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Rangeland Suitability for Livestock Grazing and Economic Implications in Irepodun Area of Osun State Nigeria Using Remote Sensing and GIS Techniques

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Abstract: The inability of Federal, State and Local Authorities to map suitable areas for livestock production had resulted in incessant bloody clashes between Fulani herdsmen and farmers in Nigeria. The need to establish rangelands for the herdsmen is worthwhile and should be pursued diligently in those states where animal husbandry is the preponderant occupation. However people are not willing to release their land for grazing because no compensation given for their lands. . This study was carried out to determine and map out suitable rangelands for livestock grazing using AgrocropSDSS Multi-criteria Evaluator (MCE) integrated with Geographic Information System (GIS) and Remote sensing techniques in Irepodun area of Osun state. Four bio-physical land parameters and two socio-economic factors including soil, topography (slope), climate (temperature and rainfall), land use/land cover, and distance to road and water were considered. The biophysical and socio-economic factors were processed and reclassified in AgrocropSDSS. The reclassified factors were overlaid in LULC of the area using weighted overlay to get suitable areas for livestock grazing. The result obtained showed that 10% of the study area were covered by water while 10, 15, 25 and 40% were unsuitable, moderately suitable, suitable and highly suitable for grazing respectively. The overall health of the vegetation as measured by the normalized differential vegetative index (NDVI) image showed poor, medium and good vegetation. The road was 100 kilometres off the settlement and Land owners were reluctant in releasing their land to herdsmen at no cost. Based on the findings, it is recommended that the highly suitable land area in Irepodun, Osun state be mapped out for the grazing of livestock followed by compensation to land owners.

Keywords*; Rangeland, Livestock, Grazing, NDVI, GIS and Remote Sensing,*

I. INTRODUCTION.

Suitability considers the appropriateness of livestock grazing for a particular land area, based on the economic, social and environmental consequences and considerations for other uses that may be affected by livestock grazing. Livestock are domesticated animals raised in an agricultural setting to produce commodities such as food , input for crop production, soil fertility management, raw material for industry, cash income, saving, fuel, social functions and employment. Rangelands are tracts of land used for grazing domestic livestock or wildlife, where natural vegetation is the main forage resource (adapted from Gils 1984). The largest proportion of the world's domestic livestock are grazed on rangeland and managed under husbandry systems that use minimal inputs. Establishment of rangeland is therefore one of the most important issues facing the future of animal production (Mifitumukiza 2004, Nestel, 1984).

Worldwide, modern livestock farming is better done in ranches than the old fashioned transhumance. In Nigeria, the attempt by the British in 1940 to separate the grazing land from the farm land, however, faltered because the Europeans imposed land use controls divorced from economic and demographic dynamics in the pastoral system (Frantz 1981). In recent years, Nigeria has witnessed series of violent communal clashes arising from the activities of the nomads who move about on a daily basis with their cattle in search of water and green pastures. During the past eight years, the Nigeria Watch database has recorded 615 violent deaths related to cattle grazing, out of a total of 61,314 violent fatalities in Nigeria.(IFRA-Nigeria working papers series, no. 34 28/11/2014). This scenario has given rise to an unhealthy rivalry between farmers and herdsmen leading to violence, loss of lives and property.

Irepodun is a Local Government Area in Osun State, Nigeria where animal husbandry is one of the preponderant occupations. In Irepodun and it's environ the story of farmers/herdsmen clash is the same and no area has been mapped out for the grazing of livestock. Locating suitable areas for livestock production using spatial models of GIS would be indispensable to improve livestock productivity. Therefore, the most important criterion for sustainable animal production is the selection of appropriate land areas, which meet biophysical, environmental and socio-economic restrictions. The present study is aimed at mapping out rangeland suitability areas for livestock grazing in Irepodun and it's environ as well as their economic implications of using GIS and remote sensing techniques. Locating suitable areas for livestock production using spatial models of Geographic Information system (GIS) would be indispensable input to improve livestock productivity in Nigeria.

