18BGE66S - Fundamentals of GIS

[Syllabus Unit V:-. Application of GIS – Agriculture –Environment- Urban - Disaster – Water Resources.]

Application of GIS in Agriculture

The various types of mapping provided by RS required by GIS to be useful for agriculture are: •

- soil type mapping.
- crop coverage mapping.
- rivers/ distributaries mapping.
- land use mapping .
- contour mapping.
- irrigation system mapping.
- meteorological mapping

Soil type mapping
For planning of agriculture on a broad scale it is extremely important to know different types of soils, type of crops they can support and areas having the type of soil. This information if used effectively can greatly improve the agricultural output and its quality.
Some attributes of soils are: humus content, nutrient content, name etc.

Crop coverage mapping
Maps indicating crop coverage are very useful in estimating the yield of various crops. These also help in analyzing existing methods of agriculture such as crop rotation, terracing etc. In order to bring forth any improvements, it is important to study the existing trends and methodologies.

Some attributes of crops are: suitable season/ climatic conditions, water requirements, manure/ fertilizer requirements, total time for sowing reaping and harvesting etc.

Rivers/ distributaries mapping
These maps show the geographical location of the different river and distributaries systems in and around an area. Knowing his is helpful in locating nearest source of water and designing of most economical canal systems. • Attributes: name, volume, depth, width etc

Land use mapping
These maps give information about how the land is already being used. It helps in analyzing how effectively the land resources are being used and in coming up with more economical suggestions for the same in addition to keeping updated records used for various other calculations. • Attributes: kind of usage, total forest coverage, total agricultural output of an area, estimated urbanization of an area etc

Contour mapping

These maps show the elevation data of the various geographical features on the earth's surface. This information helps us in estimating important data such as the most economical laying of canals considering cost of excavation and leveling etc.

Irrigation system mapping
This kind of mapping deals with details of older or existing systems such as dams and canals. Study of this information helps in estimating how efficiently the systems work and on its basis determine the extension projects and maintenance programs.
Attributes: length of systems, efficiency details, areas served, volume of water carried, benefits etc
Meteorological mapping
Rainfall patterns, climatic conditions, seasonal changes and predictions are the areas dealt with under this kind of mapping. This is important information required by famers and agriculturists to plan the type of farming most suitable and economical. It also helps in estimating how much water is to be let out into the canal systems in accordance to the predictions of the rainfall intensities.

Identification, area estimation and monitoring:
Identification, estimation of growing stock, analysis of distribution and monitoring at regular intervals are major aspects in plantation crops. he specialized management practices make the distribution of plantation crops rather more localized in comparison to other agricultural crops.

Crop condition assessment
The physiological changes that occur in a plant due to stress may change the spectral reflectance/ remittance characteristics resulting in the detection of stress amenable to remote sensing techniques
Crop monitoring at regular intervals during the crop growth cycle is essential to take appropriate measures and to asses information on probable loss of production.

Crop yield modeling and production forecasting:
The information on production of crops before the harvest is very vital to the national food policy planning and economy of the country.
Reliable crop yield estimate is one of the most important components of crop production forecasting.

Agricultural draught assessment
Draught assessment is yet another area where in remote sensing data has been used at operational level.
The district level drought assessment and monitoring

Reflectance modeling
Physical reflectance models for crops serve the important purpose of understanding the complex interaction between solar radiation and plant canopies.
In order to obtain a reliable yield prediction, growth of crops has to be modeled by means of crop growth models.
Crop growth models describe the relation between physiological process in plants and environmental factors such as solar irradiation, temperature, water and nutrient availability.

The GIS Applications on Disaster/ Emergency Services

Emergency command and rescue strongly relies on the spatial information. Staffs need to know the rescue facilities and resources available, for example, the position of the rescued, surrounding environment and rescue resources. The application of emergency system based on the GIS will greatly reinforce the accuracy and response thus winning the time for rescue. The GIS auxiliary pre-plan system can also guide the rescue. The applications of GIS in rescue will be discussed in the following sections.

