Kaleel. M.I.M[1]

GIS Based Land Degradation Analysis on Coastal Area of Ampara District (from Kalmunai to Nintavur DSDs)

(1) Department of Geography, South Eastern University of Sri Lanka, Oluvil, Sri Lanka.

Abstract: Sri Lanka is faced with several aspects of land degradation, many of which are human induced. The country is free of serious natural hazards such as volcanic activity and earthquakes resulting from climatic extremes, but there are impacts of many natural disasters, such as landslides, floods and droughts, the intensity and frequency of which are increasing due to human interventions. Some areas of Sri Lanka are also periodically subject to cyclones that occur due to climatic conditions and geographical locations.

Land degradation denotes all natural or anthropogenic processes that diminish or impair productivity of land. This occurs mainly through soil erosion, loss of organic matter and nutrients in the soil; salinization and large scale land degradation in Sri Lanka. Its manifestations today are heavy loss of soil, siltation in the water bodies, reservoirs and coastal waters, unplanned settlements, loss of arable land leading to declining productivity in agricultural lands and intensification of impacts of natural hazards such as flooding and landslides.

Land degradation is a major problem in Eastern Coastal Area from Kalmunai to Nintavur DSDs of Ampara District. However, there is a considerable spatial heterogeneity exists within this area in terms of land use, topography, land management and socio-economic conditions. Therefore, land degradation assessment studies are very important for the sustainable development of the area. Considering the above background, this study was conducted with the objectives of developing a land degradation assessment model using a GIS based approach.

Key Words: Land Degradation, Soil Erosion and GIS.

Introduction

Land degradation is a dynamic process and is the result of both natural and biotic forces operating on the earth. The scientific information of degraded lands is thus essential for formulation of strategic plan to arrest the menace of land degradation, generation of realistic information on degraded lands of the country is the utmost necessity and taken on a mission mode in order to check further degradation of the environment and loss of top fertile soils.

Land degradation is a dynamic process operating on the earth due to natural biotic forces and human activities. Development of degraded lands is one of the options available for the growing population and to restore the fragile ecosystems in Sri Lanka. The information on the extent and spatial distribution of various kinds of degraded lands is thus essential for strategic planning. Soil is a dynamic non-renewable resource which is essential for the continued agricultural productivity and to prevent degradation.

As long as the soil and land are used according to their potentials, it is good, continued unplanned and unscientific exploitation results in land degradation. The information on land degradation is needed for a variety of purposes, like planning the reclamation programmes. The land degradation problem has reached an alarming proposition due to various factors like over exploitation and mismanagement of natural resources and socio-economic factors.

The concern for protecting the productivity of natural resources without further degradation is the key issue for both the developed and the developing nations to sustain the future generations. The satellite remote sensing and GIS technologies should be fully

utilized for monitoring the land degradation (Venkataranam and Ravisankar, 2003).

Land degradation, including soil erosion, continues to be a global constraint to economic development. Despite decades of efforts to arrest land degradation, many farmers are reluctant or unable to adopt appropriate land use practices. Often, these practices fail to combine high productivity, increased soil fertility, reduced soil erosion and enhanced welfare. Still, soil conservation is proposed as a viable route to obtain these objectives.

The methodology for land degradation mapping, using remote sensing techniques developed by the organization, is based on the expertise in the field of soil survey and remote sensing acquired since inception. Database with spatial distribution of various soil and land attributes is a pre-requisite for development of strategic planning of any land development programme.

The information system on degraded lands in the country could be developed using remote sensing and geographical information systems towards strategic development of degraded lands and monitoring the status in a periodic timescale (Das, 2003).

Study Area

The study area is located between the latitudes of 7º25' 24"N and 7º 27' 25" N and the longitudes of 81º 45' 31" E and 81º 50' 32" E. (Figure 1)
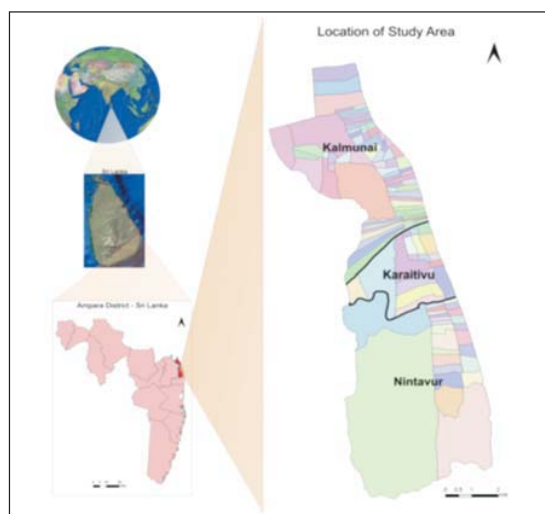

Figure 1: Study Area

Materials and Method

The following spatial and non spatial data were used in this study: Spatial data on Contour, Soil, Land use, Streams, Reservoirs, Road map of 1:50,000 scale topographic maps of the Survey Department of Sri Lanka, demographic data (Population Density, Education, Income, Land to man ratio, and agro land to man ratio), ground truth information. Further the spatial data analysis was carried out using Arc GIS 9.3.

The land degradation severity map was prepared by integrating all spatial data layers. Weights were given to each spatial data layers according to their possible contribution towards soil erosion. Since rainfall induced soil erosion is the most influential factor in land degradation, more weight was assigned to this data layer during the analysis. The assigned weightage values are shown in Table 1.

