Analysing suitability of arable land within a convertible production forest (HPK)

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Abstract. Potential land resources become one basic information needed in planning agroecological system development. The purpose of this study was to analyse the suitability of arable land in a convertible production forest area (HPK) in Konawe Kepulauan Regency, Southeast Sulawesi Province. Identification of arable land types and determination of agroecological zones was using spatial analysis through SPOT satellite imagery processing and slope map overlays and soil types to determine arable land units. Existing plant species were recorded and adjusted to the direction of land use from the Agricultural Research and Development Agency. From this study, 30 units of fertile land were obtained covering an area of 12,873.69 ha and spread across six zones, namely zone I covering 182.95 ha (1.42%), II covering 3,102.10 ha (24.10%), III covering 3,125.83 ha (24.28%), IV covering 3,594.36 ha (27.92%), V covering 631.85 ha (4.91%) and VI covering 2,236.61 ha (17.37%) with the distribution of plant species in the form of natural forests, annual crop agriculture, seasonal crops, agroforestry crops and food crops. Plants in zones I, II and III in accordance with the direction of land use but Zones IV, V and VI still not suitable.

1. Introduction

Based on a population census conducted every 10 years, there was an increase in the population in Konawe Kepulauan Regency during the period 1990 to 2010. In 1990 the population of Konawe Kepulauan Regency was 21,051 people. Then in 2000 it increased to 27,005 people and in 2010 it continued to increase to 29,126 people [1]. From the census it can be seen the rate of population growth in the period 1990 to 2000 amounted to 2.52% and the period of 2000 to 2010 amounted to 0.76%. With this increase in population, food needs and land requirements also increase, so that it can result in the conversion of agricultural and forestry land for business and residential needs. This will encourage the community to utilize forest land and other land that is not in accordance with their designation.

The area of land use in Konawe Kepulauan Regency reaches 73,992 ha [1] which consists of arable land use for agriculture covering 56,105 ha or 75.83% of the total land use area in Konawe Kepulauan Regency, non-agricultural land use covering 9,706 ha or 13.12% and unused land area of 8,181 ha or 11.06%. The use of arable land for agriculture consists of plantations / community forests / fisheries...
reaching 42,254 ha or as much as 57.11% of the total area of land use for agriculture. Whereas for dry fields / gardens it is only 7,288 ha or 9.85%, fields covering 6,213 ha or 8.40% and paddy fields covering 350 ha or only 0.47% of the total area of agricultural land use. The high percentage of arable land use for agriculture shows the large community needs for land in this area.

In the period of 2006 to 2015 there was a change in the extent of land cover in the forest area in Konawe Kepulauan Regency. Dryland forest area decreased from 12,634 ha in 2006 to 10,200 ha in 2015, while the area of agricultural / plantation land in the forest area increased from 27 ha in 2006 to 78 ha in 2015. From the results of the study, efforts to limit activities of conversion of forest land into agricultural / plantation land in the forest area in Konawe Kepulauan Regency. One effort that can be done is by optimizing arable land to prevent more widespread land clearing in the forest area and to support the development of a good agricultural and

Data on land resource potential is one of the basic information needed for the development of a good agriculture and forestry system. Land suitable for crop cultivation in agriculture and forestry systems is grouped into agroecological zones based on slope and soil type [2]. Each zone represents the same characteristics of land resources and is used as a basis for determining agriculture and forestry systems and alternative commodity development. This study aims to analyse the suitability of arable land in a convertible production forest area (HPK) in Konawe Kepulauan Regency, Southeast Sulawesi Province.

2. Material and method

2.1. Study area
This research was carried out in the Convertible Production Forest area (HPK), Konawe Kepulauan Regency, Southeast Sulawesi Province, which is geographically located between 123°17'21.00" BT - 123°15'54.20" BT and 4°0'16.27" LS - 4°15'20,73 "LS. This research was conducted for two months from November 2018 to December 2018.

![Figure 1. Study area](image)

2.2. Tools and materials
The tools used in this research include Global Positioning System (GPS) Garmin Type Montana 680, Suunto compass, NIKON Digital Camera, ESRI ArcGIS Software, and a set of HP laptop Core i3 RAM 2 GB. The materials used in this research include basic maps (roads, rivers and administrative and district boundaries) sourced from the RI Geospatial Information Agency; Thematic data include a
map of the Konawe Kepulauan District forest area in 2017 scale of 1:100,000, slope maps and soil type maps, Spot Image 7 coverage in February 2017 and Agroecological Zone guidelines as guidelines for analysis of agriculture/forestry systems from Agricultural Research and Development Agency.

