Compatibility of land use based on land capability in Tabo-Tabo Village, Bungoro District, Pangkajene

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Abstract. The purpose of this study was to determine the classification of land capability, evaluate land capability, and determine the direction of land use in the Tabo-Tabo Village according to its ability classification. This research was conducted from December 2017 to July 2018, located in Tab-Tabo Village, Bungoro District, Pangkep. This research used a purposive sampling method and a matching classification method. Tabo-Tabo Village has 3,262.54 hectares of total area, and 623.43 ha used as representative of this research. The results showed that some land use incompatible with the land capability was 100.48 ha (16.12%) while the land use, which compatible with land capability was 522.95 ha (83.8%). Tabo-Tabo Village has three Class of lands classification, which are Class IV, V, and VIII, with severe inhibitor factors such as the slopes, drainage, and permeability. Three land units that were incompatible were land in Class V in the form of rice field and two lands in Class VIII in the form of dryland agriculture mixed with shrubs. Land in Class V was directed to the production forest, while land in Class VIII was directed to the protection forest.

1. Introduction

The compatibility of land use is the level for the suitability of land with certain forms of resource use [1]. The level of land use always changes every year. Uncontrolled land use can have an impact on the ecological system. Incompatibility of land use with the characteristics of the land (physical, chemical, and biological) can cause the land to be less productive and even become critical. This causing increased in critical land area, increased erosion and sedimentation, and landslides, which can reduce the carrying capacity of a watershed.

Based on Landsat 8 image analysis in 2015 which was accessed on January 22, 2018, Tabo-tabo Village has an area of 3,262.54 ha located in Pangkajene and Kepulauan Regencies with land cover in the form of secondary dryland forest for 1,673.25 ha (51.28%), shrubs for 140.48 ha (4.31%), waterbody for 33.77 ha (1.04%), dryland agriculture mixed with shrubs for 1,013.84 ha (31.07%), and rice fields for 401.20 ha (12.30%).

Tabo-Tabo village is located in the upper reaches of the Pangkajene watershed. Based on data from the Regional Disaster Management Agency (BPBD) of South Sulawesi Province (2014) [2], the Pangkajene watershed has characteristic hydrological conditions that increased potential for flooding due to increased volume of river discharge during the rainy season and drought in the dry season. According to Pratama (2016) [3], natural factors such as climate, extreme rainfall, and human factors...
such as land use can cause significant loss, damaging public facilities and infrastructure, and declining food conditions.

The Tabo-Tabo village area is dominated by land for agriculture, plantation and forestry, and karst mountains, which are the unique characteristics of this area. It is one of the reasons this research was conducted at this location. The differences in physical conditions of the Tabo-Tabo Village are probably affecting land ability and its users.

Land use is a human intervention on land in order to meet their needs. Land use often forgets land ability, so it is necessary to use land-use directive that is following land classification to avoid the danger of natural disasters, to increase land productivity, and for sustainable land use. Therefore, it is essential to conduct research related to the Compatibility of Land Use Based on Land Capability in Tabo-Tabo Village, Bungro District, Pangkajene Regency. The purpose of this study is to determine the classification of land capability, evaluate land capability, and determine the direction of land use in the Tabo-tabo Village based on land capability.

2. Research methodology

2.1. Data collection method

2.1.1. Primary data. Primary data were collected from direct observation in the field. The method was a purposive method based on the land unit map formed. The maps were obtained by overlapping maps of soil types, topographic maps, and land use maps of Tabo-Tabo Village.

Data collection techniques from each observation in the classification of land capability can be explained as follows:

a. Observation:
   1) Slope created digitally in the ArcGIS by using a contour file.
   2) Soil samples were taken at each observation point.
   3) Soil erosion sensitivity (KE value), obtained from field data calculated by using nomographs.
   4) The level of erosion, obtained from field observations by looking at the state of the topsoil and underground layers.
   5) Soil depth, obtained from observations in the field by measuring soil depth through making soil profiles.
   6) Permeability, obtained from laboratory observations from soil samples in each land unit.
   7) Drainage, obtained from field observations by making soil profiles.
   8) Flooding risk, obtained from observations in the field by looking at land conditions

b. Laboratorium analysis:
   1) Determined the texture with a hydrometer
   2) Determined the permeability
   3) Analyzed C-Organic content
   4) Determined erosion sensitivity, which required percentage of textured soil, percentage of organic matter, soil structure, and permeability data. Based on these data, the K value can be calculated using nomographs.
2.1.2. Secondary data. Data and information obtained from various agencies, related government agencies, and documents that can support the research such as topographic maps, land types maps, land use maps, and administrative maps.

