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Utilize Geographical Information System (GIS) To Assessthe Role of Challenges in Influencing Agriculture

Saniya Syed[1], Pradeep Kumar [2], Harpal Singh[2] and Mousmi S Hashmi[2]
Department of Soil Science and Agricultural Chemistry, Banda University of Agriculture andTechnology, Banda-210001, India[1]
Department of Entomology, Institute of Agricultural Science, BundelkhandUniversity, Jhansi-284128, India[2]
Department of Vegetable Science, Institute of Agricultural Science, Bundelkhand University,Jhansi-284128, India[2]
Department of Seed Technology, Institute of Agricultural Science, Bundelkhand University,Jhansi -284128, India[2]

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Geographic Information System

Accurate assessment of the spatial variability of soil properties is key component of the agriculture ecosystem and environment modelling. The main objective of the present study is to measure the soil properties and their spatial variability. A combination of conventional analytical methods and geostatistical methods were used to analyze the data for spatial variability. Sustainable land management requires reliable information on the spatial distribution of soil properties affecting both landscape process and services (Lin et al., 2005; Shibu et al., 2006). In conventional soil survey soil properties are recorded at representative sites and assigned to entire mapping unit, which are delineated using both physiographic and geopedologic approaches. Although soil surveyors are very well aware of the spatial variability of soil properties, conventionally prepared soil maps do not reflect it as soil units are limited by boundaries (Heuvelink and Webster 2001). But in nature the soil properties are highly variable spatially (Burrough 1993) and for accurate estimation of soil properties these continuous variability should be considered

“GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their location.’’

Ducker (1979) defined GIS as “ a special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for quires and analysis".

Geoghaphic- Implies that location of the data items are known or canbe calculated in term of Geographic coordinates (latitude, Longitude).

Information – Implies that the data in a GIS are organized to yield useful knowledge, often as colored maps and images, and also as statistical graphic, tables and various on screen responses to interactivequeries.

System - Implies that a GIS is made up from several inter-related and linked components with different function. Thus GIS have functional capabilities for data capture, input manipulation, transformation, visualization, combinations, query, analysis, modelling and out.

What is GIS?

- A technology
- Hardware and software tools
- An information handling strategy

The objective: to improve overall decision making.

Why is GIS Unique?

- GIS handles SPATIAL information
- Information referenced by its location in space

GIS makes connection between activities based on spatialproximity.

History

Continued developments should lead to Integrated Geographic Information System (IGIS) for joint analysis of remotely sensed and GIS data , capable of handling multiple data structures and supporting complex spatial analyses and user quires.In contrast, scientific theory to guide modeling and analysis using the amalgamated data input and outputs of GIS has been slow to develop.

- 1963: Computing comes of age (Establishment of the Urban and Regional Information system Association (URISA) and the first GIS conference in ottowa, canada in 1963).
- 1964: Canada GIS –Roger Tomlinson " father of GIS"
- 1964: Harvard lab for computer Graphics and Spatial Analysis.
- 1970s GIS software evolves rapidly (more GIS companies appeared e.g.

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Intergraph, ESRI, Governmental department introduced GIS e.g. The US Bureau of the Census)

- 1980s GIS software advances significantly (more budget and human resources allocated for GIS, by the end of 1980s more than 4000GIS/CADsoftware are introduced).
- Digital data becomes available (TIGER, World Data Bank, DIME).
- 1990S integration of Raster and Vector based systems, Multi-media GIS, software become more user friendly.

Several features of GIS analysis make processing and interpretation of the output especially complex, for example:

Use of multiple data layers varying in their structure, level of pre- processing, and spatial consistency. Multiple (and often poorly known) measurement scales, ranging front ‘’points’’ to grids to irregular polygons. Unknown’s measurement error for most variables. Unknown spatial dependencies in the data and their propagation through spatial models.

