Digitizing the Forest Resource Map Using ArcGIS

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Abstract

The major challenges we face in the real world today is overpopulation, pollution, deforestation, natural disasters which have a critical geographic dimension and also have a geographical component. Geographical Decision Support System (Geo-DSS) is a demanding field, since enormous amount of spatial data have been collected in various applications, ranging form Remote Sensing to GIS, Computer Cartography, Environmental Assessment and Planning. Although some efforts were made to combine spatial mining with Spatial Decision Support System but mostly researchers are using a spatial database for popular data mining approach. GIS will give you the power to create maps, integrate information, visualize scenarios, solve complicated problems, present powerful ideas, and develop effective solutions like never before so that it supports strategic decision making. With GIS application we can open digital maps on computer, create new spatial information to add to a map, create printed maps customized to our needs and perform spatial analysis on it. There is a great deal of geographic data available in formats that can not be immediately integrated with other GIS data. In order to use these types of data in GIS it is necessary to align it with existing geographically referenced data. This process is also called georeferencing. Georeferencing is a necessary step in the digitizing process. Digitizing in GIS is the process of "tracing", in a geographically correct way, information from images/maps. In this paper the processing of digitizing the forest map and the converting the georeferenced map into attribute data is depicted which can be further used to construct spatial database and on which spatial analysis can be performed.

Keywords – *ArcGIS* – *Desktop, Digitization, Georeferencing, Spatial Attributes, Attribute Table.*

1. Introduction

Data acquisition and data storage technology progress has led to a huge amount of data stored in repositories, which grow faster. Among increasing and relevant data acquired and processed, there is a strategic segment: satellite images, also known as Remote sensing images. The search for less expensive and more efficient ways to observe earth, motivated man in developing Remote Sensing satellites. The Remote Sensing image based databases are the fastest growing archives of spatial information. The variety of spatial and spectral resolutions for a Remote Sensing images range from IKONOS 1-meter panchromatic images to the next generation of polar-metric radar imagery satellites. There is a need for understanding relevant data and use it effectively and efficiently in earth analysis. Although valuable information is contained in image repositories, the volume and complexity of this data makes difficult (generally impossible) for human being to extract strategic information (knowledge) without appropriate tools (Piatetsky-Shapiro, Djeraba, Getoor, Grossman, Feldman & Zaki, 2006). The availability of huge Remote Sensing image repositories demands appropriate resources to explore this data.

A vast Remote Sensing database is a collection of landscape snapshots, which supplies a single opportunity to understand how, when and where changes occurred in the world. The first operational remote sensing satellite (LANDSAT-1) was launched in the year1972. According to Canada Centre for Remote Sensing (2003), Remote Sensing is the science (and to some extent, art) of acquiring information about the Earth surface without actually being in contact with it. Remote Sensing is a field of applied sciences for information acquisition of the Earth surface through devices called Remote Sensors, which are boarded

on Remote Sensing aircrafts or satellites—also called Earth observation satellites.

In the image acquisition process, four concepts are fundamental: spatial, spectral, radiometric and temporal resolution. The spatial resolution defines the detail level of an image. The spectral resolution determines the sensor capability to define short intervals of wavelength. The radiometric resolution of an imaging system describes its ability to discriminate very slight differences in energy. The temporal resolution determines the necessary time for the sensor revisit a specific target and image the exact same area (Canada Centre for Remote Sensing, 2003). These huge volumes of the datasets need an efficient hardware and software infrastructure. However, still a limited capacity is available for extracting information from large remote sensing image databases. Currently, most image processing techniques are designed to operate on a single image. This situation has lead to a "knowledge gap" in the process of deriving information from images and digital maps (MacDonald, 2002). There are number of studies that shown the overlapping of various map to obtain the required information. The main aim of this paper is to depict the process of digitizing the forest resource map and convert it in to attribute data. The converted attribute data can be stored in to a database tables for future work.

