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TOWARDS DEVELOPMENT OF A RUBBER INFORMATION SYSTEM

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ABSTRACT

Remote sensing has been directly responsible for major advances in our understanding and ability to manage agriculture, forestry and water resources. Some work in this applied research as far as rubber is concerned was done earlier. It is now possible to have a rubber plantation distribution map of a given geographic area that could be used as one layer in the Geographical Information System. Resource map of soils under rubber in traditional region is already prepared that could be used as another theme. Earlier report is available regarding the combined application of remote sensing and GIS regarding the separation of soils under rubber. Other layers related to rubber also could be generated and brought into the environment of GIS for other activities like disease map, clonal distribution etc.

Another aspect called DEM (digital elevation model) is assuming importance in site-specific management. A DEM is a digital representation of the relief of the earth's surface Typically it consists of arrays and values that represent topographical elevations measured at equal intervals on earth's surface. Reports are available regarding the possible applications of DEM in planning of planting terraces, computation of site yield potentials, production of soil erosion risk map etc. Similarly, there were attempts to improve planting and development in hilly terrain and implementation of fieldwork through the use of DEM.

In the present article the work regarding the application of remote sensing in delineating rubber plantations from other types of vegetation is discussed. An already available soil map was shown as another layer that can be brought into the GIS environment. The digital elevation model of the study area was generated using a software, 3DEM. Draped images of supervised classification map and soil map in three-dimensional view are shown. It is possible to develop a database with different layers of information related to rubber cultivation to create a Rubber Information System (RIS) that can work as a decision support system.

INTRODUCTION

Holding a PDA (personal digital assistant) in the palm for data entry, retrieval and analysis, and taking a quick decision is a dream for an Indian planter at present. A number of PDAs or other palmtops can be integrated with a desktop computer to store and display reports and data from databases, accounting information, digital maps, simulation models, expert systems, schedules and other basic data relevant to the planter's day-to-day operations. This imagination can become a reality with the availability of ever changing Information Technology. However, there is every need to develop first a database that forms the basis in decision-making. It needs some more time to reach this sophistication in India in general and in rubber plantation in particular since the theme wise database generation had just began. Rubber Research Institute of India made a unique attempt in the country to get the soils under rubber in Kerala and Tamil Nadu mapped in 1:50000 scale (NBSS & LUP, 1999) in the direction of developing the theme wise database.

Remote sensing has been directly responsible for major advances in our understanding and ability to manage agriculture, forestry and water resources. Rao and Pothen, (1995) outlined some of the possible applications of remote sensing in rubber cultivation. Some work in this direction was dome by Rao *et al.*, (2000) who studied the spectral reflectance during leafless period, developing and developed stages of canopy that would help in discriminating rubber from other types of vegetation since rubber has got a unique shedding behaviour called wintering.

It is possible now to have a rubber plantation distribution map of a given geographic area that could be used as a layer in the GIS, in addition to the other layers, for instance the soil map already prepared. Similarly, other layers related rubber could be generated and brought into the environment of GIS for other activities. A volume of literature is available with regard to the applications of GIS in different spheres. Fairhumt *et al.*, (2000) described the potential applications of use of GIS in plantation agriculture. In a test application Rao *et al.*, (2001) integrated RS and GIS to separate soils under rubber plantations from non-rubber areas.

With the background of this information it is presumed that it is possible to develop a database including all the spatial information related to rubber and its cultivation by combining both RS and GIS. Another aspect called DEM (digital elevation model) is assuming importance in site-specific management. A DEM is a digital representation of the relief of the earth's surface. Typically it consists of arrays and values that represent topographical elevations measured at equal intervals on earth's surface. The possible applications of DEM include planning of planting terraces, computation of site yield potentials, production of soil erosion risk map etc. Tey *et al.* (2000) discussed about attempts to improve planting and development in hilly terrain and implementation of fieldwork through the use of DEM. The present article is about an exercise that was taken up for digital image processing for rubber map, GIS to integrate soil map with rubber map and DEM for understanding the retain of the study area the results of which are discussed in the text to follow.