2.3. Research procedure

2.3.1 Types and data collection techniques. The technique used to obtain primary data is observation technique, which is a method of data acquisition by direct observation of the observed object, namely the use of agricultural arable land and the types of plants cultivated on arable land within theConvertible Production Forest (HPK) area. Secondary data were collected from relevant government agencies, namely the Geospatial Information Agency and the Agricultural Research and Development Agency.

2.3.2 Identification of arable land in the HPK area. Arable land in the HPK area was identified through spatial analysis of Spot 7 image coverage in February 2017 to obtain maps of arable land types. The research steps are as follows:
a. Initial processing of satellite imagery. In this step include radiometric correction, geometric correction, composites, fusion and sharpening image contrast [3,4].
b. Classification of arable land. At first, land cover data generated through the processing of satellite imagery and field survey. Supervised classification digital feature extraction method used for land cover classification mapping. These procedures based on the spatial pattern recognition. Based on the ground check data, reclassify the results of the initial land cover classes into an arable land.
c. Ground control point was carried out at 60 control points determined evenly, taking into account the accessibility and representation of land cover types. In this verification process a data was collected on the types of use of arable land and types of plants cultivated on arable land within the HPK area.
d. Overlay the arable land map with slope maps and soil type maps to get variations of the arable land units within the convertible production forest area.

2.3.3 Analysis of the suitability of agricultural land, plantations and forestry based on agroecological zones. Analysis of arable land units based on slope and soil type based on the criteria of agroecological zone grouping issued by the Agricultural Research and Development Agency. Units of arable land that have a common characteristic of land are grouped in the same zone. There are seven agroecological zones based on similarity in land characteristics including slope and soil type [2,5].

| No | Parameter | I  | II | III | IV  | V  | VI  | VII |
|----|-----------|----|----|-----|-----|----|-----|-----|
| 1  | Slope (%) | > 40 | 16-40 | 8-15 | < 8 | < 8 | < 8 | < 8 |
| 2  | Soil Type | Peat Soil (Histosols) | Entisols, Podsol (Spodosols) | Inceptisols (Spodosols) |

Source: Agricultural Research and Development Agency

3. Result and discussion

3.1. Slope
The first parameter used in the initial selection in the development of agroecology systems based on agroecological zones is terrain, especially slope, because it can distinguish whether the area is suitable or not for the development of agricultural commodities [2,5]. The division of slope classes in arable land within the HPK area in Konawe Kepulauan Regency is presented in Table 2.
Table 2. Classes of arable land slopes within the HPK area in Konawe Kepulauan Regency

| Slope Class        | Slope (%) | Area  | %   |
|--------------------|-----------|-------|-----|
| High steep         | > 40      | 182.95| 1.42|
| Steep              | 20 – 40   | 1,722.09| 13.38|
| Moderate Steep     | 15 – 20   | 1,380.01| 10.72|
| Sloping            | 8 – 15    | 3,125.83| 24.28|
| Flat               | 0 – 8     | 6,462.82| 50.20|
| Total Area         |           | 12,873.69| 100.00|

3.2. Soil type
The second parameter considered in the development of agroecology systems based on agroecological zones is the type of soil. Soil type information is very important for determining the direction of use. Soil type influences the suitability of various agricultural crops [5]. The land naming system / land classification in Indonesia generally uses the National Land Classification system [6] which is paired with Key to Soil Taxonomy [7]. Distribution of soil types in arable land within the HPK area in Konawe Kepulauan Regency, there are six types of soil. For more details, area and percentage of each type of land are presented in Table 3.

Table 3. Soil types on arable land within the HPK area in Konawe Kepulauan Regency

| No. | Soil Type | Area  | %   |
|-----|-----------|-------|-----|
| 1.  | Organosol | 1,046.18| 8.13|
| 2.  | Litosol   | 419.64 | 3.26|
| 3.  | Regosol   | 159.95 | 1.24|
| 4.  | Kambisol  | 2,787.67| 21.65|
| 5.  | Podsolik  | 590.27 | 4.59|
| 6.  | Mediteran | 7,869.97| 61.13|
| Total Area | 12,873.69 | 100.00|

3.3. Arable land in a converted production forest area
Arable land is one form of community use of forest land in the form of rice fields, fields, gardens, mixed gardens and ponds. Based on the interpretation of satellite imagery, the results of the distribution area of arable land within the HPK area in the study area are 12,873.69 ha or 62.38% of the total area of HPK in Konawe Kepulauan Regency. These results indicate that the community's need for agricultural land in Konawe Kepulauan Regency is relatively high. This is reinforced by the data for other use areas (APL) in this district which is only 13,504.28 ha or 19.10% of the total land area, the rest is forest area with an area of 57,203.67 ha or 80.90% of the total area mainland Konawe Kepulauan Regency (SK. Minister of Forestry Number 465 of 2011).

