80	1.30	4.34	26
Stachytarpheta indica	1.98	2.33	1.56	5.87	21
Stachytarpheta jamaicensis	1.59	1.70	2.34	5.63	22
Wedelia biflora	0.42	1.70	1.04	3.16	31
Wedelia montana	1.77	2.33	2.08	6.18	18
Total	100	100	100	300	

Table 4. Tree species found in midstream area of Samin watershed

Name of species	Relative basal area	Relative canopy area	Relative Freq.	Relative Density	IVI
Albizia falcata	6.13	7.29	7.89	8.51	29.82
Artocarpus altilis	0.86	1.40	2.63	2.13	7.02
Cassia siamea	9.71	10.61	7.89	8.51	36.72
Crotalaria striata	0.80	1.42	2.63	2.13	6.98
Dalbergia latifolia	9.20	9.95	7.89	8.51	35.56
Delonix regia	10.04	7.90	7.89	8.51	34.35
Hibiscus tiliaceus	0.68	0.95	2.63	2.13	6.39
Melia azedarach	5.99	7.01	5.26	4.26	22.51
Morinda citrifolia	0.59	0.78	2.63	2.13	6.13
Muntingia calabura	2.77	1.96	5.26	4.26	14.24
Pithecellobium dulce	6.62	6.94	7.89	8.51	29.96
Polyalthia longifolia	2.68	2.46	2.63	2.13	9.90
Samanea saman	9.33	6.16	5.26	4.26	25.01
Swietenia mahagoni	12.41	12.60	7.89	10.64	43.54
Tamarindus indica	1.14	1.07	2.63	2.13	6.97
Tectona grandis	19.51	19.29	15.79	17.02	71.61
Terminalia catappa	0.64	0.77	2.63	2.13	6.16
Thevetia peruviana	0.91	1.45	2.63	2.13	7.12
Total	100	100	100	100	400

Table 5. LCC species found in downstream area of Samin watershed

Name of species	RDs	RDm	RF	IVI	Rank
Ageratum conyzoides	8.48	12.37	5.68	26.53	2
Amaranthus spinosus	1.42	1.82	1.89	5.13	21
Amorphophallus titanum	0.24	1.59	1.14	2.97	24
Canna edulis	0.18	1.93	1.89	4.00	22
Chloris barbata	5.30	5.22	7.58	18.10	3
Clitoria ternatea	0.24	1.91	1.14	3.29	23
Elephantopus scaber	1.45	2.95	3.03	7.43	18
Eleusine indica	5.91	2.70	3.03	11.64	12
Galinsoga parviflora	7.81	3.06	3.79	14.67	8
Hyptis pectinata	5.45	3.63	3.79	12.87	11
Imperata cylindrica	5.30	4.65	5.68	15.63	7
Kyllinga monocephala	1.82	4.22	3.03	9.07	15
Lantana camara	1.21	2.16	5.30	8.67	17
Mimosa invisa	3.79	3.74	3.79	11.32	13
Mimosa pudica	5.45	4.88	3.41	13.74	9
Oplismenus burmanii	13.63	8.74	12.12	34.49	1
Oxalis corniculata	0.27	0.79	0.76	1.82	26
Paederia foetida	0.24	1.13	0.38	1.76	27
Panicum barbatum	7.12	3.06	3.41	13.59	10
Paspalum scrobiculatum	2.42	3.52	3.03	8.97	16
Pennisetum purpureum	5.60	5.33	5.68	16.62	6
Peperomia pellucida	5.45	4.88	7.58	17.91	4
Phyllanthus reticulatus	0.06	0.57	0.38	1.01	28
Phyllanthus urinaria	1.06	1.52	2.65	5.23	20
Stachytarpheta jamaicensis	6.51	6.47	3.79	16.77	5
Wedelia biflora	2.42	3.52	3.41	9.35	14
Xanthosoma nigrum	1.06	2.61	1.89	5.56	19
Zingiber purpureum	0.09	1.02	0.76	1.87	25
Total	100	100	100	300	

Table 6. Tree species found in downstream area of Samin watershed

Name of species	Relative basal area	Relative canopy area	Relative Freq.	Relative Density	IVI
Albizia falcata	14.25	15.02	14.29	14.58	58.14
Artocarpus altilis	1.36	0.70	2.86	2.08	7.00
Artocarpus integra	2.36	3.17	5.71	4.17	15.41
Cassia siamea	15.59	16.13	14.29	14.58	60.59
Ficus ampelas	1.77	1.58	2.86	2.08	8.29
Hibiscus tiliaceus	8.49	10.49	8.57	10.42	37.97
Leucaena glauca	6.95	8.32	8.57	10.42	34.26
Morinda citrifolia	0.70	0.90	2.86	2.08	6.54
Muntingia calabura	1.61	2.18	2.86	2.08	8.73
Samanea saman	23.80	22.40	14.29	16.67	77.14
Swietenia mahagoni	16.67	13.75	17.14	14.58	62.14
Tectona grandis	6.45	5.36	5.71	6.25	23.78
Total	100	100	100	100	400

