



Edi Syafri <jaast.feedback@gmail.com>
To: I Gusti Diah Ayu Yuniti

Mon, 21 Feb at 14:29

I Gusti Diah Ayu Yuniti, Jhon Hardy Purba, Nanang Sasmita, Liris Lis Komara, Tomycho Oliviana, I Made Kartika:

We have reached a decision regarding your submission to Journal of Applied Agricultural Science and Technology, "BALINESE TRADITIONAL AGROFORESTRY AS BASE OF WATERSHED CONSERVATION: -".

Our decision is to: Accept Submission

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BALINESE TRADITIONAL AGROFORESTRY AS BASE OF WATERSHED CONSERVATION

Abstract. Forests, traditional gardens and green spaces play an important role in regulating the water flow of an area. Along with the high demand for land in Bali for agriculture and tourism, many forest areas have been converted into hotels and settlements. Forest conversion has caused many problems such as erosion, soil fertility decreased, flora fauna extinction, floods, drought, global warming and the disturbing watershed, especially rivers for springs. The purpose of this study is the development of watershed conservation in Bali based on traditional agroforestry. The method that used is vegetation analysis. Calculation of the erosion amount using the USLE formula. Sampling was done by ten plots. The results showed that traditional agroforestry vegetation consisted of vertical and horizontal structures. The characteristic of traditional agroforestry is that dominant plants are distributed irregularly, thus creating a miniature structure like a forest. The vertical structure consists of trees, horizontal structure filled with species of garden plants and agriculture. Trees have roots spread intensively in the soil and reduce nutrient leaching. Land cover by vegetation protects the soil and erosion. The agroforestry has a role as an act of soil and water conservation. Traditional agroforestry land cover has a relatively low C coefficient (0.05-0.25) compared to other lands. The level of erosion hazard is low and moderate. Average erosion value of 55.01 t/ha¹.yr⁻¹. This indicates that traditional agroforestry makes the soil have a higher ability to absorb water, thereby reducing surface runoff. Likewise, organic material that improves the water content capacity. In addition, water quality can be improved through the humus filter function. During a long dry season, there is a drought due to low rainfall, but rivers and springs were able to supply water for the peoples daily needs. This condition occurs because of the tree retentions in traditional gardens. Conservation actions need to be taken, namely maintaining trees vegetation, increasing reforestation, bench terraces use, mounds and mulch use. This condition also places traditional agroforestry as a sustainable land management system.

Keywords: Bali, conservation, vegetation, watershed, traditional agroforestry

Author Objectives, ok

Author Method, ok

Author Results, ok

Author Conclusion, ok

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Equipment). 10 plots were taken in the field. Vegetation analysis was carried out to describe the vertical and horizontal structures and the composition of traditional *abian*, *kebon* and *telomon*. The time of the study will be conducted from October 2017 to September 2018.

Erosion prediction on land can be calculated using the model that Wischmeier & Smith (1978) developed by Arsyad (2012) with the formula $A = R \times K \times LS \times C \times P$. Rain erosivity factor is calculated using rainfall data in the last 10 years. Rain erosion in the study area was predicted using the formula proposed by Lenvain Arsyad (2012) as follows $EI = 2.21 R^{1.36}$, with EI = erosivity index, R = monthly rainfall (cm).

The large classes of surface erosion in the study are known based on the level of surface erosion in Table 1.

Author What did author (s) mean? Telomon or telajakan?

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170 Balinese agriculture is also faced with many obstacles. One of them is about land use and adjustment. Even in the last few years, land conversion from agricultural land to non-agricultural land has increased.

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173 In general, land use is divided into agricultural and non-agricultural land uses. Potential land use is influenced by soil type, mineral resources, vegetation, topography, climate, and location. In 2016, agricultural land in Bali reached 353,491 ha consisting of 79,526 ha (22.50%) of paddy fields and 273,965 (77.50%) ha of non-paddy fields. In comparison, the non-agricultural land reaches 210,175 ha.