II. MATERIALS AND METHODS

A. Study Area

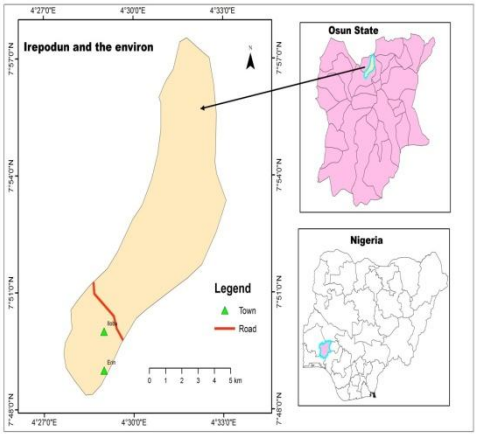


Figure 1; Map of the study Area

The study area lies between latitude 8° 00 N and 8° 25' N and between longitude 4° 40' E and 5° 30' E. Irepodun local

Government was created out of Igbomina/Ekiti Division in 1976, as a result of Local Government reform initiated by the military administration. It has two districts: Ajasse Ipo and Omu. Omu-Aran is the Local Government Headquarter; it has eleven wards (Omu-Aran I, Omu-Aran II, Omu-Aran III, Oro I, Oro II, Ajase Ipo I, Ajase Ipo II, Esie/Ijan, Oko, Arandun and Ipetu/Rore/Aran Orin) and six area Offices for Administrative Services. It shares boundaries with Ifelodun L.G.A to the North, Osun to the South, Ekiti and Offa L.G.A to the east and West respectively. Irepodun L.G.A has an area of 737km2 and a population of 148,610 people (2006 census). Irepodun Local Government area has alternating climate of wet and dry season. The wet season lasted for six months, April to November with about 1100mm-1500mm of rain. The area is on a gentle undulating land which falls within the older sedimentary rocks. The area is drained by short swift flowing stream and most of their streams are seasonal. The only important river in this area is river Oshin. The soil is edaphic in nature containing natural mineral resources such as granite, quartz, feldspar, columbite, tantalite. The nomadic Fulani practice animal husbandry in some communities of the study (Ashaolu *et al* 2014) . The map of the research area is shown in figure 1above.