2.1.3. Data analysis. Land capability assessment on each land unit in the study area was carried out using the land capability classification criteria proposed by Hockensmith and Steel in 1943, Klingebiel, and Montgomery in 1973 [4].

2.1.4. Slope

| Code | Relief Type     | Slope percentage (%) |
|------|-----------------|----------------------|
| A    | Nearly level    | 0-3                  |
| B    | Gently sloping  | 3-8                  |
| C    | Moderately sloping | 8-15               |
| D    | Strongly sloping | 15-30                |
| E    | Moderately steep | 30-45                |
| F    | Steep           | 45-65                |
| G    | Very steep      | >65                  |

2.1.5. Erosion Sensitivity

| Code | Class       | Criteria  |
|------|-------------|-----------|
| KE₆  | Very high   | 0.56 – 0.64 |
| KE₅  | High        | 0.43 – 0.55 |
| KE₄  | Moderately high | 0.33 – 0.43  |
| KE₃  | Moderate    | 0.21 – 0.32  |
| KE₂  | Low         | 0.11 – 0.20  |
| KE₁  | Very low    | 0.00 – 0.10  |
2.1.6. Level of Erosion

| Code | Class   | Criteria                                      |
|------|---------|-----------------------------------------------|
| e₀   | No erosion | No erosion                                    |
| e₁   | Light    | <25% of the top layer is gone                 |
| e₂   | Moderate | 25%-28% of the top layer is gone              |
| e₃   | Quite heavy | 28% of the top layer to less than 25% of the down layer is gone |
| e₄   | Heavy    | More than 25% of the top layer is gone        |
| e₅   | Very heavy | Trench erosion                                |

2.1.7. Soil Depth

| Code | Class   | Amount |
|------|---------|--------|
| K₀   | Deep    | >90 cm |
| K₁   | Medium  | 90-50 cm |
| K₂   | Shallow | 50-25 cm |
| K₃   | Very shallow | <25 cm |

2.1.8. Soil Permeability

| Code | Class          | Amount          |
|------|----------------|-----------------|
| P₁   | Slow           | <0,5 cm/hour    |
| P₂   | Moderately slow | 0,5 – 2,0 cm/hour |
| P₃   | Moderate       | 2,0 – 6,25 cm/hour |
| P₄   | Moderately rapid | 6,25 – 12,5 cm/hour |
| P₅   | Rapid          | >12,5 cm/hour   |

2.1.9. Soil Drainage

| Code | Class          | Criteria                                      |
|------|----------------|-----------------------------------------------|
| D₀   | Excessively drained | Water quickly escapes from the ground, and very little water is able to be retained by the soil. Thus the plant will get water shortage |
| D₁   | Well-drained    | The land has good air circulation. All soil profiles from top to bottom (150 cm) have a uniform and bright color, with no yellow, brown, or gray patches. The land has good air circulation in the yard. There are no yellow, brown or gray patches on the upper and lower layers (up to 60 cm from the ground) |
| D₂   | Moderately drained | The topsoil has good air circulation. |
There are no yellow, brown, or gray patches. Spots are found in the lower layers (about 40 cm from the ground). At the bottom of the top layer (near the surface), there are gray, brown, and yellowish patches. All layers up to the surface are gray, the bottom layer is gray, or there are patches of a bluish color, or there is water that stagnates on the surface of the soil for a long time, which inhibits plant growth.

