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Identification Of Degraded Dry Land In The Citarum Watershed, West Java Province, Indonesia

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ABSTRACT
Estimation of the level of land degradation and its distribution is essential for regional development. This study aims to identify both physical and chemical degraded land in intensive, conventional farming, with different cropping patterns in the Citarum watershed. The method used in this research is island grade and degraded land assessment, referring to Sodeg (2001) and UU Kurnia (2007) criteria. Soil Survey, LREP, 1988), Through weighting and scoring according to the intensity of their influence on degraded land. The level of land degradation and its distribution is obtained by analyzing the trigger parameters for the occurrence of degraded land. Data analysis was carried out utilizing land use/vegetation cover, slope, and annual average rainfall.

The results showed that the land area in the upstream Citarum watershed area was 307,904 ha consisting of 4,907 ha heavily degraded, 23,947 ha moderately degraded, 135,521 ha lightly degraded, and 143,529 ha not degraded. Soil analysis at all levels of degraded land in the upstream Citarum watershed shows that the C-organic levels are generally still relatively high - moderate. Soil permeability varies from moderately (6.35 – 12.7 cm/hour) to moderate (2.0 – 6.35 cm/hour).In some areas, moderate to heavily degraded land has become critical in undulating, hilly, and mountainous areas with slopes >15%. This land is generally overgrown with reeds, grass, and shrubs. In some places, it is dryland agriculture and mixed gardens whose growth is very stunted/skinny. Visible solid rock/parent material has emerged on the surface. This land has low productivity and is no longer productive.
keywords: Physical and chemical changes of soil, Upland, Watershed

Introduction

Soil degradation is the process of disrupting one or more environmental functions attached to the soil so that its productivity decreases. These functions include soil to produce biomass, filtering, buffering, transforming (water, nutrients, pollutants), biological habitats, and genetic resources. According to the International Soil Reference and Information Center (ISRIC), 46.4% of land in Asia has been degraded and has decreased productivity due to the decline in soil biological function. As much as 15.1% of the land cannot be used longer as agricultural land because it has lost its position.

Land degradation in Indonesia is mainly caused by the loss of the topsoil by the force of raindrops hitting the raindrops and the continuous carrying capacity of surface runoff, not by depletion and nutrient deficits because more harvest is carried away than given. This results in a decrease in soil quality and productivity, increasing Indonesia's number of critical lands. Critical land is land that is continuously degraded (Dariah et al., 2004), namely land whose physical condition is such that it does not function according to its designation as a production medium or as a water management medium (Kepmenhut 52/Kpts-II/2001).

In this study, the emphasis is on the physical degradation of upland land caused by water erosion. Conditions or symptoms of degradation in the field are characterized by a reduced land cover (vegetation) and erosion symptoms, which are indicated by many drainage grooves/nicks, affecting and disrupting the hydrological function and the surrounding area. Land degraded and became critical land is generally only overgrown with shrubs, reeds, and grass (Puslitbangtanak, 2004). This study does not include other forms of degradation, such as biological, chemical degradation, and changes in soil properties that result in decreased productivity.

The process of land degradation usually begins with the conversion (transfer of function) of land use from forest land for agricultural and non-agricultural purposes. In agricultural land, land degradation occurs due to soil erosion which is accelerated by land management without using conservation principles and excessive and irresponsible use of chemicals. To date, land management carried out by farmers is still varied and generally inappropriate and does not pay attention to soil characteristics. In the long term, it can accelerate land degradation.

The Citarum watershed, with an area of 6,614 km2 or 22% of the province of West Java, is strategic because it is a spring that supports the sustainability of the functions of the Seguling, Cirata, and Jatiluhur dams. The current condition of the Citarum watershed is declining, and it is undeniable that there will be floods, droughts, and obstruction of water supply for irrigation, industrial, household, and power generation needs. Damage in the Upper Watershed is mainly caused by illegal logging, improper land management, landslides, erosion, and sedimentation. However, the sensitivity of a plot of land/soil to erosion is influenced by the type of lithology/parent material, topography and slope conditions, vegetation/land use, percentage of vegetation cover, and climatic conditions, especially rainfall. In reality, on the ground, a land with low sensitivity to erosion (resistant) may be degraded or experience steep decline if the land is located on a steep slope and rainfall with high intensity.