The impact of the lack of other use areas (APL) in this district has implications for the existence of the forest area because it has been converted into agricultural land and plantations. The results of the identification of the distribution of arable land within the HPK area identified two types of arable land use, namely dry land agriculture and rice fields (figure 2 and 3).

Based on statistical data [1], the number of productive age population aged 15 years and over in Konawe Kepulauan who have worked as many as 14,496 people. The percentage working in the agriculture and forestry sector is 58.57% of the total main business sectors. The data illustrates that the average productive age population aged 15 years and over who work in the agriculture and forestry sectors is 8,490 people. When related to the area of arable land within the HPK area based on the results of the study covering an area of 12,873.69 ha, the average area of arable land cultivated by the community is 1.52 ha for each person working in the agriculture and forestry sector in Konawe Kepulauan District. The Central Statistics Agency classifies farmers into three categories, namely
small scale farmers with farm area <0.5 ha, medium scale with farm area 0.5-1.0 ha, and large scale farmers with farm area > 1.0 ha. Based on these data it can be assumed that the community who cultivates arable land within the HPK area in the Konawe Kepulauan Regency is classified as a large-scale farm.

3.4. Arable land unit
Spatial analysis results through overlaying arable land cover maps with slope maps and land type maps obtained 30 variations of arable land units (Table 4). Arable land units that have similar characteristics are grouped into the same zone. Based on the analysis of agroecological zones, the arable land units within the HPK area in Konawe Kepulauan Regency are grouped into six zones (Table 5).
### Table 4. Variation of arable land units within the HPK area in Konawe Kepulauan Regency based on slope class and soil type

| Arable Land Unit | Soil Type | Slope (%) | Area (ha) | % |
|------------------|-----------|-----------|-----------|---|
| 1                |           | >40       | 8.95      | 0.07 |
| 2                |           | 20 - 40   | 159.77    | 1.24 |
| 3                | Cambisol  | 15 - 20   | 171.30    | 1.33 |
| 4                |           | 8 - 15    | 474.74    | 3.69 |
| 5                |           | 0 - 8     | 1,972.92  | 15.33 |
| 6                |           | >40       | 1.33      | 0.01 |
| 7                |           | 20 - 40   | 61.89     | 0.48 |
| 8                | Litosol   | 15 - 20   | 53.19     | 0.41 |
| 9                |           | 8 - 15    | 98.98     | 0.77 |
| 10               |           | 0 - 8     | 204.26    | 1.59 |
| 11               |           | >40       | 157.47    | 1.22 |
| 12               |           | 20 - 40   | 1,187.01  | 9.22 |
| 13               | Luvisol   | 15 - 20   | 946.23    | 7.35 |
| 14               |           | 8 - 15    | 2,124.11  | 16.50 |
| 15               |           | 0 - 8     | 3,455.15  | 26.84 |
| 16               |           | >40       | 1.68      | 0.01 |
| 17               |           | 20 - 40   | 90.12     | 0.70 |
| 18               | Histosol  | 15 - 20   | 85.16     | 0.66 |
| 19               |           | 8 - 15    | 255.41    | 1.98 |
| 20               |           | 0 - 8     | 631.85    | 4.91 |
| 21               |           | >40       | 10.31     | 0.08 |
| 22               |           | 20 - 40   | 202.47    | 1.57 |
| 23               | Podsol    | 15 - 20   | 104.03    | 0.81 |
| 24               |           | 8 - 15    | 134.25    | 1.04 |
| 25               |           | 0 - 8     | 139.21    | 1.08 |
| 26               |           | >40       | 3.21      | 0.02 |
| 27               |           | 20 - 40   | 38.88     | 0.30 |
| 28               | Regosol   | 15 - 20   | 20.10     | 0.16 |
| 29               |           | 8 - 15    | 38.33     | 0.30 |
| 30               |           | 0 - 8     | 59.44     | 0.46 |
| **Jumlah**       |           |           | 12,873.69 | 100.00 |

