Land Critical Study and Farmers Responses in Upland Area in Indonesia

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Abstract. Cultivated land is very vulnerable of resource and environment degradation that in long term will cause the loss of economic and ecological aspects. Citarik is one of the areas affected by those problems. Thus, it is now included into prior handling in Citarum catchment management. The area characteristic and dynamics of its inhabitant with economic and social condition have created critical land. These phenomena still unrepealed, therefore the writer is interested to study and to discover farmer’s response toward the problem of critical land that occurs. By using land unit approach as the analysis unit gained by overlays soil map, slope map, and land use map, the researcher conducted identification process toward the critical land parameters viewing from the aspects of soil, topography, erosion, and land cover. Then conducting matching process between land critical parameter data with land critical TOR (Term of Reference) resulting in the classification of land critical rate and their spreads. After that, an interview was conducted to the farmers who use the land to discover they response toward the existing land critical. This research shows that the majority agribusiness area in upstream of Citarik catchment included into semi critical land category, which spread almost event, and the rest of the area is included into potential critical land, spreading in downstream area.

1. Introduction
Citarum River Basin as one of the most important river basin in West Java Province has a vital and strategic potential for the importance of development in their area.[1]. Citarum River Basin passing through Bandung City which is the capital city of West Java province as well as the center of growth area with various dynamics of political field, social, economy, culture, and science and technology. Thus, water resources of Citarum Basin River being reliable resources for domestic water needs, irrigation, industry, hydroelectric power plant, fishery, etc around Bandung basin nor the downstream.

Citarum River Basin actually has various issues that should be tackled which is flood issues in South Bandung, declining/deficit of ground water reserves, sedimentation rate in the pool of Saguling Dam, environmental pollution and the hazard of drought in dry season. As for sedimentation rate problem that occurred in the pool of Dam of Saguling Hydroelectric Power Plant can be explained that since 1992 until 1996, sedimentation volume that getting into the dam often exceeding tolerable amount of sedimentation which is 4.000.000 m3/year. The process of sedimentation in 1992 has volume in about 4.076.992 m3; in 1993, it reached 4.234.036 m3. Data of 1996, sedimentation volumes that occurred was 4.226.383 (PT. PLN Unit Pembangkitan Saguling, 1997).
Sedimentation that occurred after 1997 were predicted would bigger than previous number along with land use changes at the upstream region as a result of “reformation euphoria” so that a lot of forest has been encroached to be a farming land without followed by a proper soil conservation. The load of pollution in Citarum dam is also getting heavier which sourced from domestic waste, factory waste, farming waste, and other sources in the form of solid waste, liquid waste and harmful toxic materials. So that the quality of water and environment is being more declined. It goes the same for the hazard of drought in dry season that its intensity and spread widely which endanger the existence of water resources as basic needs for people.

Beside the problems that grouping into biophysics aspect on the above, bio economic aspect condition is also unfavorable that indicated by population density in Bandung basin water catchment area that too high, population in 1986 is 579.142 people with geographic density is 1.082 people/Km² and agrarian density is 19 people/Ha. As in 1996 the amount of population are increased to be 671.702 people with geographic density 1.225 people/Km2. It indicated that the average of population growth in Bandung basin water catchment area is 1.38% per year. Meanwhile based on criteria of watershed/sub watershed that contained in the design of RLKT Citarum watershed of year 1986 – 2010 (valid in 25 years), among others are about direction of functional land use, direction of land rehabilitation and soil conservation and scale of handling priority.

As the biggest watershed in West Java, Citarum plays an important role in supplying water for many districts in the province [2]. Citarum stream area that leads to Bandung basin are consist of 4 (four) sub watershed which is Citarik sub watershed, Cirasea, Cisangkuy and Cikapundung covers an area of 155.900 Ha. From that 4-sub watershed, the first of handling priority scale is Citarik sub watershed that relatively high on the erosion level: A big erosion will be one of causes of land resources degradation that if it have not handling well, will be a trigger of critical land occurring. So that, upstream area handling should be a priority.

