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Application Of Remote Sensing and GIS Techniques in Agriculture

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- Need of GIS
- Application of GIS techniques



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Introduction

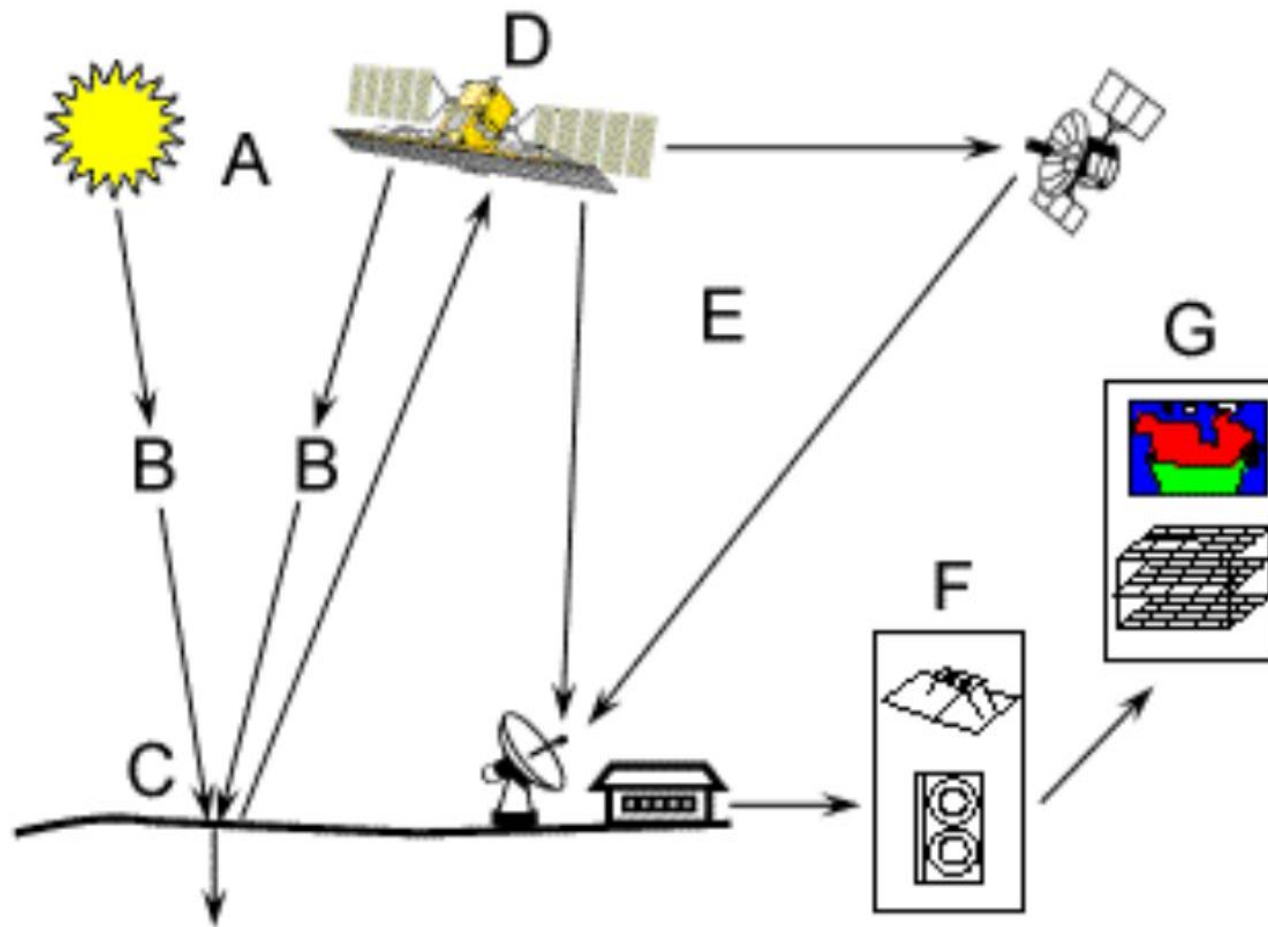
- Remote sensing means 'sensing things from a distance'.
- "The art and science of obtaining useful information about an object without physically contact between the object and sensor".
- Remote sensing using the electromagnetic spectrum to image the land, ocean and atmosphere.
- "All object on the surface of the earth have their own characteristic spectral signature".



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Process of Remote Sensing



Source : <http://www.nrca.gc.ca/node/9363>



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Remote sensing platforms

A. Ground based platforms :

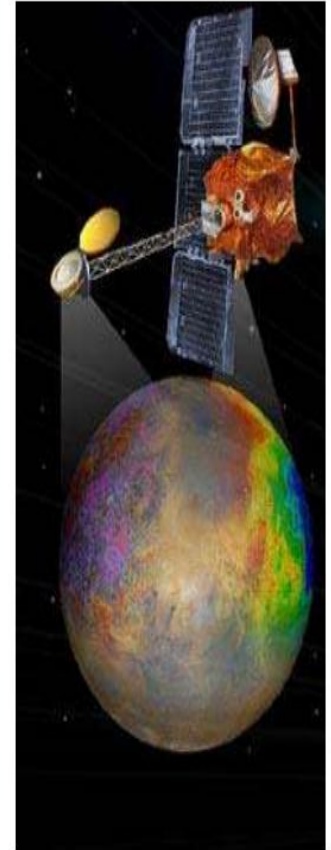
- Tripod stands

B. Air based platforms :

- Balloons
- Air crafts
- Drones

C. Space based platforms :

- Earth synchronous satellites
- Sun synchronous satellites





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Satellites used for Remote sensing

Bhaskara-1, IRS --- INDIA

LAND SAT, IKONOS, QUICKBIRD --- U.S.A

SPOT --- FRANCE

RADAR SAT-1 --- CANADA

JERS-1 --- JAPAN

ERS-1 --- U.K



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Sensors

- “ It refers to the device that record the electromagnetic radiation reflected from the object ”.
- The detection of electromagnetic energy can be performed either photographically or electromagnetically.
- Radiation is measured and recorded by a sensor.