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176 The use of non-paddy land in Bali during 2017 was mostly reserved for dry land and gardens totaling 123,774 ha or 37.63 percent of 328,908 ha of non-paddy land. The most common use of non-paddy fields is in Buleleng Regency, wherein 2017 it was 115,365 ha (35.08%), followed by Karangasem district with 53,043 ha (16.13%). Specifically for the use of paddy fields, Tabanan Regency still occupies the first position in 2017 with paddy fields reaching 21,089 ha. This is in accordance with the nickname of Tabanan as Balinese rice granary.

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179 The use of forestry land in Bali is in accordance with its function. According to its function, forests are divided into protected forests, production forests, nature reserves, tourist parks, and tourism forests presented in Table 4.

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Author

Please provide percentage of each land use type according to total area

done

Author

Please insert percentage of this land use type compare to the area of Buleleng Regency in order to give better description for reader

done

Author

Please insert percentage of this land use type compare to the area of Karangasem Regency

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Reply

Resolve

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207 Based on the classification of surface erosion in Table 5, the amount of erosion in the study area can be divided into 2 classes namely Low erosion (R) soil class with erosion rates ranging from 41.13 to 59.63 t.ha⁻¹.yr⁻¹. Being in the research plot 01, 03, 05, 06, 07, 09, 10. As well as low erosion class (S) with erosion ranging from 63.75 to 68 t.ha⁻¹.yr⁻¹ in the plot 02, 04 and 08.

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211 Community activities that cause forest land to be damaged, conversion to agriculture and tourism activities in upstream areas can cause sedimentation in downstream areas. The pattern of agriculture that does not follow the conservation method in the upstream watershed area with commodity crops and horticulture results in the downstream part of the watershed narrowing and shallowing of the river flow. Based on the results of the analysis of the erosion level at the study sites with medium and low categories, it is supposed that the area around the watershed is a conservation area with the main function as a catchment area. Land use in the upper watershed can be tolerated with agroforestry patterns such as traditional gardens. The agrotechnology pattern developed and implemented in the form of traditional agroforestry must meet the rules of soil and water conservation (Cuvelier & Greenfield, 2016; Molla & Sisheber, 2017).

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Author

If it possible it would be good if you can discuss a little bit these low - moderate soil erosion rate compare to soil erosion rate in non mixed garden/agroforestry type (but not include forest) which have been studied for Bali area

If you don't have the previous study for soil erosion rate (non mixed garden) for Bali then maybe you can find some study which have similar with your study area's climate and land use condition somewhere else in Indonesia.

It would be a good way to convince that the agroforestry has a better soil erosion rate compare to non agroforestry land use type.

Reply

Resolve

Author

Reviewer 2: Number 02, 04, 08 author categorized as medium but in line 213 author (s) write as moderate erosion class. Medium and moderate have the similar meaning, but it is better to choose words consistently

Answer by author:

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218 can be tolerated with agroforestry patterns such as traditional gardens. The agrotechnology pattern developed and implemented in the form of traditional agroforestry must meet the rules of soil and water conservation (Cuvelier & Greenfield, 2016; Molla & Sisheber, 2017).

219

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Author

Reviewer 2: Number 02, 04, 08 author categorized as medium but in line 213 author (s) write as moderate erosion class. Medium and moderate have the similar meaning, but it is better to choose words consistently

Answer by author: Actually, the error occurred in line 217, where the plot of 01, 03, 05, 06, 07, 09, 10, initially we categorized "moderate" and we changed it to "low". Thanks for the correction

Reply

Resolve

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2.	Low (L)	15 - <60
3.	Medium (M)	60 - <180
4.	Heavy (H)	180 - <480
5.	Very Heavy (VH)	≥480

3. Results and Discussion

Rainfall in the Last Ten Years (Rf)

Most of the Balinese people are planted as small farmers with traditional farming patterns. The Balinese style of agricultural production is strongly influenced by climate change, especially natural cycles and rainfall. Therefore, the transition of seasons is one indicator that can be used to detect the dry season or the rainy season earlier, so that agricultural planning, especially the planting period and commodity types, can be arranged according to actual climatic conditions.

