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# GIS-based Mapping of Crop Suitability Rating for the Re-Delineated Soil Types in Barangay Bantug, Science City of Muñoz, Nueva Ecija, Philippines

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**Abstract**

Crop suitability assessment is essential for land use planning, sustainable farming, and resource management prior to production. This research focused on the identification and re-delineation of soil types in the agricultural lands of Barangay Bantug, Science City of Muñoz, Nueva Ecija, and aimed to determine the suitability rating of the top five agricultural crops produced in the Philippines. With the use of the *Handbook for Soil Series Identification* in Nueva Ecija and the hydrometer method for soil texture determination of the surface soil (0–20 cm), six soil types were identified in Brgy. Bantug: Maligaya Clay, Maligaya Clay Loam, Maligaya Loam, Maligaya Silty Clay Loam, Maligaya Silty Clay and Bantog Clay Loam. The soil type map generated was used as land mapping units in crop suitability assessments of wetland rice, upland rice, corn, onion, mango, and sugarcane. In Maligaya Clay Loam and Bantog Clay Loam, all crops are potentially highly suitable. The permanent limitations from other land mapping units are basically related to the rooting condition, specifically the soil surface texture. The latest taxonomic classification based on secondary data indicates that the Maligaya Series is fine, smectitic, isohyperthermic, Typic Epiaquert, while the Bantog Series is very fine, mixed, isohyperthermic, Typic Endoaquert. The processes and maps used and produced from this research can benefit the local government unit in land use planning, the farmers in selecting crops to be produced, and future researchers in the identification and re-delineation of soil type maps for crop suitability assessment.

**Keywords:** *crop suitability assessment, soil series of Brgy. Bantug, soil type identification*

## Introduction

The massive increase in Philippines' population is directly related to food needs. In order to secure the food requirements of the Filipino people, agricultural productions should be increased through time. Limiting factors in food production cause a decrease in agricultural productivity. To overcome this problem, we need precision agriculture, which focuses on "doing the right thing in the right place at the right time" (Davis et al., 1914). This involves the collection and analysis of data and taking action based on it (USGAO, 2024). Ultimately, the success of production depends on farmers' knowledge and management practice.

The diversity of soils in the Philippines support a wide range of crops. Varieties of food producing crops are continuously cultivated to suppress the hunger of Filipino people. Different crops have their own preferred soil types. Plant and soil relationship is significant in bringing out the maximum yield The main reason why there is clustering of crops and vegetables in different regions or provinces in the Philippines is that the soil of one province can be different from that of another. Through proper soil survey and classification, soil differences have been identified and delineated.

Data about Philippine soil types can now be accessed by farmers through online website geoportal.gov.ph, but these data were based on small-scale mapping. This delineated map, produced in 1:250,000 scale, may have differences at barangay level boundaries. The re-delineation of soil type boundaries at a scale of 1:25,000 is more detailed than the available maps, which can improve the precision and accuracy of the previous maps in the selection of crops for food, feed, and fiber. Soil is one of the independent variables to be considered. The yield of different crops is highly dependent on soil characteristics. Through proper selection of suitable crops, maximum profit can be achieved.

Delineation is the process of producing maps with precise boundaries. This study was conducted to re-delineate the soil type map of Barangay Bantug, Science City of Muñoz in a larger scale, define its taxonomic classification based on updated secondary data and produce map that can be utilized to recommend suitable cropping patterns for a more productive, profitable and sustainable crop production system for the farmers.

## Materials and Methods

### Site Description

The study area is bounded on the west by Barangay Poblacion, which is the city proper of Science City of Muñoz, on the north by Barangay Balante and Bagong Sikat, on the east by Central Luzon State University (CLSU), on the south by Barangay Villa Nati, Sapang Cauayan and Villa Cuizon and on the southwest by Barangay Bakal 3, Talavera. Barangay Bantug is one of the biggest barangays in terms of land area and the most populated barangay in Science City of Muñoz. It has a total land area of 344 ha, and 657 ha are part of CLSU.

Barangay Bantug boundary was digitized using Google Earth Pro software. The extent of the boundary was identified by the presence of irrigation, roads, dikes, barangay arc and other landmarks. To separate the built-up areas from cultivated or agricultural areas, the built-up areas were also digitized and cut out from the boundary of Bantug. The built-up areas were marked in white on the map, and only agricultural lands were used for the soil type re-delineation.

### Plotting of Sample Points

Using a soil probe with a depth of 50 cm, the 30–50 cm soil samples were collected from three points located within the 50 cm range of the sampling point generated by ArcGIS. By using this point generator, sampling points were distributed throughout the agricultural areas of Barangay Bantug without limitation. The number of the sampling points was 25, having a sample point density of 1:12.5 ha. The map has a scale of 1:25,000.

### Collection of Soil Sample

The sampling points generated by ArcGIS 10.3 software were located using a Garmin (Montana 650) GPS device. Using a soil probe with 50cm depth the 30-50cm soil was collected on three points located within the 50 cm range of the sampling point generated by ArcGIS. These three points serve as replicates and were used as the soil samples for soil series determination; the 30–50 cm soil depth was used because it is below the cultivated soil, which has fewer disturbances. The soil sample collection method adopted was based on the Collado et. al. (2008) handbook with slight modification by the researcher. The surface soil (0–20 cm depth) was subjected to soil texture analysis in the laboratory using the hydrometer method following the procedure from Domingo et. al. (2004).

### Soil Type Identification

The process of soil series identification followed the procedure from the handbook *Simplified Keys to Soil Series: Nueva Ecija,* which was produced by the Philippine Rice Research Institute. It was slightly modified because of the digital sampling procedure. The collected soil samples from 30 cm to 50 cm depth were analyzed based on its color, texture, coarse fragments and mottles. The surface soils from 0-20 cm depth were subjected to soil texture analysis in the laboratory using the hydrometer method.

