# Evaluation of Suitability of Paddy Field (Oryza Sativa L.) in Noongan Sub-watershed and Panasen Sub-watershed

Grace F. Suoth[(✉)] and Maxi Tendean

Geography Department, Faculty of Social Science and Law, Manado State University, Manado, Indonesia
`gracesouth@unima.ac.id`

**Abstract.** Rice is a staple food crop in Indonesia because most of the population consumes rice as a staple food. For optimal production, rice plants must be planted in paddy fields according to their designation and the growing plants' requirements. Determination of land suitability class is essential to obtain a database as information on the suitability of the quality of the land characteristics so that the land suitability class and its limiting factors can be known as the basis for determining the necessary land improvement management. The study aimed to determine the land suitability class for lowland rice (Oryza sativa L.) in the Panasen and Noongan sub-watersheds. The long-term goal is for the preservation of sustainable paddy fields. The method uses a field survey, referring to the limiting factors of land quality described in the characteristics of the land. The data from the field measurements and the laboratory analysis results matched the criteria for the suitability class of lowland rice based on the Minister of Agriculture Regulation No. 79 (2013). The result of the research is that the land unit of S3 suitability class is S3rns on a land unit of 5, 9, with the limiting factors being root conditions, nutrient availability, and slopes. S3fn land unit on land unit 7, limiting factor for nutrient retention and nutrient availability, S3rfn land unit on land unit 8, limiting factor for root conditions, nutrient retention, nutrient availability, S3n land unit on land unit 10, 11, 13, 14, 15, 16, 17, 18 and 27, with the limiting factor of nutrient availability, S3ns in 12 land units, the limiting factor of nutrient availability and terrain. The land unit suitability class N is the land unit suitability class Ns on land units 1, 2, 4, 19, 20, 21, 22, 23, 24, 25, and 26, the field limiting factor. Land unit suitability class Nrs on land unit 3, with limiting factors for root and terrain conditions. Land unit suitability class Nr on land unit 6, the limiting factor for root conditions.

**Keywords:** Evaluation · Suitability of Paddy Field · Watershed

## 1   Introduction

The position and role of the Regional Government to protect and regulate land determination paddy farming are significant. Understanding paddy fields as an environmental function is, in fact, a new paradigm where farmers and communities, including the government, are obliged to preserve local resources in rural areas. The policy in maintaining the balance of the watershed environment against the threat of diversion of the function of paddy fields that is not by its designation is a system that must involve sub-systems, namely related substances [1, 2].

A Watershed (DAS) is an expanse, area, area bounded by ridges or ridges or mountains (topographical separator) that receives, stores, collects rainwater that falls on it, sediments and nutrients, and then flows it into the main river, continued its flow through sub-watersheds (tributaries) is channeled into lakes or the sea [3]. Watersheds have a significant role as a protection and life support system. Therefore, their existence needs to be appropriately managed to sustain this role [4]. One area of concern to the central government and the local government of North Sulawesi is the Tondano watershed, which is located in Minahasa Regency and Manado City. This watershed has several sub-watersheds, including the Noongan sub-watershed, and the Panasen sub-watershed, where the agricultural business of the Tondano watershed is concentrated in these two sub-watersheds.

There are problems in the Tondano watershed, namely an increase in erosion, sedimentation, flooding, eutrophication, environmental pollution, land conversion, and so on. The results of the research by Rotinsulu W. H, [5], namely the Tondano Watershed (DAS) there was a significant change in paddy field cover where there was a decrease in the area of 2966.49 ha in a period of 13 years (2002 to 2015). The reduction in the area was due to the conversion of paddy fields into residential land that was not by its designation, covering an area of 1434.24 ha and agricultural land surrounding an area of 2279.7 ha.

## 2   Method

The research uses field study methods and laboratory analysis based on land evaluation analysis by measuring several land qualities on the land unit map as a work map or unit of analysis.

The variables measured are land quality which is described in land characteristics as follows: Temperature ( C), Water Availability, Humidity (%), Texture Class, Soil Depth (Cm), Peat Thickness (Cm), Soil CEC Nutrients (cmol/kg), Base Saturation (%), pH H2O, Total Nutrient N (%), P205 (mg/100g), Salinity (ds/m), Slope (%). Furthermore, the quality of land characteristics is assessed by determining the scoring based on predetermined parameters, referring to the Regulation of the Minister of Agriculture Number: 79/Permentan/OT.140/8/2013 dated August 12, 2013.