Spatial variability of soil chemical properties among land use in the eastern part of the Dang district of Nepal

Soil Properties	**LAND**	**USE**		**F- Value**
	Agricultural	**Agro forestry**	**Grassland**	
pH1:2 water	7.53 ± 0.05	7.05 ± 0.14	7.47 ± 0.44	6.85*
OM,%	2.47 ± 0.13	2.64 ± 0.24	2.78 ± 0.99	0.22NS
N,%	0.13 ± 0.06	0.12 ± 0.01	0.14 ± 0.14	0.2NS
P,Kg ha^{-1}	11.89 ± 0.96	19.03 ± 3.10	8.49 ± 1.65	3.92*
K, kg ha^{-1}	120.95 ± 7.43	130.16 ± 14.15	144.44 ± 44.44	0.22NS
B, mg kg^{-1}	0.30 ± 0.02	0.28 ± 0.04	0.35 ± 0.17	0.17NS
Zn, mg kg^{-1}	0.14 ± 0.00	0.14 ± 0.00	0.14 ± 0.00	2.89NS

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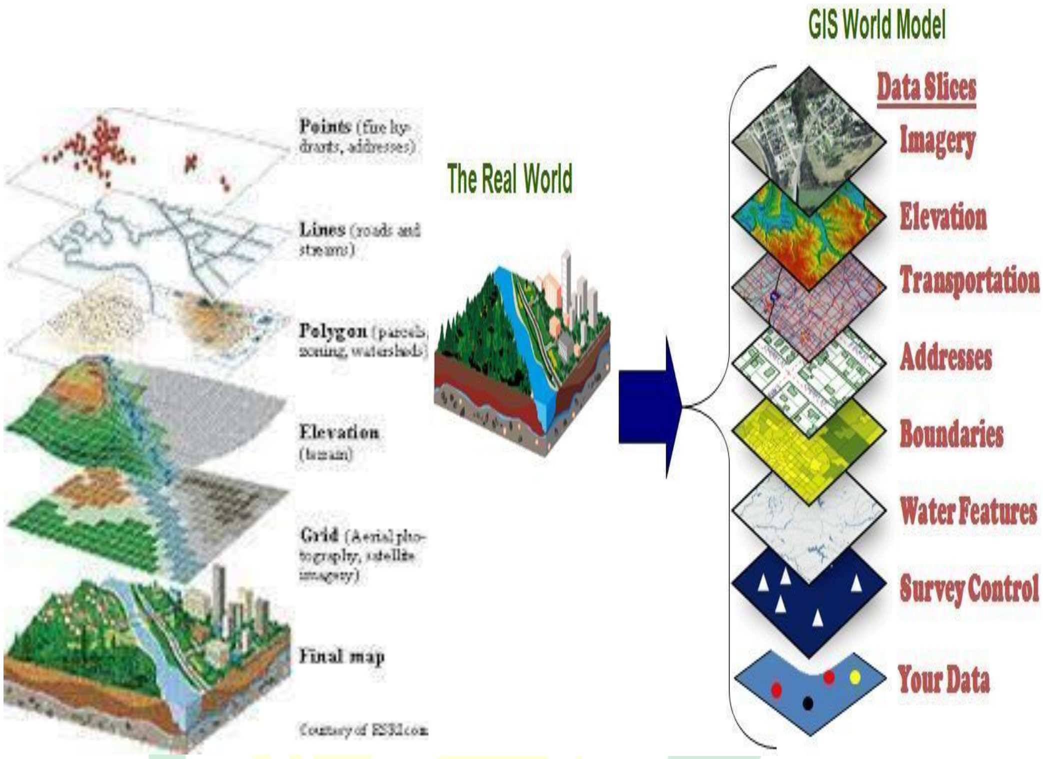
Values (mean ± standard error) in each row with the same letter are not significantly (P < 0.05, LSD) different amongland uses, *Significant at 0.05, NS: Not Significant.



Geographic Information Technologies

Technologies for collecting and dealing with geographic informationthree main types:

- Global positioning system (GPS)
- Remote sensing (RS)
- Geographic Information system(GIS)

Before we understand GIS we need to understand spatial analysis.This includes:

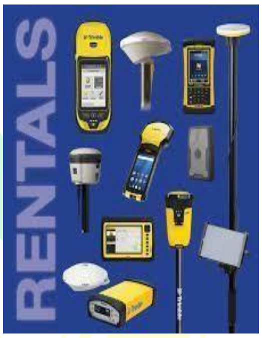
- Spatial data manipulation usually in a Geographic information system(GIS), is often referred to as spatial analysis. Ex: interpolation.
- Spatial statistics is usage of basic and complex statics to represent thereal work in a statistical model.
- Spatial data analysis; this is descriptive and exploratory based on verylarge datasets and complex data sets.
- Spatial modeling involves constructing models to predict spatial

outcomes.

What Does A GIS Look Like?

The distinct meaning of the question ‘’is this a GIS?’’

- GIS is a real application, including the hardware, data , software and people needed to solve a problem (a GIS application).
- GIS is just application software.