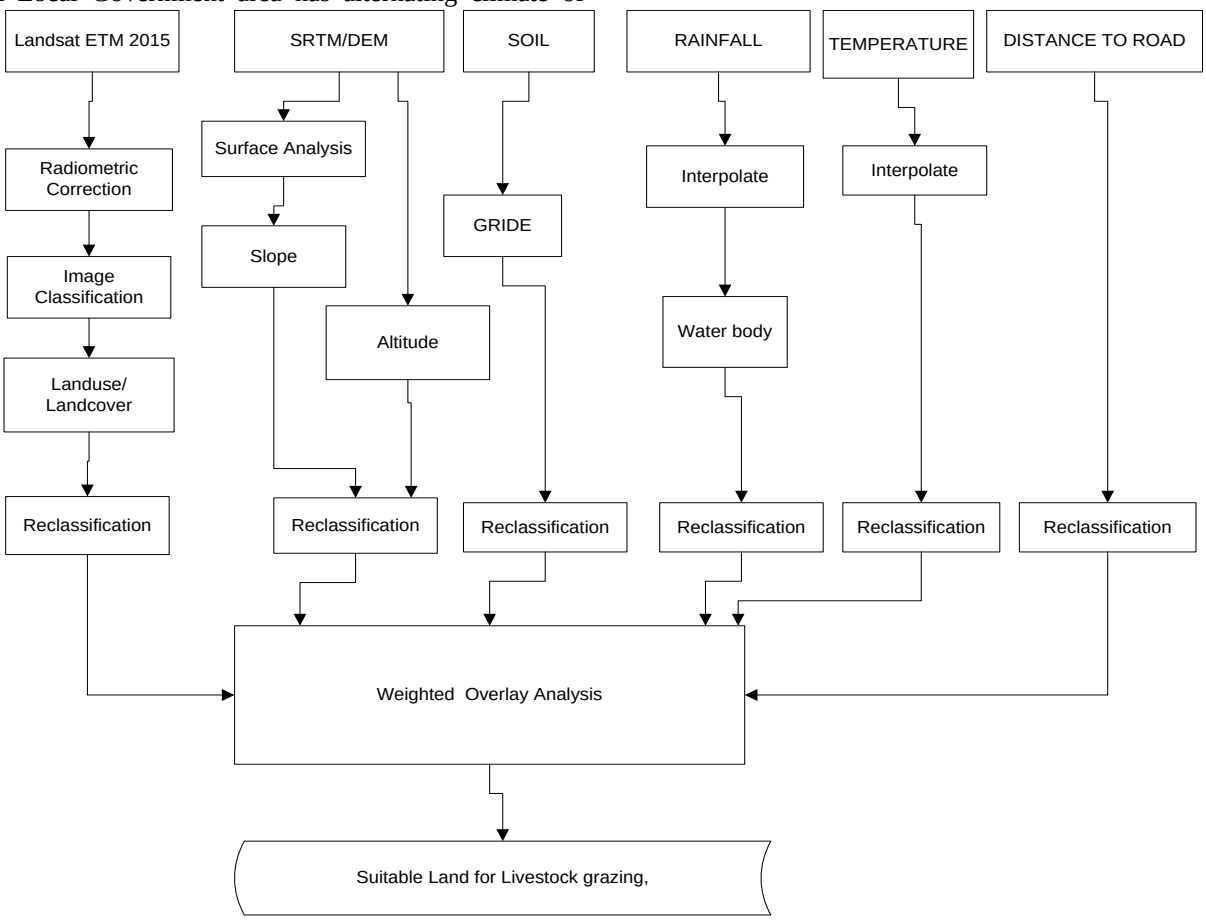


Figure 2: The Flowchart Methodology

III. DATA TYPES

The different data types and methods used in the study are presented in table 1 and figure 2.

Table 1: Data Source

S/N	Data Name	Year	Format	Resolution	Source
1	Landsat ETM+	2015	Digital	30 m	GLCF
2	Arster SRTM	1999	Digital	30 m	NASA
3	Soil map	1977	Analogue	1:250000	Wegening the Netherland
4	Rainfall	10years	Digital		NIMET
5	Temperature	10years	Digital		NIMET

A. Data Collection and Analysis

Ground trotting was carried out to acquaint the researcher to the study area to know whether the area is suitable for livestock grazing. The areas visited include Erin and Iloba.

Four bio-physical land parameters and two socio-economic factors including: soil, topography (slope), climate (temperature and rainfall), land use/land cover, and distance to road and water respectively were considered.

1. Soil

For this study, soil mapping unit of Nigeria was used as one of the parameters for suitability analysis. Physical properties of soil, specifically textural classes were considered for interpretation and analysis. The major soil types in the study area are indicated in Figure 5 and include Aerisol, Alixol, and Lixisol. It is also one of the most important parameter used by the pastoral community to evaluate the suitability of the rangelands for different livestock as a source of feed, sleeping ground, ease of trekking and livestock disease prevalence. Thus, the inclusion of soil parameter as a land quality is very important both for the plants which are the source of animal feed and the animal as well.

2. Temperature

Temperature causes stress to animals in hot, warm and very cool climates. Heat to the body comes mainly from outside and from the metabolism within the body metabolic heat.

Temperature and rainfall data of the station for 10 years was collected from Nigeria Metrological Agency (NIMET) .The surface interpolation was carried out in the GIS environment using Spatial Analyst's Inverse Distance Weighted (IDW) technique.

3. Rainfall

In this study, ten years mean annual rainfall of Irepodun collected from Nigeria Metrological Agency (NIMET) were used. The surface interpolation was carried out in the GIS environment using Spatial Analyst's Inverse Distance Weighted (IDW) technique. The annual rainfall ranges from 1200 -127 mm between 2006-2016.

4. Land use/Land cover

Cloud free Landsat ETM+ 2015 (path 190; row 055) that were acquired on January 2015 were analyzed to classify the land use/ land cover of the study area. The image is mosaics of the one scene (row 056) covering the whole extent of the study area was prepared. Landsat7 ETM+ 2015 and Band 432 was used for this study. Supervised classification was used to cluster pixels in a data set into classes corresponding to user defined training classes. This classification type requires selecting training areas for use as the basis for classification using Maximum Likelihood Classifier for parametric input data. Supervised land use/land cover classification has been carried out using ERDAS IMAGINE. In landuse /landcover analysis six classes such as settlement, Water body, shrub land. Grassland, cultivated land, Bare surface were made. The landuse/landcover of the study area is shown in Figure 5 below.

5. Slope

Slope was generated from SRTM data in GIS platform using Geostatistical analyst's surface analysis technique. Figure 6 show the slope map of the study area.

Socio-economic factor analyses

Socio-economic factors in the rangeland includes road and transport condition, communication system, market outlets, veterinary clinics and services, health canters/health posts, abattoirs, skins and hides collecting and preserving systems, communication and training systems.

Distance to water.

Several distances ranges (kilometres) away from watering points beyond which forage becomes inaccessible have been used in rangeland studies .In this study distance to water was buffered based on region's rangeland capacity criteria and protocol as shown in the figure below.

Road

Road is one of the Socio-economic factors in the rangeland suitability analysis. Good network system will help in easy movement of livestock, market outlets, veterinary clinics and services, health centres/health posts, abattoirs, skins and hides collecting and preserving systems, communication and training systems. In this study, road was buffered 1000km off the settlement.

