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Full Length Research

GIS Based Land Suitability Evaluation for Main Irrigated Vegetables in Semaz Dam, Northern Ethiopia

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In developing supplementary irrigation, potential and suitability of the land area is important for better utilization of land resources. Therefore, the objective of this study was evaluating the current and potential suitability of the study area for irrigation purposes. The area was classified into six land mapping units and samples were taken from the representative sites of these land mapping units. The parametric evaluation system and Inverse Distance Weighted (IDW) interpolation provided in Arc GIS 10.1 software were used to perform the land suitability classification The result of the study depicted that the study area was moderately suitable for any irrigated vegetable purposes. Soil texture was the only limiting factor and the cause for the area to be moderately suitable (S2). Therefore, irrigation can be applied under proper management to meet the maximum production.

Key words: Land suitability, GIS, irrigated, vegetable, parametric, land evaluation

INTRODUCTION

Land evaluation is a process of predicting land performance over time according to the specific types of use (Martin and Saha, 2009; Sonneveld *et al*., 2010). Agriculture land suitability assessment is defined as the process of assessment of land performance when used for alternative kinds of agriculture (Prakash, 2003; Mu, 2006). The principle purpose of agriculture land suitability evaluation is to predict the potential and limitation of the land for crop production (Pan and Pan, 2012).

In agricultural context, finding optimal locations for crops can increase economic benefits, as well as reduce negative environmental consequences (Ashraf *et al*., 2010). Proper recognition of land abilities and allocation of them to the best and most profitable and stable revenue operation system has special importance for preventing ecosystem structure destruction. With the increase of demand for land, land evaluation has become more important as people strive to make better use of the limited land resources. Because, it is the process of assessment land performance for specified purposes (Rossiter, 1996; Collins *et al*., 2001).

Sys *et al*. (1991) suggested a parametric evaluation system for irrigation methods which was primarily based upon physical and chemical soil properties. In their proposed system, the factors affecting soil suitability for irrigation purposes can be subdivided into four groups: physical properties determining the soil-water relationship in the soil such as permeability and available water content; chemical properties interfering with the salinity/ alkalinity status such as soluble salts and exchangeable sodium; drainage properties and environmental factors such as slope. GIS is also a useful instrument for evaluation of land for its suitability for a particular utility.

In developing supplementary irrigation, evaluating and assessing of the potential and suitability of the land area is important for better utilization of land resources. However, in Ethiopia, this is almost ignored and any type of irrigation is practiced without proper investigation on the potential of the area for irrigation purpose.

Therefore, the main target of this study was to determine the suitability of the study area for irrigation purpose using the parametric evaluation system and

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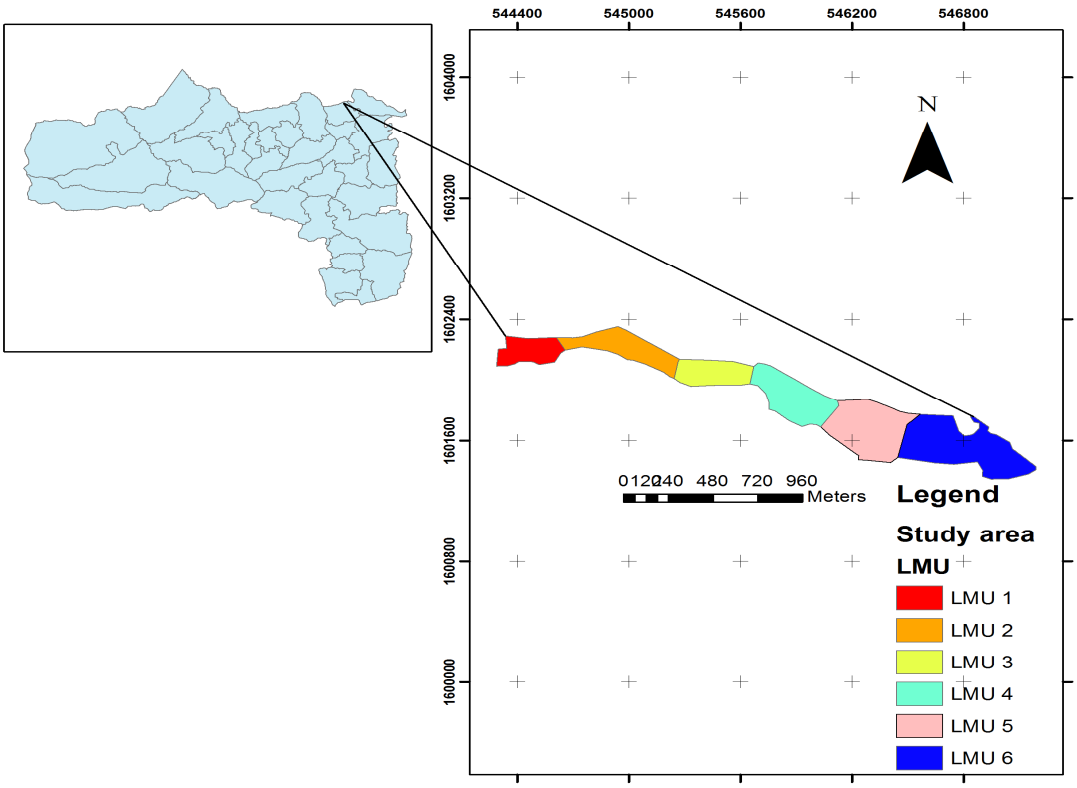