Data processing and information flow

Tracking the changes in geographic data during processing is a formidable task,in part because of the wide variety of changes that can occur, including;-

- Datum value (i.e., category, level or magnitude)
- Range of a variable
- Data precision (higher ->lower)
- Spatial or temporal resolution (higher -> lower)
- Data type (e.g., numerical -> ordinal -> categorical)
- Data structure (tabular < - > vector < -> raster)
- For GIS data, changes in polygon attribute information.

The Basic tool for creating an Agricultural GIS Provides:

- Farm accounting.
- Conducting of the soil fertility base:
- Agro-technological planning.
- Monitoring of the condition of fields and crops.
- Conducting a database of equipment.

Principle of the System Operation

- Acquisition of GNSS signal.

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- Sensor status request,
- Sending measurements to the server,
- Visualizing the moving
- Display of speed , course and sensor reading,
- Calculation of fuel consumption, mileage and treated area event recording.

Advantages of GIS

- Improved decision making.
- Increased efficiency.
- Improved communication between organizations.
- Easy record keeping.
- Geographical management.
- Crop sown area estimation.
- NATCAT modeling.

GIS And Agriculture

Powerful modeling tools, such as Decision Support System for Agro-technology Transfer (DSSAT) and soil-water-Air-Plant (SWAP), have also become incorporated with common and open source GIS tools such as GRASS, enable farmers and analysts to forecast water availability and crop health without great expense. These tools are increasingly incorporated with high performance computing (HPC) or cloud –based computing, enabling large-scale analyses for large areas in the tens of thousands of hectares to be estimated. Deep learning using convolution neural networks (CNNs) has enabled farmers to make better decisions from collected data. For instance, using drone data, CNNs can be used to count the number of livestock or make measurements on crop using visual data. Data from lot devices can also be assessed, helping to find emerging patterns of crop stress before it becomes too serious. These advancements have helped to maw machine and deep learning techniques become increasingly critical for decisions that help save resources while responding to threats.

We have seen many transformation to technologies and techniques used that can benefit agricultural decisions. Farmers have a greater variety of data to choose from to help

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with decisions needed that not only benefit them but also can have positive impact on the environment.

Challenges of GIS in Agriculture

- Low level of technological development.
- Small land holdings.
- Market imperfection.
- Inconsistency and inept implementation of government policies.

1. **It expensive:**

A GIS system is not cheap thanks to the complex interconnection of the various components that make up a GIS system. Besides the hardware and the software, there is need to have a fully trained human personnel that isexpensive to train and acquire.

2. **Integration with traditional map is difficult:**

A GIS system is made up of extremely complex map structures and information that may be difficult to integrate with the traditional maps to gain any meaningful information. This mans a GIS only works with and interprets information that has been collected using the software from the start.

3. **Excessive damage in case of an internal fault:**

Owing to the fact that a GIS system includes very complex components internally, any fault or internal outage will result into an elaborate damage that will take long hours or long periods of time to repair back to operationalization.

4. **Complex data structure:**

The data collected and stored in GIS system is usually complex with plenty of definition and restructuring required. This means that special skills are required to understand and interpret the data collected in a GIS system.

5. **Simulation is difficult:**

A GIS system captures complex data arrays that require special analysis to comprehend. For this reasons, it may be difficult to create a simulation of the data or information captured in a GIS system.

6. **Some data analysis is impossible to perform:**

Because of the complexity of the data structures captured or recorded in a GIS system, some spatial data may be impossible to analyze hence leading to incomplete information. Not all information captured in a GIS system can be analyzed completely.

7. Less impressive:

Unlike other forms of data analysis techniques, the data captured in a GIS system is usually less "pretty" or impressive leading to some level of difficulty or complexity in the analysis of the data that would otherwise have been easy.The presentation of the data in GIS system may also not organized foreasy-user consumption.

8. Difficulty in projection transformation:

Sometime it may be difficult to perform a projection transformationusing a GIS system thanks to the complexity of the data structures.

9. Generalization may lead to loss of important information:

In performing data analysis using a GIS system, there is a lot of generalization due to the massive data being analyzed. The user stands to losea lot of information due to the generalization of data.

10. Large amount of Data:

A GIS system stores extremely large amounts of data at any given time. This may create problems when it comes to analysis due to the complexity of the data and the risk of generalization. It also creates problems when it comes to interpretation.

11. Large storage:

GIS data requires extremely large storage space due to the large data sizes and data types used. This also increases the cost of storage and the manpower required to manipulate the data to make sense.