On the other hand, a susceptible land may show mild erosion symptoms on a gentle slope, with good vegetation cover and low-intensity rainfall. Thus the process of land degradation is influenced by many parameter factors, which play a role in land degradation. Therefore, it is essential to conduct a land degradation study in this area. On the other hand, a susceptible land may show mild erosion symptoms on a gentle slope, with good vegetation cover and low-intensity rainfall. Thus the process of land degradation is influenced by many parameter factors, which play a role in land degradation. Therefore, it is imperative to conduct a land degradation study in this area.

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RESEARCH METHOD

Mapping research on degraded dry land was carried out in the Citarum Watershed (DAS) upstream, covering most of the Bandung district and part of the Sumedang district. This area includes all sub-districts in Bandung Regency and part of Tanjungsari District, Sumedang Regency. Geographically, the study area is located between 6o 44' 28'' and 7o 14' 30'' south latitude and between 107o 16' 30'' and 107o 57' 04'' east longitude.

The research area is a food crop farming center whose management system is carried out intensively. In the long term, this land management system will affect the condition of the land due to the management carried out by farmers both conventionally and management systems that have implemented correct farming principles.

The criteria for assessing degraded dry land, in general, is a decrease in soil fertility function caused by changes in physical, chemical properties and decreased soil microbiological activity. Land assessment of degraded land class refers to the criteria of Sodeg (2001) and Law Kurnia (2007) and the application of the Soil Survey method of Soil, LREP, 1988. Soil sampling was carried out using a ring sample which was then analyzed for the content of physical and chemical properties of the soil.

The level of land degradation and its distribution is obtained by analyzing the trigger parameters for the occurrence of degraded land. Data analysis was carried out using the parameters of satellite imagery analysis, which included the following parameters: (1) land use/vegetation cover, (2) slopes (3) annual average rainfall. The three parameters that trigger land degradation are weighted and scored according to their influence on degraded land. The higher and more fantastic the effect on degraded land, the higher the weight and score. The number of weights and scores for each parameter characterizes the intensity or level of degraded land

The parameters used as indicators in the study of land degradation in this activity are the type of land use/vegetation cover, slope, percentage of vegetation cover, and rainfall.

RESULTS AND DISCUSSION

A. The general condition of the research site

The research location is in the Citarum watershed with the northern boundary of the Cisomang River, followed by the border between Bandung - Subang Regency and Sumedang - Subang Regency. The eastern and southern boundaries are the Upper Citarum watershed boundary, while the west is the upstream Citarum River.

The Citarum watershed is divided into three zones, namely 1) the upstream Citarum zone (upstream of the river at Mount Wayang, the tip of Saguling), 2) the middle Citarum Zone (Saguling, Cirata- and Jatiluhur, and 3) the downstream Citarum zone (downstream Citarum and Citarum estuary), or consists of 9 sub-watersheds, namely: Cihaur, Cikapundung-Cipmokolan, Cikeruh, Ciminyak, Cirasea, Cisangkuy, Citarik, Ciwidey, and water bodies (Reservoirs) sub-watersheds.

Degraded land in the upstream area of the Citarum watershed is estimated to be approximately 46,000 ha or about 20% of the location of the Bandung Basin (2434,088 ha). Degraded land in the Ciminyak watershed is spread over the Cimanuk, Cihaur, Cikapundung, Citarik, Cirasea, Ciwidey and Cisangkuy watersheds. The site of the upstream watershed that needs to be rehabilitated is 1,197.79 ha. In contrast, the catchment area (Citarik, Cikapundung, Cirasea, Cisangkuy, Ciwidey, and Ciminyak sub-watersheds of land need to be rehabilitated 22,326.12 Ha (Department of Forestry, Agriculture and Plantation, Bandung regency, 2013).