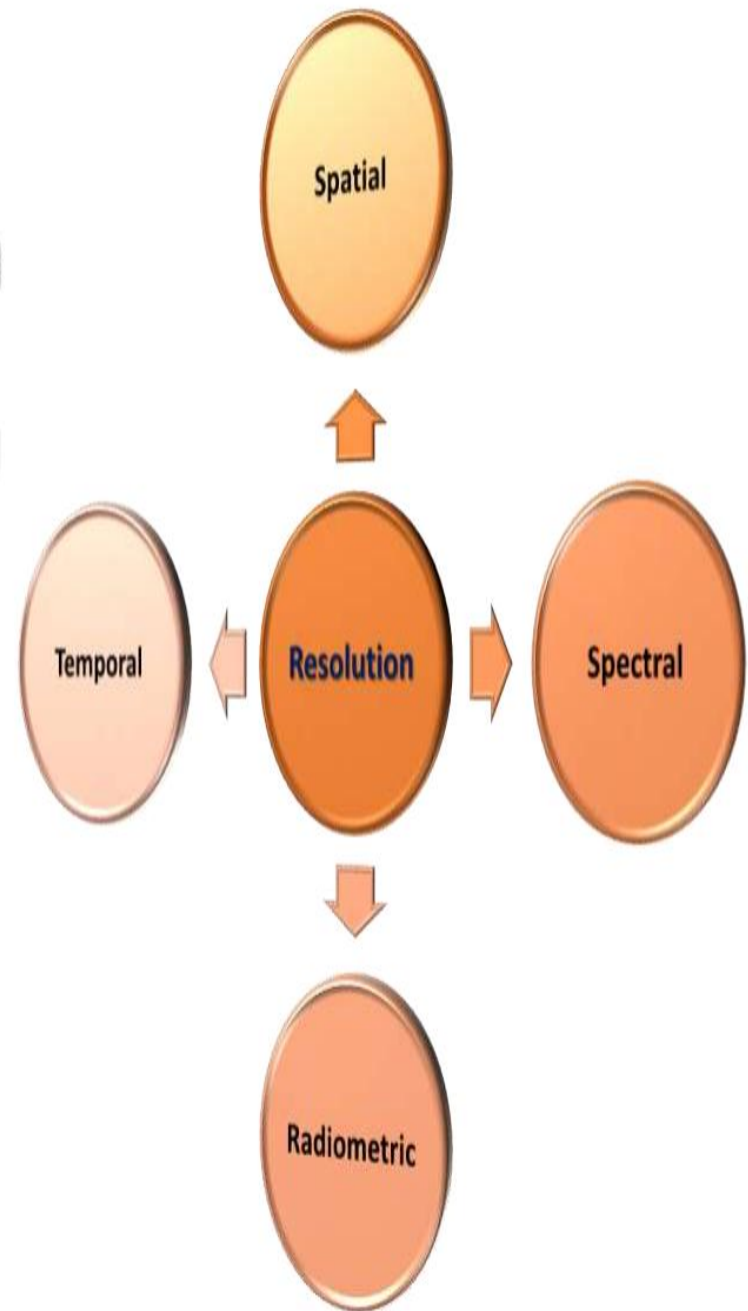


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Types of Resolution

Types of Resolution



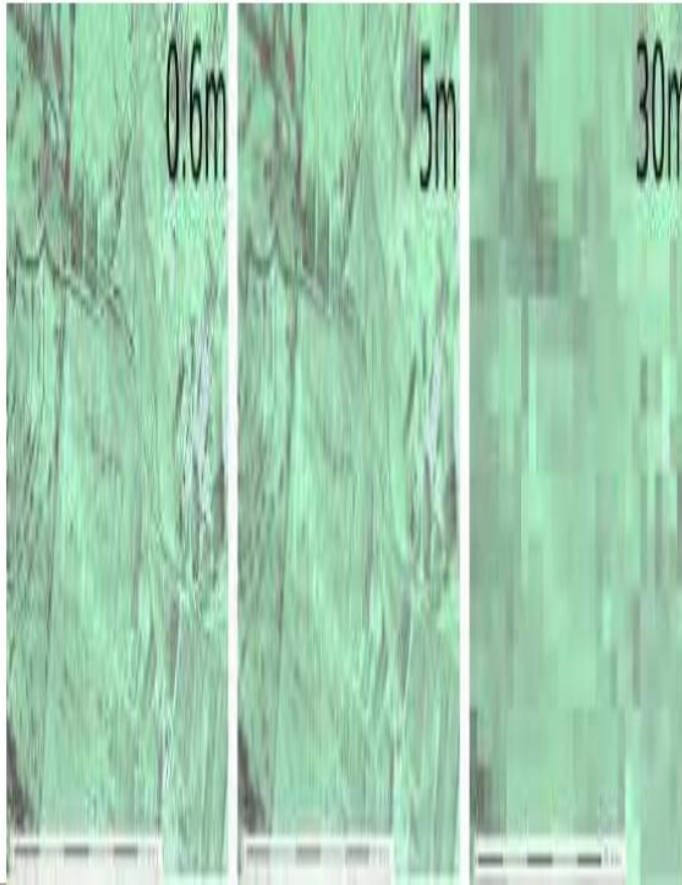


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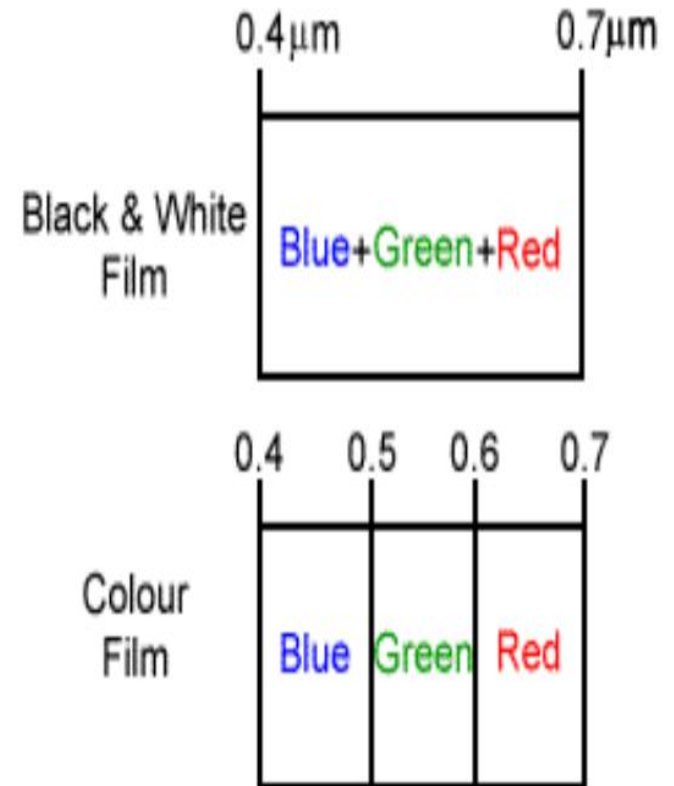
A. Spatial resolution :

- It is the minimum detectable area on the ground by a sensor.