B. Applying Multi-Criteria Evaluator: Weight and Modelling the suitability Factors in Agro CROPSDSS.

The model for the spatial factors was carried out using Agro CROPSDSS software version 1.0. These factors identified were weighed into Factors and constraints. The purpose of weighing was to express the importance or preference of each factor relative to other factor effects on crop yield and growth rate. In this study, four bio-physical land parameters and two socio-economic factors were considered. These are soil, topography (slope), climate (temperature and rainfall), land use/land cover, distance to road and water. All the above mentioned parameters have been considered for the analysis towards the identification of suitable areas for livestock production and they are mapped separately.

The first method carried out was the importation of the prepared spatial data containing the land mapping units to be assessed for suitability into Agro CropSDSS. The imported spatial data were linked to land suitability model and a logical set of Record set objectives was defined. All the relations and their records were Cache in the model into these sets of record sets objectives. In this research because of the presence of constraints in the record, computation of suitability for that record was not executed, the record was assigned zero percentage and if the modelling technique is AHP for the factors, the list of classes in the factors were retrieved relative to the weights of factors. The percentage ratings of the class of the factors present in that record and suitability computed using the following formula. % Suitability =Σ(RWi* PRj RW = Relative Weight of Factor.

PR = Percent Rating of the class of the factor.

i = 1 to number of factors used in the suitability assessment.

C. Integrating Multi-Criteria Evaluation with GIS in Agro CROPSDSS

The built model and prepared spatial data was integrated in the AgrocropSDSS Software Version 1.0 in order to run land suitability for Rangeland. The final visualization of land suitability map was produced in AgrocropSDSS to identify potential areas.

IV. RESULTS AND DISCUSSION

The union of all the parameters used when over laid in Landuse/Landcover showed that 40% of the area were covered by Water,10%,were not suitable, 15%, were moderately suitable, 25% were suitable, 10%, were highly suitable. Figure 9 and 10. This finding is in line with (Dennis O.(2008), Verema J.H. (2007), Sun G.I, (2007).

Also, Normalized Differential differences Index (NDVI) image compared with the Vegetation of the study area. It showed poor vegetation, medium vegetation, and good Vegetation. This is in line with the finding of Racheal M., (2007). Figure 11.

DISCUSSION

.All biophysical factors except that of climate (Rainfall and Temperature) and socio-economic factors show the areas of suitability and non suitability. The climatic factor (Rainfall and Temperature) did not show any effect on the final rangeland suitability areas, this was as a result of the study areas which delineate homogenous soil units and prefers to one single climate type, but their effect is masked by the other factors which have more weight. For evaluation at national scale where the main soil data base is a soil association map and where the agro climate is defined in very broad regional terms, one cannot expect that the suitability is defined with the same precision level as the case for local or village study (FAO Guide line,.Dennis.O.(2008.). Terrain is characterized by slope, Animals tends to avoid areas with steep slopes but prefers flat, plain, and gentle slope, areas having slope from 0-3% were suitable while slope areas that are steep and rugged

are not suitable. Animals take a lot of effort to graze the area (Verema J.H 2007). Landuse /landcover show a pond of forage on the land with areas of grassland, grassland and shrubland were suitable while settlement, baresurface and waterbody were not suitable. The landuse land cover showed the various areas covered by each class in hectares, (Settlement 7959h, Waterbody 2900h, Shrubland 23596h., Grassland 22459h., Baresurface 95h., and Cultivation14524h). Soil physical properties are needed for rangeland suitability analysis especially textural classes. Soil factors that are well drained, shallow well drained shows the suitability areas while poorly drained areas were not suitable. Soils of the study area are lixisol, Alisol and Acrisols which shows areas of suitability. Dennis .O (2008). Distance the animal must travel for water is more important for rangeland suitability analysis. Water is so vital for metabolic activities in livestock body. The distance to water channel is between 3-6km for rangeland suitability while above 7 are not suitable as recommended (Stelljes, K B. 1995. 15. Sun IG. 2007). this study showed that between 3-6km were suitable while 7 and above is not suitable. This is in line with the study of Dennis O.(2008).

Road network that was buffered 100m for the study area show that areas within the buffered zone were not suitable for rangeland suitability. Animal requires comfort zone for effective productivity and reproduction, being close to road will hinder their productivity. The overall percentage suitability areas are shown in pie chart in figure 10 above.