B. Climate and rainfall

The distribution of rain in the watershed area Citarum is generally not uniform. The average annual rainfall ranges from 1966 mm to 2600 mm (BMKG, 2005-2014). The variability of precipitation in the Citarum watershed is strongly influenced by topographic variations (altitude). The river gradient is divided into three parts: the upstream + 25 km is the steepest area, the middle + 150 km has a reasonably steep slope, and the downstream + 70 km has gentle topography. This is in line with rainfall variability in the Citarum watershed, which is highly variable upstream and gradually uniform downstream. The upstream part of the Citarum watershed has a high variation in rainfall due to conditions in the upstream area, which is an inter-mountain basin wherein areas with these conditions, precipitation will be relatively higher on the slopes of the mountains facing the wind direction, and for the opposite part of the so-called rain shadow areas have somewhat smaller rainfall. This phenomenon is known as the orographic rain phenomenon. The lowest average precipitation occurs in the northern coastal area with rainfall of around 1500 mm per year, while the highest average occurs in the upstream region of the Ciherang, Cilamaya, and upstream Cipunegara Rivers with rain reaching 4000 mm per year.

Like most West Java areas, climatic conditions in the watershed Citarum have a tropical monsoon climate with relatively constant temperature and humidity throughout the year. This tropical climate is characterized by the occurrence of two seasons, namely the rainy and dry seasons. The rainy season occurs from October - March, and the dry season occurs from June - September. The other months are a period of transition or transition. The average temperature in the lowlands is around 27oC. In contrast, in the upstream part of the river in the highlands/mountains, the average minimum air temperature is 15.3oC recorded in the Ciwidey, Pangalengan, and Lembang areas. Relative humidity ranges from 80-92%, with an annual mean evaporation rate of about 1640 mm.

C. Land resources

The upstream Citarum watershed developed from the parent material, mainly in volcanic (intermediate) rock, a row of hills surrounding the Bandung plain, and lake deposits (for the Bandung plain itself). This volcanic rock consists of tuff and volcanic ash. Because the nature of this volcanic rock is intermediate, that is, it has a low level of quartz, the weathering results will have a quiet/small quartz sand content. Thus, the soil formed will have a high clay content, except for land from tuff and volcanic sand ash. If it undergoes further weathering, it will include slightly coarse/sand textured soil. In this case, it will form Andosol soil (Andisol). , Latosol (Alfisols) or Alluvial (Entisol and Inceptisol).

In terms of climate and considering the location/altitude of the place, there will be highland areas with low temperatures <18% and areas with high temperatures (>18%). In the highlands (temperature <18%), the biological activity of the soil is reduced, and the decomposition of organic matter into minerals is somewhat inhibited, resulting in the accumulation of organic matter, especially for Andosol soils. In lowland areas, the temperature is relatively higher, so biological activity is more active, organic matter is more accessible, and many of it breaks down into minerals. As a result, the bases in the soil will be more easily lost by water/erosion. Silicate material or Si(OH)2, which is difficult to dissolve but is easily moved by water and carried to other places (to plains/valleys),

In terms of topography, it can be divided into upland areas and lowland areas that are still affected by groundwater (shallow groundwater or even often inundated). Therefore, the valley/plain will have slow/poor drainage compared to upland/dryland areas that generally have fast/good drainage. Thus, in the tables/valleys where the soil is formed from deposits that have not undergone much development, it will be dominated by Alluvial, GleisoI, and Cambisol soils (Inceptisols and Entisols) which are characterized by high base saturation and a higher pH than the soil in the ground. Dry highlands/slopes. Meanwhile, the sloping highlands are generally dominated by Andosol, Latosol, Mediterranean, and Molisol soils (Andisols,

In the plains/valleys along the Citarum river, the soil is formed from river sediment material. It always gets new additions when a flood occurs, so the material is relatively new (recent), Therefore along the Citarum river will be found alluvial soil (Entisol and Inceptisol), which have lower base saturation (district).