Positioning of Public Emergent Events

When tackling a public emergent event, we normally need to display the corresponding address of the event on the electronic map. In order to display a stated data record (address string) on the electronic map, the system needs to assign geographic coordinates to that record, which is called address coding. The standard address database has stored standard address codes, including the coding table and total address table. When the address string is entered, the first thing to do is to split the address string. And for the successfully split string, the system undertakes matching in the address code database, and finally matches the coordinates and marks on the electronic map, thus completes the address positioning.

Surrounding Environment Searching

For general police alarm tackling interface, the police force distribution and police alarms distribution should be displayed on it by a customized period. When a police alarm comes, the system can refresh the electronic map immediately and show just the distribution status of the rescue resources nearby like patrol cars, police boxes, police force, and hospitals. Then commanding persons can dispatch relevant resources in accordance with the display information, by voice or message. The system can also analyze and give optimized and shortest route instruction for rescue.

GPS Real-time Tracking

GPS real-time tracking means utilization of vehicle GPS or handset GPS to send the positioning message to the surveillance centre by GSM wireless network. The surveillance centre, after receiving positioning coordinate information, marks the locations of mobile police force on the electronic map. GPS/GSM system consists of three parts: GPS Section (including the GPS constellation, GPS receiver), GSM communication part (including the communication controller, GSM transmission module, GSM network and the corresponding part of cable transmission) and GIS processing part (including hardware servers, software, electronic maps, databases, systems, etc.).

Video Surveillance

Video surveillance camera information is also available on the electronic map, for example, the positioning of individual camera, or its parameter. What's more, the real-time or history video record can be obtained by the interface opened. And the commanding person can control the camera by the customer end.

Emergency Response Pre-plan

Pre-plan is a pre-arrangement aiming at tackling possible emergent events. It is a critical part of emergency management system. When undertaking real-time command or rehearsal, mere way of text communication is obviously insufficient. The pre-plan system shall be visualized so that the orders and other information can be passed down and exchanged in a lucid way. The application of GIS into the pre-plan system is a perfect solution.

Any rescue management system will involve-
Locating the sites accurately in the least permissible time
Reduces the critical time element involved in the activities
Accurate data about the resource available at the place of interest
Accessibility of information between source and destination
Correct means of alarming the resources
Real time visualization of the area of interest

GIS in Environment

It is a computer system that collects, analyzes, stores and disseminates geographic information for use by different entities to facilitate informed and smooth decision making. GIS has important uses in different fields, including in the environmental field. Below is some of the importance of GIS in environment.

1. Environmental Impact Analysis (EIA)
EIA is an important policy initiative to conserve natural resources and environment. Many human activities produce potential adverse environmental effects which include the construction and operation of highways, rail roads, pipelines, airports, radioactive waste disposal and more. Environmental impact statements are usually required to contain specific information on the magnitude and characteristics of environmental impact. The EIA can be carried out efficiently by the help of GIS, by integrating various GIS layers, assessment of natural features can be performed.

2. Disaster Management
Today a well-developed GIS systems are used to protect the environment. It has become an integrated, well developed and successful tool in disaster management and mitigation. GIS can help with risk management and analysis by displaying which areas are likely to be prone to natural or man-made disasters. When such disasters are identified, preventive measures can be developed.

3. Zoning of Landslides hazard
Landslide hazard zonation is the process of ranking different parts of an area according to the degrees of actual or potential hazard from landslides. The evaluation of landslide hazard is a complex task. It has become possible to efficiently collect, manipulate and integrate a variety of spatial data such as geological, structural, surface cover and slope characteristics of an area, which can be used for hazard zonation.

4. Determination of land cover and land use
Land cover means the feature that is covering the barren surface .Land use means the area in the surface utilized for particular use. The role of GIS technology in land use and land cover applications is that we can determine land use/land cover changes in the different areas. Also it can detect and estimate the changes in the land use/ land cover pattern within time. It enables to find out sudden changes in land use and land cover either by natural forces or by other activities like deforestation.

5. Estimation of flood damage

GIS helps to document the need for federal disaster relief funds, when appropriate and can be utilized by insurance agencies to assist in assessing monetary value of property loss. A local government need to map flooding risk areas for evaluate the flood potential level in the surrounding area. The damage can be well estimate and can be shown using digital maps.