The mainstream area of Citarik sub watershed that a part of Citarum watershed, administratively is an area of Bandung district and Sumedang district, is at the altitude of 700 – 1.500 meters above the sea level. Citarik sub watershed has an area of 4.315.41 Ha that spreads into five villages, which are Dampit Village, Tanjungwangi Village, Cimanggung Village, Sindulang Village, and Tegal Manggung Village. Physical characteristics of Citarik upstream sub watershed area is an area that relatively hilly and partly mountainous with the slope from slightly rolling (10%), till moderately steep (40%) and steep.

Soil type in the upstream of Citarik sub watershed mostly are Andosol and Latosol which is the results of volcanic process, and some of the rest is association soil between Andosol and Latosol. The andosols in Indonesia are developed from a rather wide variety of parent material, but all of them originated from recent Pleistocene eruptions [3]. The upstream of Citarik sub watershed has a high enough of annual rainfall averages, with wet months between November to March meanwhile dry months is around April to August. So that based on Schmidt-Ferguson climate classification, this region is on the C climate type, which is slightly wet.

In genesis the landform of Citarik upstream sub watershed area is a formation of volcanic and denudation. As for volcanic formation consists of young volcanic cones (V1), volcanic slope (V2), volcanic plank (V3), volcanic plains (V4), and inter-volcanic plains (V7). While the formation of denudation consists of remaining hills (D3) that formed by heavy erosion in the past with steep slope to highly steep and bentukan teras alluvial (F14). Based on map of land use, most of Citarik upstream sub watershed is a dry land farming area. Besides that, land use of this area covers forests, gardens, moors, irrigated rice fields, rain fed rice fields, shrubs and settlements.

Citarik upstream sub watershed has 26.372 of population for each is Cimanggung subdistrict 16.784 people and Cicalengka subdistrict 9.588 people (based on monography of subdistrict in 2005). From the monography, this area shows that most of occupation of the population is farmer. The main farming product are cabbage, potatoes, tomatoes, red beans, and cassava.
The farming products are considered to have a high economical value meanwhile the land ownership of farmer is relatively limited, so it spur the farmers to extend their farming land (farming extensification). However, the effort of that farming extensification in Citarik upstream watershed is.

Citarik upstream sub watershed has a population of 26,372 people for each subdistrict of Cimanggung 16,784 and Cicalengka 9,588 people (according to sub-district monograph data in 2005). From the monographic data of this area shows that most of its inhabitants work as farmers. Its main agricultural products are cabbages, potatoes, tomatoes, red beans and cassava.

This agricultural product is considered to have high economic value while the land ownership of farmers is relatively limited, thus encouraging farmers to expand their agricultural land (agricultural extensification). However, extensification of agriculture in Citarik upstream sub watershed is less in pay attention to the characteristics and quality of land, so the tendency leads to land degradation. The expansion of agricultural land mostly penetrated the forest until it approached the hilltops with a steep slope.

The above phenomenon is very apprehensive so control and conservation have to be done soon, because if without conservation practices the rate of erosion would increase intensively and causing soil layer depletion and finally the land become less productive and even not productive that trigger the occurrence of critical land. Any degradation in the quality of the soil resource through erosion can have an impact on the ability of soils to perform this range of functions [4]. From the background of the problems described above, it gives inspiration for the authors to study the critical land that occurred in the Citarik Sub Upstream Watershed and the economic response of farmers who use the land as the main actors in creating land criticality. Title of this research is "Land Critical Study and Farmers Respond in Upland Citarik Catchment Area West Java".

2. Methods
This research used survey methods, which is a research that observe directly to the studied object. Survey is a research method that aims to collect a large amount of data in the form of variables, units, individuals at the same time. Data are collected through individual or physical samples in order to generalize what is being studied.

The variables collected in this study are physical and social. Physical variables include soil, vegetation, topography, climatic factors, while social variables include population, livelihood, health, income and population activity, especially in land cultivation.