D. Levels of Degraded Land

Based on the Geographic Information System application, degraded land in the Upper Citarum watershed is grouped into four classes: not degraded, lightly degraded, moderately degraded, and heavily degraded. Because the nature and physical conditions in the field of land that has /not polluted and land that has been lightly contaminated are relative/almost the same, these two levels of degraded land are combined and called lightly degraded land. Thus, the degraded land map is grouped into three classes: light, medium, and heavy.

Degraded land dominantly occurs on land developed from lithology / volcanic material (especially on land derived from sandy tuff parent material), followed by areas with sedimentary rock lithology (especially on land derived from clay and sandstone parent material), lime, and alluvium. The soil depth varies, but generally, degraded land has a thickness of <100 cm, or in some places, the thickness of the soil solum is <50 cm

Table 2. Erosion Index that occurs at the research site

	Sub. Das											
N0	Name	Large (Ha)	Very good		Well		Currently		Bad		Very bad	
			Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
1	chihaur	27.98	14.96	53.5	1.78	6.4	946	3.4	3.74	13.4	6.56	23.4
2	Cikapundung-cimaokolan	30,472	16.15	53.0	2.53	8.3	730	2.4	3.10	10.2	7.96	26.1
3	Cikeruh	19.029	9.57	50.3	2.53	13.3	276	1.5	2.31	12.1	4.35	22.9
4	Ciminyak	32.575	12.65	38.8	3.72	11.4	1.53	4.7	4.24	13.0	10.44	32.0
5	Taste	38,110	15.61	40.9	3.16	8.3	1.26	3.3	3.38	8.9	14.71	38.6
6	Cisangkuy	34,159	10.79	31.6	2.31	6.8	2.95	8.6	6.07	17.8	12.05	35.3
7	Citarik	22,951	12.49	54.4	1.69	7.3	273	1.2	2.03	8.8	6.47	28.2
8	Ciwidey	22.169	5.44	24.5	2.15	9.7	1.34	6.2	4.37	19.7	8.83	39.8
9	Water Body	3,356	3.36	100.0	-	0.0	-	0.0	-	0.0	-	0.0
Amount		230.80	100.99	43.37	19.86	8.6	9.33	4.1	29.3	12.7	71.37	30.9

Data source; Department of Agriculture, Livestock, Plantation and Forestry, 2013

The table above shows that the erosion index is terrible in the Ciwidey sub-watershed with a value of 8.830 ha (39.8%), Cirasea sub-watershed with an area of 14.705 ha (38.6%), and the Cisangkuy sub-watershed with an area of 12.046 ha (35.3 %), Ciminyak area of 10,439 ha (32.0%) followed by Citarik Sub-watershed with an area of 6.474 ha (28.2%).

Soil erosion is a process of erosion of the topsoil by rainwater influenced by soil erodibility, rain erodibility, land slope, vegetation type, and plant cultivation management. WIn comparison, sedimentation is the amount of sediment that enters the river due to soil erosion. The percentage of areas with heavy erosion rates (>180/ha/year) is 31a.4% of the Citarum watershed area. Agricultural commodities in the upstream Citarum still choose a vegetable cropping pattern with a short cropping pattern that cannot accelerate water infiltration into the soil and does not have supporting roots that can hold the ground from the danger of erosion. Landslides on cliffs generally occur with a height of more than 2 m with a slope of more than 50%.

Higher levels of erosion have resulted in sedimentation in riverbeds and even into the water infrastructure network. The upstream of the Citarum River on Mount Wayang has turned into a highland vegetable plantation area. The decrease in supporting plants that can hold the soil from the danger of erosion and absorb water accelerates the erosion process on land with a slope of more than 50%. The development of forms of soil erosion is strongly influenced by the level of soil erosion hazard (TBE). Factors that affect the danger of soil erosion include rain erodibility, soil erodibility, land-use vegetation and slopes, crop management, and soil conservation.