B. Spectral resolution :

- It is the smallest amount of spectral change that can be detected by a sensor.





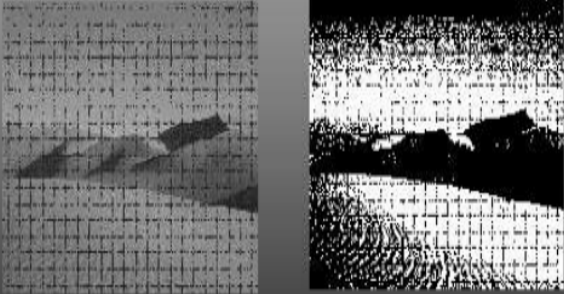
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C. Radiometric resolution :

- It is the number of grey levels which a sensor can distinguish between complete black and white.
- It reflected or emitted energy in form of bits.

C -- Radiometric Resolution



■ The smallest detectable intensity variation in radiant flux.

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D. Temporal resolution :

- It is characterized by the smaller period of repetitive coverage.
- It is helpful in the monitoring an event continually.

CHARACTERISTIC	LANDSATs 1-3	LANDSATs 4-5
Nominal orbital altitude (km)	920	705
Orbital type	POLAR SUN SYNCHRONOUS	
Inclination (degrees)	99.1-99.2	98.2
Equatorial crossing (local time)	8:50-9:30am	9:45am
Paths	251	233
Repeat coverage	18 days	16 days
Sensor type	MSS	MSS/TM



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Radiation - Target interactions

1. Absorption (A)

2. Transmission (T)

3. Reflection (R)

-Specular reflection

-Diffuse reflection





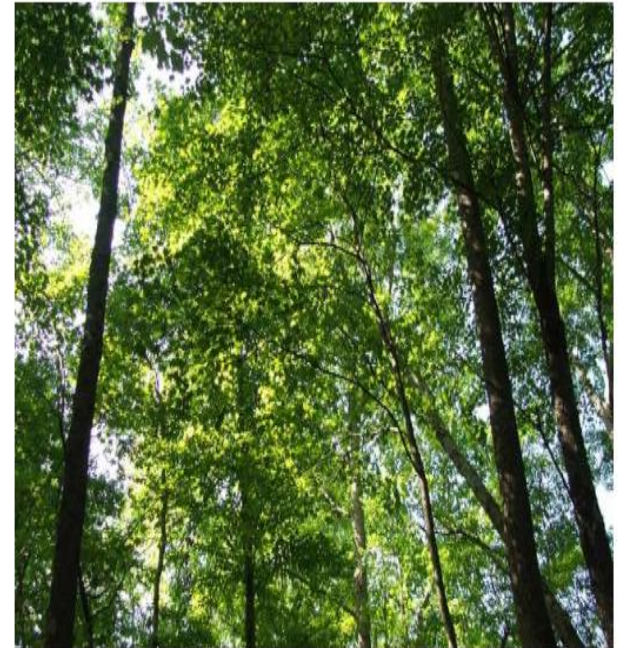
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- **Needle-leaf tree canopies reflect significantly less near-infrared radiation compared to broad-leaf vegetation.**



Broad-leaf vegetation



Needle-leaf vegetation



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- Immature leaves contain less chlorophyll than older leaves, they reflect more visible light and less infrared radiation.



Mature leaves



Immature leaves



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1. Multi-temporal wheat disease detection by multi-spectral remote sensing