**2.1.10. Soil Texture**

| Code | Class          | Type of Soil                                      |
|------|----------------|--------------------------------------------------|
| t_1  | Smooth         | Includes sandy clay, dusty, and clay textures.    |
| t_2  | Moderately     | Includes sandy clay loam, clay, and dusty clay   |
|      | smooth         | loam textures                                    |
| t_3  | Slightly gritty| Includes clay, dusty clay, and dust textures      |
|      | and fairly     |                                                  |
| t_4  | Moderately     | Includes sandy loam, fine sandy loam, and         |
|      | gritty         | very fine sandy loam textures                    |
| t_5  | Gritty         | Includes loamy sand and sand textures            |

**2.1.11. Flooding Risk**

| Code | Class            | Notes                                                      |
|------|------------------|------------------------------------------------------------|
| O_4  | Very often       | For period 6 months or more, land is flooding regularly for more than 24 hours |
| O_3  | Often flooding   | During the period of 2-5 months in a year, flooding occurs for more than 24 hours |
| O_2  | Sometimes flooding | For one month in a year, flooding occurs for more than 24 hours |
| O_1  | Rarely flooding  | Irregular flooding in a period of less than one month that occurs for more than 24 hours |
| O_0  | Never flooding   | In one year period, no flooding occurs for more than 24 hours |

**2.1.12. Matching Classification.** This assessment was based on the results of classifying each parameter where the land capability classification is matched. The Class of land capability is divided into eight classifications with respective land criteria. Each classification has its criteria that indicate the condition and capability of the land. The class criteria for land capability shown in Table 9.
Table 9. Class of Land Capability [4]

| Inhibiting Factors | Class of Land Capability | I   | II  | III | IV  | V   | VI  | VII | VIII |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Surface Slope     | A                         | B   | C   | D   | A   | F   | G   | H   |
| Erosion Sensitivity | KE₁,KE₂               | KE₃ | KE₄,KE₅ | KE₆ | (1) | (1) | (1) | (1) |
| Level of Erosion  | e₀                       | e₁  | e₂  | e₃  | (2) | e₄  | e₅  | (1) |
| Soil Depth        | k₀                       | k₁  | k₂  | k₃  | (1) | (1) | (1) | (1) |
| Soil Texture      | t₁₁,t₂₁,t₃₁           | t₁₂,t₂₂,t₃₂,t₄₄ | t₁₄,t₂₄,t₃₄,t₄₄ | (1) | t₁₅,t₂₅,t₃₅,t₄₅,t₅₅ | (1) |
| Permeability      | P₂,P₃                  | P₂₅,P₃₂ | P₂₂₅,P₃₂₂ | P₁₅ | (1) | (1) | P₅  |
| Drainage          | d₁                       | d₂  | d₃  | d₄  | d₅  | (2) | (2) | d₀  |
| Gravel / rock     | b₀                       | b₁  | b₂  | b₃  | (1) | (1) | b₄  |
| Flooding risk     | O₀                       | O₁  | O₂  | O₃  | O₄  | (2) | (2) | (1) |

2.1.13. Analysis of Land Use Directive. The map of land capability classification results used to determine the land use direction in Tabo-Tabo Village. The land use directive is a recommendation based on the results of the classification.

3. Result and Discussion

3.1. Classification of Land Criteria

Based on the results of the land cover map overlay, slope classification map, and land type map, 61 units of land unit maps were obtained. From 61 land units, seven land units were chosen with a purposive sampling method with consideration of access to locations and aspects of land representation. The grouping of land units is presented in Table 10.

Table 10. Grouping of Land Unit

| No | Land Use                | Area Unit | Number of Units | Area (ha)   |
|----|-------------------------|-----------|-----------------|-------------|
| 1  | Secondary dryland forest| 1, 4, 10, 16, 21, 28, 31, 34, 41,47, 51, 57 | 12 | 1670.774 |
| 2  | Shrubs                  | 24, 30, 44, 49, 60 | 6 | 140.4809 |
| 3  | Waterbody               | 7, 9, 25, 37, 40, 45, 50, 56, 61 | 9 | 33.77237 |
| 4  | Dryland agriculture mixed with shrubs | 22, 26, 27, 29, 32, 35, 38, 42, 46, 48, 52, 54, 58 | 20 | 1013.841 |
| 5  | Rice field              | 3, 6, 12, 15, 18, 20, 23, 33, 36, 39, 43, 53, 55, 59 | 14 | 401.1993 |
| Total |                        |           | 61              | 3262.54     |

The results of observations and measurements of the criteria for inhibiting factors from the classification of land capability can be seen in Table 11. In Table 11, the inhibiting factors of the lower layer texture, rock, and salt/salinity were not observed. Lower layer texture does not
affect the classification of land capability because, in the classification table of Arsyad (2010) [4], this inhibiting factor can have random data. On the other hand, gravel/rocks were not observed because they were not found in the field. Salt/salinity was also not observed because the study location was in the upstream area, which far from the coastal area.