2. Methodology

In this paper an implementation procedure for the construction of a spatial attribute table from scratch by digitizing the forest area map and generating topologically corrected data set is derived. You are given a scanned map of forest area of AP. At first, taking the scanned map as a base map, you will digitize using ArcCatalog, and save the digitized data into attribute tables. The methodology for the above said task is depicted in the following sub sections.

2.1 Data Collection

As the main aim of this paper is to depict the process of digitizing the forest resource map and convert it in to attribute data, the data collection phase derives data from various sources. The data are collected from divisional forest office, district land and land reform office etc. The maps may also be acquired from the FSI, NRSC and Google Earth.

2.2. Data Preprocessing

Results from this project suggest that the use of digital image processing in conjunction with editing,

georeferencing and spatial analysis in a Geographic Information System is an effective mean of quantifying deforestation, and that the use of high resolution LANDSAT data may in fact yield much better precision than AVHRR-based analyses. The use of digital preprocessing with visual post-processing greatly reduces analysis time over that of hand digitizing of a photographic product and greatly reduces the confusion of classes associated with purely digital processing techniques.

2.3. Data Editing

This stage can further be subdivided into various sub stages, like Software: In this study the used software packages are ArcGIS Desktop.

ArcGIS

ArcGIS is an integrated collection of GIS software products for building a complete GIS. It consists of a number of frameworks for deploying GIS:

- ArcGIS Desktop—an integrated suite of professional GIS applications
- ArcGIS Engine—embeddable developer components for building custom GIS applications
- Server GIS—ArcSDE®, ArcIMS, and ArcGIS Server
- Mobile GIS—ArcPad as well as ArcGIS Desktop

DESKTOP GIS

Desktop GIS is the primary seat from which GIS professionals compile, author, and use geographic information and knowledge. ArcGIS Desktop is an integrated suite of advanced GIS applications. It includes a series of Windows desktop applications—ArcMap, ArcCatalog, ArcToolbox, and ArcGlobe—with user interface components. Using these applications and interfaces in union, you can perform any GIS task, simple to advanced, including mapping, geographic analysis, data editing and compilation, data management, visualization, and geoprocessing. ArcGIS Desktop is scalable to meet the needs of many types of users. It is available at three functional levels:

- ArcView focuses on comprehensive data use, mapping, and analysis.
- ArcEditor adds advanced geographic editing and data creation
- ArcInfo is a complete, professional GIS desktop, containing comprehensive GIS functionality, including rich geoprocessing tools.

DIGITIZATION

Digitizing is the process of converting features on a paper map into digital format. You can use a digitizer in conjunction with the editing tools in ArcMap to create new features or edit existing features on a digital map. Digitization is process of making an electronic version of a real world object or event, enabling the object to be stored, displayed and manipulated on a computer, and disseminated over networks and/or the www. But before digitization, the map must be georeferenced.

GEOREFERENCING

There is a great deal of geographic data available in formats that can not be immediately integrated with other GIS data. In order to use these types of data in GIS it is necessary to align it with existing geographically referenced data, called georeferencing. The process of georeferencing relies on the coordination of points on the scanned image (data to be georeferenced) with points on a geographically referenced data (data to which the image will be georeferenced). By "linking" points on the image with those same locations in the geographically referenced data you will create a polynomial transformation that converts the location of the entire image to the correct geographic location. We can call the linked points on each data layer as control points. The selection of control points is important.

DATA

A .jpg file format can be used as data for georeferencing, which contains Andhra Pradesh forest map. After performing georeferencing, the file is saved as .mxd format.

GEOREFERENCING/REGISTERING AN IMAGE – PROCEDURE

- The Primary tool used is the georeferencing toolbar.
- Add the APforest.jpg file.
- Right click the file (not image) and "Zoom to Layer".
- From the georeferencing toolbar, click the "Layer" dropdown arrow and select the APforest.jpg image name.
- Click "Georeference" and select "Fit to display" from the dropdown.
- Now, it is ready to add control points. Click on the control point's tool.