6. Management of Natural Resources

By the help of GIS technology the agricultural, water and forest resources can be well maintain and manage. Foresters can easily monitor forest condition. Agricultural land includes managing crop yield, monitoring crop rotation, and more. Water is one of the most essential constituents of the environment. GIS is used to analyze geographic distribution of water resources. They are interrelated, i.e. forest cover reduces the storm water runoff and tree canopy stores approximately 215,000 tons carbon. GIS is also used in afforestation.

7. Soil Mapping

Soil mapping provides resource information about an area. It helps in understanding soil suitability for various land use activities. It is essential for preventing environmental deterioration associated with misuse of land. GIS Helps to identify soil types in an area and to delineate soil boundaries. It is used for the identification and classification of soil. Soil map is widely used by the farmers in developed countries to retain soil nutrients and earn maximum yield.

8. Wetland Mapping

Wetlands contribute to a healthy environment and retain water during dry periods, thus keeping the water table high and relatively stable. During the flooding they act to reduce flood levels and to trap suspended solids and attached nutrients. GIS provide options for wetland mapping and design projects for wetland conservation quickly with the help of GIS. Integration with Remote Sensing data helps to complete wetland mapping on various scale. We can create a wetland digital data bank with spices information using GIS.

9. Irrigation management

Water availability for irrigation purposes for any area is vital for crop production in that region. It needs to be properly and efficiently managed for the proper utilization of water.

10. Identification of Volcanic Hazard

Volcanic hazard to human life and environment include hot avalanches, hot particles gas clouds, lava flows and flooding. Potential volcanic hazard zone can be recognized by the characteristic historical records of volcanic activities, it can incorporate with GIS. Thus an impact assessment study on volcanic hazards deals with economic loss and loss of lives and property in densely populated areas.

GIS in Urban Planning

Resource Inventory

GIS platforms, especially those used in conjucion with remote sensors, decrease time spent collecting land-use and environmental information. With remote images, urban planners can detect current land use, as well as changes to land use for an entire urban area. These images can also be used to create compelling visualizations with 3D CAD models.

Creating Land-use Maps & Plans

Future land-use maps act as a community's guide to future infrastructure, build plans, and public spaces. These maps help ensure that a city's urban planning accounts for environmental conservation, pollution, mitigating transportation issues, and limiting urban sprawl.

With GIS, urban planners can quickly create maps of the city as it is today, and then use various modeling and predictive data techniques to explore scenarios for the future. Ideally using this exercise to create a future land-use map that is thoughtful, sustainable, and sound.

Planning Applications

GIS can help the government and businesses process and organize planning applications.

Many GIS portals can be made public facing, which means citizens can access data such as parcel outlines and information, county/district boundaries, and area zoning. With vital information more widely available to all, government resources (which might have been spent fielding these requests and finding the data) can be put to use elsewhere.

Moreover, with all the applications stored in a central database, organization, processing, and status tracking becomes much simpler.

Analyzing Socioeconomic & Environmental Data

Creating future land-use maps must take into account several environmental scenarios, as well as project future demand for land resources. Modeling must include population data, economic activities, and spatial distribution.

The visual component of GIS makes analyzing location-based data (like socioeconomic and environmental trends) simpler and more effective. GIS enables the creation of thematic maps i.e. maps that combine data and location in order to explore correlation and display trends.

With the various data sets stored in the GIS database, users can create layered images that include topography, street maps, thematic maps, and more - helping to easily identify ideal spaces, as well as areas of potential conflict.

Land Suitability Analysis/Site Selection

GIS tools like map overlay enable urban planners to conduct land suitability analysis, an important step in site selection.

Remote sensing, spatial queries, and environmental data analysis help urban planners find areas of environmental sensitivity. By overlaying existing land development on land suitability maps, they can identify any areas of conflict between the environment and potential development.

Measuring Connectivity

GIS geoprocessing functions like map overlay, buffering, and spatial analysis help urban planners to conduct connectivity measurement.

