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The classification of the level of land degradation as the flood cause in some sub-watersheds at Pesawaran Regency, Lampung

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Abstract. The purpose of this study was to evaluate the distribution and classification of land degradation levels in several sub-watersheds in the Pesawaran Regency. This research employed the survey and non-experimental approaches. The research was conducted in four sub-watersheds of Pesawaran Regency, namely Way Semah, Way Punduh, Way Ratai, and Bulok. Topographic, land-use changes, soil type, and rainfall were the parameters used to assess the degradation of sub-watersheds. The land analysis unit was the unit of interpretation and mapping. The results showed that the dominant factors causing land degradation were changes in land use for settlements and agriculture. The sub-watersheds with the highest degradation was Way Ratai.
Keywords: *land, degradation, sub-watershed*

1. Introduction

Land degradation is a decline in land quality caused by human activities. It has been a major global issue during the 20th-century and will remain high on the international agenda in the 21st-century [1]. Land degradation is a temporary or permanent process of decreasing land productivity. It is characterized by a decrease in physical, chemical, and biological characteristics, a phenomenon affecting drylands, a long-term decline in ecosystem function, and productivity [2]. A critical land is a form of degraded land[3] Degraded land in other definitions is often referred to as unproductive land, critical land, or idle land that is left abandoned and is generally overgrown with shrubs [4]. Factors of land degradation are the biophysical processes and attributes that determine the kind of degradative processes, e.g. erosion, salinization, etc. it is also affected by intrinsic properties of climate, terrain and landscape position, climax vegetation, and biodiversity, especially soil biodiversity [5]. The causes of land degradation are agents that determine the rate of degradation [1]. Land degradation is characterized by a large flow coefficient value of more than 50% [6]. The provinces that have heavily degraded land with an area of more than 1 million ha are Central Kalimantan, West Sumatra, Southeast Sulawesi, South Kalimantan, Jambi, Aceh, Lampung, East Java, and East Nusa Tenggara [4]. Lampung, based on data from the forestry ministry in 2011, had a severely degraded land area of 1,197,984 ha, a degraded land area of 329 055 ha, and a lightly degraded land area of 186 408 ha. In 2018, the environmental quality index of Lampung Province was in the poor

category (50 < = IKLH <= 60) compared to other provinces. The IKLH criteria are river water quality, air quality, and land cover quality.

One of the bad environmental qualities is the presence of land drainage in the watershed. The degradation of this watershed is characterized by the expansion of critical land and erosion on steep slopes. Agriculture and settlement contribute a wide impact on the environment, including heavier and ever-increasing floods [7]. Flood is an indicator of the damaged watershed. Watershed management planning to date has not shown optimal results. Increasing the number and diversity of population activities is closely related to the increased demand for land. This problem can lead to the conversion of agricultural land to non-agricultural land, resulting in ecological changes that lead to environmental degradation [8]. Pesawaran Regency is a new regency resulting from the expansion of the Tanggamus Regency. The division of the region into new regency which is to increase the acceleration of development through efficiency and effectiveness within the span of control will certainly encourage the acceleration of development in this region. Pesawaran Regency which runs simultaneously will be closely related to competition for land use for development activities. Pesawaran Regency which runs simultaneously will be closely related to competition for land use for development activities. The transformation of agriculture land into non-agricultural land in the Pesawaran Regency needs to be anticipated as early as possible because if this happens uncontrollably, it will not only threaten food security but also a decrease in environmental quality. The degradation of environmental quality that is often not taken into account will ultimately have bigger and more prolonged negative impacts. This is evidenced by flooding every year and land degradation [9].

The Sekampung River Basin is the largest river area in Lampung Province covering 8 autonomous regions or regencies /cities. It spans from the end of the spring in Tanggamus Regency up to the river in Pringsewu, Central Lampung, Metro City, Pesawaran, Bandar Lampung City, and the coastal areas in East Lampung and South Lampung [10]. The sub-watershed in Way Sekampung includes upstream and downstream of Bulok, Semah, Kandis, and Ketibung sub-watersheds. The Sekampung watershed passes through the Pesawaran Regency which covers the Semah, Pidada Punduh, Way Ratai, and Bulok subzones. The longest river in Pesawaran Regency is the Way Kandis river with a length of 50 km and a watershed area of 336 km^2. Many small rivers in Pesawaran Regency have the potential to flood (Lintas berita.id, 2019). The causes of flooding include (1) meteorological factors, (2) watershed characteristics, and (3) humans activities [11].