MATERIALS AND METHODS

An area called Cheruvally Estate area in the Kottayam district of Kerala was selected as the study area. This area consisted of rubber plantations both in estate and small holding sectors, mixed forest and teak plantations. The digital data of IRS-IC (Indian Remote sensing Satellite - 1C) pertaining to the above area (falls in Path 100 and row 67) of 7 February 1997 was used in the present study. This image was geometrically corrected using an IRS-1B geocoded image of the same area (29-01-1997) as the reference. A supervised classification of the study area with maximum likelihood classifier was performed on the image using the training sites, which were verified, in the ground truth survey. A total of six signatures were developed, two for rubber based on the reflectance and one each for teak, mixed forest, river & shallow waters and others (which mainly include bare lands). The digital image was processed using IDRISIW version 2.0 and ground truth survey was conducted on 7-02-1997.

A soil map of the corresponding area in 1:50000 scale was extracted from the soil maps published by NBSS&LUP (1999). This piece of soil map and the contours with reference to the corresponding toposheet in 1:50,000 scale were digitized using the software, Mapinfo. This X, Y (co-ordinates) and Z (elevation) information was converted into ASCII text file. This text file was used as an input for the software 3DEM for generating the third dimension of the study area. The bitmaps of classified image and soil map were draped on this 3D map for visualization of the terrain for interpretation.

RESULTS AND DISCUSSION

The classified image shown in figure 1 showed that there were six classes identified based on the training statistics including tow classes of rubber based on spectral reflectance. The visual interpretation of the classified image showed that the classification was satisfactory (Rao, 2000) with some minor discrepancies. Rao *et al.*, (2001) reported similar study pertaining to another rubber growing area Mooply Valley in Thrissur district of Kerala. It is understood that rubber separation is possible by using LISS-III data of IRS-IC that has got a good resolution of 23 meters. Further study by Rao (2000) included temporal variations in spectral reflectance from rubber during no leaf period, developing and developed canopy since rubber has a leaf shedding behaviour, which is called 'wintering'. This information helps in decisively separating rubber from teak and mixed forest that are the other major plantation activity in Kerala. Coconut has a typical spectral reflectance that in any case does not interface in identifying rubber (unpublished). It is imperative from the study that application of remote sensing is an easier and more efficient viable tool in generating a rubber distribution map of any given area at a given level of scale.

Fig. 2 showed the soil map of the study area extracted from already prepared soil maps of the traditional rubber growing areas (NBSS&LUP, 1999). Various soil series associations were identified in the study area the details of which are given in Table 1. It could be seen that the soil series associations were of different combinations and proportions of soil series identified. Soil series 'Agl' and 'Ipr' were Ustic Palehumults, while 'Tvr', 'Cvl', 'Mnm' and 'Tkd' were Ustic Kanhaplohumults. The soil series 'Lah' also was

Ustic Kanhaplohumults but with clayey texture. The other series namely 'Ktd', 'Knm' and 'Tpl' were Ustic Haplohumults and 'Kpl' was Ustic Kandihumults. Though the soil series 'Plg' and 'Vpm' also were Ustic Knadihumults, the texture was clayey in the control section. The soils of 'Tbm' and 'Kgl' series were Ustic Humitropepts (NBSS&LUP, 1999). A volume of literature is available on combined utilities of remote sensing and GIS in several fields. As far as utilization of these modern tools in rubber cultivation is concerned, separation of soils under rubber from non-rubber areas was reported by Rao (2001) using both remote sensing and GIS techniques to know more precisely the soils supporting rubber. Technically it is possible to develop some other themes like distribution of rubber clones that vary in spectral reflectance, maps of diseases of rubber etc and to bring these themes into GIS environment not only for preparation of maps but also for spatial analysis.

The digital elevation model of the study area is shown in the Fig. 3. The terrain could be visualized with the help of 3D projection. In addition of this, 3DEM also has the capability of showing flying model of the terrain. Fig. 4 showed the classified image draped on the DEM, which gave different land covers with their elevation information. Similarly, Fig. 5 indicated the draped soil map on 3D image of the area showing different types of soils (shown table 1) in the study area in third dimension also. Three-dimensional view of terrain is a modern tool, which can be used in landscape management showing the topography in maps. In the past, three-dimensional maps were laboriously constructed for many other purposes.

