The Egyptian Journal of Remote Sensing and Space Sciences (2016) 19, 125–141

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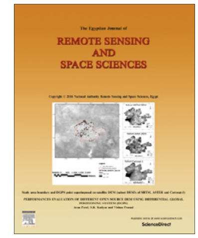

RESEARCH PAPER

Assessment of land suitability and capability by integrating remote sensing and GIS for agriculture in Chamarajanagar district, Karnataka, India

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Received 27 April 2015; revised 19 January 2016; accepted 1 February 2016
Available online 23 February 2016

KEYWORDS

Capability evaluation;
Geographic information system (GIS);
Remote sensing;
Suitability evaluation

Abstract To reduce the human influence on natural resources and to identify an appropriate land use, it is essential to carry out scientific land evaluations. Such kind of analysis allows identifying the main limiting factors for the agricultural production and enables decision makers to develop crop managements able to increase the land productivity. Objectives of this study were to develop a GIS based approach for land use suitability assessment which will assist land managers and land use planners to identify areas with physical constraints for a range of nominated land uses. Georeferenced soil survey data and field work observations have been integrated in a GIS based land use suitability assessment for agricultural planning in Chamarajanagar district, Karnataka, India. Also, GIS has been used to match the suitability for main crops based on the requirements of the crops and the quality and characteristics of land. Different land quality parameters, viz. soil texture, depth, erosion, slope, flooding and coarse fragments under various land units were evaluated for the crops. Subsequently all of them were integrated using a sequence of logical operations to generate land suitability and capability maps. Suitability and capability maps for each land use were developed to illustrate these suitability degrees and display the spatial representation of soils suitable for agriculture. It was also found that better land use options could be implemented in different land units as the conventional land evaluation methods suffer from limitation of spatial analysis for the suitability of various crops.

1. Introduction

The land capability evaluation characterizes and appraises land development units from a general point of view without taking into consideration the kind of its use. There are defined classes ranging from I to VIII (Landon, 1991). This classification is useful as some soils can be suitable for specific crops

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Peer review under responsibility of National Authority for Remote Sensing and Space Sciences.

http://dx.doi.org/10.1016/j.ejrs.2016.02.001
1110-9823

and unsuitable for another's; therefore precision of land utilization types is necessary. It cloud be expressed not only in terms of types of crop productions, but also how these specific crops are produced (Sys et al., 1991).

Land suitability refers to the ability of a portion of land to tolerate the production of crops in a sustainable way. Its evaluation provides information on the constraints and opportunities for the use of the land and therefore guides decisions on optimal utilizations of resources, whose knowledge is an essential prerequisite for land use planning and development. Moreover, such a kind of analysis allows identifying the main limiting factors for the agricultural production and enables decision makers such as land users, land use planners, and agricultural support services to develop a crop management able to overcome such constraints, increasing the productivity. Land could be categorized into spatially distributed agriculture potential zones based on the soil properties, terrain characteristics and analysing present land use (Bandyopadhyay et al., 2009).

Production could be met through systematic survey of the soils, evaluating their potentials for a wide range of land use options and formulating land use plans which were economically viable, socially acceptable and environmentally sound (Sathish and Niranjana, 2010).

Remote sensing (RS) data are used for estimating biophysical parameters and indices besides cropping systems analysis, and land-use and land-cover estimations during different seasons (Rao et al., 1996 and Panigrahy et al., 2006). However, RS data alone cannot suggest crop suitability for an area unless the data are integrated with the site-specific soil and climate data. RS data can be used to delineate various physiographic units besides deriving ancillary information about site characteristics, viz. slope, direction and aspect of the study area. However, detailed information of soil profile properties is essential for initiating crop suitability evaluation. Hence, soil survey data are indispensable for generating a soil map of the given region, which helps in deriving crop suitability and cropping system analysis.

RS data coupled with soil survey information can be integrated in the geographical information system (GIS) to assess crop suitability for various soil and biophysical conditions. The present study was undertaken to demonstrate the usefulness of RS and GIS technologies coupled with soil data to assess crop suitability in order to implement sustainability for crops in the study area. The potential of the integrated approach in using GIS and RS data for quantitative land evaluation has been demonstrated earlier by several researchers (Beek et al., 1997 and Merolla et al., 1994). Therefore, the objective of this study was assessment of land evaluation using RS and GIS environments.

2. Materials and methods

2.1. Description of the study area

Chamarajanagar district, (Fig. 1) is situated in the south part of Karnataka state, geographical area of Chamarajanagar district is about 5101 km^2 and lies between the North latitude 11 o 40′58″ and 12 o 06′32″ and East longitude 76 o 24′14″ and 77 o 46′55″. It falls in the southern dry zone. Topography is undulating and mountainous with north south trending hill ranges of Eastern Ghats. Salem and Coimbatore districts of Tamilnadu in the east, Mandya and Bangalore districts in the north, parts of Mysore district in the west and Nilgiris district of Tamilnadu in the south, bound the Chamarajanagar district (Central Ground Water Board, 2008) (see Fig. 1).

2.2. Remote sensing data and ancillary data

Data used in this study are Indian Remote Sensing satellite (IRS P-6) LISS III and LISS IV sensors (Table 1) and Hyperion. Remotely sensed data provide timely, accurate and reliable information on degraded lands. Also length and degree of slope were derived from SRTM (downloaded from http://www.usgs.gov) and Topographic maps. Ancillary data: Topo sheets used (1:50,000) and (1:2,50,000). Toposheets (1:50,000) used in this study were (i) 57 H/7, (ii) 57 H/4, (iii) 57 H/8, (iv) 57 H/12, (v) 57H/16, (vi) 58A/9, (vii) 58A/13 (viii) 58E/1, (ix) 58E/5, (x) 58E/9, (xi) 58A/6, (xii) 58A/10, and (xiii) 58A/14, where Topo sheets scaled (1:250,000) used in this study were xiv) 57 A, (xv) 57 E, (xvi) 57 D, (xvii) 57H.

2.3. Digital image processing

Digital image processing techniques were carried out for Indian Remote Sensing satellite (IRS) LISS III and LISS IV sensors and Hyperion. Radiometric correction, Geometric corrections and image geo-referencing, image enhancement and color composites, were carried out to change and alter the original raw spectral data to increase the information availability, and to provide the best possible product for analysis and interpretation for information extraction (unsupervised classification, supervised classification), normalized difference vegetation index (NDVI). GIS was also used to build the soil properties, the land resource database and to work out the spatial model to produce the different maps.

2.4. Software used

ENVI 5.0 and GIS 10.1 package was used for integration between RS and GIS to arrive at the capability and suitability final spatial map decision. Map interpretation was done using Geographic information system (GIS).

2.5. Land evaluation classification

Land evaluation classification was undertaken according to the FAO (1976, 1983, 1985 and 2007) system to assess the suitability of the studied area soils for agriculture and development.

Land capability classification was also undertaken based on the capability or limitations according to the U.S. Soil conservation service (1958, 1959, 1963 and 1992). The methodology flow chart for both land capability and land evaluation classification is shown in Fig. 2.

2.6. Generating of thematic maps using geostatistics techniques

For this purpose ArcGIS Geostatistical analyst was used which provided a suite of statistical models and tools for spatial data exploration and surface generation. Using ArcGIS