### Verification/Reclassification of the Current Soil Taxonomic Classification

The current soil taxonomic classification of each delineated soil series was verified/reclassified using secondary data from Miura et. al. (1995). The identified properties of soil series from Miura et al. (1995) were used to determine the soil taxonomic name from differentiation of mineral soils and organic soils, epipedon, sub-surface horizon, soil moisture regime, soil temperature regime, order, suborder, great group, subgroup, particle size, to its mineralogical class.

### Land Suitability Assessment

The land suitability of each soil type in Bantug, Science City of Muñoz was classified into two orders: *suitable* and *not suitable*. Each order was further classified into classes with symbols S1 (Highly Suitable), S2 (Moderately Suitable), S3 (Marginally Suitable), N1 (currently not suitable), and N2 (permanently not suitable) and lastly with its subclasses or limitations that are represented by t (annual average temperature), w (dry months; annual average rainfall), r (Soil drainage class; soil texture; soil depth), f (CEC; pH), n (total N, available P; exchangeable K), x (salinity), and s (slope; surface stoniness; rock outcrops). Land suitability evaluation of rice (wetland and upland), corn, coconut, mango, and banana, which are the top five agricultural crops according to the Philippine Statistics Authority (2016), was determined. Assessment of different crop requirements for soil characteristics was based on secondary data. The *FAO Guidelines* (1976), *Crop Suitability Evaluation* by Fiegalan et al. (2017), Sys et al. (1993), and Ritung et al. (2007) were used for crop suitability classification for mango.

### Re-delineation of Soil Type and Land Suitability

From the method of soil series identification and soil texture analysis, the identified soil type of each soil sample was entered into each point generated by ArcGIS 10.3 software. Likewise, the noted GPS point with soil type data was interpolated. The produced soil type map, after interpolation was used as a basis for land mapping units and was also used for producing land suitability maps.

### Production of Map

Re-delineation of the different soil types in barangay Bantug was plotted in a map using ArcGIS 10.3 software. Production of map was done through exporting the map in an image file.

## Results and Discussion

### Soil Types of Barangay Bantug

Barangay Bantug is comprised of two soil types: Maligaya Clay Loam and Maligaya Silt Loam (BSWM, 2013). In the re-delineation of the map with a scale of 1:25,000, a total of six soil types were identified from two soil series. These soil types are Maligaya Clay, Maligaya Clay Loam, Maligaya Loam, Maligaya Silty Clay Loam, Maligaya Silty Clay and Bantog Clay Loam. Figures 1 and 2 represent the delineated and re-delineated map of Barangay Bantug, respectively.

The re-delineated soil type map was limited only for the agricultural areas of Bantug, Science City of Muñoz. The agricultural area of Barangay Bantug has an area of 313 ha which is 79.34% of its total land area. The 658 ha area of Central Luzon State University located within the Barangay Bantug was excluded in the study. At a scale of 1:25,000, after the samples were subjected to soil series identification, the Maligaya and Bantog Series were identified. However, the Bantog Series was not identified in the Soil Type Map published on Geoportal.gov.ph by BSWM (2013). On the other hand, according to Cañete et al. (2016), the Bantog Series is present in Barangay Bantug, Science City of Muñoz, Nueva Ecija.

**Figure 1**

*Original Soil Type Map of Barangay Bantug, Muñoz, Nueva Ecija, Philippines (BSWM, 2013)*

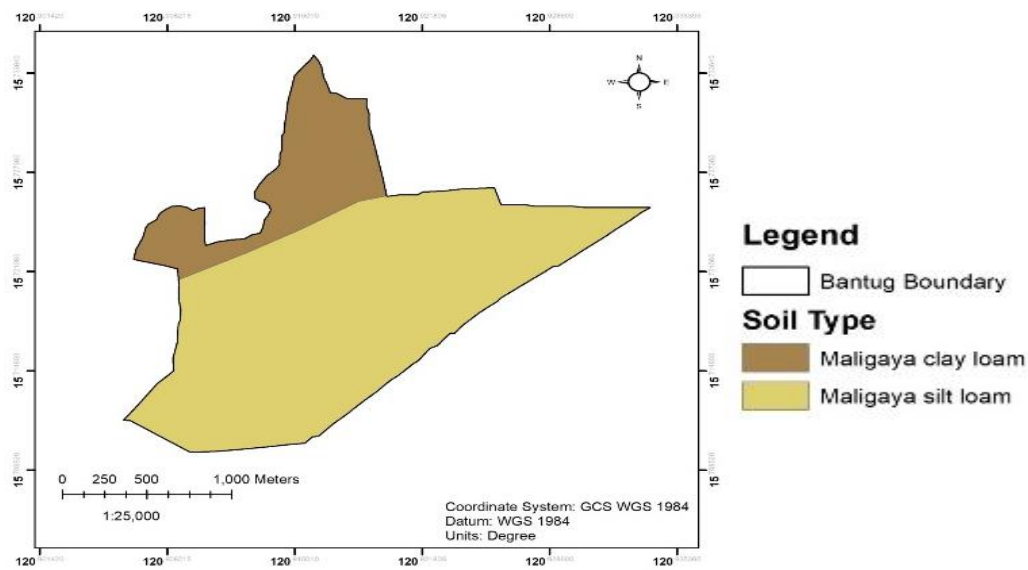



**Figure 2**

*Re-Delineated Soil Type Map of Barangay Bantug, Muñoz, Nueva Ecija, Philippines*