- You should be using the clipped data for linking, and use the labels too.
- To add a link, click the mouse on the image first, then on a known location on the GIS database.
- Once you've added a few links you can open the link table to see how each has worked.
- In the link table you can view the Total RMS Error as well as the residual for each link that contributes to the overall total control points. The errors are associated with the amount of disagreement between the two control points for each link once the transformation is set.
- You have to be sure that the two points that are linked are the someplace in world, as you could have a very low error and residuals but not have an accurately registered image.
- Once you are satisfied with the registration, and you can delete links or start all over by deleting them all, you can Update Georeferencing, this will save your transformation.
- This process will add a.aux file that contains information about the transformation that is necessary to view this file in the future with other data.
- Save your map as "apf1.mxd".

DIGITIZING FEATURES

Digitizing is the process of making features. We can see on the AP forest image editable and making them features to which additional spatial and non-spatial attributes can be assigned. This means we are going to follow a process of making digital versions of objects that will have an attribute table with them. Once they are digitized and have an associated attribute table these objects will also be known as polygon features. By digitizing these features you make them available for mapping once you have added the tabular data to the attributed table. The digitizing process is started by creating new layers in ArcCatalog, and then adding features in ArcMap.

CREATION OF NEW LAYER BY CLIPPING

- Open the layer (AP forest map).
- Open Arc Toolbox (red toolbox on menu) and open Analysis Tools, then Extract. Choose the clip tool.
- The input feature is the forest map.
- The clip feature is the AP forest map.
- The output class should go somewhere you can find it and be named something you will recognize.

- Left the cluster tolerances as it is and Click OK.
- Add the new layer and remove the original map layer.

CREATING AN EMPTY SHAPE FILE

In ArcCatalog, browse to the location of your current .mxd file. This is the folder in which you will create your new shape file, so select that folder and right-click on it. Go to New and select shapefile and give an appropriate name such as Area. Click on Edit to see the coordinate system of the file. In the Spatial Reference Properties window click Import to use the projection of the AP forest layer. Click OK and OK again to create the shapefile.

ADD A NEW FILED IN THE ATTRIBUTE TABLE

Return to ArcMap, and add your new shapefile to the Data frame (TOC). If you open the Attribute Tables of this shapefile you will find it empty. Now you will start working with the new shapefile. Before you start editing, first open its Attribute table. Click on the Options Button and click on Add Field. First create a Short Integer (choose in the Type drop-down menu) field called Area where the area number identifier will be entered. Note that you cannot create new fields while you are editing a layer.

DIGITIZING AREAS AND ENTERING TABULAR DATA

You will need the Editor Toolbar. Select View then select Toolbars and then select Editor. On the toolbar, click on the Editor Menu and Start Editing. You will be prompted to choose the folder that your shapefiles are in, and then click OK. Before you get started creating polygons, turn off all but the registered forest image layer.

In the Editor Toolbar, start Editing. Choose Area (whatever you named it), layer as the layer you want to edit. In the Editor Toolbar, Create New Feature. You are going to create a polygon for maps. From the pull down menu next to the editor pull down choose the sketch tool. By clicking at the four corners (Single clicks) of the area you are digitizing you will create a continuous outline of it. Double clicking when you get back to where you started you will finish Sketch. This should make your polygon become an actual, filled polygon. You can digitize 3-5 area boundaries and enter corresponding area ID numbers into the AREA field in the attribute table. Now that you have digitized a few polygons in ArcGIS you have acquired the skills to create editable features from scanned maps that can be linked with tabular data. If you are interested you can do a number of things to extend what you have learned.

DATABASE CONSTRUCTION PROCEDURE

Part B, of this project is intended to instruct you on how to integrate the Microsoft Access into Arc View using the Andhra Pradesh environmental sampling data as an example. Then it list the procedure for how to set up the link between Access and Arc View, by which you can use Access to store and manage the environmental sampling data, and use Arc View to display and analyze the subset data of interest.