The problem of land degradation in the watershed of the Pesawaran Regency which causes land damage is due to improper land management actions, decreased physical quality of land, high rainfall, mismatch of land use, the existence of agricultural land in protected forests, and settlements. Increasing various activities in the watershed area that do not pay attention to zoning will result in negative impacts in the form of decreasing river water quality. High rainfall, steep slopes in the upstream area accompanied by changes in the ecosystem from perennials or deep-rooted perennials to shallow-rooted annual crops resulted in reduced water being stored in the soil, increased surface runoff, and caused landslides. High rainfall in a short period and cannot be absorbed by the soil will be released as a surface flow which eventually causes flooding [12]. The cause of land quality degradation at this time is not only erosion and uncontrolled land exploitation, but also due to industrial waste pollution in several agricultural areas adjacent to industrial activities. Degradation of land belongs to the category of deterioration of soil physical properties caused by the collision, raindrops, or erosion, soil compaction due to the use of tools and farm machinery or elevation process, flooding, and inundation.

Watershed management objectives are to control flooding and regulate water yield in terms of quantity, quality, and continuity. One of the consequences of the hydrological imbalance in the watershed is the occurrence of flooding. Flood is an indicator of watershed damage caused by decreased infiltration due to reduced vegetation cover and incompatible land use [13]. The sub-watershed in Pesawaran Regency that is

often flooded and has the potential to experience land degradation is the Way Semah, Way Punduh, Way Ratai, and Way Bulok sub-watersheds. The Way Ratai sub-watershed is known to have a larger number of settlements than the other sub-watershed. The objective of this research was to analyze the classification of the level of land degradation in the Pesawaran Regency as the cause of flooding.

2. Method

The survey and non-experimental approaches were used in this research. The research was done in four sub-watersheds in Pesawaran Regency with high flood frequency, namely the Semah, Way Punduh, Way Ratai, and Bulok subzones. The parameters used to assess land degradation were topography, changes in land use, soil type, rainfall, degraded lands increases. The unit of analysis used in this research was the land unit as the interpretation and mapping unit. The land unit had been obtained from an overlay of several land degradation parameters to obtain the level of land degradation. The classification of land degradation can be seen in Table 1.

Table 1. Geographical Classification of Land Degradation Rates in Sub-Watershed

Category	Score	Description	The Rate of Degradation
High	> 45	Rainfall> 2712 mm/year Used for paddy fields, settlements, plantations, mixed-dryland farming, Soil type: fluvaquents, paleudults, dystropepts, humitropepts, and steep slopes	High Degradation
Moderate	31-45	Rainfall 2040-2700 mm/year, Used for agricultural land, plantations, mixed-dryland farming, rice fields. Soil type: Andaquepts, dystropepts, humitropepts, hydraquemts, paleudults, tropaqupts, tropodults, fluvaquents, gentle slope	Moderate Degradation
low	<15	Rainfall < 1356 mm/year, Forest land use dryland, Soil type: Andaquepts, dystropepts, humitropepts, hydraquemts, paleudults, tropaqupts, and tropodults, very steep to steep slopes.	Low Degradation

The assessment of land characteristics had been carried out on each land unit. The land values in the entire sub-watershed had been weighted and calculated from all existing land units. The calculation of the value of each aspect/component of the characteristics of the sub-watershed was done by adding all the results of the score and weight of each parameter divided by 100. Based on the parameters that compile the sub-watershed characteristics formula, the weight with a high score (category value) indicates that the sub-watershed is vulnerable to degradation [14].

Table 2. Score of Each Parameter that Causes Land Degradation

No	Factor	Class	Score	Weight
1	Rainfall (mm/year)	> 3000	5	4
		2412-3000	4	
		1812-2400	3	
		1212-1800	2	
		612-1200	1	
2	Land Use	Forest,	1	
		Plantation,	2	
		Dryland farming	3	4
		Mixed land farming	4	
		Rice fields	5	
		Settlement	6	
3	Slope	> 45% or more (Very Steep)	1	3
		25% - 45% (Steep)	2	
		15% - 25% (Slightly Steep)	3	
		8% - 15% (Ramps)	4	
		0% - 8% (Flat)	5	
4	Type of soil	Hydraquepts	1	2
		Tropaqupts	2	
		Humitropepts, Paleudults, Tropodults	3	
		Andaquepts, Fluvaquents	2	
		Dystropepts	1	

2.1 Tools and data

The computer devices assisted by Arcview software were used to assist to confirm the field maps and studio equipment. The data sources of this research were the topographical map of Indonesian on a scale of 1:50000, land use data of Pesawaran Regency in 2000-2019, slope data in 2019, soil type data of Pesawaran Regency in 2019, and bulk rain data of Pesawaran Regency in 2019. The data can be seen in Table 3.