Tabel 7. Diversity Index of vegetation in Samin Watershed

Vegetation and areas	H’	Interpretation
LCC:		
Upstream	1,04	Medium
Midstream	1,34	Medium
Downstream	1,23	Medium
Trees:		
Upstream	1,31	Medium
Midstream	1,15	Medium
Downstream	0,97	Low

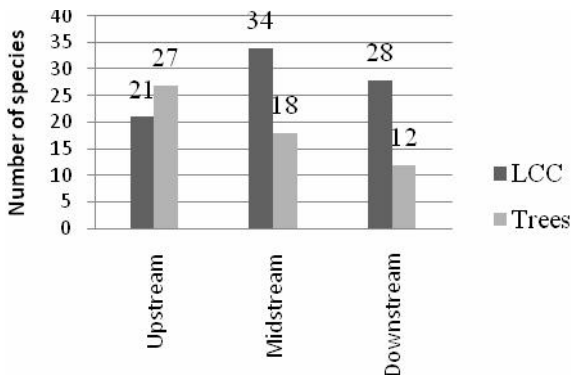

Figure 2. Comparison of number of species in upstream, midstream, and downstream area of Samin watershed

In the downstream area there were 12 tree species belonging to 7 families. The IVI of tree species in the downstream area are presented in Table 6. The tree species with the greatest IVI were *Samanea saman* (77.14), *Swietenia mahagoni* (62.14), and *Cassia siamea* (60.59). Tree species in the downstream area canopy area ranging from 79 to 320 m^2 while the height of trees ranged from 3.50 to 9.21 m.

The results of vegetation analysis in Samin watershed showed that composition of vegetation in three areas was different from each other. Composition of vegetation gives an overview of the spatial occupation level of each plant species making up the community which is the result of interaction between biotic and abiotic components (Fachrul 2007). Comparison of the number of species making up community in three observation areas is presented in Figure 2.

There were differences in both LCC and tree species, in terms of species and the number of individuals, although some species were found in all three observation areas. The differences are due to environmental factors. This is supported by Gupta et al. (2008) who state that environmental factors influence the diversity of living organisms making up an area (both density and species richness) including vegetation and fauna. The environmental factors include soil temperature, pH, and nutrient content in the soil. In addition, Krebs (2009) and Ardhana (2012) mention that the climatic conditions in the habitats of plants also influence plant community. Elevation is one of environmental factors. Elevation of some areas influences the importance value index (IVI) of vegetation.

IVI shows the contribution or importance of species in plant communities. Giliba et al. (2011) state that the higher IVI, the higher contribution of species in its community. From Figure 2, we know that for tree vegetation, number of species decreased from the upstream to the downstream area. This suggests differences in environmental conditions between the upstream and downstream. The downstream region was dominated by farming areas so that the number of tree species found was fewer than that in the upper and middle regions.

Diversity of vegetation in Samin watershed

The diversity indexes (H') for LCC in upstream, midstream, and downstream areas were 1.04; 1.34; and 1.23 respectively. While the H' for tree vegetation in upstream, midstream, and downstream areas were 1.31; 1.15; and 0.97 respectively. Complete interpretation for diversity of vegetation in Samin watershed is presented in Table 7. Interpretation based on Fachrul (2007) which defines: 1) the value of H '> 3 indicates a high diversity; 2) the value of H ', 1 ≤ H' ≤ 3 shows medium diversity; and 3) the value of H '<1 indicates low diversity.

Shannon-Weiner index, according to Giliba et al. (2011), shows the species richness (number of species) and species evenness (distribution) in a region. The higher the H' value, the higher the species diversity and distribution in a region. This is similar to Paramitha (2010) statement that the diversity index is correlated positively with the number of species. The diversity of organisms in a community is affected by the components of space, time, and food.

The highest diversity index for LCC vegetation was found in the midstream area while the lowest was in the upstream area. The highest tree diversity index was found in the upstream area while the lowest was downstream area. This is closely related to environmental factors in the three areas of observation. Differences in environmental factors can affect the lives of both trees and LCC vegetation. The downstream region has the lowest tree diversity. The number of individual species found in the downstream region was also the least. This is caused mainly by the large size of land in the downstream area used as agricultural land and tree plantations so the vegetation is uniform. Sujalu (2008) explains that habitat types that have more species are likely to have higher species diversity index.