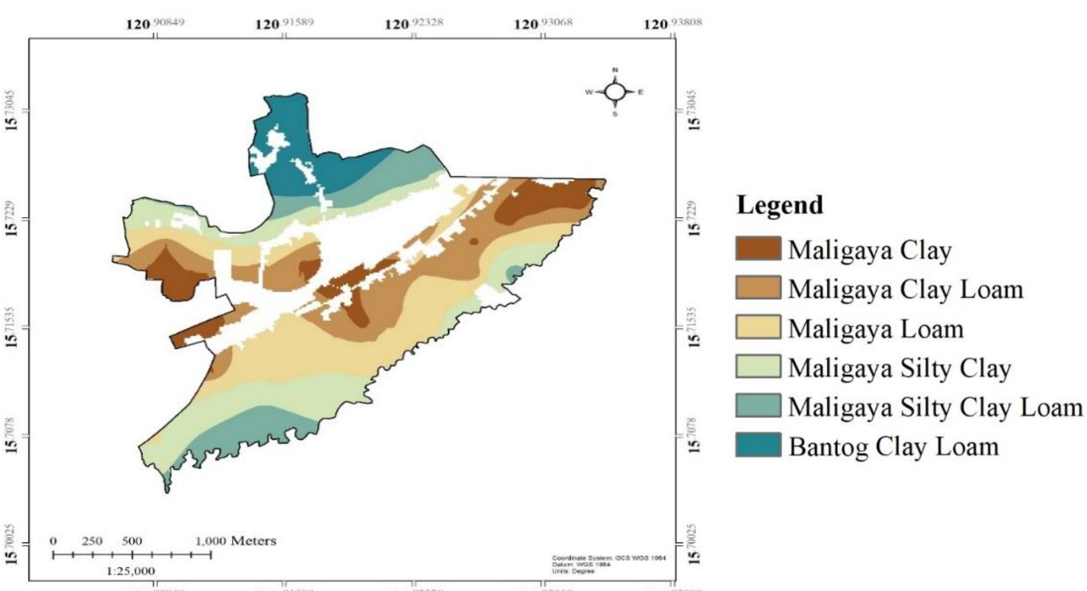


**Table 1**

*Characteristics of Soil Types at Barangay Bantug, Munoz, Nueva Ecija, Philippines*

| Parameter | Soil Type<br>Maligaya Clay (LMU 1) | Maligaya Clay Loam (LMU 2) | Maligaya Loam (LMU 3) | Maligaya Silty Clay (LMU 4) | Maligaya Silty Clay Loam (LMU 5) | Bantog Clay Loam\ (LMU 6) |
|---|---|---|---|---|---|---|
| t- Temperature Regime | | | | | | |
| 1. Annual Average Temp. (°C)[1] | 27.7 | 27.7 | 27.7 | 27.7 | 27.7 | 27.7 |
| w- Water Availability | | | | | | |
| 1. Dry months[1] | 5 | 5 | 5 | 5 | 5 | 5 |
| 2. Annual Average Rainfall (mm)[1] | 2139.3 | 2139.3 | 2139.3 | 2139.3 | 2139.3 | 2139.3 |
| r- Rooting Condition | | | | | | |
| 1. Soil Drainage Class[2] | Imperfectly | Imperfectly | Imperfectly | Imperfectly | Imperfectly | well |
| 2. Soil Texture (surface)[3] | Clay | Clay Loam | Loam | Silty Clay | Silty Clay Loam | Clay Loam |
| 3. Rooting Depth[2] | 150cm | 150cm | 150cm | 150cm | 150cm | 150cm |
| f- Nutrient Retention | | | | | | |
| 1. CEC me/100g (surface)[2] | High | high | high | high | High | high |
| 2. pH (surface)[2] | 6.8-7.2 | 6.8-7.2 | 6.8-7.2 | 6.8-7.2 | 6.8-7.2 | 6.5-7.6 |
| n- Nutrient Availability | | | | | | |
| 1. Total N (surface)[2] | Low | low | low | low | Low | medium |
| 2. Available P2O5 (surface)[2] | High | high | high | high | high | high |
| 3. Available $K_2O$ (surface)[2] | Low | low | low | low | low | low |
| x- Toxicity | | | | | | |
| 1. Salinity | | | | | | |
| s- Terrain | | | | | | |
| 1. Slope[2] | Flat | Flat | Flat | Flat | Flat | Flat |
| 2. Surface Stoniness[2] | None | None | None | None | None | None |
| 3. Rock outcrops[2] | None | None | None | None | None | None |

[1]PAGASA, CLSU, [2] Collado et. al., (2008), [3]-Laboratory Analysis

**Table 2**

*Current Crop Suitability Rating of Soil Types in Barangay Bantug, Muñoz, Nueva Ecija, Philippines*

| | Crops | | | | | |
|---|---|---|---|---|---|---|
| **Soil Types** | **Wetland Rice** | **Upland Rice** | **Corn** | **Onion** | **Mango** | **Sugarcane** |
| Maligaya Clay | S2wrn | S3r | S3r | Ntw | S3r | S3wr |
| Maligaya Clay Loam | S2wn | S2tr | S2trn | Ntw | S3r | S3w |
| Maligaya Loam | S2wrn | S2tr | S2trn | Ntw | S3r | S3w |
| Maligaya Silty Clay | S2wrn | S3r | S3r | Ntw | S3r | S3wr |
| Maligaya Silty Clay Loam | S2wrn | S2tr | S2trn | Ntw | S3r | S3w |
| Bantog Clay Loam | S3r | S3f | S2tfn | Ntw | S1 | S3w |

**Table 3**

*Potential Crop Suitability Rating of Soil Types in Barangay Bantug, Muñoz, Nueva Ecija, Philippines*

| | Crops | | | | | |
|---|---|---|---|---|---|---|
| **Soil Types** | **Wetland Rice** | **Upland Rice** | **Corn** | **Onion** | **Mango** | **Sugarcane** |
| Maligaya Clay | S2r | S3r | S3r | S3r | S1 | S3r |
| Maligaya Clay Loam | S1 | S1 | S1 | S1 | S1 | S1 |
| Maligaya Loam | S2r | S2r | S1 | S1 | S1 | S1 |
| Maligaya Silty Clay | S2r | S3r | S3r | S1 | S1 | S3r |
| Maligaya Silty Clay Loam | S2r | S1 | S1 | S2r | S1 | S1 |
| Bantog Clay Loam | S1 | S1 | S1 | S1 | S1 | S1 |