Normalize differential Vegetative index (NDVI) from remote sensing data was used to ascertain the overall health of the vegetation. NDVI image were compared to the Nigeria soil forage polygons to see if the health of vegetation in the NDVI image compares to low or high forage polygons in Nigeria soil survey data. Vegetation area NDVI is high, while the non vegetative NDVI is low. NDVI image compared with the vegetation of the study area which indicated poor vegetation, medium vegetation and good vegetation. Rangeland analysis identified areas with the physical characteristics capable of supporting livestock grazing; these are areas producing adequate forage that are accessible to livestock. The area has NDVI values between -1and + 1 with 1 being the most beneficial (figure10). This finding is in line with that of Racheal (2012) on rangeland suitability classes which have grassland, grassland/shrub land and shrub land.

A. Economic implication for the release of Rangeland for livestock grazing

In some countries rangeland has improved both their social and economic life of the people in those areas where rangeland were sited. But in Nigeria acquiring land for rangeland becomes a problem because of method of land ownership as stipulated in landuse act decree of 1984. According to various opinions, livestock rearing is a business of individuals who are not the owner of the land for ranching, thus anybody that want to rear livestock should be ready to buy land. Farmers who are interested in owning pastures must acquire land either by lease or purchase. This study tried to solve the problems and difficulties in acquiring land for rangeland by introducing economic measures which will allow land owners to provide land for rangeland by suggesting that there should be payment per plot of land to the owners of the land every year. The money should be paid to the community or the individuals that owns the land. The land can be acquired through tenancy as practice in developed countries for a period of time, where the lessee pay the owner of the agreed sum of money which can be renewable after the expiration of leased agreement (FAO,1983).

CONCLUSION

Suitability considers the appropriateness of livestock grazing for a particular land area,based on the economic and environmental consequences and considerations for other uses that may be affected by livestock grazing. In Nigeria there had being an incessant problems and clashes resulting to death and loss of properties between Fulani herdsmen and the various communities visited. This problem was as a result of using old method of grazing reserve when the population was small and inability of government to map out rangeland for livestock grazing. This study was intend to identify available land areas suitable for livestock grazing in irepodun and the environment as a pilot project integrating GIS and Remote sensing Techniques with multi-criteria evaluation (MCE). Bio-physical and socio-economic factors which determine rangeland suitability as outlined by International Region's rangeland capability, amongst are Slope, Landuse/Landcover (LULC), Soil, Rainfall, Temperature, Distance to Water, Road were used to determine the available land areas, suitable for livestock grazing. The result of the study showed that land areas in the study areas were useful for rangeland for livestock grazing. From the result of the final suitability Map, 10% of the area were covered by water while 10% are not suitable, 15%, 25%, 40% were, moderately suitable, suitable, and highly suitable respectively. The NDVI image of the study areas showed poor vegetation, medium vegetation and good vegetation when ascertain the overall health of the vegetation in the study area. Economic measure was opted for means of releasing land by the owners of the land through payment of money to the land owners and communities.

Recommendation

This study was carried to determine the rangeland suitability for livestock grazing using Irepodun and it's environing of osun state of Nigeria as a pilot study. The study observed that some land areas were useful for for rangeland for livestock grazing. The study recommends that government should establish Rangeland for livestock production in this area to enable any individual that is interested in rearing livestock to operate. Moreover, whoever wants to rear animal should buy land from the owners and estabilish its own rangeland because livestock production is a business venture. Rangeland will be useful to alleviate the clashes between Fulani herdsmen and various communities and improve/increase the production of livestock thereby encouraging individuals to buy cattle, goat, and sheep at cheaper rate. Ranching will be the best solution to the crises of Fulani herdsmen in Nigeria. The poll respondents pointed out that since ranching is being practiced all over the world and has worked well in reducing conflicts between farmers and herdsmen, the model should also be adopted in Nigeria.

References

[1] Ashaolu E.D and Onunde F.T (2014); A Look into Households Water Use Behaviour in Irepodun Local Government Area of Kwara State, Nigeria

[2] Journal of Environment and Earth Science www.iiste.org ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol.4, No.2, 2014.

[3] Dennis. O. (2008) ;Determining rangeland suitability for cattle grazing based on distance-to-water, terrain, and soils MGIS Capstone Project - Peer Review

[4] July 8, 2008 , Wyoming Game & Fish Dept. Academic Advisor: Joseph A. Bishop, Ph.D.,Penn State University, Department of Geography.

[5] FAO. Guidelines: land evaluation for rain fed agriculture. FAO Soils Bulletin No. 52. 1984a FAO, Rome. 249 pp.

[6] FAO. Guidelines: land evaluation for extensive grazing. FAO Soils Bulletin No. 58 November 1983.FAO, Rome .pp 45. Recommended.