Table 3. the Types of Data Sources

No.	Type of Data	Data source	Year
1	Flood Incident Data	BPBD of Pesawaran Regency	2019
2	Land Use Data	BAPPEDA of Pesawaran Regency	2019
3	Rainfall Data	BMKG climatology station Pesawaran, Lampung	2018
4	Sub-watershed Distribution Data	BAPPEDA of Pesawaran Regency	2016
5	Slope Data	BAPPEDA of Pesawaran Regency	2010
6	Soil Type Data	BAPPEDA of Pesawaran Regency	2016

3. Result and Discussion

3.1 Characteristics of the Sub-watershed

The Way Ratai sub-watershed is one of the most extensive sub-basins in Padang Cermin Regency with an area of 916,065,438 ha (99.91%) compared to other sub-watershed. The shape of the sub-watershed in the 4 sub-watershed of the Pesawaran Regency is complex and radial. The normal flow discharge in the four sub-watershed is between 031-0.40 m^3 / second. The average area of the largest vegetation cover is in the Way Ratai sub-watershed, namely 912,191 ha. Table 4.

Table 4. Characteristics of the Four Sub-watershed in Pesawaran Regency, 2020

No.	Name of Sub-watershed	sub-regency	Area (ha)	%	Sub-watershed form	Average Vegetation Cover Area (Ha)
1	Way Semah Sub-watershed	Gedong Tataan	201,189	0.021	Complex	139,126
2	Way Punduh Sub-watershed	Punduh Pidada	126,792	0.013	Radial	114,882
3	Way Ratai sub-watershed	Padang Cermin	916,065,438	99.91	Complex	912191030
4	Way Bulok Sub-watershed	Way Khilau Kedondong	4,103,187	0.44	Complex	2870350
	Total		**916,806,606**	100		

3.2 Land Degradation Parameters

3.2.1 Rainfall

Table 5. Rainfall per Year

No.	Name of Sub-watershed	Year 2000	Year 2006	Year 2011	Year 2016	Year 2019	Average Rainfall
		Average rainfall (mm/year)					
1	Way Semah	2520	2196	1824	2304	1608	2090
2	Way Punduh	2316	2052	1800	1452	1812	1886
3	Way Ratai	2316	2052	1800	2472	2388	2205
4	Bulok Sub	1992	1752	1716	2016	1860	1867
	Total						8048

The highest rainfall average in 2000 -2019 was in the Way Ratai sub-watershed (2205 mm/year) and then followed by the Way Semah sub-watershed (2090 mm/year).

3.2.2 Land Use

The land use in the four sub-watershed of the Pesawaran Regency consists of 6 types, namely plantations, settlements, dryland farming, mixed-dryland farming, rice fields, and forests. Data on area and percentage of land use in each sub-watershed can be seen in the table below.

Table 6. The Extent of Land Use around the Way Semah Sub-watershed in 2000-2019

No.	Land Use	2000 (ha)	%	2006	%	2011	%	2016	%	2019	%
						Area (Ha)					
1	Plantation	69762	6.53	69762	26.34	5418	24.89	34005	29.58	54878	23.27
2	Settlement	68207	6.38	68207	25.75	3194	14.67	36486	31.74	57. 961	24.57
3	Dryland Farming	83648	7.83	83648	31.38	7577	34.81	62598	54.46	77. 646	32.92
4	Mixed-dryland farming	3862	0.36	3862	1.45	1689	7.76	1674	1.45	4. 806	2,037
5	Rice fields	41,903	3.92	39,140	14.77	3,676	16.89	9,962	8.66	39,019	16.54
6	Forest	209	0.019	209	0.078	209	0.96	209	0.18	1520	0.64
	Total	**1,067,591**		**264,828**		**21,763**		**114,934**		**235. 830**	

The land use in Way Semah sub-watershed in 2000 was dominated by dryland farming by 7.83% and plantation by 6.53%. Dryland farming in this sub-watershed area was dominated by secondary crops. Changes in land use began to decrease the quantity of area in 2006 by the establishment of paddy fields reaching 14.77%. From 2016 to 2019, land use was dominated by settlements and dryland farming. The growing population caused the need for housing to increase. Changes in land use are characterized by extensive dryland farming and plantations at the year of 2000.

