GRAM++ - An Indian GIS Suite With Decision Support Applications

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Abstract: GRAM++ is a collection of software packages for geographic information system (GIS) applications, developed indigenously at the Centre of Studies in Resources Engineering (CSRE), Indian Institute of Technology (IIT), Bombay. This software is now being used for a number of GIS applications that assist decision makers in taking informed decisions. Some of these applications include simulation of the spatial impact of raising height of dam and assessment of the costs and benefits; identifying sites suitable for inland aquaculture and validation with existing sites; developing resource profiles and computation of human development indices for prioritized development; land suitability analysis for agriculture applications.
Keywords: GIS, Resources Management, Decision Support

1. Introduction

CSRE, IIT Bombay developed an indigenous GIS software suite known by the name GRAM++ (Geo-Referenced Area Management) that includes GRAM++ 1.0 Runtime GIS, VecViewer – a desktop mapping tool, GRAMTools – a toolkit software development, RAK – customized raster GIS subsystem for spatial modeling; DPT – customized vector GIS subsystem for spatial database creation supporting import/export between popular GIS formats, onscreen map digitization, interactive and automatic error removal, topology creation, polygon labeling and attribute database linking [1]. This GIS suite is supported by a generic multimedia GIS Tutor [2] to assist self-study of the concepts of GIS and a second tutor to train novice users on operation of the GRAM++ software. This activity was supported through a grant from UNDP, India and Department of Science and Technology under the Ministry of Science and Technology, Government of India.

2. Motivation

India being a vast country has hundreds of districts divided into thousands of blocks and hundreds of thousands of villages. In the absence of proper tools for generating spatial profiles of the administrative units, resource utilization is often skewed or unplanned and does not fully meet the local requirements. Through Constitutional amendments, Indian Parliament has created a framework for local self-governance through people's representatives. GIS is considered as an important tool in this process so that the presence and absence of resources and local needs can be spatially assessed, leading in the long run to a convergence of services and resource utilization schemes.

3. Design of Indigenous GIS

The design of GRAM++ emerged by exploring a number of Windows based GIS packages that are moderately priced. The criteria for comparison included functionality, ease of use, self-learning tools, sample data sets, help and documentation. Based on this study the basic functionality of GRAM++ was arrived at, as described below.

1) Functionality of GRAM++

The software supports both raster and vector functions including:

1. Data Preparation Tools (Import/Export, Map Edit)
2. Query
3. Spatial Analysis
   - Raster analysis including image analysis
   - Statistical analysis
   - Network analysis

4. Terrain modeling [3]
- Spatial interpolation in raster
- TIN Watershed delineation
- Visibility and Profiling

5. Layout
- Vector layouts
- Raster layouts
- Superimposition of map grid, and placing North-Arrow, legends, scale bar, Titles etc.

6. Sample datasets
7. Online help

A screen shot of the software is seen in Fig. 1.

2) Additional Packages

To supplement and complement the full runtime GIS, several additional packages are developed including:

1. VecViewer – supports display, query and desktop mapping [4]
2. GRAMTools – Collection of ActiveX controls capturing the functionality of GRAM++ for building applications in simple environments such as Visual Basic and C++
3. GIS Tutor – A CD-ROM based self-learning GIS tutor to enable new entrants to the field get the basic concepts and an overview
4. RAK – Raster analysis kit that is a customized subset of GRAM++ with all the raster functionality to enable spatial modelers implement various models using natural resources and environmental data. This package consists of raster analysis, terrain modeling, image processing, import/export and raster layout facilities and is self-contained.
5. DPT – Data Preparation Toolkit that is a customized subset of GRAM++ with all the needed functionality for preparing the spatial databases. This package supports import/export, onscreen map digitization, map edit, display and layout facilities

In order to facilitate new users to rapidly get familiar with the software, a multimedia tutor on GRAM++ is in preparation. This tutor is intended to help users understand the installation, and operations of all the modules and the functions contained therein. It is envisaged that the generic GIS Tutor, GRAM++ software tutor, and the GRAM++ Suite to evolve long term training courses on GIS including distance education through internet equivalent to a Masters level course on the principles and applications of GIS. The software is so far used to train a few hundred users in India on GIS applications.

In order to help the users evaluate the software, sample datasets are provided that can be used to execute every function supported in the packages. The software also contains a detailed context sensitive help that assists in running the software without external assistance.