Table 11. Results of observation and measurement of inhibiting factors classification of land capability

| Inhibiting Factors | Observation Sample | Dryland second | Dryland secondary | Dryland secondary | Dryland agriculture mixed | Dryland agriculture mixed |
|-------------------|--------------------|---------------|------------------|------------------|--------------------------|--------------------------|
| Slope Erosion sensitivity | 14% Low | 16% Moderately high | 22% Low | 11% Low | 37% Moderate | 38% Moderate |
| Level of erosion | Very light because covered with a lot of organic litter | Very light because covered with a lot of organic litter | Very light because covered with a lot of organic litter | Moderate, upper layers are thinner, and lighter soils begin to appear | 110 cm (deep) | 91 cm (deep) |
| Soil depth | 71 cm (medium) | 47 cm (medium) | 84 cm (medium) | 72 cm (medium) | 113 cm (deep) | 113 cm (deep) |
| Top layer texture | Clay | Loam | Clay | Clay | Sandy clay loam | Dusty clay |
| Down layer texture | - | - | - | - | - | - |
| Permeability | Moderately Slow | Slow | Slow | Slow | Rapid | Rapid |
| Drainage | Poorly drained | Well-drained | Well-drained | Well-drained | Poorly drained | Poorly drained |
| Gravel / rock | None | None | None | None | None | None |
| Flooding risk | Never | Never | Never | Never | Never | Never |
| Salinity | - | - | - | - | - | - |

3.2. Erosion sensitivity

Erosion factor causing a decrease in soil fertility, disrupting plant growth, and reducing crop yields. Controlling soil erosion means reducing the influence of these erosion factors [5]. Based on the research conducted, the secondary dryland forest unit 28 had a low erosion sensitivity...
classification with a value of 0.13, assessed by the clay texture, organic matter, structure, and slow permeability. While in the secondary dryland forest unit 47, it had a moderately high erosion sensitivity with value 0.41, which was affected by the clay texture. Secondary dryland forest unit 21 had a low erosion sensitivity with a value of 0.18 assessed by the clay texture, organic matter, structure, and slow permeability. Shrubland unit had a low erosion sensitivity with a value of 0.18 assessed in the form of clay texture, organic matter, structure, and slow permeability. Dryland agriculture mixed with bushes unit 29 had a low erosion sensitivity with a value of 0.24 assessed from the form of sandy clay loam texture, organic matter, structure, and rapid permeability, as well as dryland agriculture mixed with shrubs unit 22 which had moderate erosion sensitivity with a value of 0.21 due to aspects of rapid permeability and sandy clay texture. The rice field unit had a low erosion sensitivity with a value of 0.17 assessed in terms of clay texture, structure, organic matter, and permeability.

3.3. Level of erosion
The secondary dryland forest unit 28 was dominated with ferns, seedlings, saplings, trees such as lobe-lobe (Flacourtia enermies) trees, and lento-lento (Arthrophyllum sp). While in secondary dryland forest, unit 47 was dominated with lobe-lobe (Flacourtia enermis), dao (Dracontomelon), cempedak (Artocarpus integer), lento-lento (Arthrophyllum sp), nutmeg (Myristica fragrans), and most were dominated by saplings. Secondary dryland forest unit 21 was dominated by plants such as mangosteen (Garcinia mangostana), rattan (Calamus L), and lento-lento (Arthrophyllum sp) trees. Since many plants dominated it, the ground surface was covered with a lot of dry leaves on the surface of the soil. Thus the possibility of erosion in these three land units is very little.

The shrubland unit was dominated by melanoma plants (Melastoma candidom), copasanda (Cromolaena orodata), fir (Lantana camara), Malotus sp, and ferns (Tracheophyta). Thus it had a moderate level of erosion. The dryland agriculture mixed with bushes unit 29 had a moderate level of erosion because the bush was low; thus, the soil was exposed. Whereas in the dry land, unit 22 had a moderate level of erosion, due to thin topsoil and brighter soil begin to appear due to the dominance of sparse plants, trees grow quite sparsely.