Relationship between vegetation and water and soil conservation

Condition of vegetation in Samin watershed including both composition and diversity of trees and LCC can be used as an indicator of sustainability of Samin watershed, especially in relation to water and soil conservation. The results of the study Wang et al. (2013) state that vegetation affects the ability of soil to retain water in order to prevent erosion and landslides in the surrounding cliffs. This result is supported by Maridi et al. (2014) that states vegetation condition in watershed can be used as monitoring of erosion and landslide in watershed. Arrijani (2006) also states that the thick vegetation and grass vegetation types are more effective in curbing erosion than relay cropping plants, cotton and corn. Plant roots can significantly improve the stability of the soil and act as anti-erosion system (Zheng et al. 2007). This is also supported by Maridi (2012) showing that grass vegetation is lower crop community that can resist erosion and retain sediment, since grasses have the ability to hold soil due to their strong root system.

The results showed that the overall diversity of trees and LCC vegetation was in the medium category except for LCC vegetation in the downstream area. However, there were no significant differences in diversity indexes among the three sub-watershed areas in Samin. It indicates that the diversity of LCC vegetation in Samin watershed was still in the moderate category. One reason is that the land in Samin watershed for crop production and agriculture and received less attention from the government. There were some similarities among the three regions in species composition, although there were differences in the number of individuals. LCC vegetation in the upstream region was dominated by *Mimosa pudica*, *Ageratum conyzoides*, and *Tridax procumbens* which are shrub, while the middle and downstream areas were dominated by grasses. Shrubs and grasses have the potential to be developed in water and soil conservation efforts, as shown in the results of research of Sancayaningsih and Saputra (2013) showing that the grass vegetation could withstand runoff and increase infiltration. The average retention to hold rainwater in this study, were 33% for bare ground, 77% for grasses and herbs, and 81% for shrubs. Shrub is a woody plant which has good ground coverage and root system. Root systems of vegetation both LCC and trees can significantly improve the stability of the soil and act as an anti-erosion system. Vegetation can also reduce erosion by reducing water flow in the soil surface. The percentage reduction of sediment is higher than the average reduction of run off. The reduction of run off in forest vegetation is 30.8% and in the grass vegetation is 5.6% while the average reduction of sediment is 88.8% in forest vegetation and 77.4% in grass vegetation (Zheng et al. 2007).

Tree canopy can retain rain water through several mechanisms. Vegetation canopy can intercept droplets of rain water that falls on it, hold it above the canopy and release it over the surface of the soil (through fall) and let it run it through a carrier vessels in the stem (stem flow) as well as reduce its kinetic energy when it falls on the ground. This reduces the direct blow of the rain water on the ground, thereby reducing the risk of damage to the soil surface, lowering the erosion rate. Trees produce a litter layer which can also reduce the negative effects of the rain drop, curb runoff, increase infiltration and reduce friction with the ground so that erosion and sedimentation are reduced.

The results of vegetation analysis showed that the dominant tree species in the upsteam and midstream areas was *Tectona grandis* and in the downstream area was *Samanea saman*. These trees have large and strong root system as indicated by the height of plants and the canopy area. In the upstream, midstream, and downstream regions, the canopy area ranged from 31 to 430 m^2, 102-470 m^2, and 79-320 m^2 respectively While the height of plants ranged from 5.50 to 15.50 m, 3.38-11.25 m, and 3.50- 9.21 m respectively. Day et al. (2010) states that size and spread of roots are influenced by plant height and canopy area. Trees with large root serve to strengthen the soil, to prevent erosion and to hold a large amount of water. Litter layer also has the potential to enrich the soil so that the soil is not barren. Having these conditions, the watershed is expected to remain in good condition characterized by a small erosion and sediment, because the rain water is infiltrated and stored mostly as ground water. This also has the potential to cope with droughts and flooding in the Samin sub-watershed.

CONCLUSION

The results of this research showed that in the upstream, midstream, and downstream areas the numbers of LCC species were 21, 34, and 28 respectively. The diversity indexes of LCC vegetation in the upstream, midstream, and downstream areas were 1.04, 1.34, and 1.23 respectively, categorized as medium diversity. The numbers of tree species in the upstream, midstream, and downstream areas were 27, 18, and 12 respectively. The diversity indexes of tree vegetation in the upstream, midstream, and downstream areas were 1.31, 1.15, and 0.97 respectively, categorized as medium for upstream and midstream areas and low for downstream area. To maintain the sustainability of Samin Watershed, the vegetation in the watershed must be conserved.

REFERENCES

Ardhana IPG. 2012. Plant Ecology. Udayana University Press, Bali. [Indonesian]

Arrijani. 2006. Correlation between Trees Architecture Model with Stem flow, Canopy Interception, Infiltration, Surface Flow, and Erosion. [Dissertation]. Bogor Agricultural University, Bogor. [Indonesian]

Barbour MG. 1987. Terrestrial Plant Ecology. The Benjamin Cummins, Menlo Park, C.A.