### Table 5. Agroecological zone grouping in arable land units within the HPK area in Konawe Kepulauan Regency based on land characteristics and existing plat species

| Zone | Arable Land Unit | Area (ha) | Percentage (%) | Land Characteristics | Existing Plant Types | Suitability |
|------|------------------|-----------|----------------|----------------------|----------------------|-------------|
| I    | 1, 6, 11, 16, 21, 26 | 182.95    | 1.42           | Slope > 40%, soil type has no effect | Jabon, singi tree (Wormia, sp.) and other forest plants, | Suitable |
| II   | 2, 3, 7, 8, 12, 13, 17, 18, 22, 23, 27, 28 | 3,102.0   | 24.10          | Slope 16-40%, soil type has no effect | Jabon, rattan, singi tree, other forest plants, nutmeg, coconut, cashew, bamboo fur, cloves, teak and langsat | Suitable |
| III  | 4, 9, 14, 19, 24, 29 | 3,125.83  | 24.28          | Slope 8-15%, soil type has no effect | Nutmeg, coconut, cashew, rattan | Suitable |
| IV   | 15, 25            | 3,594.36  | 27.92          | Slope < 8%, soil type has no effect | Coconut, nutmeg, jackfruit, jabon, | not suitable |
The types of plants that are spread in the six regional zones are mostly in accordance with the direction of the agroecological zone commodities. This conformity is in zones I, II and III. Zone I is a catchment area with a slope of >40%. It is feared that the conversion of forest plants to agricultural commodities could reduce the quality of forest functions as a buffer zone. The recommended types of plants are forestry plants that have a strong root system. In zones II and III there are several types of plants that can be recommended for intercropping with existing plants in the field. Recommendations for zone II are perennial / perennial / forestry / estate crops including teak, jabon, durian, jackfruit, cashew, rambutan, langsat, coconut, robusta coffee, rubber, pepper, cashew, cocoa, clove and kapok. Whereas recommendations for zone III are annual crops and agroforestry crops including nutmeg, coconut, cashew, rattan, rubber, pepper, clove, cocoa, robusta coffee, vanilla, pete, areca nut, soybean, sugar palm, durian, duku, oranges, jackfruit, langsat, star fruit, bananas, mangosteen, corn, soybeans, beans and tubers.

The discrepancies between the existing plants in the field with the direction of the agroecological zone commodities are found in zones IV, V and VI. In zone IV, existing plant species include coconut, nutmeg, jackfruit, jabon, rattan, banana, cocoa, areca nut, cashew, a type of jabon, singi tree, other forest plants, langsat, coffee, sugar palm, pepper; not in accordance with the direction of the agroecological zone commodity. Commodity directions for zone IV are food crops / annual crops including cereal crops (lowland rice, upland rice, corn, wheat), legumes (green bean, peanut, Phaseolus vulgaris), tubers (sweet potato), cassava), soybeans, tobacco, pepper, onion, cayenne pepper, watermelon, cucumber, pineapple, ginger, kencur, turmeric, galangal. In zone V, existing plant species include paddy, cashew, coconut, langsat, cocoa, nutmeg, mango, jackfruit, kapok, guava, areca nut, banana, srikaya, teak, orange, kedondong, sugar palm, bamboo; not in accordance with the direction of the agroecological zone commodity. Commodity directions for zone V are plantation crops including cashew, coconut, langsat, cocoa, nutmeg, mango, jackfruit, water guava, areca nut, banana, srikaya, rubber, orange, pineapple, kedondong, bamboo and vegetables. In zone VI, existing...
plant species include cashew nuts, coconut, nutmeg, cocoa, mango, jackfruit, kapok, bayur wood, pepper, clove, rambutan, jabon; not in accordance with the direction of the agroecological zone commodity. Commodity directions for zone VI are forestry plants (mangroves) and fisheries (ponds).

4. Conclusions

From the study, it can be concluded that (1) The arable land in the HPK area in Konawe Kepulauan Regency reached 62.38% (12,873.69 ha) of the total HPK area (20,638.45 ha) in Konawe Kepulauan Regency, consisting of 12,860.77 ha of farming and 12.92 ha of rice fields. (2) The arable land in the HPK area in Konawe Kepulauan Regency is divided into six agroecological zones based on slope and soil type, namely zone I covering 182.95 ha (1.42%), zone II covering 3,102.10 ha (24.10%), zone III covering 3,125.83 ha (24.28%), zone IV covering 3,594.36 ha (27.92%), zone V covering 631.85 ha (4.91%) and zone VI covering 2,236.61 ha (17.37%). (3) Suitability in the direction of agroecological commodities is in zones I, II and III, while for zones III, IV and V are still not suitable.

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