**Figure 3**

*Current Wetland Rice Suitability Rating Map*

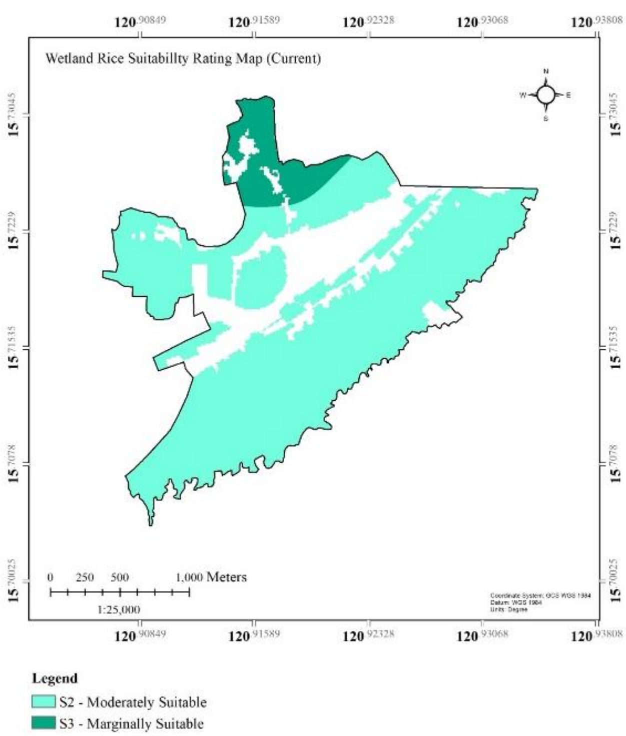


**Figure 4**

*Potential Wetland Rice Suitability Rating Map*

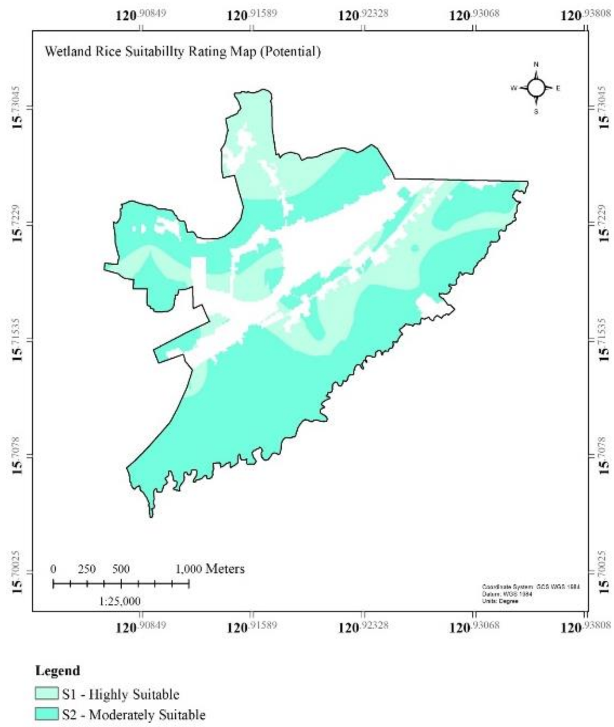



**Figure 5**

*Current Upland Rice Suitability Rating Map*

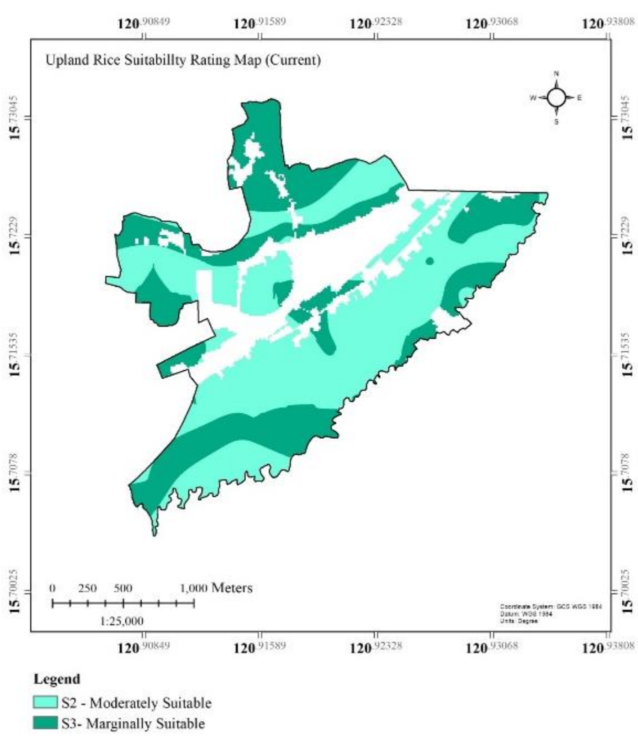