[7] Frantz, C. "Fulbe Continuity and Change Under Five Flags Atop West Africa: Territoriality, Ethnicity, Stratification, and National Integration." In *Change and Development in Nomadic and Pastoral Societies*, ed. John Galaty, and Philip Salzman, 89-115. Netherlands: E. J. Brill, 1981.

[8] Gils, H. van. Rangelands of the world. Unifying vegetation features. In: Siderius, W.1984 (ed.). Proceedings of the Workshop on Land Evaluation for Extensive Grazing. ILRI, Wageningen. pp. 17-27.

[9] Mfitumukiza D; (2004): Evaluating Rangeland potentials for cattle grazing for a mixed farming system. Thesis submitted to the International Institute for Geo-information science and Earth Observation in partial fulfilment of the degree of Master of Science in Geo-science and Earth observation, Environmental Systems Analysis and management.

[10] Nester .B.(1984) :Development of animal production systems (Vol. SA2) Amsterdam etc:Elseiver Noy-Meir, I. Stability of grazing systems: an application of predator-prey graphs. 1975 J. Ecol. 63: 457-481.

[11] Nigeria Metrological Agency (NIMET DATA 2006-2016.)

[12] Nigerian government demarcate grazing reserves: eWASH Nigeria's News on Water, Sanitation and Hygiene Nigeria Watch Project IFRA-Nigeria working papers series, n°34 28/11/2014.

[13] Rachel R. M. (2012); utilizing gis and remote sensing to determine sheep grazing patterns for best practices in land management protocols. A Thesis Presented to the faculty of the usc graduate school university of southern california in partial fulfillment of the requirements for the degree master of science (geographic information science and technology) august 2012.

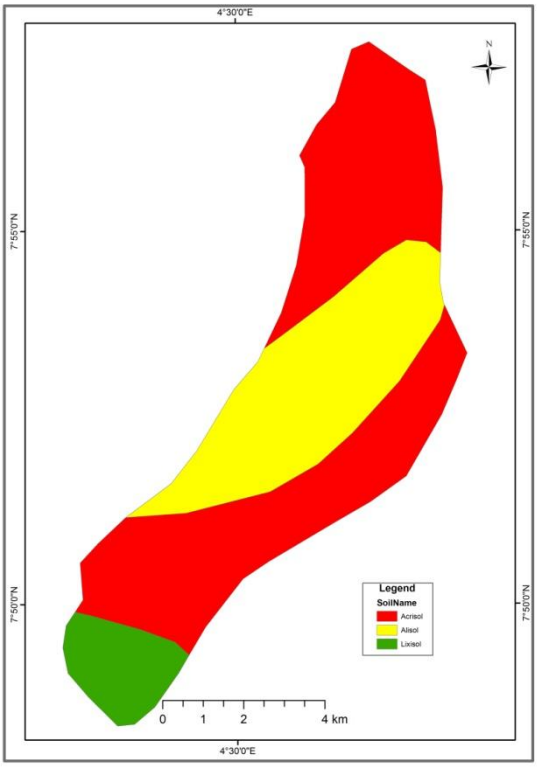
[14] Stelljes, Kathryn B. 1995. Rangeland can improve with grazing. *Agricultural Research* 43 (9): 15.).Sun IG. 2007.

[15] Sun.I. G (2007).: Estimating Areas Suitable for Livestock Grazing in Wyoming student handout.

[16] Venema, J.H. and Vargas, R. R. 2007a. Land suitability assessment of a selected study area in Somaliland. Technical Project Report L-06. FAO-SWALIM. Nairobi.

[17] Venema, J.H. and Vargas, R. R. 2007b. Land suitability assessment of the Juba and Shabelle riverine areas in Southern Somalia. Technical Project Report L-09. FAOSWALIM.Nairobi.

Appendix1. Figures showing the Thematic maps of the Factors Used.