Climate is closely related to human activities, plays an essential role in economic development. It has even become an essential factor in the aspect of prosperity because increasing human needs will increase industrial activity, forest clearing, agricultural businesses, and households that release greenhouse gases. Bali is generally a tropical region, which is influenced by seasonal winds. There is a dry and rainy season interspersed with a transition season. From June to September, wind currents originate from Australia and contain little moisture, resulting in a dry season. While in December to March, wind currents provide a lot of water vapor from Asia and the Pacific Ocean, resulting in the rainy season.

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Community activities that cause forest land to be damaged, conversion to agriculture and tourism activities in upstream areas can cause sedimentation in downstream areas. The pattern of agriculture that does not follow the conservation method in the upstream watershed area with commodity crops and horticulture results in the downstream part of the watershed narrowing and shallowing of the river flow. Based on the results of the analysis of the erosion level at the study sites with medium and low categories, it is supposed that the area around the watershed is a conservation area with the main function as a catchment area. Land use in the upper watershed can be tolerated with agroforestry patterns such as traditional gardens. The agrotechnology pattern developed and implemented in the form of traditional agroforestry must meet the rules of soil and water conservation (Cuvelier & Greenfield, 2016; Molla & Sisheber, 2017).

Table 4. Soil Erosion Rate (A)

PLLOT SAMPEL	R	K	LS	CP	A	TBE
Land unit 01	1370.90	0,12	2,8	0,1	46,06	Low
Land unit 02	1370.90	0,15	3,1	0,1	63,75	Medium
Land unit 03	1370.90	0,15	2,9	0,1	59,63	Low

[illegible]

2 Micrie stratum (height 1-5 m): stakes and piles vegetation

3 Lower stratum (height < 1 m): annual plants such as palawija plants and shade-resistant herbs

(Source: research data by authors)

The vertical structure of traditional gardens in Bali is arranged based on plant height and the need for ethnobotany. The height of the tree is then based on the combination of Agroforestry including the types of plants that are suitable for the agroecosystem, the types of plants that are suitable for their functions, and the types of plants that are resistant to shade (tolerant).

64 *Mandala* in the form of yards including buildings place to live and *natah*, meanwhile despicable
65 *mandala* in the form of a backyard (*teba*) and the front yard (*telajakan*). Traditional Balinese
66 landscaping uses *Tri Mandala* concept (Dewi, 2018).




Figure 1. *Telajakan* in Penglipuran, Bali Traditional Village, Bangli
Regency, Bali (Tika 2015)

Until now the land use system of *abian*, *kebon* and *telajakan* has an important role as a source of fulfilling community needs. The benefits of *abian*, *kebon* and *telajakan* are as a source of daily food needs, a source of income and other environmental service benefits. *Abian*, *kebon* and *telajakan* as a traditional agroforestry system in Bali have not received the attention and recognition of various parties both the government and local government agencies, agriculture, forestry in the development and use of land in their area. This study aims to evaluate the value and benefits of traditional dry land use (*abian*, *kebon* and *telajakan*) in the Bali area.

Erodibility factor (K) is determined based on analysis of soil texture, soil permeability, organic matter content and soil structure by the procedure proposed by Wischmeier & Smith (1978) as follows $K = 1, 292 \{2.1 M1.14 (10-4) (12-a) + 3.25, (b-2) + 2.5 (c-3)\} / 100$ with K = soil erodibility, M = particle size (% dust + % fine sand) (100 - % clay), a = percent organic matter b = soil structure class and c = soil permeability class. The length and slope factor (LS) can be searched using $LS = \sqrt{(0.00138 L^2 + 0.00965 L + 0.0138)}$ with L = slope length (m), S = slope (%) (Arsyad, 2012). Factors of crop management and soil conservation (CP) can be seen in the table of crop management (C) and soil conservation factors (P) (Asdak, 2018).