The main factor that causes the criticality of the watershed area is the encouragement of farmers to work on the land upstream due to the high rate of population growth. This farmer clears the forest and cultivates food crops to meet the needs of his family. Some farmers in the upstream watershed have not paid attention to environmental sustainability issues in growing food crops. This can be seen from the lack of implementation of soil and water conservation measures and a sound land management system. Therefore, the process of erosion and land degradation runs rapidly, resulting in a decrease in productivity and a decrease in critical land in the watershed, including the Upper Citarum watershed, which is supposed to protect reservoirs from silting (Saguling Cirata, and Jatiluhur).

Condition The physical environment in the Upper Citarum watershed is very diverse, so the farming system is also more complex. The existing farming components include food crops, horticultural crops, industrial plants, plantation crops, livestock, and forestry crops. Based on field observations, conservation efforts have been carried out on several vegetable farmers in hilly areas such as Pangalengan and Lembang, but they are not perfect. Generally, bench terraces have been applied, and only terrace reinforcement is rarely used and also, the vegetable cultivation system (potato cultivation) is still planted in the direction of the slope. Hence, the erosion that occurs is substantial. Even though the erosion process is entirely accurate, many farmers think that this is not a problem. This is because the soil fertility between the top and bottom layers (Andisol soil) is almost the same,

There are all levels of degraded land in the upstream Citarum watershed; the analysis of representative soil samples shows that soil permeability varies from relatively fast (6.35 – 12.7 cm/hour) and moderate (2.0 – 6.35 cm/hour), C-organic levels are still relatively high - average. At the same time, the data on the texture percentage of the clay content is higher than that of the silt and sand content. Data on physical and chemical properties of soil chemical soil are texture, CEC, base saturation, N, P, and K; soil chemistry is presented in Table 3,

Table 3. Physical and chemical properties of soil in Citarum watershed, West Java Province

CONCLUSION

Moderate to heavily degraded land and some areas have become critical land in undulating, hilly, and mountainous regions with more than 15% slopes. This land is generally overgrown with weeds, grass, and shrubs; in some places, it is dryland agriculture and mixed gardens whose growth is very stunted. Visible solid rock/parent material has emerged on the surface. This land has low productivity and is no longer productive. Non-structural approaches include upstream watershed management, spatial planning, erosion control, land conversion, land use permits, community empowerment in upstream areas, management of flood-prone areas, early warning systems and flood evacuation, institutional capacity building, and community participation flood prevention. Control of groundwater use, management, and river water quality improvement should be prioritized over a structural approach.

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Code	Keda Page	BD	Room Pore Total	Water available	Permeability	Organic ingredients	pH	Texture (%)		
	cm	gr/c	% vol	% vol	cm/hour	%	H20	Sand	dust	clay
SL-03	0-20	0.97	59.5	4.6	10.12	1.05	5.2	11	18	75
SL-03	20-40	0.95	60.2	4.6	18.31	1.02	5.4	13	14	73
SL-05	0-20	0.80	62.8	5.7	14.78	1.19	5.1	7	11	82
SL-05	20-40	0.85	61.1	4.4	12.71	1.10	5.3	5	11	84
SL-06	0-20	0.99	59.6	6.2	13.00	1.44	5.2	27	16	57
SL-06	20-40	0.90	52.3	4.5	13.85	1.26	4.9	28	14	58
SL-07	0-20	0.98	57.7	4.1	6.53	1.50	6.0	16	13	71
SL-07	20-40	0.93	58.2	5.3	3.79	1.44	6.2	17	14	69
SL-08	0-20	0.99	56.3	9.4	3.24	1.01	4.5	34	44	72
SL-08	20-40	0.98	58.3	13.5	7.64	1.54	5.5	51	35	64
SL-09	0-20	0.99	55.4	5.8	6.41	1.60	6.2	65	21	62
SL-09	20-40	0.89	59.9	5.5	0.44	1.30	6.5	63	22	67

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