Figure 1: Map of Tigray and the study area (Semaz Dam with different land mapping units).

geographic information system (GIS) techniques.

MATERIALS AND METHODS

Description of study area

The study was carried out in Semaz Dam, Eastern Tigray (Figure 1). It is geographically located between 14°25′N and 39°20′E. It is part of the Misraqawi (Eastern) Zone of the Tigray Region which is about 38 kilometers north of Adigrat. This is an area with heavily deforested, and the remaining vegetation is predominantly scattered bush, and acacia trees. The production system is mixed farming with crop and livestock production. Agriculture is dependent on the summer rains that fall from June to August. The soils are sandy and of low fertility, giving only minimal yields without fertilizer. The major food vegetables cultivated are tomato, onion, potato, pepper and cabbage.

Methodology

Soil sampling and chemical analyses

Profile descriptions were made at the representative sites of the study area and were georeferenced using global positioning system (GPS). Soil samples were collected and analysed in a laboratory with respect to soil's physical and chemical properties. The effective soil depth, drainage, and the slope were measured directly at the field. EC was determined using (1:2.5 ratio of soil to water) suspension using EC meter. Texture of the soil was determined by the hydrometer method (Gee and Bauder, 1986). $CaCO_3$ was estimated using a rapid manometric method using Collin's Calcimeter (Williams, 1949).

Land evaluation procedure

Land suitability evaluation was performed following Sys *et al.* (1991) procedures using soil and land characteristics. These characteristics concern: drainage properties, soil physical and chemical properties. They are rated and used to calculate the capability index for irrigation (Ci) according to the formula:

Ci = A*B/100*C/100*D/100*E/100*F/100

Where: Ci: capability index for irrigation, A: rating of soil texture, B: rating of soil depth C: rating of $CaCO_3$ status, D: salinity/alkalinity rating, E: drainage rating, and F: slope rating.

According to the results of measured land index in

Table 1. Summary for area coverage, capability indices, and suitability classes of Semaz Dam.

Land Unit	Area (ha)	Capability index	Suitability classes
1	6.17	76.5	S2
2	7.23	64.1	S2
3	6.48	64.1	S2
4	10.3	76.95	S2
5	13.59	76.95	S2
6	17.85	72.68	S2