Table 1. Classification of Soil Erosion Rates









No.	Classification of erosion rates	Erosion rates ($t \cdot ha^{-1} \cdot yr^{-1}$)
1.	Very Low (VL)	<15










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2.	Low (L)	15 – <60
3.	Medium (M)	60 – <180

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140 a wet atmosphere, so the intensity of rainfall increases.

141 According to the Meteorological, Climatological, and Geophysical Agency (BMKG)

142 Bali Region, as presented in Table 2, that when viewed from rainfall in each region of Bali,

143 recorded the highest rainfall occurred in January, reaching 371.10 mm. Conversely, the lowest

144 rainfall occurred in August, reaching 36.62 mm.

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Table 2. Conditions for Rainfall in the Last Ten Years (mm) in Bali









Month	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Mean
January	260.40	373.60	554.20	638.20	552.10	316.10	134.30	373.00	289.98	219.10	371.10
February	191.60	281.70	208.60	163.60	273.20	179.30	561.40	209.00	370.11	392.30	283.08
March	66.00	274.40	528.50	121.10	57.00	294.80	91.50	201.00	292.30	275.10	220.17
April	326.50	281.60	43.20	76.60	29.50	48.10	25.00	66.00	221.12	214.23	133.18
May	86.90	120.10	119.70	125.90	28.60	60.50	94.30	230.00	109.10	107.21	108.23
June	138.70	17.80	3.80	188.80	9.50	1.90	263.20	233.00	102.22	101.42	106.03
July	114.70	19.70	50.10	111.90	48.50	0.10	122.30	97.00	89.23	87.35	74.09
August	114.40	0	0	5.20	4.90	0	62.60	61.00	58.26	59.80	36.62
September	298.40	0	2.00	1.40	0	0.30	391.10	49.40	20.78	21.54	78.49
October	250.70	35.60	11.00	10.10	0.90	0	67.70	295.00	82.40	84.10	92.96
November	168.30	150.80	92.70	195.50	150.80	32.50	276.60	567.00	81.50	82.40	179.81










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111 using $LS = \sqrt{(0.00138 L^2 + 0.00965 + 0.0138)}$ with L = slope length (m), S = slope (%) (Arsyad,

112 2012). Factors of crop management and soil conservation (CP) can be seen in the table of crop

113 management (C) and soil conservation factors (P) (Asdak, 2018).

114

115

Table 1. Classification of Soil Erosion Rates

No.	Classification of erosion rates	Erosion rates (t.ha ⁻¹ .yr ⁻¹)
1.	Very Low (VL)	<15
2.	Low (L)	15 – <60
3.	Medium (M)	60 – <180
4.	Heavy (H)	180 – <480
5.	Very Heavy (VH)	≥480

116 Source: Regulation of Directorate General of Watershed Management and Social Forestry, Ministry of Forestry,

117 Republic of Indonesia Number: P.4/V-SET/2013

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3. Results and Discussion

121 Rainfall in the Last Ten Years (Rf)

122 Most of the Balinese people are planted as small farmers with traditional farming

123 patterns. The Balinese style of agricultural production is strongly influenced by climate

124 change, especially natural cycles and rainfall. Therefore, the transition of seasons is one

125 indicator that can be used to detect the dry season or the rainy season earlier, so that

126 agricultural planning, especially the planting period and commodity types, can be arranged

127 according to actual climatic conditions.