Table 7. The Area of Land Use around the Way Punduh Sub-Watershed (Ha) in 2000-2019

No.	Land Use	2000 (ha)	%	2006	%	2011	%	2016	%	2019	%
1	Plantation	-		-		-		-		-	
2	Settlement	24,108	16.16	22,032	15.96	89	0.38	95	0.109	13,224	27.23
3	Dryland farming	1,420	0.95	1,384	1.00	1,384	5.98	1,384	1.59	4,767	9.81
4	Mixed-dryland farming	69,565	46.64	66,104	47.89	21,163	91.36	84,482	97.11	47,525	97.87
5	Rice fields	54,033	36.23	48,496	35.13	477	2,063	1,008	1.15	30,567	62.94
6	Forest	-		-		-		-		-	
	Total	**149,126**		**138,016**		**23,113**		**86,989**		**48558**	

Land use in the Way Punduh sub-watershed in 2000 was dominated by mixed-dryland farming (46.64%) and rice fields (36.23%). In 2011, the area of dryland farming was the dominant land use (91.36%). Dryland farming dominated the area in 2016 (97.11%). In 2019, mixed-dryland farming has decreased. It was turned into settlements and rice fields.

Table 8. The Area of Land Use Around the Way Ratai Sub-watershed (Ha) 2000-2019

No.	Land Use	2000 (ha)	%	2006	%	2011	%	2016	%	2019	%
1	Plantation	-		-		-		-		-	
2	Settlement	1,448,819	28.70	1,448,819	28.70	16,013,180	22.59	6505	0.20	454,714	30.56
3	Dryland farming	2740	0.054	2740	0.054	426,140	0.60	85	0.002	34,895	2.34
4	Mixed-dryland farming	1,536,955	30.50	1,545,027	30.61	3,113,450	4.39	3,113,450	98.99	705,502	47.42
5	Rice fields	2,046,575	40.62	2,046,575	40.55	51,315,761	7.24	24,014	0.76	694,342	46.67
6	Forest	3241	0.064	3421		870	0.0012	870	0.027	5.2423	3.52
	Total	**5,038,330**		**5,046,582**		**70,869,401**		**3,144,924**		**1,487,616**	

Land use in the Way Ratai sub-watershed in 2000 was dominated by rice fields (40.62%) and mixed-dryland farming (30.50%). There was an increase in the quantity of area until 2011, both in settlements, dryland farming, and rice fields. But in 2016, there was a decrease in the area of land for settlements, dryland farming, rice fields, and forests. However, there was an increase in mixed-dryland farming by up to 98,99%. In 2019, the area of mixed-dryland farming decreased because it was used as a settlement which reached 454,714 ha (30,56%).

Table 9. The Area of Land Use Around the Way Bulok Sub-watershed (Ha) 2000-2019

No.	Land Use	Year 2000	%	Year 2006	%	Year 2011	%	The 2016 year	%	Year 2019	%
1	Plantation	414,144	5,51	7,460	0.027	2,322	2.76	103,493	6.84	173,977	4.54
2	Settlement	2,468,508	32.86	2,552	0.009	5,994	7,14	46,725	3.08	1,187,963	31.06
3	Dryland farming	12,329	0.16	31,850	0.11	57,431	68.49	7,270	0.48	39,642	1,036
4	Mixed-dryland farming	2,205,146	29.36	14,686	0.054	6,067	7.23	901,713	59.61	1,171,791	30.64
5	Rice fields	2,403,098	31.99	23,574	0.086	9,816	11.70	451,052	29.82	1,212,213	31.70
6	Forest	7.106	0.094	7.106	0.026	2,216	2.64	2,216	0.14	38,172	0.99
	Total	**7,510,331**		**27,139,752**		**83,846**		**1512469**		**3823758**	

The land use of Bulok sub-watershed in 2000 was dominated by settlements (32.86%). From 2006 to 2011, land use was dominated by dryland farming and agriculture. In 2016, the land use was dominated by mixed-dryland farming (59.61%). In 2019, the land use increased in settlements (31.06%), mixed-dryland farming (30.64%), and rice fields (31.70 %). The changes in land area due to changes in land use can be seen in Table 8 and the dominance of land use from 2000-2019 in each sub-watershed is shown in Table 10.