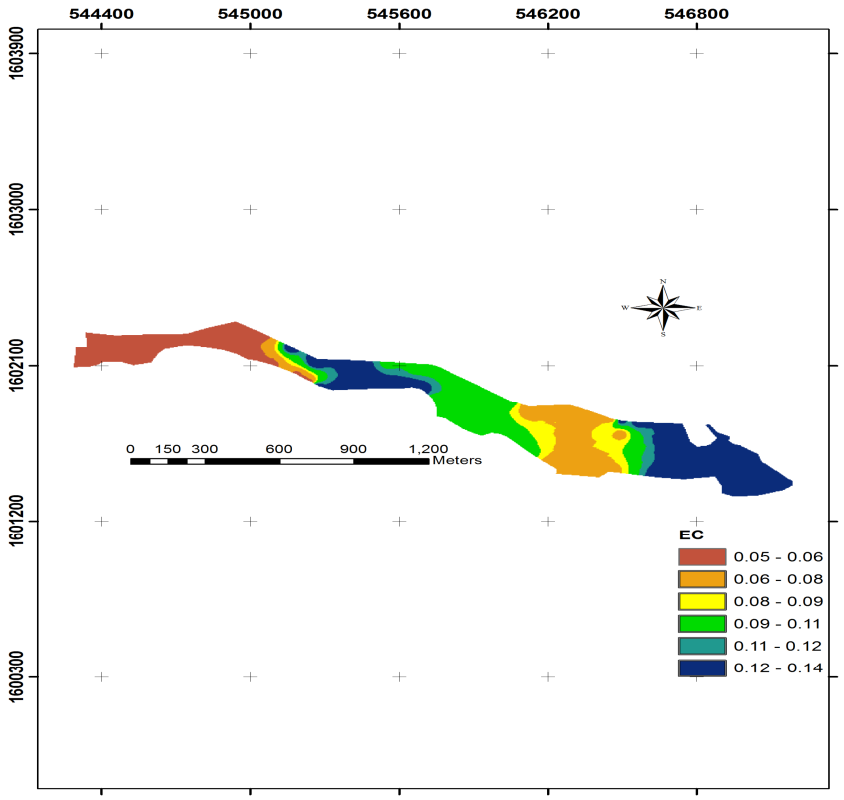

Figure 2. Spatial variability of Electrical conductivity (EC).

parametric method suggested by Sys *et al*. (1991) lands having indexes >80 are in S1 (very suitable); 60-80 are in S2 (moderate suitable); 40-60 are in S3 (marginal suitable); 30-45 are in N1 (currently not suitable); and <30 are in N2 (permanently not suitable).

Statistical analysis

Thematic maps of each land mapping units and soil physical and chemical parameters were generated using Inverse Distance Weighted (IDW) interpolation provided in Arc GIS 10.1 software.

RESULTS AND DISCUSSION

Based on the results of soil analysis data, the study area is classified as moderately suitable (S2) for vegetable irrigation purposes (Figure 6). The result of the study also showed that no part of the study area was recorded to be most suitable (S1), marginally suitable (S3), currently not suitable (N1) and permanently not suitable (N2) (Table 1). For almost the total study area texture was the cause for the area to be moderately suitable (S2) as it is one of the important parameter of soil and can be improved by specific management. Figures 2, 3, and 5 depict the spatial variability of EC, CaCO3, and texture respectively Most of the physical characteristics of the soil depend upon texture class. Four texture classes occurred in the study area which is clay (c), sandy clay (sc), sandy loam (sl), and sandy clay loam (scl). The spatial variability of soil texture classes is given in Figure 4. These results are incongruent to Ali *et al*., (2009) who investigated soil quality for different irrigation systems in Lali Plain, Iran.