128 Climate is closely related to human activities, plays an essential role in economic



129 development. It has even become an essential factor in the aspect of prosperity because









130 innovation, human needs, soil, income, industrial activities, forest, clearing, agriculture










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Rain Erosion Index (R)

152 The Rain Erosivity Index (R) is obtained using equations developed by Lenvain (1989). So

153 the R-value obtained for the last 10 years is 1370.90 t.ha⁻¹.yr⁻¹ and can be seen in Table 3.

154

155

Table 3. Rain Erosion Index (R)

Month	Mean (mm)	Mean (cm)	2,21 x (Rf) ^{1.36} (mm)	R (t.ha ⁻¹ .yr ⁻¹)	
January	405.23	40.52	2,21	153.63	339.52
February	288.17	28.81	2,21	96.63	213.56
March	215.37	21.53	2,21	65.03	143.72
April	107.04	10.70	2,21	25.12	55.53
May	100.68	10.06	2,21	23.12	51.09
June	88.27	8.82	2,21	19.33	42.72
July	59.81	5.98	2,21	11.38	25.16
August	24.97	2.49	2,21	3.47	7.67
September	83.50	8.35	2,21	17.92	39.61
October	80.13	8.01	2,21	16.95	37.45
November	175.21	17.52	2,21	49.11	108.55
December	375.69	37.56	2,21	138.60	306.31
Total					1370.90

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The erosivity value can be an indicator of the occurrence of high surface runoff in the

160 watershed area of Bali when it rains. This surface flow carries soil particles that result from






















































161 damage to soil aggregates due to strong pressure rain because of the kinetic energy of the rain.

162 According to Asdak (2018), if the amount and intensity of rain is high, then the potential for

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Source: Rainfall Observation Laboratories in Bali (data processed)

Rain Erosion Index (EI)
The Rain Erosivity Index (EI) is obtained using equations developed by (Arsyad, 2012).. So the R-value obtained for the last 10 years is 1370.90 t.ha⁻¹.yr⁻¹ and can be seen in Table 3.

Table 3. Rain Erosion Index (EI)

Month	Mean (mm)	Mean (cm)	2,21 x (Rf) ^{1.36} (mm)	R (t.ha ⁻¹ .yr ⁻¹)
January	405,23	40,52	2,21	153,63
February	288,17	28,81	2,21	96,63
March	215,37	21,53	2,21	65,03
April	107,04	10,70	2,21	25,12
May	100,68	10,06	2,21	23,12
June	88,27	8,82	2,21	19,33
July	59,81	5,98	2,21	11,38
August	24,97	2,49	2,21	3,47
September	83,50	8,35	2,21	17,92
October	80,13	8,01	2,21	16,95
November	175,21	17,52	2,21	49,11
December	375,69	37,56	2,21	138,60
Total				1370,90

Author

In line 96 it said R (monthly rainfall in cm). In this table it use as Rf. Are those the same ? Please consistent in using the symbol for the formula.

Another thing is about the monthly data for coloumn Rf (153,63; 96,63, etc) : where is data come from ? As long as you have justification for it, it is fine. I just need to clarify it.






















































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I just want to clarify : this coloumn is mean rainfall data, but if I refer to table 2, I could not find these data you put as mean value (mm) for this table. I just want to clarify which data you used for this.

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Source: research data processed

The erosivity value can be an indicator of the occurrence of high surface runoff in the watershed area of Bali when it rains. This surface flow carries soil particles that result from damage to soil aggregates due to strong pressure rain because of the kinetic energy of the rain. According to Asdak (2018), if the amount and intensity of rain is high then the potential for surface runoff and erosion will also be high. Erosivity is affected by the fall of raindrops directly on the ground and partly because of the flow of water above ground level.

Land Use (LU)

Author






















































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Source: Rainfall Observation Laboratories in Bali (data processed)

Rain Erosion Index (R)
The Rain Erosivity Index (R) is obtained using equations developed by Lenvain (1989). So the R-value obtained for the last 10 years is 1370.90 t.ha⁻¹.yr⁻¹ and can be seen in Table 3.

