Journal of the Saudi Society of Agricultural Sciences (2016) 15, 91–97

King Saud University

Journal of the Saudi Society of Agricultural Sciences

www.ksu.edu.sa
www.sciencedirect.com

FULL LENGTH ARTICLE

Land-use/land-cover dynamics in Sego Irrigation Farm, southern Ethiopia: A comparison of temporal soil salinization using geospatial tools

Shegena Zewdu [a], **K.V. Suryabhagavan** [a,*], **M. Balakrishnan** [b]

[a] *School of Earth Sciences, Addis Ababa University, P.O. Box No. 1176, Addis Ababa, Ethiopia*
[b] *Department of Zoological Sciences, Addis Ababa University, P.O. Box No. 1176, Addis Ababa, Ethiopia*

Received 21 November 2013; revised 24 March 2014; accepted 29 March 2014
Available online 8 April 2014

KEYWORDS

Barren lands;
Environmental impacts;
Geographic information system;
Irrigation;
Land-use patterns;
Remote sensing

Abstract Land-use patterns are changing fast in most of the tropical nations in relation to the human population growth and related impacts. Majority of the rural population in Ethiopia depends on agriculture, and hence the land-use changes during the past couple of decades in rural Ethiopia are mostly linked to agricultural developments. The present study deals with the status and trends of land-use and land-cover dynamics in Sego Irrigation Farm in southern Ethiopia. Geospatial tools were used to assess changes in land-use/land-cover patterns in the study area during 1984–2010. Patch dynamics was assessed to understand the degree of fragmentation and changes along the terrain topography. Detailed analyses have revealed that the extent of cultivated land, which was 38.1% in 1984 has increased to 60.7% by 2010, with an average change of 58 ha per year. The extent of land, which was intensively and sparsely cultivated in 1984 and 1995, was converted to barren and fallow land due to irrigation-related salinization problems. The water body/swamp, which was 55 ha in 1984 has significantly decreased to 2 ha by 2010. Land-use changes have been attributed to factors such as population pressure and environmental changes as more land area was put under irrigated cultivation, leading to salinization and lowering productivity of the soils in the area. Findings of the present study have implications for other rural areas in Ethiopia and elsewhere in the tropical regions, where irrigated agriculture is practiced.

* Corresponding author. Tel.: +251 911998588.
E-mail address: drsuryabhagavan@gmail.com (K.V. Suryabhagavan).
Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.jssas.2014.03.003

1. Introduction

Like many other developing countries across the globe, significant land-cover changes have occurred in Ethiopia since the last century. These changes were primarily due to anthropogenic activities, in connection with the population increase, which forced people to clear forest for cultivation and other activities (Gebresamuel et al., 2010). In the present study area, irrigation has been in practice since over four decades. Significant land-cover and land-use changes occurred in the area in response to the increase of soil salinity from time to time affecting agricultural productivity leading to land-use changes. Accurate information on land-cover changes and the forces behind are essential for designing sound environmental programmes and management activities. Land-cover analysis provides the baseline data required for proper understanding on the land-use patterns in the past and its impacts. It also aids to understand the ratio of the past land-cover changes, and the physical and socio-economic factors behind (Mengistu and Salami, 2007).

Studies on land-cover changes also yield valuable information for analysis of effects of climate change and environmental impacts of human activities. Such information is of great use for resource managers to help in resolving conflicts between human use of natural resources and sustainability of natural habitats and ecosystems (Belay, 2002). A change in the land-cover of an area can negatively affect the potential characteristics of the area, and may ultimately lead to degradation and loss of productivity.

Soil salinization is one of the major impacts of land-use/land-cover (LULC) changes in arid and semi-arid regions, wherever irrigation is practiced. Soil degradation due to salinity and sodicity is increasing at an alarming rate of endangering the environment and agricultural ecosystems (Reza et al., 2008). It is a severe environmental hazard that impacts the growth of many crops. Even though salt affected areas are extended through all continents, statistical data on the extent of salt affected areas vary. However, general estimates show the extent of such areas as close to one billion hectares, which represents about 7% of the extent of the terrestrial area of earth. Salt affected areas are primarily located in the irrigated areas of the old alluvial plains and zones of low rainfall in shallow water table depth and in hot and dry moisture regions (Mandal and Sharma, 2005). More than 120 countries are directly affected by the problem of soil salinity (Al-Khaier, 2003).

Land degradation, which is a product of complex interactions of many of the physical and biological variables, reduces the potential capability of soil to produce goods and services. Semi-arid regions are under high pressure to supply the required food for their rapidly increasing populations. Consequent changes in the land-use patterns due to agricultural intensification, together with the harsh climatic conditions including global climate change, have accelerated land degradation processes, with yield reduction in many parts of the arid world. Therefore, the need for detecting the occurrence of land degradation while assessing its severity at any given time becomes vital. Hence, the present study was aimed to detect temporal and spatial dynamics of LULC and soil salinity, which are major driving forces of land degradation.

2. The study area and methods

The present study area is situated in the Southern Nations Nationalities and Peoples Regional State (SNNPRS) of Ethiopia in Arba Minch Zuria Woreda (Gamo Gofa Zone), at about 24 km in the south of Arba Minch town, extended on both sides of Arba Minch – Konso asphalt road. Geographically, the study area is bounded by longitude 37°25′9″–37°30′50″ E and latitude 5°48′12″–5°54′9″ N with an area of 6747 ha (Fig. 1). This area is a flood plain land bounded by Lake Chamo in the eastern and southern directions, while its northern and western directions are bounded by mountains. The area is drained by Sile and Sego Rivers, which drains into Lake Chamo.

2.1. Topography and climate

There is an abrupt change of topography where Sego and Sile rivers emerge into a plain, bordering Lake Chamo (at the command area). This is the lowest part of the Great Ethiopian Rift Valley in the area at an elevation of 1100–1250 m asl, composed of recent superficial deposits with no rock exposure, and with very shallow gradients sloping toward Lake Chamo.

The study area is characterized by hot sub-humid lowlands in the eastern and northern parts and warm sub-humid to warm humid lowlands in the west and northwestern parts of the watershed. Its evapotranspiration is almost uniformly distributed throughout the year. Seasonal temperature variation is very small. At Arba Minch, the township close to the study area, the mean monthly temperature is 23.9 °C, varying between 22.7 °C (July) to 25.7 °C (March). Rainfall distribution in the study area is bimodal with a long rainy season from the beginning of March to the end of May with maximum rainfall around the month of April (228 mm), and a short rainy season from mid-August to mid-October. The minimum monthly rainfall is recorded in January (18 mm).

2.2. Materials and methods

Landsat satellite images of 1984, 1995 and 2010 (path and row of 169/056) were used to analyze temporal changes in the study area. The Ethiopian Mapping Agency (EMA) toposheet (0537 A2) of 1:50,000 scale pertaining to the study area was used for geo-referencing of satellite images. Landsat satellite data provided by Global Land Cover Network (GLCN) was radiometrically and geometrically processed using ERDAS Imagine 9.2. (Ortho-rectification with Adindin UTM Zone 37 N).

A pre-field interpretation map was prepared and the ground truth of the area was verified by direct observation. The Ground truth information was collected by GPS survey by 85 GCP points for the entire study area. Recent satellite data were used during the field survey and the current land-use practices were noted in the field. The past LCLU information was gathered by informal interviews with the local people and concerned government departments. The GPS points were downloaded and overlaid on the imagery and used for refinement of the pre-field interpreted LULC map.

For LULC mapping, visual interpretation technique was adopted. With the extensive ground truth and detailed information, an interpretation key was developed. The mapping