Table 10. The Changes of Four Sub-watershed in Pesawaran Regency

No.	Sub-watershed	2000-2006	2006-2011	2011-2016	2016-2019
1	**Plantation**		Hectares		
	Way Semah Sub-watershed	-	-64.34	-28,587	+ 20,873
	Way Punduh Sub-watershed	No data available	No data available	No data available	No data available
	Way Ratai sub-watershed	No changes	No changes	No changes	No changes
	Way Bulok Sub-watershed	-982	-404259	+94,590	+70,484
2	**Settlement**		Hectares		
	Way Semah Sub-watershed	No changes	- 20,873	+33,292	+21,475
	Way Punduh Sub-watershed	-2,076	-21,943	+6	+13,129
	Way Ratai sub-watershed	Permanent	+14,564,361	-8059,361	+448,209
	Way Bulok Sub-watershed	+22039499	+36546	-24,497,828	+46,723
3	**Dryland farming**	Hectares			
	Way Semah Sub-watershed	No changes	-76071	-55,021	+ 54,852
	Way Punduh Sub-watershed	No changes	-36	-36	+3383
	Way Ratai sub-watershed	Permanent	+423,400	-426,055	+34810
	Way Bulok Sub-watershed	-2454	-7575	+4970	+ 32372
4	**Mixed-dryland farming**		Hectares		
	Way Semah Sub-watershed	No changes	-2173	-15	+3132
	Way Punduh Sub-watershed	-3,464	- 44941	+ 63,319	-36,957
	Way Ratai sub-watershed	+8072	+1,868,423	+1,868,423	-2,407,948
	Way Bulok Sub-watershed	- 1,986,050	-132,100	+814,717	+270,078
5	**Rice fields**		Hectares		
	Way Semah Sub-watershed	-2763	-35,464	+ 6286	+29057
	Way Punduh Sub-watershed	-5537	-48,019	+531	+29559
	Way Ratai sub-watershed	Permanent	+49,269,186	-51,291,747	+670,342
	Way Bulok Sub-watershed	-7843	-2,377,624	+433421	+761,161
6	**Forest**		Hectares		
	Way Semah Sub-watershed	No changes	No changes	No changes	+ 1311
	Way Punduh Sub-watershed	No changes	No changes	No changes	Nothing changes
	Way Ratai sub-watershed	Permanent	-2371	-2371	+51553
	Way Bulok Sub-watershed	Permanent	-4890	-4890	+ 35,956

Table 11. The Land Use in the Four Sub-watershed of Pesawaran Regency

No.	Sub-watershed	2000	2006	2011	2016	2019
1	Way Semah	Dryland farming and plantation	Dryland farming and plantation	Dryland farming and plantation	Dryland farming and settlement	Dryland farming and settlement
2	Way Punduh	Mixed-dryland farming and	Settlement, mixed-dryland	Mixed-dryland farming	Mixed-dryland farming	Mixed-dryland farming, rice fields, and

		rice fields	farming, and rice fields			settlement
3	Way Ratai	Rice fields, Settlement, and mixed-dryland farming.	Rice fields, settlement, and mixed-dryland farming.	Rice fields, settlement, and mixed-dryland farming	Mixed-dryland farming	Mixed-dryland farming
4	Way Bulok	Rice field and mixed-dryland farming	Dryland farming and rice fields	Dryland farming and rice fields	Plantation, rice, fields, and mixed-dryland farming	Rice fields, settlements, and mixed-dryland farming

3.2.3 Topography

The areas of Way Semah, Way Punduh, Way Ratai, and Bulok sub-watershed were mostly flat topography with the percentage: Way Semah sub-watershed of 92.83%, Way Punduh sub-watershed of 61.41%, Way Ratai sub-watershed of 62.38%, and Bulok Sub-watershed of 78.34%.