Table 3. Rain Erosion Index (R)

Month	Mean (mm)	Mean (cm)	2,21 x (Rf) ^{1.36} (mm)	R (t.ha ⁻¹ .yr ⁻¹)
January	405,23	40,52	2,21	153,63
February	288,17	28,81	2,21	96,63
March	215,37	21,53	2,21	65,03
April	107,04	10,70	2,21	25,12
May	100,68	10,06	2,21	23,12
June	88,27	8,82	2,21	19,33
July	59,81	5,98	2,21	11,38
August	24,97	2,49	2,21	3,47
September	83,50	8,35	2,21	17,92

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
September	298.40	0	2.00	1.40	0	0.30	391.10	49.40	20.78	21.54	78.49							
October	250.70	35.60	11.00	10.10	0.90	0	67.70	295.00	82.40	84.10	92.96							
November	168.30	150.80	92.70	195.50	150.80	32.50	276.60	567.00	81.50	82.40	179.81							
December	508.20	334.90	235.10	515.80	485.60	200.20	399.00	486.00	176.21	175.46	351.65							

Source: Rainfall Observation Laboratories in Bali (data processed)

Rain Erosion Index (R)

The Rain Erosivity Index (R) is obtained using equations developed by Lenvain (1989). So the R-value obtained for the last 10 years is 1370.90 t.ha⁻¹.yr⁻¹ and can be seen in Table 3.

Table 3. Rain Erosion Index (R)

Month	Mean (mm)	Mean (cm)	2,21 x (Rp) ^{1.36} (mm)		R (t.ha ⁻¹ .yr ⁻¹)
January	405,23	40,52	2,21	153,63	339,52
February	288,17	28,81	2,21	96,63	213,56
March	215,37	21,53	2,21	65,03	143,72
April	107,04	10,70	2,21	25,12	55,53
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December	375,69	37,56	2,21	138,60	306,31
Total					1370,90

The erosivity value can be an indicator of the occurrence of high surface runoff in the

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108 Erodiability factor (K) is determined based on analysis of soil texture, soil permeability, organic
109 matter content and soil structure by the procedure proposed by Wischmeier & Smith (1978) as
110 follows $K = 1.292 (2.1 M1.14 (10^{-4}) (12-a) + 3.25 (b-2) + 2.5 (c-3)) / 100$ with K = soil
111 erodibility, M = particle size (% dust +% fine sand) (100 -% clay), a = percent organic matter b =
112 soil structure class and c = soil permeability class. The length and slope factor (LS) can be searched
113 using $LS = \sqrt{(0.00138 L^2 + 0.00965 + 0.0138)}$ with L = slope length (m), S = slope (%) (Arsyad,
114 2012). Factors of crop management and soil conservation (CP) can be seen in the table of crop
115 management (C) and soil conservation factors (P) (Asdak, 2018).
116

117

Table 1. Classification of Soil Erosion Rates

No.	Classification of erosion rates	Erosion rates (t.ha ⁻¹ .yr ⁻¹)
1.	Very Low (VL)	<15
2.	Low (L)	15 – <60
3.	Medium (M)	60 – <180

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The average erosion value of 55.01 t/ha.yr indicates that traditional agroforestry makes the soil have a higher ability to absorb water, thereby reducing surface runoff. Low erosion occurs because people plant and maintain trees in the traditional garden area. Conservation actions maintain tree vegetation, increase reforestation, use of bench terraces, ridges and use of mulch as one of the watershed conservation efforts. Traditional agroforestry as a sustainable land management system indicates that watershed conservation activities are going well.

References

Anputhas, M., Janmaat, J., Nichol, C., & Wei, A. (2019). If They Come, Where will We Build It? Land-Use Implications of Two Forest Conservation Policies in the Deep Creek Watershed. *Forests*, 10(7), 581. <https://doi.org/10.3390/f10070581>

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