Figure; 3 Soil Map

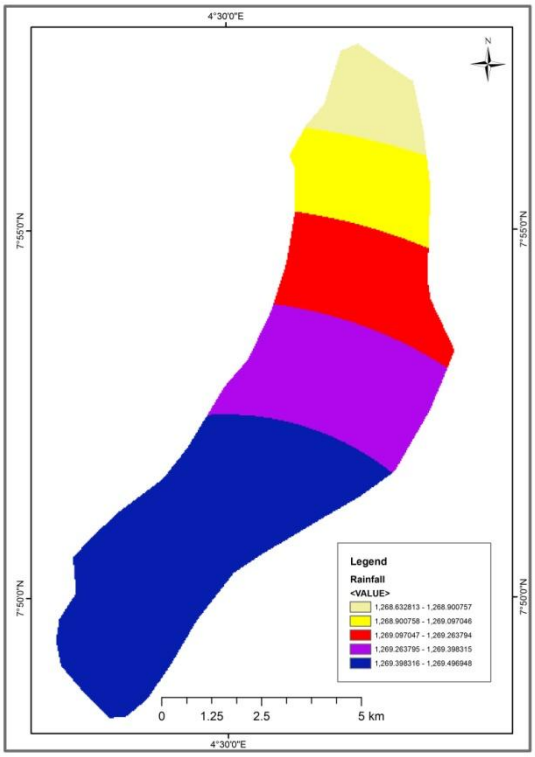


Figure 4; Rainfall Map

Figure 5:Temperature Map

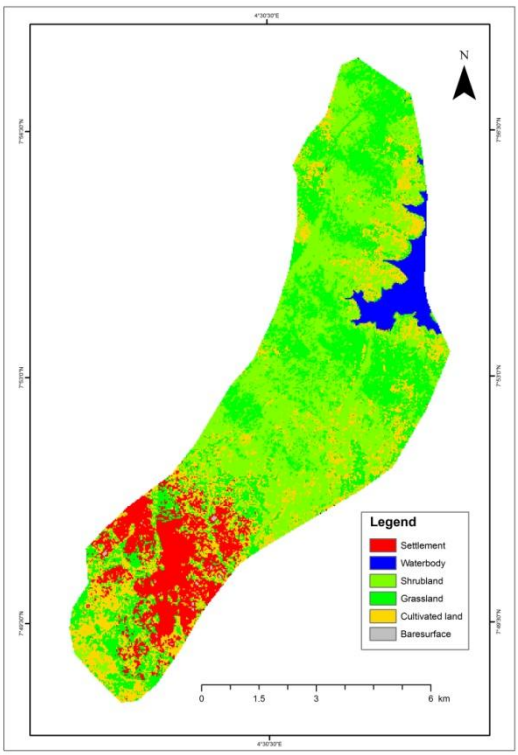


Figure 6:landuse landcover Map

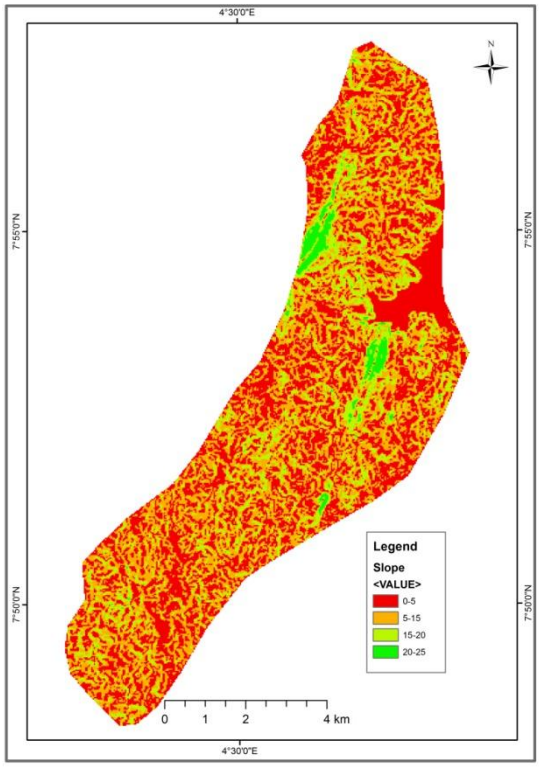


Figure 7; Slope map

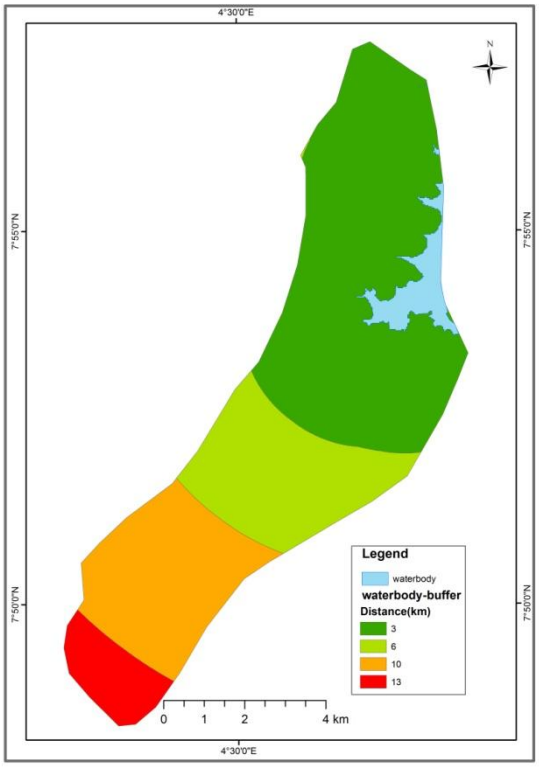