Table 1:
Weightage values for different spatial data type

Spatial data type	Weightage (%)
Soil loss	45
Population density	25
Agro land-man ratio	15
Land-man ratio	10
Samurdhi beneficiaries	05

Land degradation severity was assessed by using Weighted Sum algorithm in ArcGIS software. Applying simple arithmetic calculations, final land degradation map was produced.

Results and Discussion

An analysis about the overall patterns of gain and loss of different categories of land degradation provides greater insights into an understanding of the changes in land uses and resultant degradation. Table 2 shows the net changes in gains and losses due to degradation of land during 1981-1991, 1991-2001, 2001-2006 and 1981-2006 in the study area.

Table 2:
Land Degradation in Kalmuani to Nintavur (extent in km2) 1981-2006

| Classification Degraded	1981	1991	2001	2006
Highly	14.30	15.79	16.75	18.62
Moderately	9.73	10.04	9.80	10.11
Less	9.71	10.45	11.10	11.18
Non	34.17	31.63	30.26	28.00
Total	67.91	67.91	67.91	67.91

Source: Field measurements and Computation using GIS (M.I.M. Kaleel, 2010)

The highly degraded land has experienced also a loss of -6.36 per cent during the 25 years of observation, which is a sign of deterioration. This class of land has experienced a loss of -2.19 per cent (1981 to 1991), -1.41 per cent (1991 to 2001) and -2.76 (2001 to 2006) during the various periods in the overall period of analysis. The overall loss of a sizeable proportion of lands in the highly degraded category reveals that measures should be taken on a war footing to preserve the quality of land in the study area (see Figures 6.17 to 6.20).

Figure 2:
Land Degradation in Kalmuani to Nintavur 1981-2006
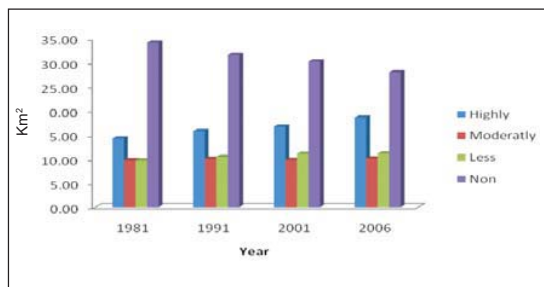
Figure 3:
Land Degradation in Kalmuani to Nintavur DSDs 1981 and 1991
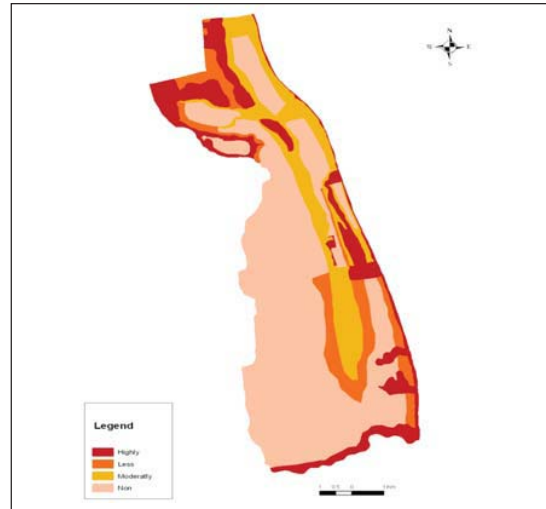
Figure 4:
Land Degradation in Kalmuani to Nintavur DSDs 2001 and 2006.

Conclusions

Based on the analysis of dynamics of land degradation in the study area, the following conclusions have been drawn:

1. The study area has experienced an adverse effect in land degradation throughout the study period 1981-2006.

2. The annual degradation score has shown an increasing trend during 1981 to 1991 and 2001 to 2006, which is an unhealthy development.

3. The negative annual degradation rates indicate a higher level of human interference and disturbance in the normal processes in the study area.

4. Human interference has been the highest and this has been validated by the fact that nearly 70 per cent of the settlements of the area have shown wider human impacts on the environment.

5. There is a strong positive relationship between land degradation and soil erosion as well as land degradation and population density while strong negative relationship can be observed between land degradation and land to man ratio. A sound correlation could not be observed between land degradation and poverty level.

References

1. Venkataratnam L and Ravisankar T, (2003): Remote Sensing for Soils and Land Degradation, BSP.BS Publication, Hyderabad, 4-4-309:158-168.

2. Das S.N., (2003): Land Degradation Status in India, BSP.BS Publication, Hyderabad, 4-4-309:171-177.

3. State of Environment in Sri Lanka, (2002): Land Degradation and Natural Hazards in Sri Lanka, Environmental Economics and Global Affairs Division, The Ministry of Environment and Natural Resources, Colombo, Sri Lanka, 61-72.

4. Swan S. B. St. C, (1965): Coast Erosion Principles and a Classification of South-West Ceylon a beaches on the bias of their Erosional Stability, *Bullcey Geogr, Soc. Vol.19.*

5. Wijesekera S. and Samarakoon L., (2001). Extraction of parameters and modeling soil erosion using GIS in a GRID environment. [access 27 September, 2007]. Available from internet: .

6. Hesadi H., Jalili K. and Hesadi M., (2003). Applying RS and GIS for Soil Erosion and Sediment Estimation by MPSIAC Model - A case study of Kenesht watershed in Kermanshah, Iran. [Access 27 September, 2007].

7. geology/geomorphology/geogmf001.htm.