**Figure 6**

*Potential Upland Rice Suitability Rating Map*

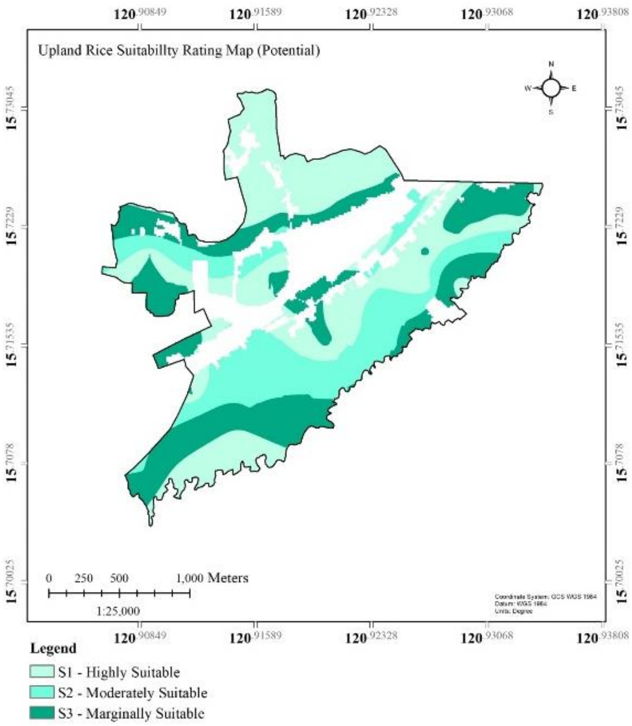



**Figure 7**

*Current Corn Suitability Rating Map*

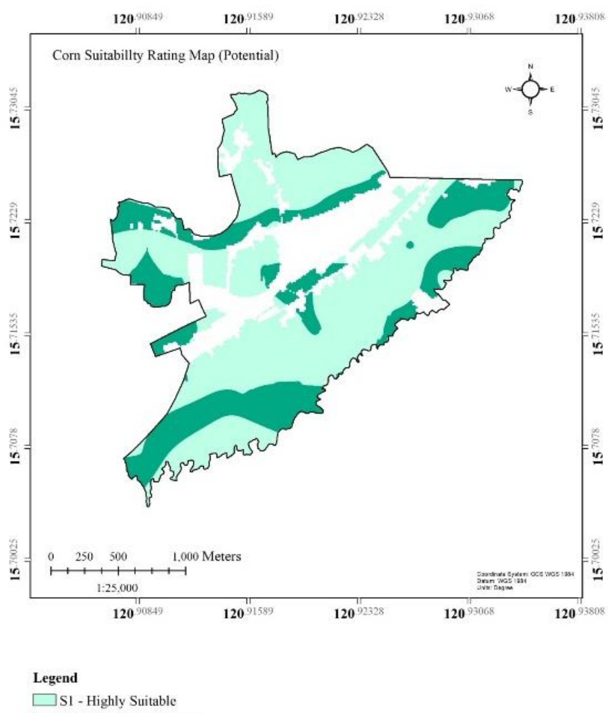


**Figure 8**

Potential Corn Suitability Rating Map

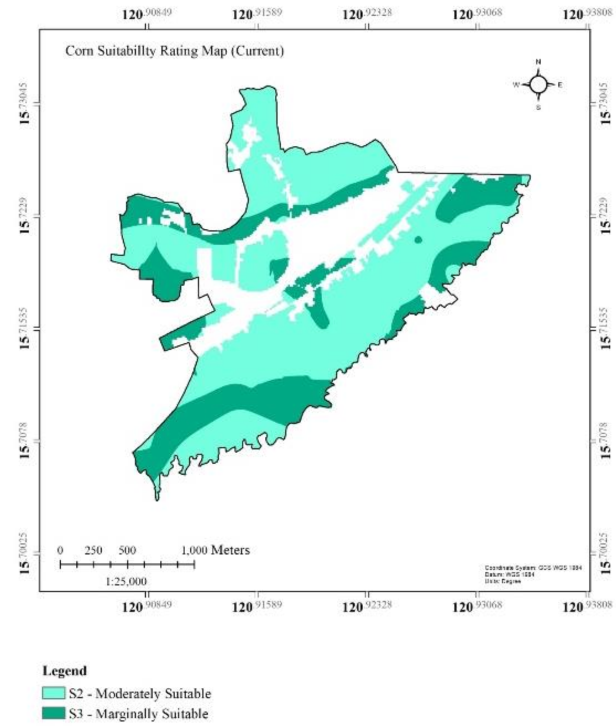
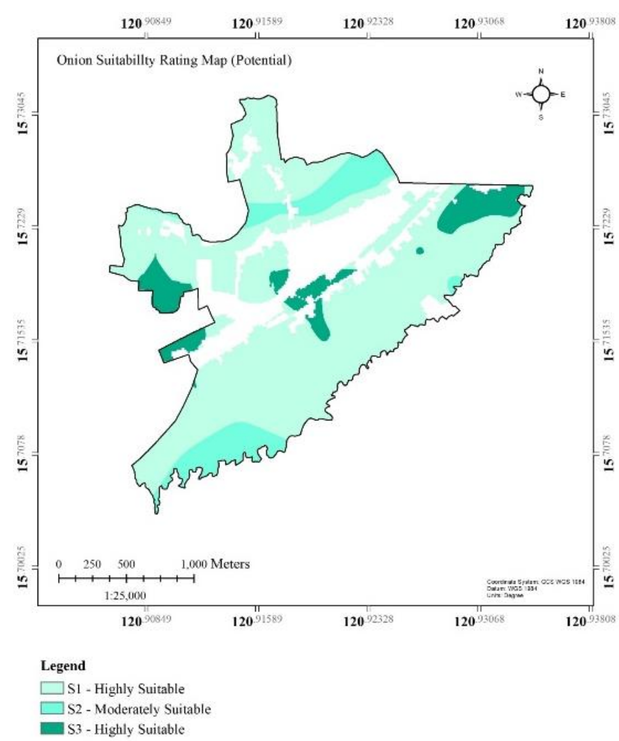