Table 12. Percentage of Slope

No.	**Sub-watershed**	**Slope (%)**				
		0-8 Flat	8-15 Sloping	15-25 A Little Steep	25-45 Steep	> 45 Very Steep
1	Way Semah	92.83	5.95	1.19	0.02	-
2	Way Punduh	61.41	34.31	4.04	0.23	-
3	Way Ratai	62.38	33.31	4.23	0.06	-
4	Bulok	78.34	18.78	2.82	0.04	-

3.2.4 Soil Type

The soil types in the four sub-watershed of the Pesawaran Regency are Andaquepts, dystropepts, humitropepts, hydraquemts, paleudults, tropaqupts, tropodults, and fluvaquents. the first soil order is Inceptisols (soil begins to develop, has an alteration horizon that has lost base, iron, and aluminum, but contains weathered minerals). The soil fertility is low with the effective depth varies from shallow to deep. The lowlands are generally thick while in the steep slope area is thin. The ground slopes are suitable to preserve the soil [15]. The second is Entisol (the order of land are generally young, almost has not been progressing). The permeability is generally slow with moderate drainage and quite sensitive to erosion symptoms [16]. The third is Ultisols that has horizon epipedon check and few have the horizon albik (horizon B). The soil organic matter content is very low. The soil acidity and alkaline saturation is less than 35% with high Al saturation, low CEC, low N, P, and K contents and is very sensitive to erosion [17]. The constituent materials of this soil are mostly loose soil materials with very weak soil development and little water-holding power [18].

Table 13. Name of Soil Type in Each Sub-watershed

No.	Name of WATERSHED / Sub-watershed	Soil Type Name
1	Way Semah	Dystropepts, Humitropepts, Paleudults, Tropudults
2	Way Punduh	Dystropepts. Fluvaquents, Hydraquents
3	Way Ratai	Humitropepts, Dystropepts, Hydraquents
4	Bulok	Humitropepts, Dystropepts, Andaquepts,

Table 14. Soil characteristics

No.	Soil Type (Great Group)	Great Group Soil Characteristics	Order of the Land
1	Andaquepts	Has an aquatic condition, a young level of development, indicated by the lower horizon of the character	Inceptisols
2	Dystropepts	Has black soil with low-base saturation (infertile).	Inceptisols
3	Humitropepts	Has high organic matter, blackish on the top layer, smooth to medium texture, slightly acidic to neutral soil reactions, and is classified as fertile.	Inceptisols
4	Hydraquents	Young, soft, muddy, and undeveloped	Entisols
5	Paleudults	Has the lowest fertility rate. The level of soil acidity is generally quite acidic	
6	Tropaquepts	Is a young mineral soil	Inceptisols
7	Tropudults	It is a soil that has developed somewhat further. The main material is clay/shale, marl, or sandstone with rapid drainage and is sensitive to erosion. Medium soil cross-section, poor physical properties, but quite easy to cultivate. The fertility rates and their potential for food crops are low to moderate.	ultisols
8	Fluvaquent	Its development is influenced by fluvial processes so that the influence of water is very dominant. This type of soil has not undergone structural development, formed from clay, dust, sand, or the mixture. It has a layered soil cross-section (clear stratification) with varying depths. It has a smoother texture than fine loamy sand with moderate to slow drainage.	Inceptisols

3.2.5 Flow Discharge

Flow discharge describes the response of the watershed system to the overall rainfall input. The amount of flow rate is strongly influenced by soil conditions, the area of vegetation cover, topography, and rainfall (BPDAS, 2008).

Table 15. Flow Discharge of Four Sub-watershed in Pesawaran Regency

No.	Sub-watershed	2000	2006	2011	2016	2019
1	Way Semah	20.63	59.45	138.14	216.83	295.52
2	Way Punduh	22.44	101.13	179.82	258.51	332.3

No.	Sub-watershed	2000	2006	2011	2016	2019
3	Way Ratai	17.44	96.13	174.82	253.51	337.2
4	Bulok	12.45	51.27	129.96	208.65	287.34

It is stated by [19] that if the discharge fluctuation is greater than 30: 1, it indicates that a watershed has been damaged. The same thing is stated in the monitoring and evaluation of watershed which is derived from the Regulation of the Ministry of Forestry No.P.61/2014 that the high flow regime coefficient (discharge fluctuation) indicates that the surface runoff in the rainy season is large and in the dry season, the flow is very high, small, or dry. Indirectly, this condition indicates that land infiltration in a watershed is less able to hold and store rainwater that falls and much of its runoff continues to enter the river and is wasted into the sea. The availability of water in the watershed during the dry season is minimal.

3.2.6 Classification Unit Land Degradation

From the parameters of the degradation, a scoring had been carried out to determine the classification of land degradation in each sub-watershed.

