Assessment of land evaluation on erosion reduction with Agroforestry approach around Lake Ngade area

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Abstract. Ngade Lake is surrounded by steep cliffs with a very high level of erosion insecurity with a very steep slope > 45% without sloping edges and no outlets. In the upstream region the water catchment area of Ngade Lake is dominated by land use in the form of coconut and nutmeg plantations. This study aims to examine the form of land evaluation strategy to maintain forest function from erosion threat in the area of Ngade Lake water catchment with agroforestry management pattern. The method used in this research was a quantitative descriptive method using field surveys to collect data on the characteristics of the land that is assisted by secondary data from various literature. The collection of land characteristics data was done at each observation point. To collect the primary data used sampling techniques carried out with stratified random sampling method considering accessibility of roads. The results of the study showed that there were several classes of land capacity. Among them were Class II with high potential of land so it can be cultivated for agriculture and settlements. Land capacity Class VI and VII with low-potential land or difficult to be cultivated for agriculture, this land capacity class intended for forestry plants and grazing fields.

Keywords: valuation, land evaluation, erosion, agroforestry, Ngade Lake

1. Introduction
The increase of population in the city of Ternate caused pressure on forests, land, and water resources are increasing. This condition leads to increased forest area for use outside the forestry sector, increased erosion rate, resulting in decreased land productivity, increased surface water flow and flood hazard, sedimentation, Drought. Utilization of the potential water catchment area both land and water resources that do not heed the rules of conservation will result in degradation to the conditions of the water catchment area. In the end, there is environmental degradation such as the loss of soil cover plants in the water catchment area in the upstream area, erosion that causes the flow of rivers due to sedimentation, the narrowing of the river flows settlement of settlements and so on [1].

The damage to the upstream areas of water catchment that is supported by the increase of natural resource utilization is suspected as one of the main causes of natural disasters. Nowadays, the public issue is the change of land, the density of settlement causes land, erosion, and sedimentation that occur in various urban and regional areas. The insecurity of the flood will increase if the region is a steep slope, a shallow river and the increase in the volume of water is much greater than the one that is attached.

Ngade Lake is surrounded by steep cliffs with a very high level of erosion insecurity with very steep slope > 45% without sloping edges, so like a basin, it has no outlet. In the upstream region the water catchment area of Ngade Lake is dominated by land use in the form of coconut and nutmeg plantations. Considering the condition with various problems that occur in the water catchment area of Lake Ngade, it is necessary to study scientific research that can provide information related to the assessment of land evaluation in erosion management by agroforestry approaches.
2. Materials and Methods

2.1. Methods
The sampling was stratified random. The quantitative descriptive was used by using field surveys to collect data on the characteristics of the land assisted by secondary data from various government agencies. The collection of land characteristics data was carried out at each observation point considering the accessibility of roads.

2.2. Land capability evaluation
The evaluation of land capability was done using matching method by pairing the value of the inhibitory factor in the land unit of field observations with Table 2.1. The criteria of land capability classification will generate land-capacity classes as a basis for land use recommendation. The criteria for classification of land capacity consist of several inhibitory factors, among others; inclination slope, erosion sensitivity, erosion rate, soil depth, soil texture, permeability, drainage, percentage of rocks/gravel and flood threats [2]. Criterion of each limiting factor used in land capability Classification Analysis is presented in the following tables:

| Limitations Factor | I   | II  | III | IV  | V   | VI  | VII | VIII |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-------|
| 1 Surface slope    | A   | B   | C   | D   | (*) | E   | F   | G     |
| 2 Erosion          | KE1,KE2 | KE3 | KE4,KE5 | KE6 | (*) | (*) | (*) | (*)   |
| 3 Erosion Rate     | e0  | e1  | e2  | e3  | (**)| e4  | e5  | (*)   |
| 4 Depth to Soil    | k0  | k1  | k2  | k2  | (*) | k3  | (*) | (*)   |
| 5 Texture          | t1,t2,t3 | t1,t2,t3,t4 | t1,t2,t3,t4 | (*) | t1,t2,t3,t4 | t1,t2,t3,t4 | t3 |
| 7 Permeability     | P2P3 | P2P3 | P2P3 | P2P3 | P1  | (*) | (*) | P5    |
| 8 Drainage         | d0/d1 | d2  | d3  | d4  | (**)| (*) | (*) | (*)   |
| 9 Gravel/Rocks     | b0  | b0  | b1  | b2  | b3  | (*) | (*) | b4    |
| 10 Flood risk      | O0  | O1  | O2  | O3  | O4  | (*) | (*) | (*)   |

Source: Arsyad (2010)

Note:
(*) Can have any nature of the inhibitory factor
(**) Ground level is always flooded

Table 1: Criteria of land capability classification

2.3. Research Stages
In order to be implemented in a directional and timely manner with a result, then the research was carried out gradually; Stage of preparation, stage of fieldwork and completion stage.

2.3.1 Preparation Stages
Studies or study libraries by studying reference books and previous research results that support the study.

2.3.2 Field Work Stage
Collecting primary data by observing the land parameters, slope, depth of the land, erosion rate, land drainage, gravel/rocks and the threat of puddle.
2.3.3 Completion Stage
The completion phase of the study focused on managing the data of survey results analyzing data and writing the final report to assess the assessment of land evaluation strategy in erosion management with the agroforestry approach.

3. Results and Discussion

3.1. Land Unit
Quite a lot of cases happened that land use was no longer suitable for the carrying capacity and its potential. The field of agriculture is a sector that has a role in the provision of groceries, but in other cases, the increase in population was very fast, as happened in Ternate City indirectly spur the opening of new land for development agricultural crops without heed to the principles of land capacity class. It was mostly happening around the Ngade Lake area.

3.2. Slope
The slope factor is also the magnitude of potential erosion hazard in dryland farming. In Ternate city, the farming of food crops was much done on dry land. This is difficult to avoid because most dry land in Indonesia has a slope of more than 3% with the form of wavy, corrugated, hilly and mountain areas, which includes 77.4% of all land. Erosion-sensitive land and agricultural practices not accompanied by erosion control efforts also determine the level of insecurity of agricultural lands on erosion.

Slope tilt and slope length are two of the main properties of topography affecting erosion. The steeper and long the slope, the greater the speed of surface flow and the danger of erosion. Ground-level slopes are not always uniform, as in the Ngade Lake area there were three classes of slopes [3].

![Ngade Lake Region](image)

Description of the land characteristics surrounding the Ngade Lake area can be seen in Table 2.

| Observation points | Land use   | Slopes (%) |
|--------------------|-----------|------------|
| 1                  | Mixed garden | (0 – 8)    |
| 2                  | Mixed garden | (0 – 8)    |
| 3                  | Fields     | (25 – 45)  |
| 4                  | Forest     | (> 45)     |

Table 2. Description of surrounding land of Ngade Lake area
Observation point 1
The use of land around the Ngade Lake region at the 1st observation point was largely in domination by mixed gardens, slope ranged from 0-8%. Soil characteristics were generally dynamic, always changing, therefore the characteristics of the soil can change as the time changes and the transparent of the land or cropping system.

Observation point 2. Land use around the Ngade Lake area, especially at observation point 2 largely dominated by mixed garden, slope, ranged from 0-8%. Soil characteristics were generally dynamic, always changing, therefore the characteristics of the soil can change as the time changes and the transparent of the land or cropping system.

At observation point 2 included in the class of land capacity II can be processed or directed for season crops (arable land), land in this class has some obstacles or threats damage that reduces the choice of use or causes it conservation measures are required. Management needs to be cautious including conservation measures to prevent damage or improve water and air connections if land is cultivated for farming.