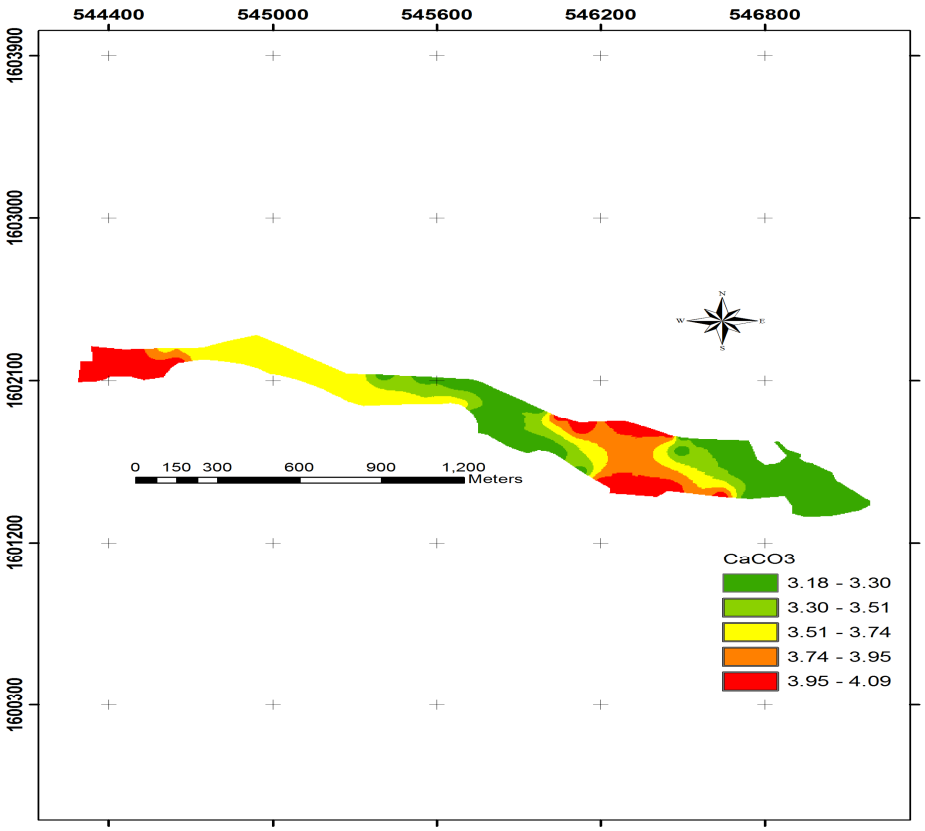

Figure 3. Spatial variability of calcium carbonate ($CaCO_3$).

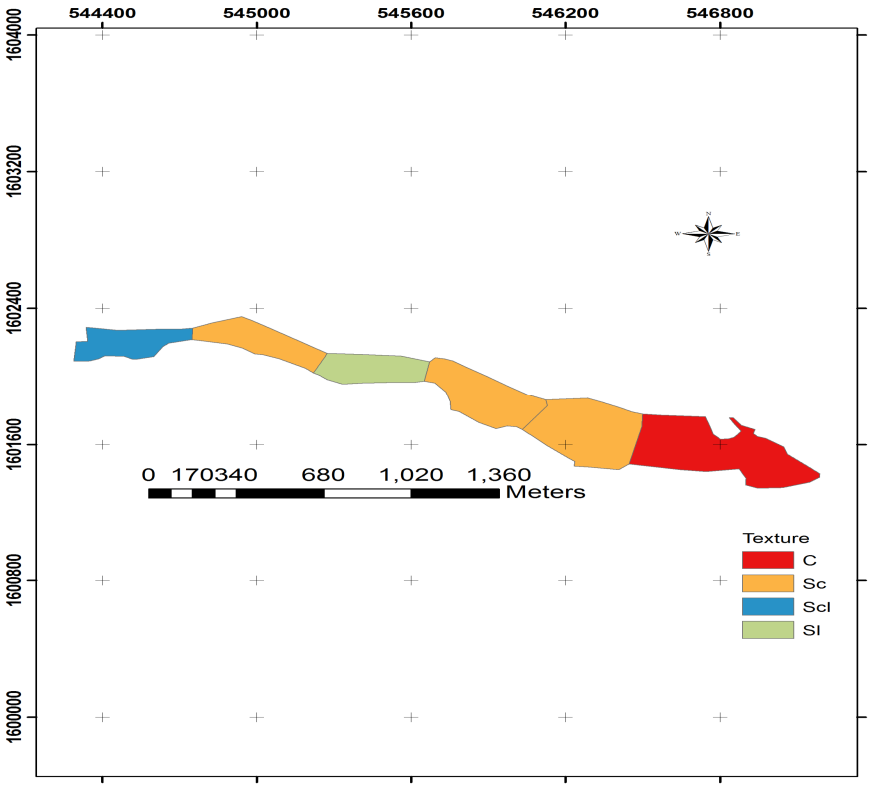

Figure 4. Spatial variability of soil texture.