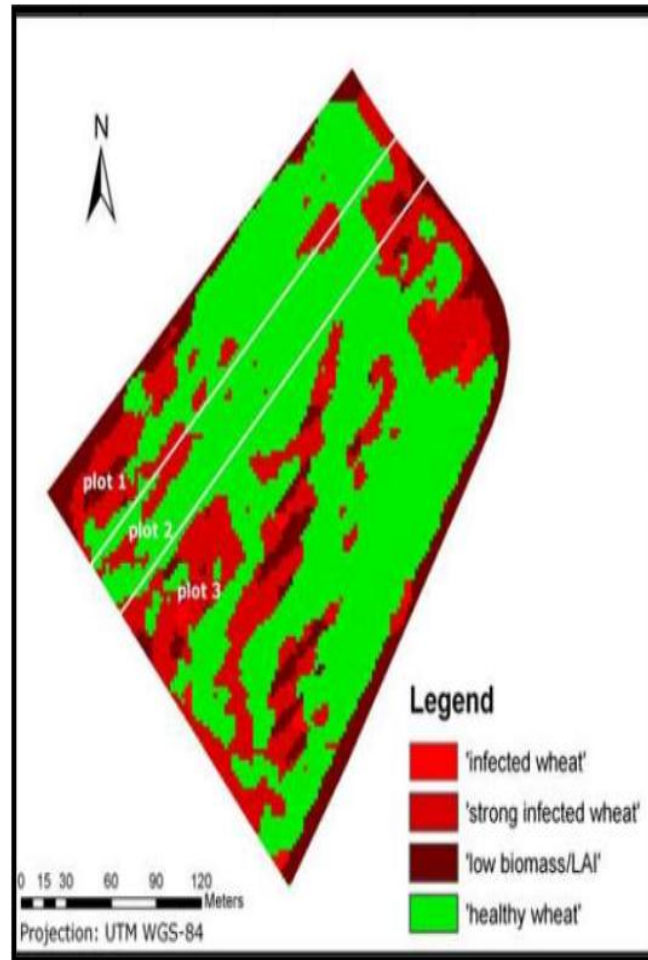


Fig.1 (a). 22-04-2005

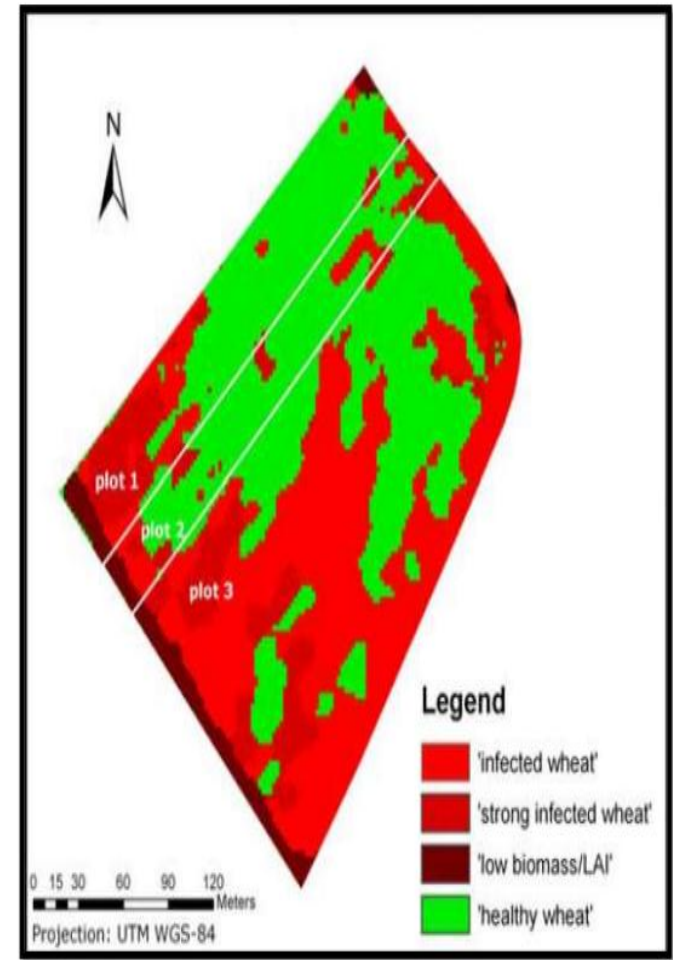


Fig.1 (b). 28-05-2005

Franke *et al.*, (2007)



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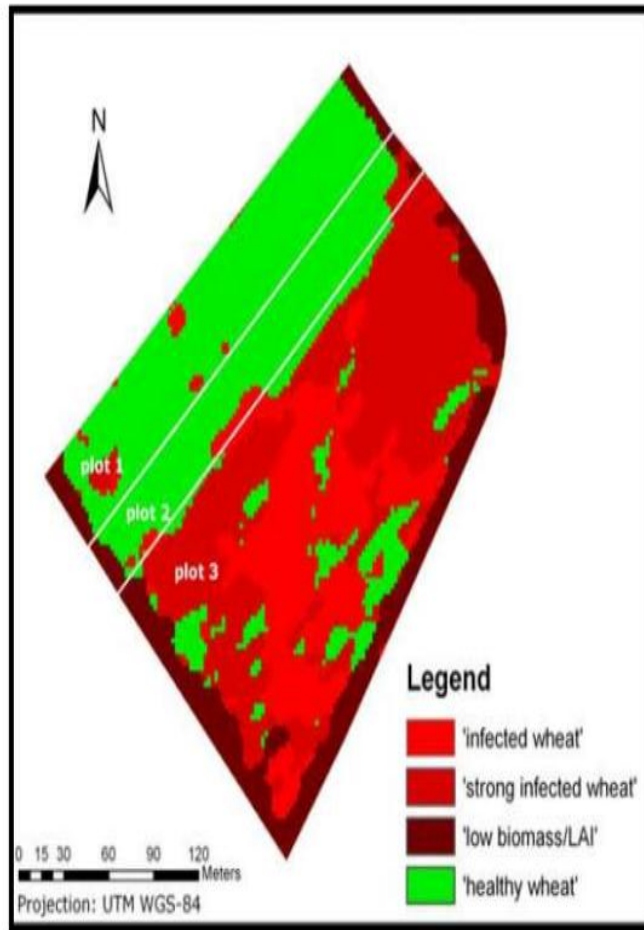


Fig. 1 (c). 20-06-2005

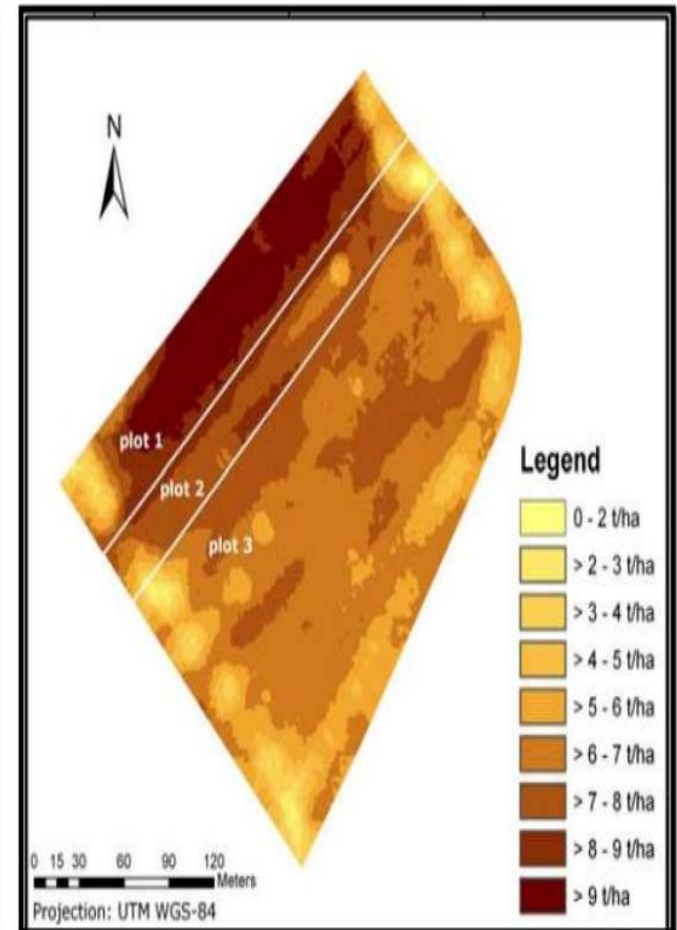


Fig.1 (d). Final yield plots



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2. Normalized Difference Vegetation Index (NDVI) applications in part of South - Eastern dry agro-climatic zones of Karnataka using Remote sensing and GIS