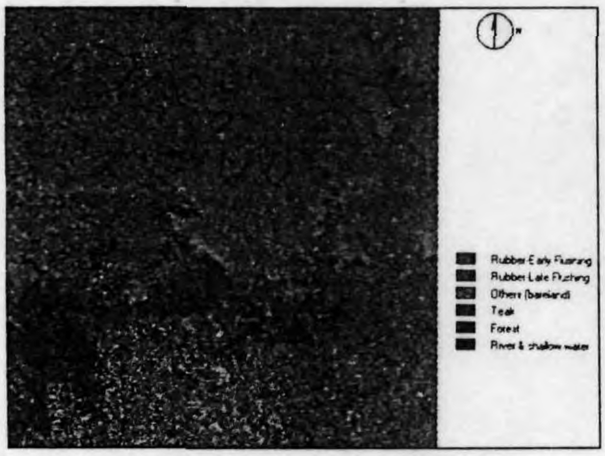

Fig. 1. Classified image of Cheruvally Estate Area

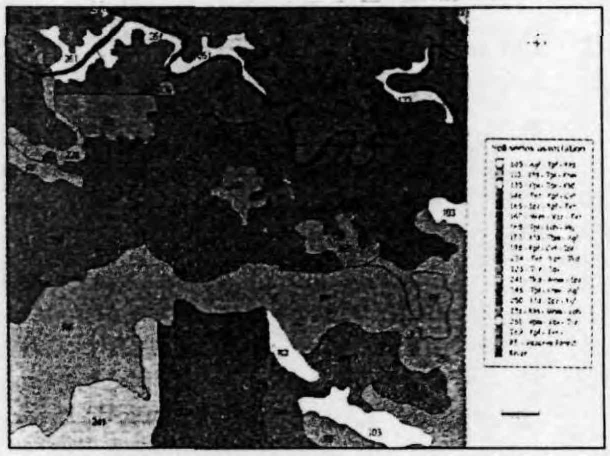

Fig. 2. Soil map of Cheruvally Estate Area

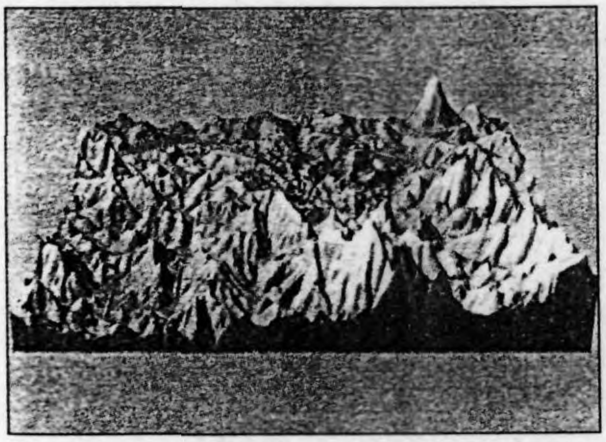

Fig. 3. Digital elevation model of Cheruvally Estate Area

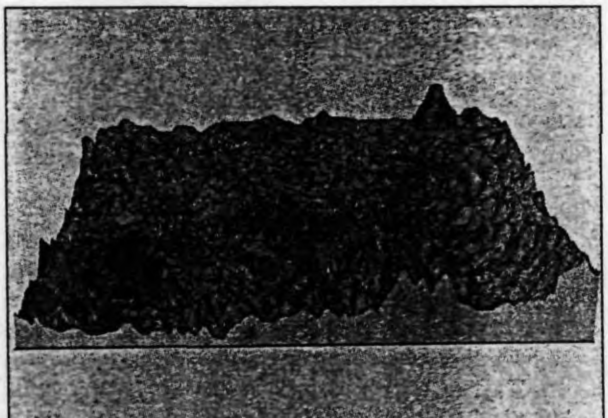

Fig. 4. Classified image draped on DEM of Cheruvally Estate Area

Table 1. Soils in the study area

Map symbol	Soil series association	Description
103	Agl-Tpl-Ktd (slope 25-33%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Palehumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults
113	Ktd-Tpl-Knm (slope 25-33%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults
133	Kpl-Tpl-Ktd (slope 15-25%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults
146	Tvr-Kpl-Cvl (slope 15-25%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults
166	Ipr-Kpl-Tvr (slope 15-25%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Palehumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults
167	Mnm-Tpl-Tvr (slope 15-25%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults
168c	Tpl-Lah-Plg (slope 15-25%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey, kaolinitic, isohyperthermic, Ustic Kanhaplohumults - Clayey, kaolinitic, isohyperthermic, Ustic Kandihumults
173	Ktd-Tbm-Agl (slope 15-25%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Loamy-skeletal, kaolinitic, isohyperthermic Ustic Humitropepts - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Palehumults
198	Kpl-Cvl-Ipr (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic kanhaplohumults
224	Tvr-Vzr-Tkd (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults
226	Tvr-Tpl (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults
241	Tkd-Mnm-Ipr (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults

Map symbol	Soil series association	Description
246	Tpl-Knm-Agl (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Palehumults
250	Ktd-Ipr-Kgl (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Loamy-skeletal, kaolinitic, isohyperthermic Ustic Humitropepts