3.4. Soil Depth
Based on the results of field measurements (Table 11), the average soil depth results in the three secondary dryland forest units are less than 90 cm and including in moderate soil depth criteria because the soil layer is clay or solid clay textures. In shrubland, the soil depth is 72 cm, which means that it includes in a moderate depth classification because of the clay padding layer. Whereas the dryland agriculture mixed with shrubs and rice fields have a soil depth of more than 90 cm, which is included in the deep depth soil classification.

3.5. Soil Texture
The laboratory test result showed the percentage of soil texture in all land unit samples, and each percentage value (dust, clay, and sand) entered into the soil texture triangle diagram for texture readings, as shown in Figure 1.
The soil in the secondary dryland forest unit 28 had a clay texture with 58% clay content, 30% dust, and 12% sand. In the secondary dryland forest unit 47, it had clay texture with 23% clay content, 42% dust, and 35% sand. The next land unit, secondary dryland forest unit 21, had clay texture with 59% clay content, 29% dust, and 12% sand. Furthermore, the shrubland unit had clay texture with 56% clay content, 28% dust, and 20% sand. For dryland agriculture mixed with shrubs unit 29, it had sandy clay loam texture with 21% clay content, 22% dust, and 57% sand. While unit 22 had sandy clay texture with 44% clay content, 29% dust, and 27% sand. Last, the rice field unit had clay texture with 66% clay content, 13% dust, and 21% sand.

3.6. Permeability
Permeability is the quality of soil to pass water or air, which measured based on the amount of flow through a unit of land that has been fulfilled before a particular time unit [6]. Permeability test results obtained classified as slow criteria with the average value below 0.5 cm/hour because the average soil texture was clay texture. It was known that clay-textured soils were difficult to pass by water because of the small pore diameter, which was only around 0.002 mm. The secondary dryland forest unit 28 had a moderately slow permeability rate with a value of 0.7 cm/hour.

3.7. Drainage
All land units except secondary dryland forest unit 28 and rice field had good drainage and good air circulation. All soil profiles from top to bottom were uniformly light with no yellow, brown, or gray patches. Whereas in secondary dryland forest units 28 and rice fields, the top layer of soil had good air circulation with no yellow, gray, or brown patches. However, spots were found in the lower layers about 40 cm from the soil surface.

3.8. Determine the Classification of Land Capability
Criteria data were adjusted to the classification of a land capability table. The table of the grouping criteria (inhibiting factors) and determination of classification and sub-classification (limiting factors) are as follows:

| No. | Inhibiting Factor | Observation Sample | Dryland secondary forest 28 | Dryland secondary forest 47 | Dryland secondary forest 21 | Shrubs | Dryland agriculture mixed with shrubs 29 | Dryland agriculture mixed with shrubs 22 | Rice field |
|-----|------------------|-------------------|----------------------------|-----------------------------|----------------------------|-------|--------------------------------|--------------------------------|-----------|
| 1   | Erosion sensitivity | KE2 | C | D | D | C | E | E | B |
| 2   | KE4 | KE2 | KE2 | KE2 | KE3 | KE3 | KE2 |   |   |
| 3   | Level of erosion K1 | E1 | E1 | E1 | E1 | E1 | E2 | E1 |   |
| 4   | K1 | K1 | K1 | K1 | K0 | K0 | K0 |   |   |
| 5   | Soil depth t1 | t3 | t1 | t1 | t2 | t1 | t1 |   |   |
| 6   | Permeability t2 | P2 | P1 | P1 | P1 | P2 | P2 | P1 |   |
| 7   | D1 | D1 | D1 | D1 | D1 | D1 | D1 |   |   |
| 8   | Flooding | O0 | O0 | O0 | O0 | O0 | O0 | O0 | O0 |

Table 12. The results of inhibiting factors and determination of land capability classification grouping

Based on the results of the grouping by using the matching classification method, the Tabo-Tabo Village had three variations of capabilities in the seven land units. This capability classification was known to have a limiting factor, which was permeability in all land units. The ability of land Class IV had the most severe inhibiting factor, which was permeability, with an area of 110.97 ha, had one unit of land. The ability of land Class V, with the influence of permeability and drainage limiting factors with an area of 146.78 ha, had four land units. While the ability of land Class VIII with the influence of the most severe inhibiting factor was permeability and slope with an area of 70.00 ha, had two land units. The results of ability classification could be compared with land use in Tabo-Tabo Village and used as land use directive in Tabo-Tabo Village based on the land potential.