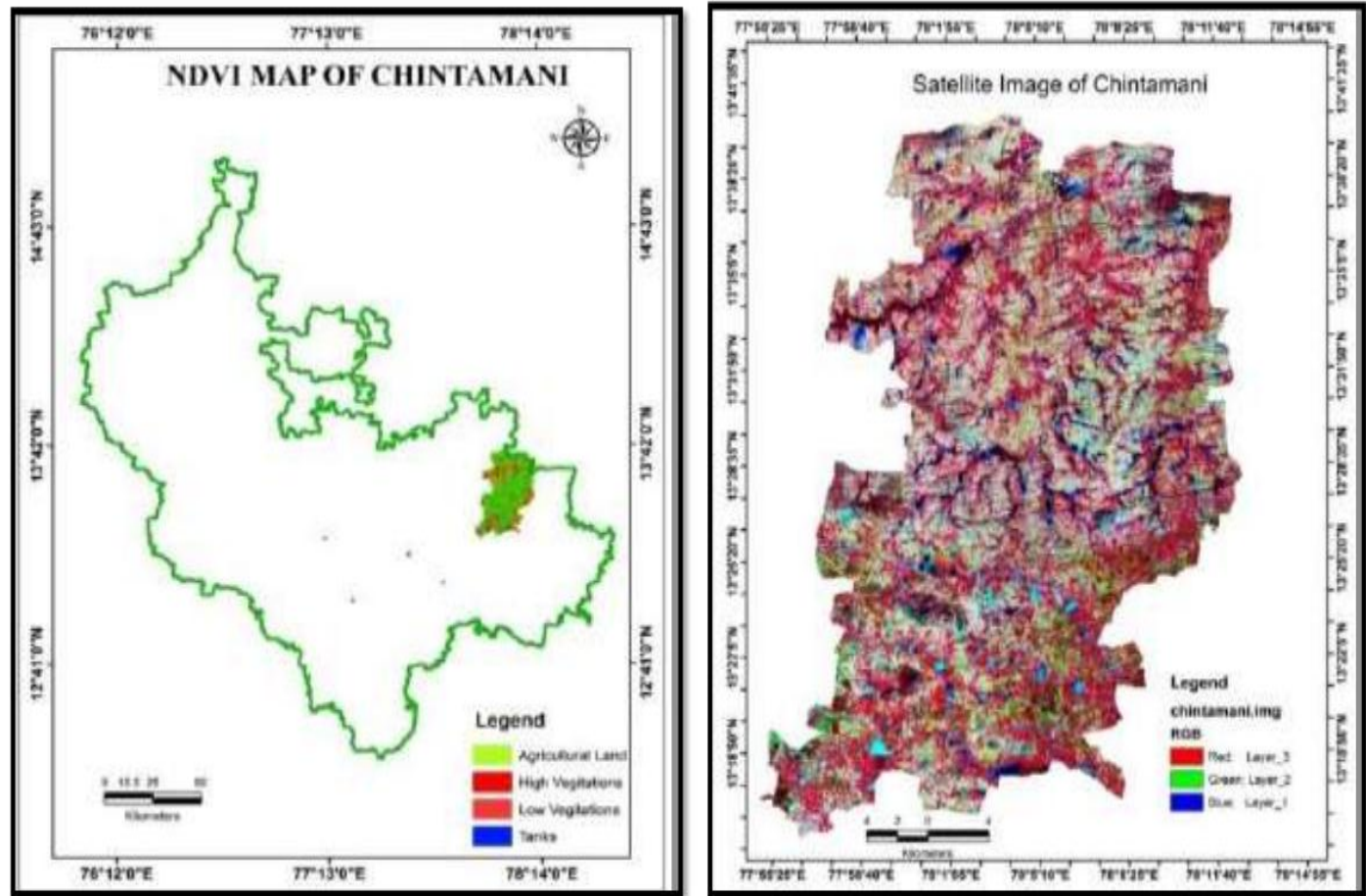


Fig. 2 (a). NDVI Map and Satellite image of Chintamani

Kattimani *et al.*, (2015)