BPDAS. 2009. Circular Letter Number SE.02/V-SET/2009 about Decision in Working Area of BPDAS. [Indonesian]

Day SD, Wiseman PE, Dickinson SB, Harris JR. 2010. Contemporary concepts of root system architecture of urban trees. Arboricult Urb For 36 (4): 149-159.

Eamus D. 2010. Catchment water balance, climate, and groundwater. Groundwater 1: 1-6.

Fachrul MF. 2007. Bioecology Sampling Method. Bumi Aksara, Jakarta. [Indonesian]

Giliba RA. 2011. Species composition, richness, and diversity in Miombo Woodland of Bereku Forest Reserve, Tanzania. J Biodiv 2 (1): 1-7.

Gupta RB, Chaudhari PR, Wate SR. 2008. Floristic diversity in urban forest area of NEERI Campus, Nagpur, Maharashtra (India). J Environ Sci Eng 50 (1): 55-62.

Krebs CJ. 2009. Ecology: The Experimental Analysis of Distribution and Abundance. 6th ed. Benjamin Cummings, San Francisco.

Maridi, Marjono, Alanindra, Agustina. 2014. Identification of Vegetation Diversity for Keeping the Quality of Slope Around Dengkeng Watershed, Klaten, Central Java. Proceeding of International Conference on Basic Science (ICBS) and International Conference on Global Resource Conservation Initiade in 2010, Malang, February 2014.

Maridi. 2012. Sedimentation Prevention (Control) through Community Based of Vegetative Conservation Approach of the Keduang Sub-Watershed Wonogiri, Central Java, Indonesia. [Dissertation]. Sebelas Maret University, Surakarta. [Indonesian]

Marsono Dj. 2008. The requirement use of the ecosystem knowledge in Land and Forest Management. Speech on the 45th Anniversary of Faculty of Forestry, Yogyakarta, November 7, 2008. [Indonesian]

Mitchell K. 2007. Quantitative analysis by the Point-Centered Quarter Method. arXiv:1010.3303v1

Mueller-Dumbois D, Ellenberg, H. 1974. Aim and Methods of Vegetation Ecology. John Willey and Sons, New York.

Nugraha S, Sulastoro, Sutirto TW, Sudarwanto S. 2006. Potential and Breakage Level of Land in Samin Watershed Karanganyar and Sukoharjo Regency Central Java in the year of 2006. PPLH LPPM, Sebelas Maret University, Surakarta. [Indonesian]

Paramitha IGAAP, Ardhana IPG, Pharmawati M. 2010. Biodiversity of ephiphytic orchid in Danau Buyan, Tamblingan National Park. Metamorfosa 1 (1):11-16. [Indonesian]
Parejiya NB, Detroja SS, Panchal NS. 2013. Vegetation analysis at Bandiyabedi Forest in Surendranagar District of Gujarat State of India. Intl J Life Sci Biotechnol Pharm Res 2 (2): 241-247.
Postel SL, Thompson BH. 2005. Watershed protection: Capturing the benefits of nature's water supply services. Nat Resour Forum. 29: 98-108.
Riyanto HD, Paimin. 2011. Performance of hardwood tree in Samin Watershed in the perspective of watershed conservation. For Nat Conserv Res J 8 (1): 45-54. [Indonesian]
Sancayaningsih RP, Saputra A. 2013. Tree vegetation analysis around springs for water conservation. Gadjah Mada University, Yogyakarta. [Indonesian]
Sujalu AP. 2008. Vegetation analysis of ephypitic orchid in felled tree receptacle forest Malinau Research Forest (MRF)-CIFOR. Media Konservasi. 13 (3): 1-9. [Indonesian]
Susanto W. 2012. Vegetation Analysis in Tropical Rainforest Ecosystem for Managing Raden Soerjo Public Forest. (www.wayansusantoshut.blogspot.com). [Indonesian]
Triwanto J. 2012. Forest Land and Watershed Conservation. UMM Press, Malang. [Indonesian]
Wang C, Chuan YZ, Zhong LX, Yang W, Huanhua P. 2013. Effect of vegetation on soil water retention and storage in a semi arid Alpine forest catchment. J Arid Land 5 (2): 207-219.
Whittaker RH. 1975. Communities and Ecosystems. Macmillan, London.
Widoretno S. 2011. Plant Ecology Learning Module. Sebelas Maret University, Surakarta. [Indonesian]
Yan Y, Xu X , Xin X, Yang G, Wang X, Yan R, Chen B. 2011. Effect of Vegetation Coverage on Aeolian Dust Accumulation in Semiarid Steppe of Northern China. Catena 87: 351-356.
Zheng MG, Cai Q, Chen H. 2007. Effect of vegetation on runoff-sediment yield relationship at different spatial scales in Hilly Areas of the Loess Plateau, North China. Acta Ecol Sin 27 (9): 3572-3581.