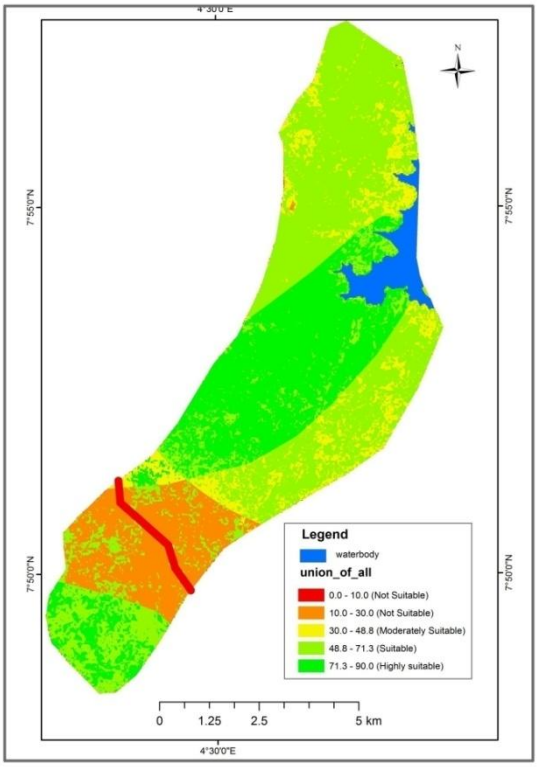


Figure8; Distance to water buffer Map

Result Maps and Chart



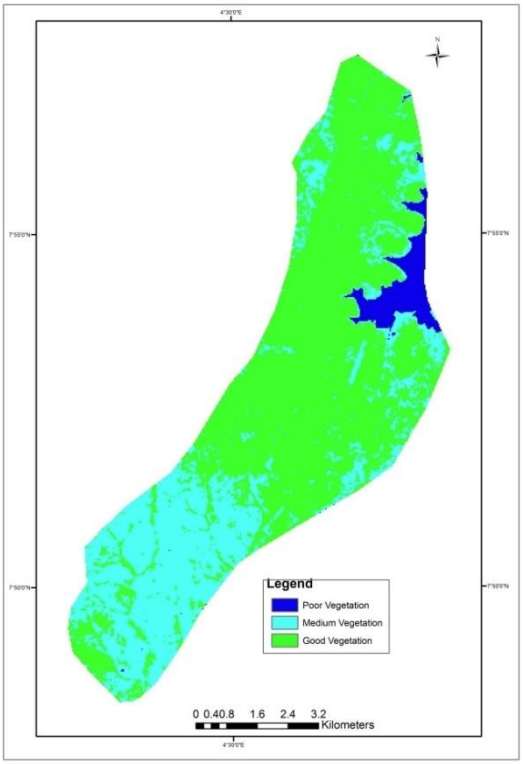


Figure 9: Final Rangeland Suitability Map. Figure 10: Map of the study Area. NDVI

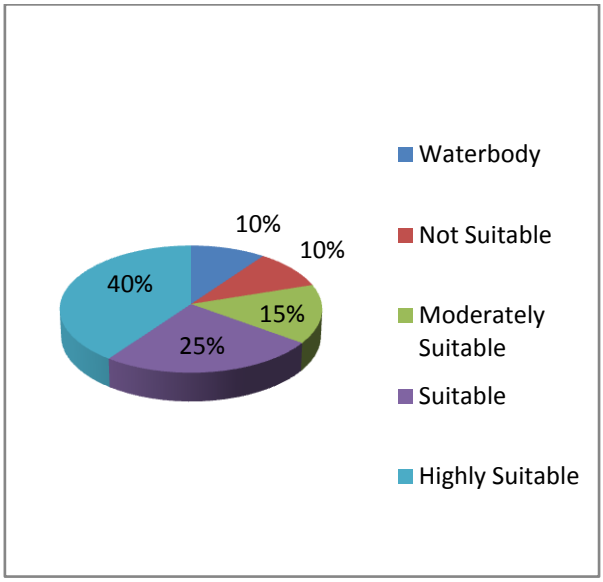


Figure 11: Suitability Pie Chart.