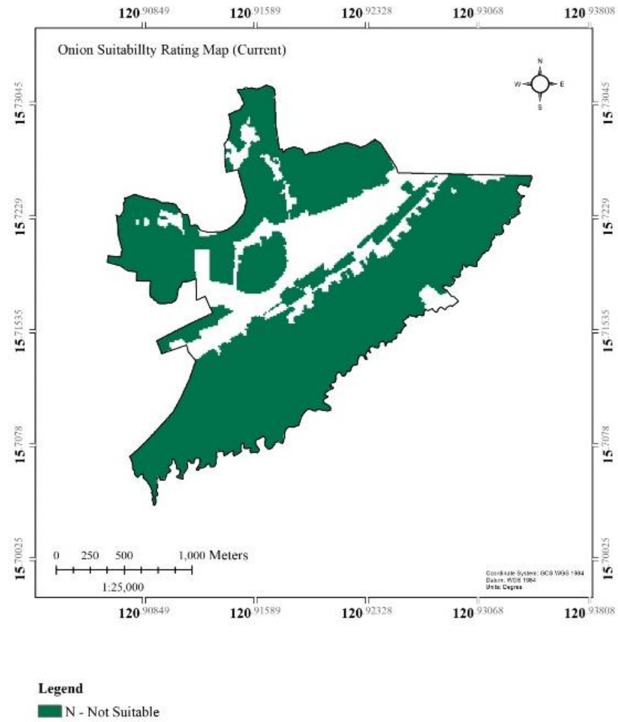

**Figure 9**

*Current Onion Suitability Rating Map*



## Figure 10

Potential Onion Suitability Rating Map




## Figure 11

*Current Mango Suitability Rating Map*

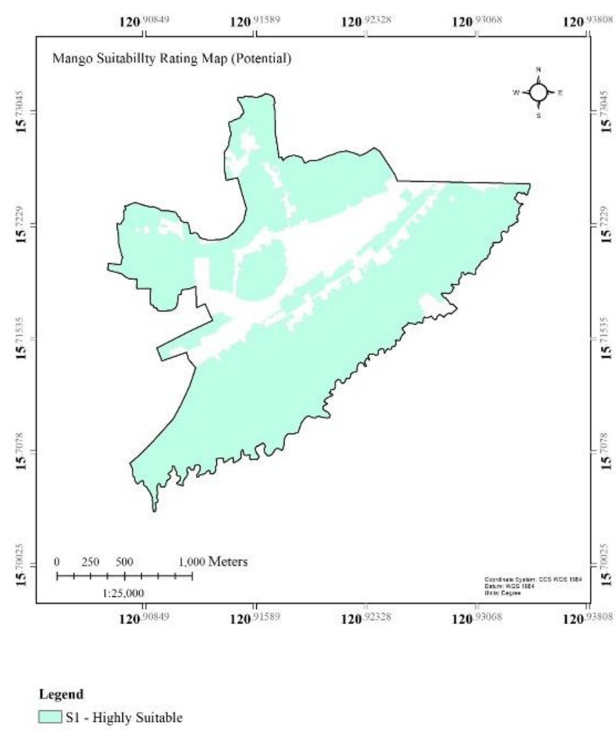


**Figure 12**

Potential Mango Suitability Rating Map

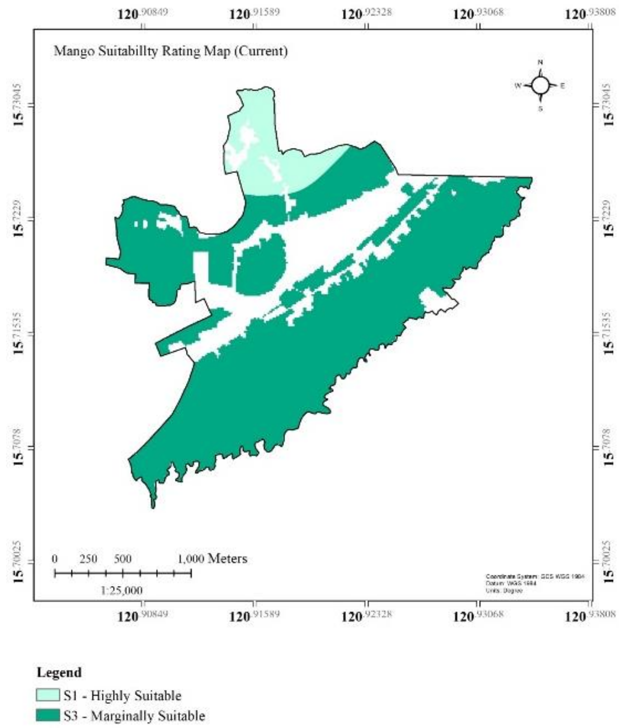



**Figure 13**

*Current Sugarcane Suitability Rating Map*

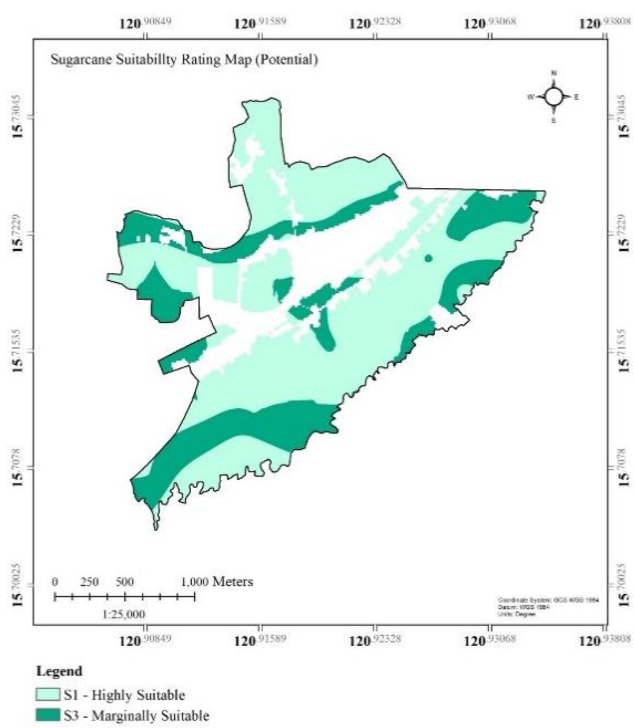
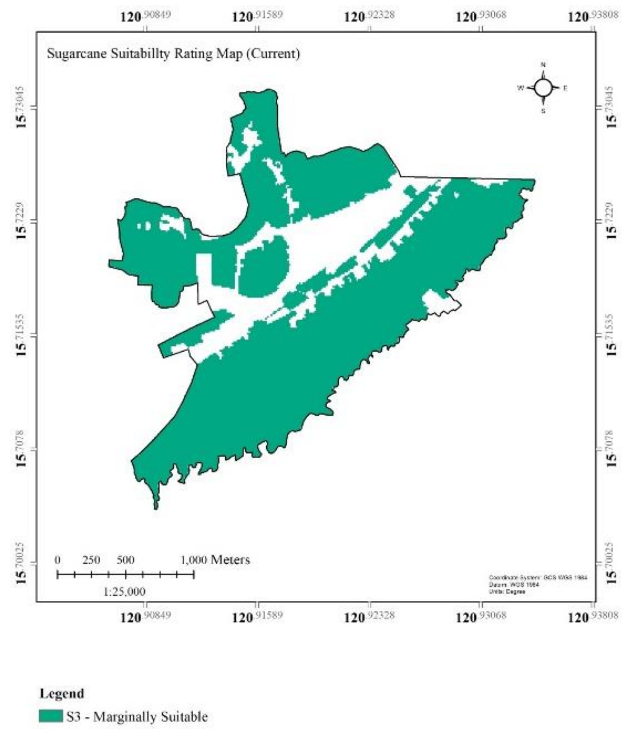