Population is a total amount of analysis unit that its characteristics will be estimated [5]. Population in this research is all farming land in sub watershed of Citarik upstream. Sampling of this region using stratified sampling technique based on land unit approach that obtained from compilation of slope map, soil map and land use map of Citarik Hulu Sub watershed. In every same land units the samples were taken and then has the observation and measurement of the land characteristics to measure the level of land criticality.

Population sampling is determined randomly according to the units of land that has been obtained. Determination of the number of respondents is limited but represents the population of 100 respondents. The determination of this amount is based on the consideration that the sample size does not have a definite numbers, the main subject of the sample must have the properties of the population [6]. Accidental selection of respondents in the field by visiting the farmers who are working in the research area. The results of sampling area of this research area are as follows table 1:
Table 1. Technique of research sampling.

| No | Soil Type                      | Slope Class | Land use                  | Unit       |
|----|--------------------------------|-------------|---------------------------|------------|
| 1  | Andosol association with       | IV          | Rainfed rice fields       | Asal IVSt  |
| 2  | Andosol association with       | IV          | Moor                      | Asal IVT   |
| 3  | Latosol                        | IV          | Moor                      | Lat1VT     |
| 4  | Andosol                        | IV          | Moor                      | And IVT    |
| 5  | Andosol                        | IV          | Moor                      | And IVT    |
| 6  | Andosol                        | III         | Moor                      | And IVT    |
| 7  | Andosol                        | V           | Garden                    | AndVK      |
| 8  | Andosol                        | IV          | Garden                    | And IV K   |
| 9  | Latosol                        | IV          | Rainfed rice fields       | Lat IVSt   |
| 10 | Andosol association with       | IV          | Garden                    | Asal IV K  |
| 11 | Andosol association with       | IV          | Irrigated rice fields     | Asal IV Si |
| 12 | Andosol association with       | III         | Irrigated rice fields     | Asal III Si|
| 13 | Latosol                        | III         | Irrigated rice fields     | Lat III Si |
| 14 | Latosol                        | III         | Rainfed rice fields       | Lat III St |
| 15 | Latosol                        | III         | Moor                      | Lat III T  |
| 16 | Latosol                        | III         | Garden                    | Lat III K  |

Source: Research results

Variables are the object of research, or the point of attention of a study [7]. Variables of this research consist of independent variable and dependent variable. Independent variables are physical variables that used as parameters to determine the level of land criticality and the dependent variable is the level of land criticality itself.

1) Independent variables are:
   a. Land characteristics that consists of:
      • Topography (slope)
      • Soil (effective depth and fertility)
      • Erosion (erosion level)
      • Vegetation (land cover percentage)
   b. Farmer Responses of Critical Land
      Farmer responses of land criticality would be affected by socio-economics condition. Those socio-economic aspects are:
      • The dependents of farmer families
      • Education level
      • Health
      • Income from basic labor of agricultural business determined by land area, land ownership status, land use
      • Income from side jobs (excluding farming)
      • Farmer ownership, including: house, transportation, communication tools, and information sources

      Farmer responses showing a form of farmer behavior on the activities of farming land utilization as well as an effort to overcome critical land of soil conservation that they have implement.

2) Dependent variables is land criticality that consists of:
   • Critical land
   • Semi-critical land
   • Potentially critical land
The relationship between these two variables can be seen in figure 1. The independent variables affect dependent variable, which is the elements in the independent variables such as slope, rainfall, soil and rock and vegetation affect the critical land in Citarik upstream sub watershed, while independent variables can stand alone and it is the main element that affects dependent variable. Slope for each box, then the group is classified as follows [8], which are: class I (0-8%), class II (8-15%), class III (15-30%), class IV (30-45%), V (45-60%), and class VI (> 60%). Each plot of the same slope is united and separated by the slope of the other slope and then given a border, and given a description to get the desired slope class.