The land unit map is a working map for evaluating land suitability for lowland rice. Land units refer to such conditions in terms of landform, slope, land use, and soil type. Land unit maps are compiled by overlapping landform maps, slope maps, land use maps, and soil type maps. The results of the overlapping of these maps produce 27 land units of land units that will be analyzed for land characteristics.

## 3  Results and Discussion

The results of land suitability studies are actual land suitability or land suitability produced based on existing data. Its usefulness has not considered the assumptions or efforts to improve and the level of management that can overcome the constraints or limit factors that exist in each land unit. Determination of land suitability class for rice plants is obtained by comparing (matching) land characteristics as parameters of each land unit with the requirements for growing rice plants based on the criteria of the Minister of Agriculture Regulation Number: 79/Permentan/OT.140/8/2013 dated August 12, 2013, Explanation of each parameter of each land unit [6], namely: The annual mean temperature (tc) of land units 1, 2, 11, 12, 13, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 27, 27 26 indicates 22.2 °C -22.6 °C, including class S2 (fairly suitable). Land units 3, 4, 5, 6, 8, and 9 annual mean temperature of 21.6 °C belongs to class S3 (marginally appropriate).

Availability of water (wa) humidity shows all land units, including class S1 (very suitable), with an annual average rate of 85–90%. Rooting Media (rc) drainage shows that land units 1 to 26 are well-drained and included in the S2 class classification; only 27 land units with slightly obstructed drainage are included in the S1 class classification. Land unit 1 and land unit 27 with clay-clay texture (gl-slightly fine) including class S1, land unit 2 and land unit 25 with clay texture (l-fine) class S1, land units 3 and 6 with sand texture (p-coarse) k class N, land units 4, 5, 8 and 9 textured loamy sand (pg-slightly coarse) class S3, land units 11, 17 and 19 textured Clay-clay-sandy (glp-medium) class S2, land unit 12, 13, 15, 19, 20, 21, 23, 24, and 26 textured Sandy-clay (gp-medium) class S2, and land units 16 and 22 textured (g-slightly fine) class S.

The results of observations on the distribution of coarse material, all land units < 2%, are classified as S1 class. Soil depth (cm) indicates that all land units with a depth of > 60 cm are classified as S1. Nutrient Retention (nr) Soil CEC (cmol/kg), all land units with a percentage of > 16 cmol/kg enter the S1 class. Base saturation (%) indicates land units of 10, 12, 13, 14, 15, 16, 17, 20, 21, 22, 24, 25 including S1 class, are in family planning criteria > 50%. Land units 6, 11, 18, 23, 26, and 27, including the S2 class, are in the 35 – 50% criteria range. Land units 2, 3, 4, 7, 8, 9, and 19 are included in the S3 class and are in the family planning criteria < 35%. Ph (H2O), all land units, namely land units 1 to 27 land units, including class S1, are in the pH range of 5.5–7.0. In general, changes in soil pH from 6 to 7.5 have a minimal direct effect on plant roots or microorganisms [7].

The variation in the pH value of the study area is the variation of the optimum pH value for most soil microorganisms, which is between 5–8 (Winarso, 2005) [7]. Nutrient available (nr) total N content (% N) of soil showed, Land units 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, including S1 class, are in the N-total criteria range of 0.21%–0.50% (medium); Land unit 11 class S2 with a value of 0.18% (low); Land units 1 and 2 are S3 class with N-total value = 0.01. The P-soil content (mg P2O5/100 g), P2O5 shows that land units 1 to 27 are classified as S3 class, within the criteria < 152 mg/100 g. The K-soil content (mg K2O/100 g), land units 10, 12, 13, 20, and 27 belong to class S1 and are in the K-soil range criteria > 196 mg/100g . Land units 1, 7, 14, 16, 23, 24, 25 belong to S2 class, are in the K-soil range criteria = 90–196 mg/100g.

Land units 2, 3, 4, 5, 6, 8, 9, 11, 15, 17, 18, 19, 21, 22, 26 belong to the S3 class, are in the K-soil content criteria < 90 mg/100 g. Soil Toxicity (xc) Salinity indicates land unit 1 to land unit 27 is included in class S1 and is in the criteria < 2 mg. Landslide Hazard (uh) slope (slope) (%), land unit 14, 16, 27, classified as S1, is in the slope criteria < 3%. Land units 7, 8, 10, 11, 15, and 17 enter the S2 class and are in the slope criteria range of 3% - 8%.