**Figure 14**

Potential Sugarcane Suitability Rating Map




## Suitability Rating of Wetland Rice

The current suitability rating map (Figure 3) for wetland rice shows large areas are moderately suitable while the remaining areas are marginally suitable. The six soil types produced three suitability ratings: S3r, S2wn, and S2wrn. It shows that from six soil types four have the same suitability rating for wetland rice. Bantog Clay Loam has a suitability rating of S3r which is marginally suitable for wetland rice with rooting condition as major limitations. This rooting condition is brought by a limitation in drainage; it can be corrected and brought to S1 by providing dikes that controls the drainage supply in the area. The suitability rating S2wrn is for Maligaya Clay, Maligaya Loam, Maligaya Silty Clay Loam, and Maligaya Silty Clay. S2wrn can be corrected by supplying water through pump well, proper drainage management, and application of both organic and inorganic fertilizer. The Maligaya Clay Loam has a suitability rating of S2wn. The limitations were brought by water availability and nutrient availability. The water availability can be adjusted to S1 by irrigating the land in the month where there is lack of rainfall, while the nutrient availability can be solved by supplying inorganic and organic fertilizer.

After the limitations were corrected, potential land suitability rating for wetland rice was developed as shown in Figure 4. The rooting condition, especially the soil surface texture cannot be corrected making the suitability rating of LMU 1, 3, 4, and 5 moderately suitable for rice. The remaining LMU 2 and 6 are highly suitability for wetland rice.

## Suitability Rating of Upland Rice

At present (Figure 5), Barangay Bantug has been shown to have moderate and marginal suitability for upland rice. There are three land suitability ratings that evaluated; S3r was rated to the Soil Type Maligaya Clay and Maligaya Silty Clay it was caused by the soil surface texture; S2tr was rated from Maligaya Clay Loam, Maligaya Loam, and Maligaya Silty Clay Loam; and S3f was rated from Bantog Clay

Loam. LMU 2, 3, and 5 limiting factors were temperature regime and rooting condition specifically soil drainage. LMU 1 and 4 have soil surface texture as major limitations while LMU 6 was nutrient retention, specifically the pH of soil surface.

As shown in Figure 6, S3r rating cannot be corrected because the soil surface texture is the limiting factor. LMU 2 and 5 were rated highly suitable from a rating S2tr, because the limiting factor temperature regime can become S1 by growing the rice plant during the month of December to March where average temperature is lower, while rooting condition was corrected by application of organic matter that can increase the water retention of the soil for good drainage. S3f suitability rating of Bantog Clay Loam can be corrected by applying organic fertilizer and liming.

**Suitability Rating for Corn**

As shown in Figure 7, there are moderately and marginally suitable lands in Barangay Bantug for corn. Maligaya Silty Clay and Maligaya Clay have a suitability rating of S3r for corn. Maligaya Clay Loam, Maligaya Loam, and Maligaya Silty Clay Loam have suitability rating of S2trn. Bantog Clay Loam has a suitability rating of S2tfn.

Figure 8 shows that the potential suitability rating in Barangay Bantug were highly suitable and marginally suitable for corn. The soil surface texture limitations were not corrected due to its almost permanent property, while the limitations brought by temperature regime, soil drainage, and nutrient retention can be corrected to become highly suitable by choosing heat-tolerant variety, constructing of dikes for drainage and applying organic material, respectively.

According to the Ministry of Food Production of Trinidad and Tobago (2013), although corn can grow well in all soil types, corn cropped in loose friable soil produced better result. Additionally, best soil texture for corn are silt loam or loam type soil according to Agricultural Training Institute (2014). Maligaya Clay and Maligaya Clay Loam are considered marginally suitable for corn because of their limitation in soil texture. Although corn can be produced in these soil types, they will produce a lower yield compared to other soil types.

**Suitability Rating for Onion**

Figure 9 shows that the current suitability rating of Barangay Bantug was not suitable for onion production. The rating was Ntw in all the land mapping units. The major limitations were caused by the temperature in the area, which is 27.7°C, and by the area's average precipitation of more than 1600 mm.

In application of proper management, as shown in Figure 10; from a not suitable rating the area becomes highly suitable, moderately suitable and marginally suitable. The temperature regime and water availability will not be excessive if onion is planted during the months when there is not too much rainfall and the average temperature is lower. These months are from November to April. Onion is best planted after the rice season. It cannot be planted year-round due to its specific climatic requirements.

**Suitability Rating for Mango**

Figure 11 shows that LMU 6 or Bantog Clay Loam is highly suitable for mango. LMU 1, 2, 3, 4, and 5 are marginally suitable because of the imperfectly soil drainage characteristics of Maligaya Series.

As shown in Figure 12, all land mapping units have become highly suitable in the area. The limiting factor, an imperfect soil drainage class, can be corrected through the application of large amounts of organic material, which can improve the land's drainage, making it suitable for mango production.

## Suitability Rating for Sugarcane

As shown in Figure 13, Sugarcane is marginally suitable in Barangay Bantug. The limiting factors of LMU 1 and 4 were the water availability and rooting condition. The LMU 2, 3, 5, and 6 have water availability as major limitations.

In Figure 14, the potential suitability rating of Sugarcane in Barangay Bantug was highly suitable, moderately suitable and marginally suitable compared to the current suitability rating of marginally suitable in all land mapping units. The water availability was solved and become highly suitable because of the irrigation present in the area. The soil surface texture as a limiting factor in LMU 1 and 4 remain in the potential suitability rating.

## Soil Series Classification

There are two soil series observed in Barangay Bantug, Science City of Muñoz, Nueva Ecija. These are Maligaya and Bantog Series. The taxonomic classifications were verified and reclassified using *Keys to Soil Taxonomy, Twelfth Edition* (USDA 2014). The secondary data of profile description of two soil series was from Miura et al. (1995).