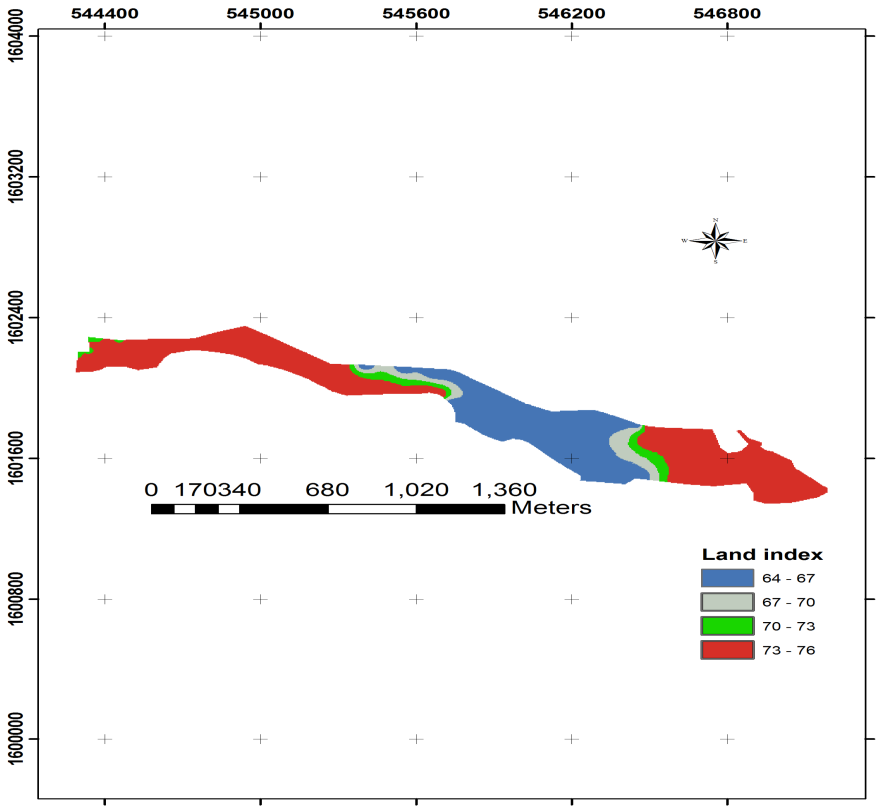

Figure 5. Land capability index of Semaz Dam.

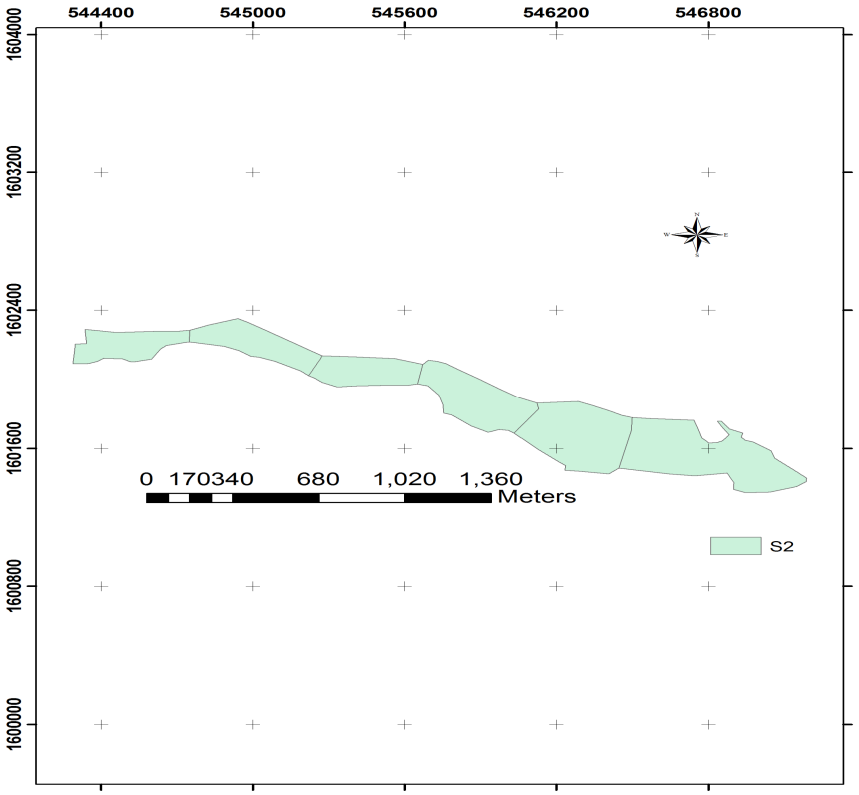

Figure 6. Land suitability classification of Semaz Dam.

They found that factors such as drainage, salinity and $CaCO_3$ never influenced the suitability of their study area.

Conclusion

To evaluate the land suitability for irrigated vegetables, the parametric evaluation system was applied using soil and land characteristics. These characteristics concern environmental factors, drainage properties, soil physical and chemical properties. Inverse Distance Weighted (IDW) interpolation provided in Arc GIS 10.1 software was used to study land suitability of the area. The result of the study depicted that the study area was moderately suitable for any irrigation purpose. In this particular study, soil texture was the limiting factor and the cause for the area to be moderately suitable (S2). Therefore, the area is potential for irrigated vegetable production with some limitations and under proper management it can benefit the local community to meet the food demand.

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