251	Ktd-Mnm-Lah (slope 10-15%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Haplohumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults - Clayey, kaolinitic, isohyperthermic, Ustic Kanhaplohumults
261	Vpm-Kpl-Tvr (slope 5-10%)	Clayey, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults
269	Kpl-Tvr (slope 5-10%)	Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kandihumults - Clayey-skeletal, kaolinitic, isohyperthermic Ustic Kanhaplohumults

Agl = Angle Valley; Tpl = Tulappally; Ktd = Koruthode; Knm = Kunnam; Kanjirappally; Tvr = Thiruvanchoor; Cvl = Cheruvally; Ipr = Ittiyappara; Mnm = Manimala; Lah = Lahai; Tbm = Thombikandom; Vzr = Vazhoor; Tkd = Thambalakkad; Kgl = Kottangal; Vpm = Vijayapuram

But with the advent of computer technology, creation of 3D image is made easy once the elevation data is available. This approach is employed in most GIS and terrain visualization software and 3DEM is such a programme. This three dimensional visualization has got definite advantages in plantation management activities. The possible applications of DEM include planning of plating terraces, computation of site yield potentials, production of soil erosion risk map etc. Tey *et al.*, (2000) discussed about the attempts to improve planting and development in hilly terrain and implementation of fieldwork through the use of DEM.

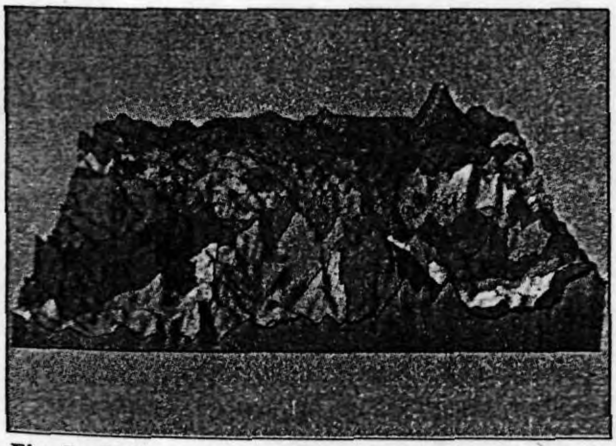

Fig. 5. Soil map draped on DEM of Cheruvally Estate Area

CONCLUSIONS

It is seen practically that the available technology helps both development and management of a database on aspects related not only to rubber cultivation but also to any aspect of interest linked to rubber and geography leading to an integrated Rubber Information System (RIS). Combined utilization of remote sensing and GIS technologies surely helps in development and updating of the database. It is needless to state the importance of a database in research and in planning to keep the rubber plantation industry viable since the management is dependent on facts but not fancies. It is time to use modern technological tools for effective information system.

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