### *Maligaya Series*

According to Miura et al. (1995), the Maligaya Series has a surface horizon that exhibits a dark bluish-gray color in the matrix (gleyic horizon), which tests positive in a dipyridyl test, and the major part of the subsurface horizons is gray in color. Abundant filmy iron mottles are found in the surface, but no iron mottles below. Fine manganese concretions are found at a depth of more than 23 cm. Common fine calcareous nodules are present in the part deeper than 90 cm. The profile has a clay texture up to 120 cm, with silty clay below. Intersecting slickensides are developed throughout the profile, except in the surface horizon. It has very wide surface cracks ranging from 5 to 10 cm.

**Table 4**

*Classification of Maligaya Series*

| Classification | Result | Maligaya Series[1] |
|---|---|---|
| Differentiae for Mineral Soils and Organic Soils | Mineral Soil | Organic matter in all soil horizons was below 3%, The profile was subjected to disturbances that cause low organic material accumulation. |
| Epipedon | Ochric Epipedon | The profile does not meet the criteria for any of the other seven epipedons due to its low organic carbon content and its massive, very hard structure when dry. It also has eluvial horizon that are at soil surface. It does not have rock structure and does not include finely stratified fresh sediments. |
| Sub-surface Horizon | Argillic Horizon | The profile has a diagnostic subsurface argillic horizon because of the evidence of clay illuviation. It also meets both the requirements of having a particle-size class of fine or clayey, and having a coefficient of linear extensibility greater than 0.04, along with a distinct wet and dry season. |
| Soil Moisture Regime | Aquic soil moisture regime | The profile has iron and manganese concretions that are brought by the reduction and oxidation of the soil. During reduction, there is a free dissolved |

| | | |
|---|---|---|
| | | oxygen cause by water saturation and biological activity. |
| Soil Temperature Regime | Isohyperthermic | The mean annual soil temperature is 22°C or higher. |
| Order | Vertisols | High montmorillonitic/smectitic type of clay — this type of clay is highly expansive and causes cracks that open and close periodically. |
| Suborder | Aquerts | Enough active ferrous iron to give a positive reaction to alpha,alpha-dypyridyl. |
| Great Group | Epiaquert | Other aquerts that have episaturation. The soil was from rice fields where the water table is perched on top of an impermeable layer. |
| Subgroup | Typic Epiaquert | It does not achieve all the requirements of any other subgroup category. |
| Particle size | Fine | Have less than 60 percent clay. |
| Minerology classes | Smectitic | Have more smectite minerals than any other single kind of clay mineral. |

[1](Miura et. al., 1995)

### *Bantog Series*

According to Miura et al. (1995), the Bantog Series has a matrix that shows a gray color in the upper 80 cm below the surface. The surface horizon is positive in dipyridyl test. Iron mottles are found throughout the profile; thread-like brown mottles below. Development of slickensides is found at a depth below 25 cm. The profile has clay textural class throughout. It has wide surface cracks ranges from 2 to 5 cm.

**Table 5**

*Classification of Bantog Series*

| Classification | Result | Bantog Series[1] |
|---|---|---|
| Differentiae for Mineral Soils and Organic Soils | Mineral Soil | Organic matter in all soil horizons was below 4%. The profile was subjected to disturbances and cultivated every planting season, which caused low organic matter accumulation. |
| Epipedon | Ochric Epipedon | The profile does not qualify as any of the seven other epipedons because it lacks sufficient organic carbon and has a massive, very hard consistency when dry. It also has eluvial horizon that are at soil surface. It does not have rock structure and does not include finely stratified fresh sediments. |
| Sub-surface Horizon | Argillic Horizon | It has >90% clay accumulation It meets both the requirements of having a particle-size class of very fine or clayey and has higher than 0.04 coefficient of linear extensibility with distinct wet and dry season. |
| Soil Moisture Regime | Aquic soil moisture regime | There is free dissolved oxygen caused by water saturation and biological activity; the presence of iron and manganese concretion is brought by redoximophic process wherein there are times the soil is saturated with water. |
| Soil Temperature Regime | Isohyperthermic | The mean annual soil temperature is 22°C or higher. |

| | | |
|---|---|---|
| Order | Vertisols | High montmorillonitic/smectitic type of clay — this type of clay is highly expansive and causes cracks that open and close periodically. |
| Suborder | Aquert | Enough active ferrous iron to give a positive reaction to alpha, alpha-dypyridyland 50% or more of chroma 2 or less if redox concentration is present. |
| Great Group | Endoaquert | Other aquerts that doesn't meet the criteria of other great group. It has endosaturation, meaning it is saturated with water in all layers. The liquid phase distribution increases with depth, as the percentage of water content rises in the lower layers. |
| Subgroup | Typic Endoaquert | Fails to meet the requirements of other subgroup category |
| Particle size | Very Fine | Have 60 percent or more clay. |
| Minerology classes | Mixed | There are kaolin minerals as well as smectite and vermiculite minerals. |

[1] (Miura et. al., 1995)

## Conclusion and Recommendation

The soil type classification, re-delineation, and crop suitability assessment of Barangay Bantug resulted in the identification of the Maligaya and Bantog Soil Series, which were further classified into six different soil types. Each soil type was used as land mapping units to determine the crop suitability rating of top five agricultural crops produce in the Philippines. Various crops have different suitability ratings which can be improved by application of several management practices. These management practices include fertilizer application, construction of dikes for drainage, selection of suitable varieties, application of irrigation water, and other soil physicochemical management practices.

The soil series classification updates in the present study could potentially provide farmers in the area with a better understanding of how these agricultural lands can be used with respect to their environmental and soil physicochemical properties. The local government unit can utilize the results of this research in the development of the barangay land use plan. Extension workers could interpret the maps to the farmers within the barangay for more effective communication. The process in soil type classification, re-delineation, and crop suitability assessment could also be adopted for regular updating of maps to assess the climate change impacts.

These re-delineated maps will guide them in selecting crops and adopting proper management practices that are suitable based in land characteristics and climatic data. The re-delineation of maps from small scale to more detailed GIS mapping can greatly help land users to improve crop production. This must be adopted by the government, extension workers, and capable agencies to be conducted on a larger scale—from the barangay to the national level.

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