3) Scoring the factors in calculating critical land, ie: soil (effective depth and fertility); topography (slope inclination), vegetation (percentage of land cover), and erosion (erosion appearance and erosion level). These four factors are grouped in three classes that give score 1 to 3. This quantity weighs 1, 2, or 3 which possess different meanings. An amount of weight 1 if the influence to land damage is very small or small, weight 2 if the influence towards criticality is moderate, and weight 3 is for an amount of large or very large influence towards land criticality occurrence. Weighting of critical land parameters can be seen in Table 2.

### Table 2. Weighting of critical land parameters.

| No. | Parameter       | Scale                 | Weight |
|-----|----------------|-----------------------|--------|
| 1   | Topography     | <18%                  | 1      |
|     |                | 18-30%                | 2      |
|     |                | > 30%                 | 3      |
| 2   | Effective depth| > 25 cm               | 1      |
|     |                | 5-25 cm               | 2      |
|     |                | < 5                   | 3      |
| 3   | Fertility      | bit high – high       | 1      |
|     |                | moderate              | 2      |
|     |                | low – very low        | 3      |
|     |                | > 75 %                | 1      |
| 4   | Land cover     | 50-75 %               | 2      |
|     |                | < 50%                 | 3      |
| 5   | Erosion        | very slight – slight  | 1      |
|     |                | moderate              | 2      |
|     |                | severe – very severe  | 3      |

Source: Munandar (1995) [9]

3. Result and Discussions

3.1. Land population and physical land samples
The population in this research is all of Citarik upstream sub watershed area especially agriculture area. The samples in this study are determined based on a map of land units obtained from overlaying the map of soil type, slope map, and map of land use. Slope and land use slopes are obtained from Peta Rupa Bumi 1209-321 Cicalengka and Lembar 1209-322 Lembar Baginda.

While the soil type map is based on secondary data and the field research of the overlap, produces 30 units of land, including land units in the forestry area. This research focuses on farmland area, so that yielded 16 unit of land. In units of land with similar physical biotic characteristics, it is assumed to have similarity of other characteristics, then plotting to determine the 16 sample sites, to be clearer about the sample and the extent can be seen in Table 3 and the following map:
Table 3. Classification of land criticality in Citarik upstream sub watershed.

| No  | Sample   | Parameter | Score | Criticality Level |
|-----|----------|-----------|-------|-------------------|
|     |          | Erosion   | Slope | Effective Dept    | Fertility | Land Cover |       |
| 1   | Sample 1 | Scale     | Very slight | 15.1%  | >25 cm | Moderate | >75% | 6 | LPK |
|     |          | Score     | 1      | 1      | 1  | 2    | 1    |
| 2   | Sample 2 | Scale     | Moderate | 30%   | >25 cm | Slight | 75% | 10 | LSK |
|     |          | Score     | 2      | 2      | 1  | 3    | 2    |
| 3   | Sample 3 | Scale     | Severe  | 28.4%  | >25 cm | Moderate | <50% | 11 | LSK |
|     |          | Score     | 3      | 2      | 1  | 2    | 3    |
| 4   | Sample 4 | Scale     | Moderate | 27.8%  | >25 cm | Moderate | 75% | 9  | LSK |
|     |          | Score     | 2      | 2      | 1  | 2    | 2    |
| 5   | Sample 5 | Scale     | Very slight | 15.3%  | 25 cm | Moderate | >75% | 7  | LPK |
|     |          | Score     | 1      | 1      | 2  | 2    | 1    |
| 6   | Sample 6 | Scale     | Very severe | 11.7%  | >25 cm | Moderate | <50% | 10 | LSK |
|     |          | Score     | 3      | 1      | 1  | 2    | 3    |
| 7   | Sample 7 | Scale     | Very severe | 39%   | >25 cm | High | <50% | 11 | LSK |
|     |          | Score     | 3      | 1      | 1  | 2    | 3    |
| 8   | Sample 8 | Scale     | Slight  | 16.6%  | >25 cm | Moderate | >50-90% | 7  | LPK |
|     |          | Score     | 1      | 1      | 1  | 1    | 3    |
| 9   | Sample 9 | Scale     | Slight  | 18%   | 25 cm | Low | >75% | 8  | LPK |
|     |          | Score     | 1      | 1      | 2  | 3    | 1    |
| 10  | Sample 10| Scale     | Very slight | 15%   | 60 cm | Moderate | 50% | 8  | LPK |
|     |          | Score     | 1      | 1      | 1  | 2    | 3    |
| 11  | Sample 11| Scale     | Slight  | 29.5%  | 49 cm | Moderate | >75% | 7  | LPK |
|     |          | Score     | 1      | 2      | 1  | 2    | 1    |
| 12  | Sample 12| Scale     | Very slight | 13%   | 15 cm | Moderate | >90 | 7  | LPK |
|     |          | Score     | 1      | 1      | 2  | 2    | 1    |
| 13  | Sample 13| Scale     | Very slight | 10%   | <20 cm | Moderate | >90% | 7  | LPK |
|     |          | Score     | 1      | 1      | 1  | 2    | 1    |
| 14  | Sample 14| Scale     | Very slight | 11%   | >25 cm | Low | <10% | 9  | LSK |
|     |          | Score     | 1      | 1      | 1  | 1    | 3    |
| 15  | Sample 15| Scale     | Severe  | 12%   | >25 cm | Moderate | <10% | 10 | LSK |
|     |          | Score     | 3      | 1      | 1  | 2    | 3    |
| 16  | Sample 16| Scale     | Very severe | 14%   | >25 cm | Moderate | <50% | 10 | LSK |
|     |          | Score     | 3      | 1      | 1  | 2    | 3    |