Connectivity refers to how easy it is to walk or bike in a given city. A highly-connected area will give its residents numerous options to get from A to B quickly.

Impact Assessments

An environmental impact assessment can be conducted to evaluate the potential effects urban development will have on the environment. If issues are found, the urban planner can then recommend ways to alleviate or mitigate negative outcomes.

Evaluation, Monitoring, & Feedback

GIS tools can help evaluate a building plan, monitor the project after completion, and even gather feedback to help make improvements.

Together with remote sensing, GIS can help planners to track if development is following the area's land use plan. It can also help them evaluate impact and suggest adjustments - if required.

GIS in Water Resources

Storage and management of geospatial data:

Geographic information Systems keep data and records about water sources. The data collected about water resources is stored on servers in different parts of the world. Some of the information is usually as a result of processing done on data collected by GIS. Huge amounts of data related to water resources can thus be stored for shared access with the help of GIS. Big externally launched geospatial satellites that are always on motion and rotating near the earth's atmosphere are integrated with GIS and then used to help in inter-continental data and information dissemination. The satellite provides wireless data access to all base stations that request for the geospatial data. Most Geographic Information systems also offer cloud-based platforms. This means that geospatial centers in any part of the world can have access to data stored in any of the GIS servers. This pervasiveness and flexibility of data and information access is part of the applications or uses of GIS.

Hydrologic management:

Studies on the water have shown that water is in most cases under motion, or changes its state and pressure with time. GIS comes to play a big part in keeping track of these water conditions. Hydrologists are thus among the biggest beneficiaries of Geographic information systems. Various studies on the water can be accomplished using well-engineered GIS. Hydrogeology, for example, is a discipline that investigates groundwater together with its storage, occurrence, and motion characteristics. The nature and characteristics of water stored underground or one which is on the surface either stagnant or in motion can be entered into GIS as data, stored and retrieved for future processing by the geographic Information System.

Modeling of groundwater: Groundwater

Modeling involves the hydrologists trying to understand groundwater behavior and characteristics**.** Bearing in mind the scarcity of water so much study can be done to protect water catchment areas. GIS can also help in the creation of models and designs to help utilize underground water responsibly. Soil properties and other geographic features are natural to investigate using GIS in relation to ground water. Digital images on groundwater can then be created, for example, by the use of magnetic fields during investigations and case studies.

Quality analysis of water:

Not all water that exists on earth is safe for consumption by human beings or animals. Taking unsuited water can lead to adverse health conditions. Through GIS, studies on a slope, drainage features, and land utilization patterns can be used to predict whether the water in a given area is safe. Due to the ability of GIS to handle large amounts of data sets, sample data can

be processed, stored as well as reports generated. These reports can be used by the relevant organization or even the government to make future study and regulations on water and to determine whether the water is safe for human consumption.

Water supply management:

As we have seen earlier rain is a handy resource that no government or individual can afford to waste. Water supply pipes are laid on the ground and can be monitored on a real-time basis. Leaking water system components can also be identified and fixed on a real-time basis, which is much possible due to the integration of supply systems with GIS.

Sewer system management:

Most of the human waste in most parts of the world are treated and conveyed to water bodies. However, strict and accurate supervision of sewer lines must be periodically made. Failure to manage the sewer system well can lead to diseases outbreaks that lead to degrading the country's economy. GIS has also played a commendable role in sewer system management. Treatment of sewage can also be done with the help of GIS. Proper and mapping techniques that are delivered by these information systems on sewer lines are also important as they prevent damaging waste pipes during construction of structures like buildings, roads, railways among many others.

Storm water control and Floods disaster management:

During floods and storms, it is most likely that water will accumulate in places inhabited by human beings. This can prove challenging for the rescue team to go into rescue operations with little information about the flooded areas. Geographic information System has to help emergency rescue teams to their services safely and professionally. Thus in such instances of flood disasters and harsh weather condition, GIS can be used to give statistics on affected areas, enable the government to plan evacuation as well as can be integrated with weather forecasting systems to offer an accurate prediction and decision making. Aerial views and simulation of the floods can also be made using special system components and tools that rely on Geographic Information Systems.