Table 16. Degraded Land Unit Classification

No.	Sub-watershed	Rainfall	Slope	Type of Soil	Land Use	Score	Class	Extent Ha
1	Way Bulok	> 2712 mm/year	Flat-ramps	Andaquepts, dystropepts, Humitropepts	Settlement, Plantation, Dryland farming, Rice fields		High degradation	2634
		2040-2700 mm/year	Flat-a bit steep	Andaquepts, dystropepts, Humitropepts	Settlement, Plantation, Dryland farming, Rice fields	37	Moderate relegation	1304
		<1356 mm/year	A bit steep	Humitropepts	Forest, Dryland farming	<15	Low degradation	11952
	Way Semah	> 2712 mm/year	Flat	Dystropepts, humitropepts, paleudults, tropudults	Settlement, Plantation, Dryland farming, Rice fields	> 45	High degradation	3578
		2040-2700 mm/year	Flat - a bit steep	Dystropepts, humitropepts, paleudults, tropudults	Settlement, Dryland farming, Rice fields	31-45	Moderate relegation	10993
		<1356 mm/year	Ramps - rather steep	Dystropepts, humitropepts, paleudults,	Forest, Settlement Dryland farming	<15	Low degradation	231
3	Way	> 2712	Flat-	Dystropepts,	Settlement,	<45	High	163

No.	Sub-watershed	Rainfall	Slope	Type of Soil	Land Use	Score	Class	Extent Ha
	Punduh	mm/year	ramps	Fluvaquents, Hydraquents	Rice fields		degradation	
		2040-2700 mm/year	steep	Dystropepts, Fluvaquents, Hydraquents	Settlement, Dryland farming, Rice fields	31-45	Moderate relegation	4044
		<1356 mm/year	Flat-ramps	Dystropepts, Hydraquents	Mixed-dryland farming	<15	Low degradation	27
4	Way Ratai	> 2712 mm/year	Flat-Ramps	Dystropepts, Humitropepts, Hydraquents	Forest, Settlement, Dryland farming, Rice fields	<45	High degradation	10295
		2040-2700 mm/year	flat - a bit steep	Dystropepts, Humitropepts, Hydraquents	Forest, Settlement, Dryland farming, Rice fields	31-45	Moderate relegation	1467
		<1356 mm/year	Flat-steep	Dystropepts, Humitropepts, Hydraquents	Forest, Settlement, Rice fields		Low degradation	966

Table 17. The Degradation Land d ith Size of Largest

No.	Sub-watershed	Degradation Classification	Area (ha)	Rainfall	Slope	Type of Soil	Land Use
1	Way Semah	Medium degradation	10993	2040-2700 mm/year	Flat-a bit steep	Dystropepts, Humitropepts, Paleudults, Tropudults	Settlement, Dryland farming, rice fields
2	Way Punduh	Medium degradation	4044	2040-2700 mm/year	Flat-a bit steep	Dystropepts, Fluvaquents, Hydraquents	Settlement, Dryland farming, rice fields
3	Way Ratai	High degradation	10295	> 2712 mm/year	Flat-ramps	Dystropepts, Humitropepts, Hydraquents	settlement, Dryland farming rice fields
4	Bulok	Low degradation	11952	<1356 mm/year	A bit steep	Humitropepts	Forest, Dryland farming

3.3 Discussion

The average rainfall from 2000-2019 in the four sub-watershed was 8048 mm/year. The widest area is the Way Ratai sub-watershed by 916,065,438 ha. Three sub-watersheds are the complex types and one sub-watershed is radial. This type of sub-watershed occurs due to the combination of two or more watersheds. In the same rainy conditions, the radial watershed has a sharper hydrograph and the period of flooding is shorter than that of the complex watershed [20].

Some soil types are somewhat sensitive to very sensitive to erosion. The inceptisol order which is often found in rice fields requires high input for both inorganic input (balanced fertilization for N, P, K) and organic input (mixing crop residues into the soil during soil processing by providing manure or green manure), especially if it is prepared for secondary crops after the rice is calculated with C-Organic content and CEC can be formed [15]. The entisol order in Indonesia is cultivated for rice fields. This type of soil has a loose consistency, low level of aggregation, sensitive to erosion, and the available nutrient content is low [21]. In this connection, it is appropriate that the use of land or space above its surface should be ground cover vegetation that has strong roots and should not become open land or deforested land. The said land's vegetation exists both in the protected areas (in the form of forests) and in cultivated areas (especially in the form of plantations or other dryland farming). Ultisol soil has an acidity of less than 5.5 according to its chemical properties. The chemical composition of the soil plays the biggest role in determining soil properties and the characteristics in general. The pH value that is close to the minimum can be found up to a depth of several cms from the intact rock (not yet decayed). These soils are poorly weathered or in alkaline-rich areas of groundwater. The pH increases at and below the solum. Ultisol soil is often identified with infertile soil, but in fact, it can be used for potential agricultural land as long as management takes into account. It turns out to be potential land if the climate is favorable. The ultisol soil has an acidity level of 5.5 [17].