Observation point 3. Land use around the Ngade Lake area especially at observation point 3 largely dominated by the field, slope ranged from 25-45%. The type of vegetation in the field of plantation appears to vary from height and type. Fields did not require regular irrigation (relying on raindrops). In the area of Lake Ngade, the use of farmland was usually planted with plants such as crops vegetables and fruit plants and is usually interspersed with annual crops such as sengon and teak.

Observation point 4. Land use around the Ngade Lake area especially at observation point 4 largely dominated by forest, slope slopes ranged from > 45%. Forest land utilization in the upper area of Ngade Lake in hilly area with a steep slope. From the interpretation of the image appears with a green color with a high density, a somewhat rugged texture, the leaf canopy appears to vary with a regular pattern[4]. The appearance of forest land in the image appears to be a row (set) of trees with almost the same height [5].

3.3. Vegetation and land management
The vegetation and land management in Ngade Lake area were entirely utilized by the community, both ramps, and very steep land. Vegetation management can affect the time and dissemination of water flows. This vegetation factor is associated with land closure conditions in the area of Lake Ngade which is dominated by land use in the form of mixed garden and fields. The influence of soil cover vegetation against erosion is (1) protecting the ground surface of rainwater pressure (lowering the speed and reducing the diameter of rainwater), (2) lowering the speed and volume of run-off, (3) holding ground particles in place Through the rooting system of the resulting litter and (4) maintaining the stability of the soil capacity in absorbing water [3].

The practice of agroforestry in the research area is held regularly, seen from some land use dominated by mixed plantation, production forest, and cutting. Inland use in the form of people's gardens, in general, is already using conservation action soil and water is done by making a simple terrace. While the use of land in the form of the building of the terrace is better is the use of bench terrace [6]. The making of the patio basically aims to reduce the level of slope, so it will be able to reduce the destructive energy of the surface runoff so that the possibility of erosion becomes small. The management of this land has a double benefit for farmers when built properly and assisted by the provision of facilities and infrastructure to accommodate the products they produce. In general, people in the research area have been able to combine both soil and water conservation techniques. Although it still uses simple mechanical techniques, but on the steep lands until very steep it has been made a terrace to reduce erosion. Erosion control on a land scale is a combination of three activities, namely agronomist action, land processing, and mechanical action. Any land use should place certain types of crops that have economic value [9]. Such crops will certainly be pursued sustainably by the
population, as well as related parties. The use of plant types that can serve to cover the land, also need to be followed by good soil processing so that growth and production is optimal [7]. Furthermore, the need for mechanic action is the completeness of a crop that on one side is productive, the rate of loss of land is low on the other side.

3.4. Land Capability Classification

Land Capability Classification is a classification of potential land for the use of various agricultural systems in general without explaining the provisions for certain types of plants or management actions. The aim is to classify the land that can be cultivated for agriculture based on its potential and restrictions in order to produce continuous production [2]. Land capability demonstrates the similarity of the inhibitory factors. The land is grouped into Class I to Class VIII, where the higher the class, the quality of the land is getting worse, means the risk of damage and the magnitude of the increasing inhibitory factor and the use of the more restrictive area used. Ground Class, I to IV is a land suitable for agricultural business, while the Class V to VIII not suitable for agricultural business or required a very high cost for management [8].

The results of the analysis of land capabilities in the Ngade Lake area are 3 classes of land capacity, including land capacity class II, VI and VII. Land that belongs to the class of land capacity II can be processed or directed for season plant (arable land), while land that entered land conformity class VI and VII land that cannot be processed or cultivated (unbearable land), this class land is a land that must be conservation and protected land that belongs to the class of land capacity II can be processed or directed for the plantation (arable land), land in this class has some obstacles or threats damage that reduce the choice of its use or causes it requires a moderate conservation action. Management needs to be cautious including conservation measures to prevent damage or improve water and air connections if land is cultivated for farming [8].