3. Review of Literature

In Analyzing deforestation rates, spatial forest cover changes and identifying critical areas of forest cover changes in North-East India during 1972–1999,by Nikhil Lele · P. K. Joshi - The objective of this paper is to depict forest cover change (namely deforestation) processes occurring in North-East India, with the aid of geographic information system (GIS). The results are aimed at understanding how GIS methods can provide rapid and precise outputs that may help to improve conservation policies and land use-planning strategies. The temporal forest cover datasets were acquired from the available sources. NRSA, India made use of satellite datasets and mapped forest cover of India in 1972; followed by a second time mapping in 1982. This mapping was carried out at a coarse scale of 1:1M, using Landsat datasets. The maps were thus converted into digital database and imported into geospatial environment using ERDAS Imagine 8.7 and ArcGIS 8.3. In Monitoring and Mapping India's Forest and Tree Cover through Remote Sensing, by J. K. Rawata, Alok Saxenab and Saibal Dasguptac - In its latest assessment of 2001, taking advantage of advancements in remote sensing and improvement in digital interpretation qualities, FSI has provided a much more comprehensive status of forest cover in the country. In Detecting Tropical Deforestation Using Satellite Radar Data, by Belinda Arunarwati and Yousif Ali Hussin - The main objectives of this research were to investigate the potential of satellite radar data for detecting, differentiating and classifying deforestation in the forest concession area which has been selectively logged by PT Sylva Gama, Jambi, Central Sumatra, Indonesia. The following satellite images were used for this research project: Landsat-5 TM data of September 15, 1993, Spot XS data of March 21, 1993, ERS-1 images of October 17, 1993, June 6, 1994, and July 7, 1994, and JERS-1 of August 16, 1993.

4. Conclusions

The power of a GIS as an aid in spatial data analysis lies in its geo-relational Database structure, i.e., in the Combination of value information and location

information. The link between these two allows for the fast computation of various Characteristics of the spatial arrangement of the data, such as the contiguity structure between observations, which are essential inputs into spatial data analysis. The GIS also provides a flexible means to "create new data," i.e., to transform data between different spatial Scales of observation, and to carry out aggregation, partitioning, interpolation, overlay and buffering operations.

Andhra Pradesh has experienced a combination of land cover changes such as deforestation and afforestation since past 30 years. For any spatial analysis, the Pre-dominant step is Digitization. So in this process, digitizing the map features of Andhra Pradesh by using GIS software called ArcGIS is depicted. By digitizing the map, it is clear and make easy for performing spatial analysis. The result of Digitization is more accurate and provides more information than Digitizing Tablet. In further enhancement, this work can also be carried out by any other digitizing software like GRASS, Enguage Digitizer etc. This work also proceeds by classification to get clearer classified digitization map.

The main aim of this paper is to depict the process of digitizing and converting the forest resource map in to attribute data. The converted attribute data is stored in to a database for future analysis which can be achieved in future work.

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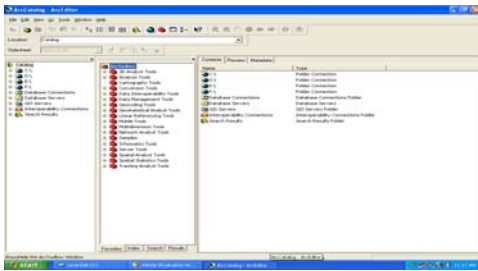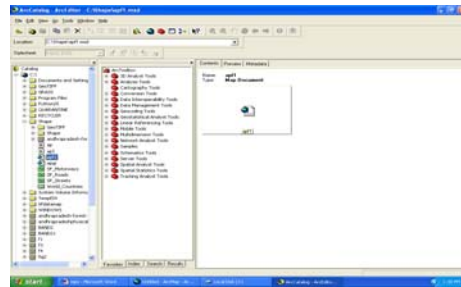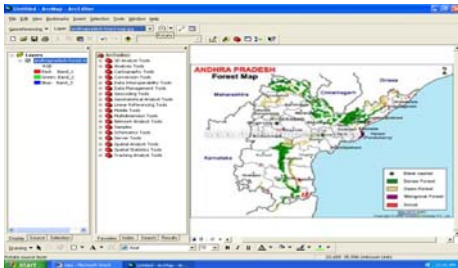
Annexure