Land units 5, 6, 9, 12, 13, and 18 are included in the S3 class and are in the 9% - 30% slope criteria range. Land units 1, 2, 3, 4, 19, 20, 21, 22, 23, 24, 25, 26 belong to class N, are on slope criteria > 30%. The danger of Flood/Inundation During the Planting Period (fh) based on the characteristics of Inundation Height (cm), the main cause is that rice fields in the downstream area are widely used as residential areas.

As a result, the Downstream area of the Tondano River has several meanders and several bottlenecks obstructing the flow of water during the rainy season so that the flow of the river is blocked in the narrow sections, and the land downstream is inundated. Around Lake Tondano, heavy flooding occurred in the paddy field area and most of the city of Tondano in the north of the lake, partly including the Noongan Sub-watershed and Panasen Sub-watershed. This area is derived from lacustrine deposits with a slope of less than 1/900, and the lake water level varies by more than 2 m; many areas are broad and flat along the inundated lake. Because of this, people living in the north of the lake suffer from a lack of clean water and poor health. Part of the paddy fields in the Noongan sub-watershed south of the lake was inundated due to rising riverbeds due to sedimentation in the weir ponds at the intake and narrow bridge sections. The distribution of landslide-prone areas in the Tondano sub-watershed consists of five landslide susceptibility classes spread over three sub-districts, namely Eris, Kakas, and East Tondano sub-districts. Landslide Hazard Classification Landslide Vulnerability Value is in the classification: < 2.5 (Low); 2.5–3.5 (Medium); > 3.5 (High) [8].

Long Puddle, there was extensive flooding in Minahasa Regency and Manado City in 2014, with water depths reaching 2 m in some places and flood waters receding after three days. Floods have resulted in enormous property losses, loss of life, and damage to life in this city. The actual land suitability can be seen in Picture Map 13 (Fig. 1).
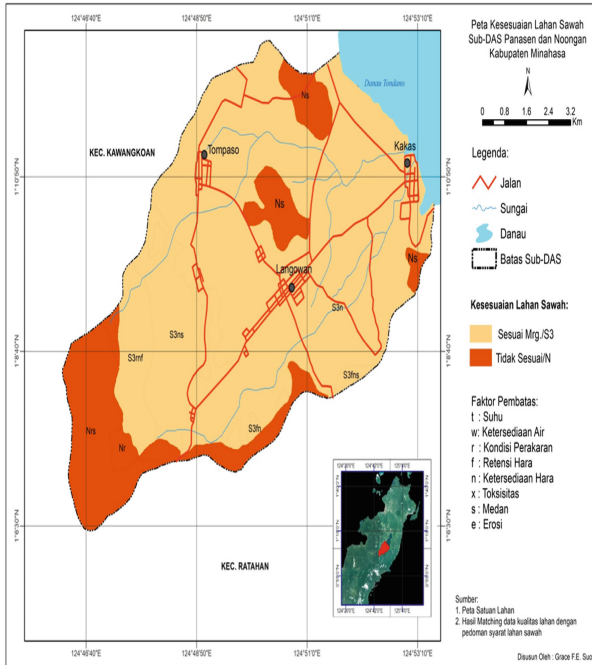
**Fig. 1.** Map of Actual Rice Field Suitability.

## 4   Conclusion

The land unit suitability class S3 is S3rns on land units 5 and 9, with the limiting factors being root conditions, nutrient availability, and slopes. S3fn land unit on land unit 7 is the limiting factor for nutrient retention and availability. S3rfn land unit in land unit 8, limiting factors for root conditions, nutrient retention, and nutrient availability. S3n land units on land units 10, 11, 13, 14, 15, 16, 17, 18, and 27, with limiting factors for nutrient availability, S3ns on land units 12, with limiting factors for nutrient availability and terrain.

Land units of suitability class Ns are found in land units 1, 2, 4, 19, 20, 21, 22, 23, 24, 25, and 26, the field limiting factor. The land unit suitability class Nrs is found in land unit 3, with limiting factors for root and terrain conditions. Land unit suitability class Nr on land unit 6, limiting factor for root conditions.

Inland units with Land suitability class S3 Marginal Suitable (Marginal Suitable) and land suitability class N (not suitable), the limiting factor can be improved so that for optimum land use for lowland rice, the suitability class can be increased. During the dry season, paddy fields can be cultivated with other types of annual crops according to the characteristics of the land, namely secondary crops and horticultural crops (tomatoes, onions, chilies, etc.).

**Authors' Contributions.** The first author in this study served as the head of the research and coordinated the entire series of research activities. The second and third authors served as members and assisted in data collection and analysis.

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