Land entry into the class criteria of land capacity VI has a heavy barrier that causes these lands not suitable for agricultural use. Class VI land has a barrier or threat of damage that cannot be eliminated in the form of a rather severe erosion rate, shallow depth of land, and is located on a slightly steep slope. If used for grazing and production forests should be well managed to avoid erosion with heavy conservation measures, such as the manufacturing of a good bench terrace. Land capacity Class VII is a land that cannot be processed or cultivated (unbearable land), this land is a land that must be conservation and protected. The VII land ability class has land criteria not suitable for farming. If for pasture or production forest should be carried out severe erosion prevention. It is necessary to create a bench terrace supported by vegetation for soil conservation. The land capacity class in Ngade Lake area is present in Table 3 as follows:

| Observation points | land capability class |
|--------------------|-----------------------|
| 1                  | II                    |
| 2                  | II                    |
| 3                  | VI                    |
| 4                  | VII                   |

Table 3: Class of land capability in Ngade Lake area

Based on the results of the analysis of land capability class in the area of Lake Ngade indicates that at observation point 1 is included in the class of land capability II. The Data illustrates that land is suitable for agroforestry development compared with observation points 3 and 4. Based on the results of the research in the field, there are several classes of land capacity such as land capability II has a high potential of land that can be cultivated or processed for agriculture, season and Settlements. Barriers to class II land are very slight, and the necessary conservation measures are easy to apply.

Land capability II, with IId capability sub-class which means the main barrier factor was drainage. Land Proficiency Class II is found at observation points 1 and 2, had some obstacles or threats of
damage that reduce their choice of use or require moderate conservation action. Class II land requires careful management, including conservation measures to prevent damage or improve the governance relationship. This land was suitable for the use of the plant season, grass plants, grazing fields, production forests, and nature reserves. This ability class can be used for all land use unless the farm is very intensive. Overview of land capability in the Ngade Lake region in Table 3.

Obstacles or threats of damage to Class II land are one or a combination of the following factors: (1) Ramps or waves (3-8%), (2) mild erosion levels, (3) effective depth in to moderate, (4) un-good soil structures, (5) sometimes affected by a destructive flood, (6) excess water can be repaired by drainage. Class II land provides less use and heavier management demands from Class I land to farmers. This class of land requires special conservation farming systems, erosion prevention measures, water control, or processing methods if used for season crops and plants that require soil processing [9]. For example, deep ground with sloping slopes that are stunted in erosion if used for the plant will require one or land according to the contour, turn the plant with grass and Leguminosae, mulch other than fertilization. Precisely the actions or combinations to be applied, are influenced by the properties of soil, climate and farming systems.

Land capability Class VI with a subclass capability of VI e, k, has a limiting factor in the form of severe erosion, located at a slope of 25-45%, depth of shallow soil. Land in Class VI has a heavy barrier so that the designation is not suitable for farming. Land use is limited to pasture or grazing fields, production forests, protected forests or nature reserves. Land that resides on a Class VI located on a somewhat steep slope if it is to be used for grazing and production forests should be well managed to avoid erosion.

The land included in the VI and VII classes had a heavy barrier factor. If used for production forest should be done with good erosion prevention efforts, such as the manufacture of bench terraces that are supported by vegetative ways for soil conservation. Land capacity Class VI and VII are land-with low potential or difficult to be cultivated for farming. Land in the area was not supposed to be used for agricultural plants, and settlements, but in fact, the field shows that in these classes the VI and VII land capabilities are widely used as agricultural land, and settlements. The conservation efforts of the VI and VII capability classes need to be cultivated by forestry plants or permanent crops as soil protective plants from the erosion process [10].

4. Conclusions
1. There were several land capability classes including land capability Class II, had a high potential of land so that it can be cultivated for agriculture, and settlements.
2. Land capability Class VI and VII were a land with a low potential or difficult to be cultivated for agriculture, this class of land capacity is intended for forestry plants and grazing fields.

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