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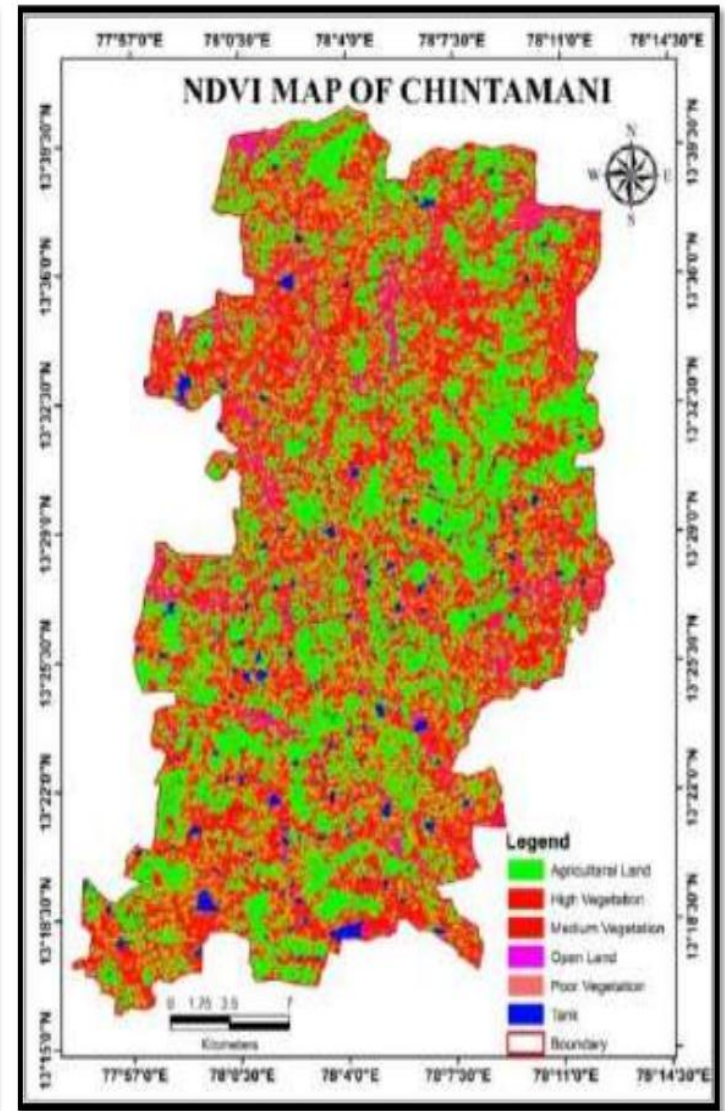
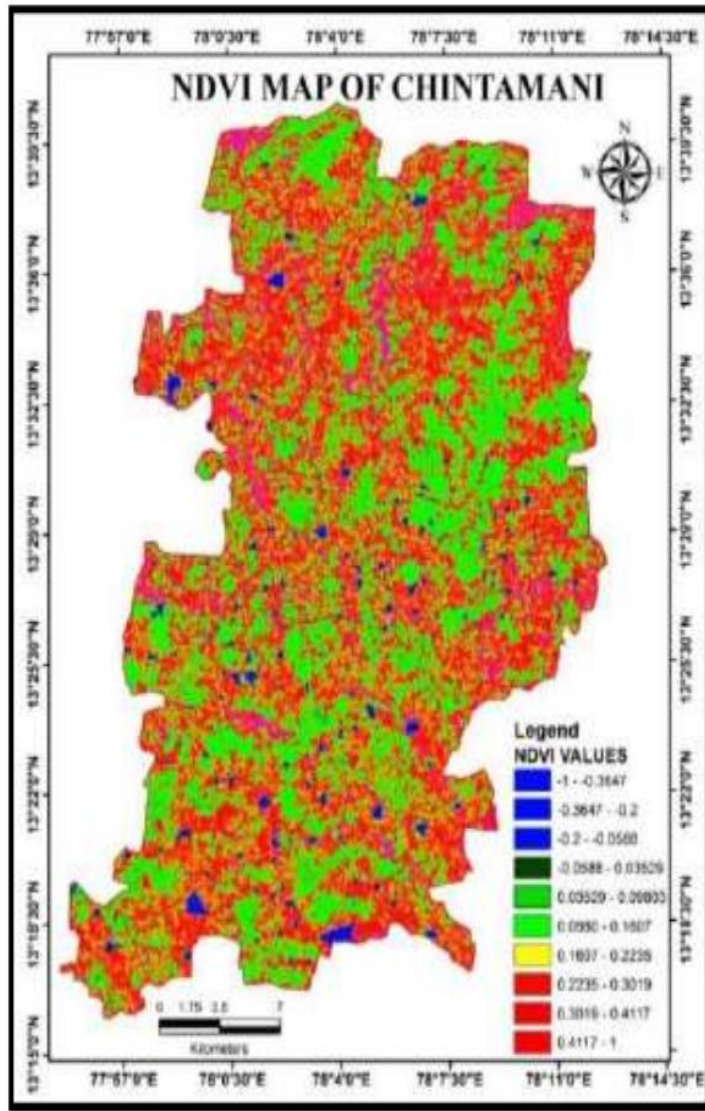


Fig. 2 (b). Ranges and Thematic Maps of NDVI Map of Chintamani



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Forms of Agricultural Remote sensing

A. Strategic

- Involves large areas
- Concerned with overall crop estimates

B. Operational

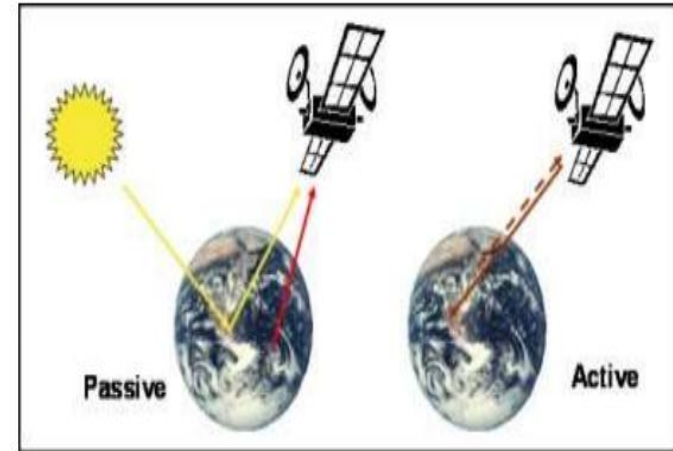
- Involves single farms or even fields
- Concerned with day to day management



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Sensors of Remote sensing



A. Active Remote sensor

- Energy leading to radiation received comes from an external source.
- Eg., Radar, Lidar

B. Passive Remote sensor

- Energy generated within the sensor system is beamed outward and fraction returned is measured.
- Eg., Photographic sensors, Multi spectral scanners



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3. The management and planning of citrus orchards at a regional scale with GIS