Fig. 1 Arc Editor Window

Fig. 2 Importing the map for Georeferencing

Fig. 3 Physical Map of Andhra Pradesh

Fig. 4 Viewing the Link Table

Fig. 5 Arc Catalog Window
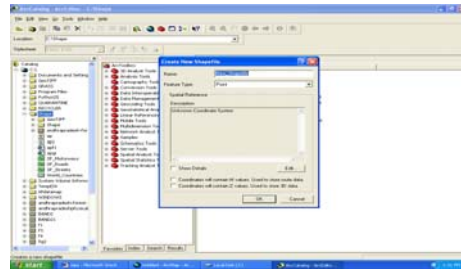
Fig. 6 Viewing an .mxd file format
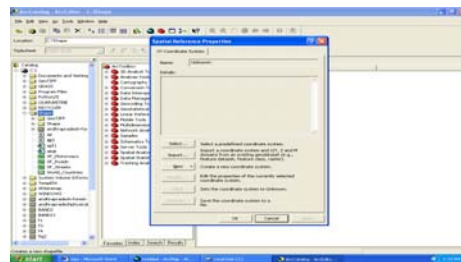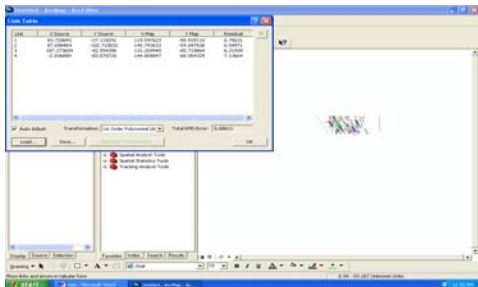

Fig. 7 Creation of Shapefile
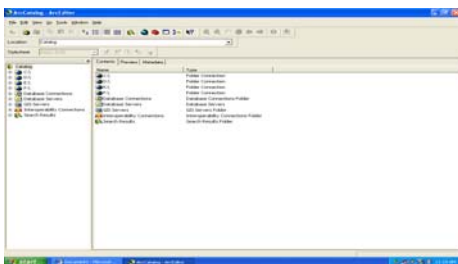

Fig. 8 Spatial Reference Properties Window

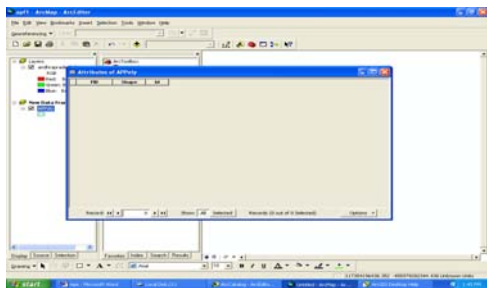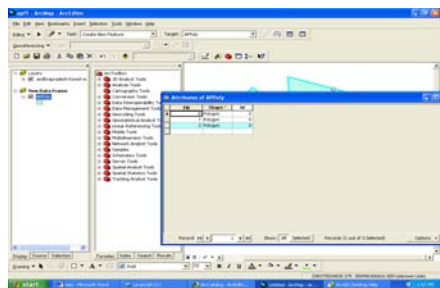Fig. 9 Viewing the Shapefile in an Arc Catalog

Fig. 10 Attributes of Shapefile

Fig. 11 Values of Attributes of Shapefile