4. Applications

The GRAM++ GIS suite has been employed in a number of applications including simulations, temporal change monitoring, crop suitability studies, site selection for inland aquaculture, generation of village-wise rural spatial and socio-economic resource profile for assessment of human development etc. Some of these applications are briefly described below:

1) Raising height of dam

Government of Maharashtra in western part of India planned to raise the height of Barvi dam near Mumbai city to increase water supply to the city. Using GRAM++ a simulation was carried out on the impact of raising the height of the dam by 2 metres to 9 metres. At each height the spatial impact is estimated in terms of new submergence of agricultural land, settlements, forest land and open areas vis-à-vis the increase in the capacity of the reservoir. This study helped the Government in making the decision to raise the dam height by about 5 metres wherein the gain in the capacity of the reservoir was sufficiently high and the displacement of the villagers was within manageable limits.

2) Site selection for inland aquaculture

A study was carried out jointly with the Central Institute for Fisheries Education (CIFE), Mumbai using the raster component of GRAM++ for identifying sites suitable for inland aquaculture near the Thane creek north of Mumbai city. A number of engineering parameters, social constraints, landuse/landcover and other layers of information were utilized for this purpose and several sites were identified. The study was validated by the fact that some of the identified sites were already in use for inland aquaculture. Encouraged by this study, CIFE is setting up a GIS laboratory around GRAM++ for their projects and student training.

3) Crop suitability analysis

In parts of the Karnataka state in Southern India shortage of water is a problem. A study was carried out jointly with an academic institute from Bijapur district on the suitability of crops in a sample village under the given conditions of soil, water, and other conditions. Several crops are identified in decreasing order of suitability for the village Kowlagi. This study utilized the GRAMTools to develop a custom application embedding the GIS functionality of GRAM++.

4) Human resource index generation [5]

Many areas of the Madhya Pradesh state in Central India are quite backward in terms of economic development, literacy etc. In order to assist the decision makers to get a

detailed picture of the existing conditions, a detailed spatial resource profile and the associated socio-econimic conditions were built up, jointly with Regional Research Laboratories, Bhopal, using the DPT module of the GRAM++ suite. This project was funded by the UNDP. The study area included several thousand villages spread across ten blocks in Madhya Pradesh and the adjoining state of Chattisgarh. Using the spatial resource profile, a human resource development index is generated for each village that ranks them according to the level of their development relative to each other. The resource development index is computed as a function of three indices – human capital index, agro-ecological index and socio-economic index. The spatial resource profile, and the resource development index are currently being used to identify the villages that need immediate attention and improve the income generation potential of the village using the locally available resources.

5) Monitoring temporal urban growth

A temporal growth profile of a city can be used by the city planners to monitor and predict future growth of a city. Based on the spatial data collected from a number of sources covering the period 1926 – 1992, the increase in urbanization of Mumbai city was mapped as a series of layers using GRAM++. The study revealed the explosive growth of the island city and the increase of the suburbs particularly after the 1960's. The study showed that a large part of the open areas are now completely converted to built-up areas. Related studies include the mapping of urban pollution, and the density of population in different parts of the city using GIS.

5. Future Directions

The future directions for GRAM++ GIS Suite include providing GPS support for online tracking of vehicles, navigation, building custom spatial decision support systems embedding fuzzy logic, neural networks, and object oriented processing of high resolution earth resources satellite images. The GIS tutor is being expanded into a full fledged online GIS course comparable to a postgraduate level course offered in the Universities. Some of the other plans for the future include providing a geo-gateway for handling most of the current GIS formats enabling greater interoperability, and building spatial data mining functionality around GRAM++.

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References

[1]   P. Venkatachalam and B. Krishna Mohan, 2002, GRAM++ - An Indigenous GIS Suite, *Proc. Conference on IT Enabled Spatial Data Services*, Bharatidasan University, Trichy, India.

[2]   P. Venkatachalam and B. Krishna Mohan, 2000, Teaching GIS Through a Multimedia GIS Tutor, *Proc. ASPRS Symposium on Remote Sensing and GIS,* Washington D.C.

[3]   P. Venkatachalam, B. Krishna Mohan, Amit Kotwal, Vikas Mishra, V. Muthukrishnan and Mayur Pandya, 2001, Automatic Delineation of Watersheds for Hydrological Applications, *Proc. Asian Conference on Remote Sensing,* Singapore, vol. 1, pp. 1096-1101.

[4]   P.Venkatachalam, B.Krishna Mohan, M. Farooque and Amit Kotwal, 2001, GRAM++ Viewer - A User Friendly Tool for Spatial Planning, Presented in the *National Symposium on Recent Advances in Remote Sensing and Geographic Information Systems for Natural Resources Management*, Indian Institute of Technology, Bombay, India.

[5] URL: M.V.R.L.Murthy, P.Venkatachalam, B. Krishna Mohan and J.K.Suri, 2002, A Rural Land Information System for Generation of Human Development Index, *Proc. Of International Conference MAPASIA 2002, Bangkok* Available at: http://www.gisdevelopment.net/application/lis/overview/lisrp025.htm