12. Expensive data collection:

The data collection process using a GIS system is usually expensive in the long run since not all the data collected will be useful and yet all require storage and analysis.

13. Difficult overlay operations:

GIS data require complex overlay operations that are difficult to achieve especially when the personnel involved are not properly trained.

14. Time consuming:

The process of collecting, storing and analyzing of information using a GIS system is long and tedious and therefore time consuming. It may take a long time to get complete information regarding a particular set of data due tothe vastness of the data available.

Cost and technology access may limit some farmers from benefiting changes occurring for modern agriculture; however, many of these technologies are declining in cost and, in fact, many of the tools, such as GIS and some of the satellite data, are free to use.

Improving how agriculture is done will increasingly be more critical as we try to be more effective in how we use landscape resources to mitigate negative impacts on the economy and climate.

Impact of GIS on Indian Agriculture

Information Technology, Geographical information system and a complete ecosystem of services in agriculture sector can make a big difference in improving the performance of the sector. With the help of GIS techniques the challenges faced by Indian agriculture are being reduced. GIS application in Agriculture examines ways that this powerful technology can help framers produce a greater abundance of crop with more efficiency and at lower costs. Indian ranks second in agriculture output in the world. Indian Agriculture which is waiting for revolutionary growth in crop productivity and agriculture related business is looking forward to implement the knowledge by next generation youth handy for computerized technology. The solution for providing food security to all people of the world without affecting the agro-ecological balance lies in the adaptation of new research tools, particularly which is easily conventional to them and as well as frontier technologies like Geographic Information System. The GIS is the blessing 21st century which helps in achieving the desirable growth rate. GIS technology are being effectively utilize in India in several areas for sustainable agricultural development and management. The Indian agriculture mainly depends upon many socio-economics factors. The main challenges faced by of Indian agriculture are: Government policies for funding, crop specific programmers, Education and Awareness for Farmers, Farming and Crop Technologies, Cropping pattern for profitability, Environmental factors such as water availability, soil degradation and climate changes.

Infrastructure such as irrigation, electricity, storage and raw materialssuch as seeds, improper land use as there is huge fragmentation of land due to traditional land holding pattern, Suitable agricultural skills development and availability of Labor.

How GIS and Information Technology can address these challenges;-

Information technology, Geographical information system and a complete ecosystem of services for agriculture sector can make a big difference in improving the performance of the sector. So overcome thesechallenges following are the way to help GIS technique as follows:

Government policies:

Information technology can enable e-Governance for agriculture, making range of services available to farmers and various stakeholders of thesector.

Farming and crop technologies:

Geographical information and analytics system can be developed and mad available through e-governance, public- private partnerships and other market forces.

Environmental factors:

GIS can be used to provide Data Analytics for soil degradation and education on how to take preventive measures to avoid it. Soil science experts can provides the required content for this. This would need step- by –step approach as it requires a soil data over the period of time. It can provide information, education, awareness programs for farmers and other stakeholders of the sector about climate change and impact on them.

Infrastructure:

GIS can be used to provide analytics for planning for irrigationnetwork across the country. Overall e-GOV portal can be developed as dashboard to track various infrastructure for particular area and help local authorities take right decisions. Farmers can access these services through e- Governance programmers for agriculture sector.

Land Use:

Land use has to be implemented at the grass root levels or by introducing the western model of corporate farming. The expertise from agriculture discipline can be leveraged for proper crop patterns aligned with land use.

Crop valuation

Data analytics can be used to align the crop valuation with quality parameters, national and global demand.

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Step by step procedure as give below is adopted.

a) Data collection
b) Location map of a region.
c) Land use information from Nagar Nigam.
d) GPS reading of the Study area
e) Road network information
f) Field survey : This included extensive interviewing of farmers, manual survey and field photographs

Conclusion:-

From the above discussion, it is clear that spatial decision making is a highly complex process and most spatial decision problems are complex and ill structured. GIS are required for solving these problems but each of them has its own limitations and drawbacks in dealing with spatial decision making. The integration of these tools may avoid some of the limitations and difficulties existing in each of them and provide the decision maker with an efficient tool for solving these problems. Any spatial analysis software will require facilities for the input, management and display of spatially-referenced data. All these facilities are currently available within GIS package .GIS, if they are to develop as a general-purpose tool for handling spatial data, need to incorporate functionality which goes beyond data management to data analysis.