Source: Calculation result 2004

Information:
Score: 5-8=LPK, 9-12=LSK, 12-15=LK
LPK: Potentially Critical Land
LSK: Semi-Critical Land
LK: Critical Land
Citarik upstream sub watershed with 4,315, 41 Ha area has characteristics such as climate, soil, geology, morphology and hydrology, which are highly vulnerable to critical land. The interaction of the population along with the socio-economic dynamics, participate in determining the direction of land use change that occurred in the region, especially on the farm business area. Agricultural cultivation activities that occur in the research area, especially dry land agriculture become the main cause of Citarik upstream sub watershed is called as super critical watershed in Citarum watershed.

From this research, using the land unit approach in the process of identification, classification and further evaluation of the phenomenon of land criticism. The results show that most of the agricultural land in the Citarik upstream sub watershed is categorized as semi-critical and some are categorized as potentially critical. These conditions should be a concern both of the government through ministries, agencies, relevant agencies and communities, especially farmers. The attribution of land degradation to characteristics of soil, geology and climate, and to purely physical constraints tends to leave untheoried where the constraints lie and how far they are social [10]. The criticality of the land must be more controlled so it would not harm the public importance with the emergence of various disasters or importance of farmers, especially in maintaining land productivity and their life viability.

The farmers' responses to land criticality were actualized by the conservation and land rehabilitation activities, which were sufficiently quantified through the activities of making the terrace, planting contour cutting, crop rotation and intercropping system. However, in terms of quality, conservation and land rehabilitation activities need to be improved because farmers are still constrained by their socio-economic condition (See figure 2).

Figure 1. Sample of the research
Source : Research Results
4. Conclusions

Study of critical land and the response of farmers is part of the effort to solve the Citarum River Basin problem especially in the upstream area, while for the middle and downstream areas is also needed alternative solutions with integrated comprehensive concept that involves all related parties so that it could optimize economic and ecological concern. Other research that oriented to the concept of community empowerment through: the study of environmentally sustainable agribusiness, agro-forestry study on land forest edges, and upstream watershed ecosystem study.

For the Government, through the relevant departments, official agencies and other related institutions in carrying out the program package, watershed management projects to pay more attention to the data (information) of the level and distribution of land criticality, so that the activities are more focused and targeted especially on land that has entered semi-critical phase so that it does not leads to more severe environmental degradation. For the government, it must be able to compensate farmers who has fairly good response in the conservation and improvement of the land (land rehabilitation) with more intensive training and development activities, which raises the conservative behavior of the farmers that will benefit all parties.

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