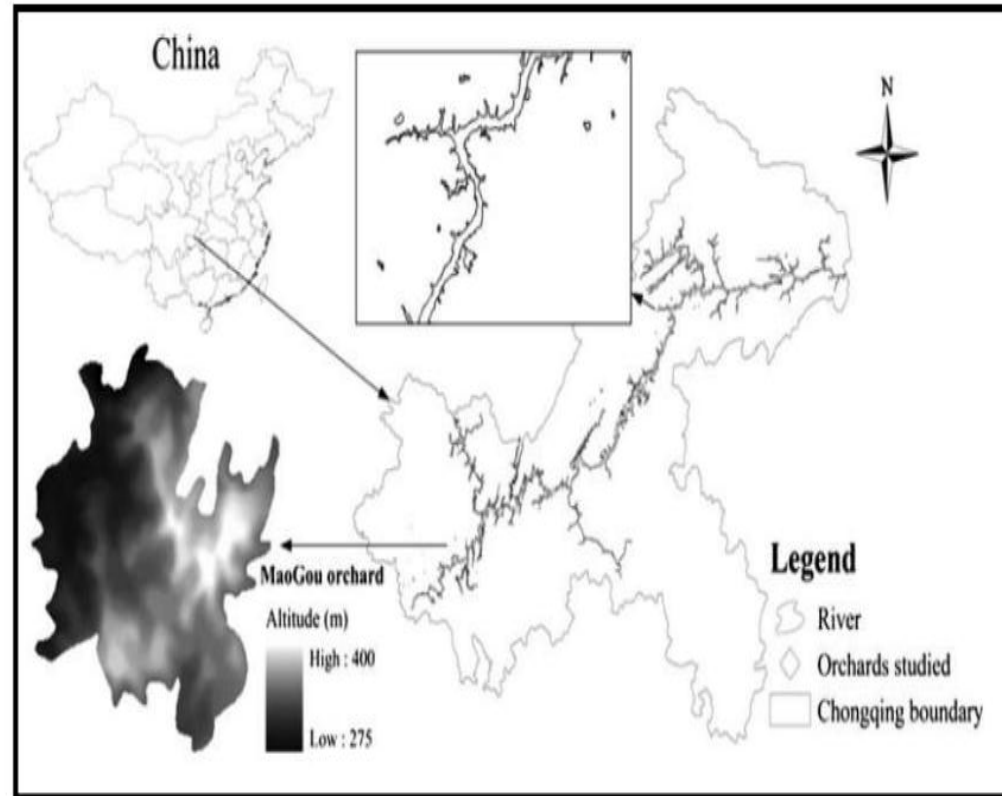


Fig.3 (a). Location of the study area, distribution of the representative citrus orchards and a digital elevation model (DEM) of orchard studied



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Map of 30 year average annual (a) Sunshine and (b) Temperature for Chongqing

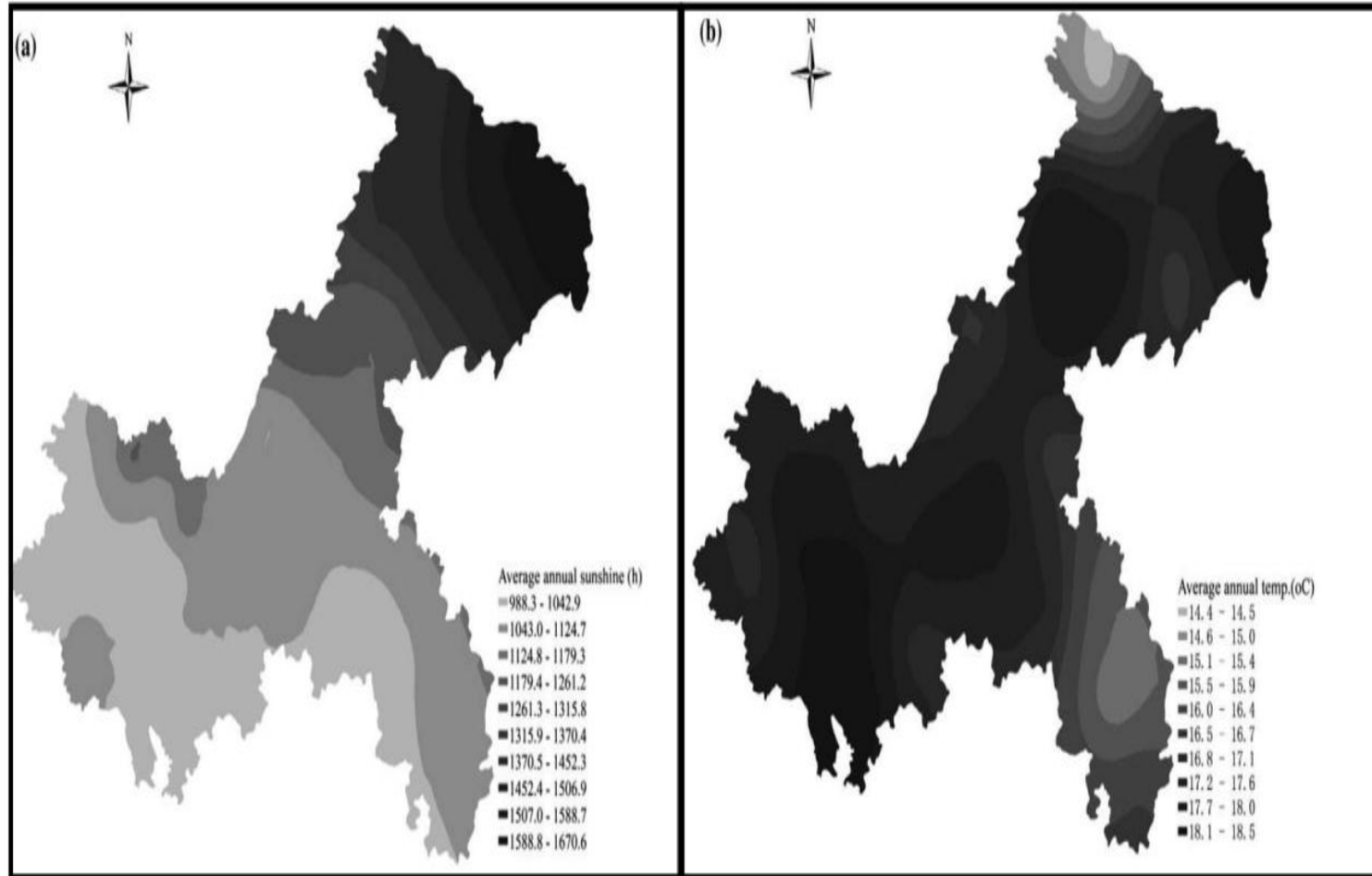


Fig. 3 (b). Average annual sunshine (h)

Fig. 3 (c). Average annual temperature ($^{\circ}\text{C}$)