The majority of land uses in the sub-watershed are for agriculture and human settlements. This is because the need for food and housing for the people around it continues to increase. The land use in four sub-watershed is dominated by a mixture of dryland farming, rice fields, and settlements. In dryland farming with seasonal food crops, productivity is relatively low and faces socio-economic problems because of the increasing population pressure and biophysical problems [22]. In all sub-watersheds in 2016, there was a change in the area of land use which significantly increased and decreased because, in 2015, a flood occurred for the first time in the Pesawaran Regency. In 2011, especially in Way Ratai, an increase in the area of settlement was 16.01318 million ha. In 2019, the settlements in all regions of the sub-watershed increased rapidly. With the decreasing forest area replaced by dryland farming and settlements in the Bulok watershed area, the changes in the quality of the hydrological characteristics can occur. The more watershed built areas, the process of surface water infiltration into groundwater will be disrupted. This causes high surface runoff and high river discharge during the rainy season which can cause flooding. The lack of river discharge during the dry season decreases the quality of river water [14].

The change in land use from agricultural to non-agricultural causes changes in environmental conditions that can be felt by the surrounding community. The land in the sub-watershed area that is different from its designation will certainly disrupt the river's hydrological system. Farmers who sell their paddy fields and then change their function into settlements destroy the order of the watershed. These conditions certainly affected sub-watershed hydrology conditions that could potentially cause flooding [23]. The mixed-dryland management continuously carried out in the territory lowers the productivity of the land and exacerbates land degradation. Land use is a cause that can directly affect the condition of soil quality in an area. The more intensive the use of land, the greater the chance of land experiencing degradation [24]. Physical changes that occur in the watershed will have a direct effect on the watershed's retention capacity against flooding. The more land is open or built, the smaller the retention

ability. Agricultural land has turned into a residential area. This condition greatly slows down and reduces the land area for water infiltration into the soil which causes floods [25].

When viewed from the distribution of land degradation area, the incidence of degradation began to occur since 2006 and it has been increasing every year. The sub-watershed in Pesawaran Regency shows land degradation. High degradation with the widest area occurred in the Way Ratai caused by high rainfall, type of soil, located in a flat area, and the use of more land for settlements. There has been an expansion of the land cover by buildings in the area. Land cover by buildings (building coverage) is the type of land use that most influences the conditions of runoff and infiltration. Way Semah and Way Punduh sub-watershed was in the moderate degradation category caused by rainfall intensity which is 2040-2700 mm/year, land use is dominated by mixed-dryland farming. Bulok sub-watershed is included in the low degradation category due to rainfall <1356 mm/year with land use for forest and dryland farming.

The radial form of Way Punduh sub-watershed occurs because of the direction of the river flow as if centered in a point that describes the radial shape. As a result, the time required for flow coming from all directions of the river channel takes almost the same time. If the rain is evenly distributed throughout the watershed, there will be a big flood [20]. The complex watersheds consist of the Way Semah, Bulok, and Way Ratai sub-watersheds. The concept of sustainable agriculture must ensure the quality of land by implementing conservation and rehabilitation efforts. Improvement efforts that can be made on degraded land are (1) the application of conservation farming patterns such as agroforestry, intercropping, and integrated agriculture; (2) the application of environmentally friendly organic farming patterns in maintaining soil fertility (applying lime, fertilizing, adding organic matter; and (3) make a spatial use direction/plan capable of controlling spatial use as well as maintaining and restoring the function of the area.

4. Conclusion

Based on the results of research on the classification of the level of land degradation that causes flooding in several sub-watershed in the Pesawaran regency, the Way Semah sub-watershed was in the moderate degradation category, the Way Punduh sub-watershed was in the moderate degradation category, Way Ratai sub-watershed was classified in the high degradation category, and Way Bulok is in low degradation category.

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