Capability Class IV, according to Arsyad (2010) [4], can be used for annual crops and generally crops, grass plants, production forests, pasture, protected forests, or nature reserves. Based on a study by Hardjowigeno and Widiatmaka (2011) [7], an example of lands in Class V is often flooding. Thus plants cannot be produced normally because the characteristics are flat land with the short growing season, rocky flat land, and stagnant areas that are not suitable for crops. Land with Class VIII is not suitable for agricultural cultivation, should be left in a natural state. Land Class VIII threats are very steep slopes and low water holding capacity. This land is useful as a protected forest or nature reserve.

### 3.9 Determine Directive for Land Use

Tabo-Tabo Village, located in Bungoro District, Pangkep Regency, had the land capability with classifications IV, V, and VIII. The results of the comparison with the existing land use in the field showed that the majority of the areas in Tabo-Tabo Village were used for agricultural land, resulting in uncontrolled land use in order to meet the needs of the local community.

The result of the study showed the comparison between land capability and land use, some lands already compatible, such as secondary dryland forest and shrubs. Furthermore, in Class V, there was one land that not under the current community use, which was a rice field with permeability as the most significant inhibiting factor. Thus land use directive is needed on this land.

Land use directive was in the form of recommendations following the potential and carrying capacity of the Tabo-Tabo Village, based on the land capability classification. From the results of the analysis, there were two land classifications, which were Class V and VIII, still had inappropriate land uses. Table 15 shows the land conditions that compatible and incompatible with the land capabilities in Tabo-Tabo Village.

| Capacity Class | Land Use          | Compatibility | Land Use Directive | Area (ha) | Area Percentage |
|----------------|------------------|---------------|--------------------|-----------|----------------|
| IV             | Secondary Dryland Forest | Compatible   | Secondary Dryland Forest | 110.97    | 17.80%         |
| V              | Secondary        | Compatible   | Secondary          | 56.11     | 9.00%          |
Based on the results of the study, the Tabo-Tabo Village had an area of 3262.54 ha and a total land area representing 623.43 ha. Area of land uses that were incompatible with class capabilities was 100.48 ha (16.12%), while 522.95 ha (83.8%) was compatible with class capabilities. Class IV with land use conditions, such as secondary dryland forest, was compatible with land capability classification. Class IV also used for annual crops and crops, grass plants, production forests, pastureland, forests, and nature reserves, so this condition shows that this location was compatible with land use. Class V capability with land use in the form of secondary dryland forest and shrubs, were compatible with the classification of land capability for class V, which used for grass plants, production forests, pastureland, forests tree like Arenga pinnata [8], and nature reserves. However, the rice field was incompatible for class V and directed to the production forest. Class VIII was only intended as a protected forest, so it was incompatible for agricultural production purposes.

4. Conclusion
Tabo-Tabo Village, Bungoro District, Pangkep Regency had three land capability classes, which were Class IV, V, and VIII. The severe inhibiting factors were permeability, drainage, and slope. Each land unit had different slope classification, from low to very low erosion sensitivity, light and moderate level of erosion, average soil texture in the form of clay, slow and rapid permeability, average drainage with no flooding risk exist in all land units. The land capability classification in Tabo-Tabo Village showed that secondary dryland forest unit 28 had land ability class IV. Secondary dryland forest unit 47 had land ability class V. Secondary dryland forest unit 21 had land ability class V. Shrubs were in Class V. Dryland agriculture mixed with shrubs unit 29 was in Class VIII. Secondary dryland forest unit 22 in Class VIII, and rice field belonged to Class V. Three land units that were incompatible was a land in Class V in the form of rice field and two lands in Class VIII in the form of dryland agriculture mixed with shrubs. Land in Class V was directed to the production forest, while land in Class VIII was directed to the protection forest.

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