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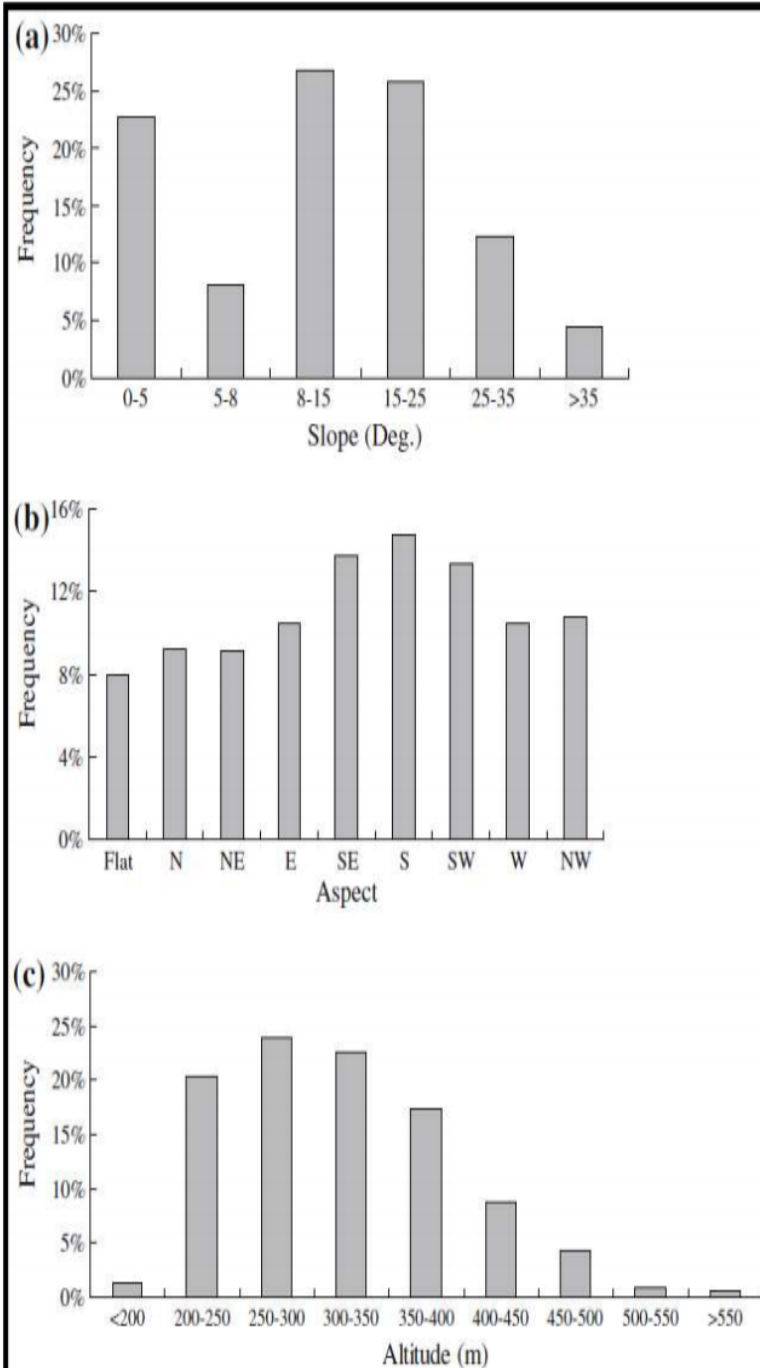


Fig. 3 (d)

(a). About 53% of the area covered by slopes 8-25° and 4.4% with slopes steeper than 35°.

(b). Peaks for South-facing slopes followed by North-facing slopes for 40 and 29 % of the area, respectively.

(c). The graph of convex distribution with a peak at 250-300 m covering 485 ha (24% of the area) and about 80% of the orchard are located within 200-400 m altitude range.



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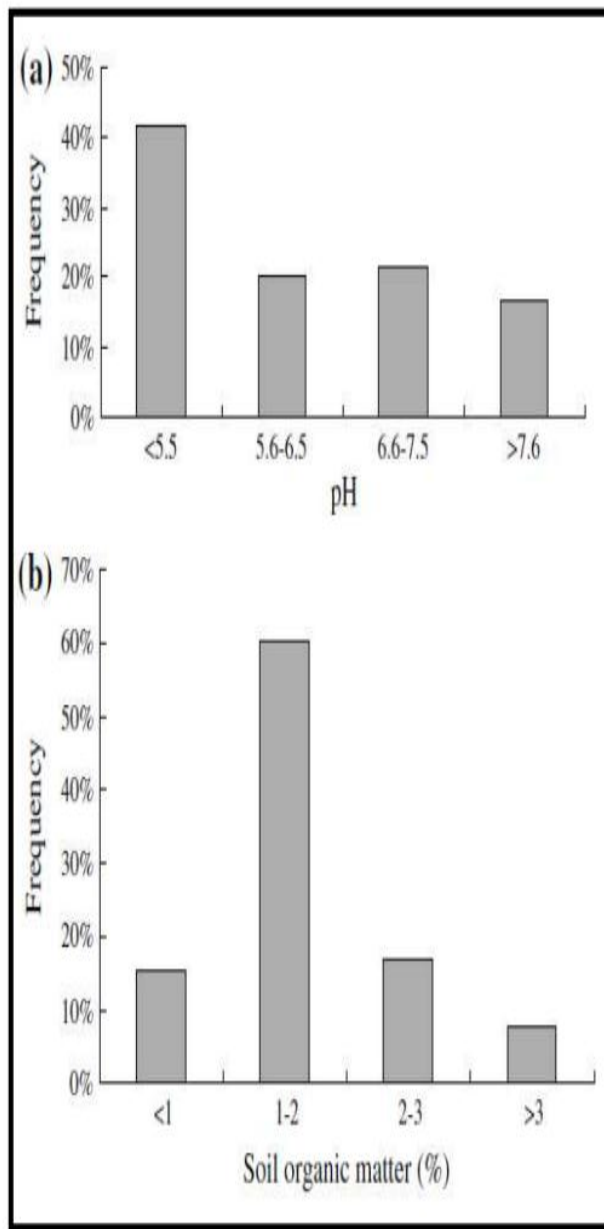


Fig.3 (e). Soil properties of the Citrus orchards

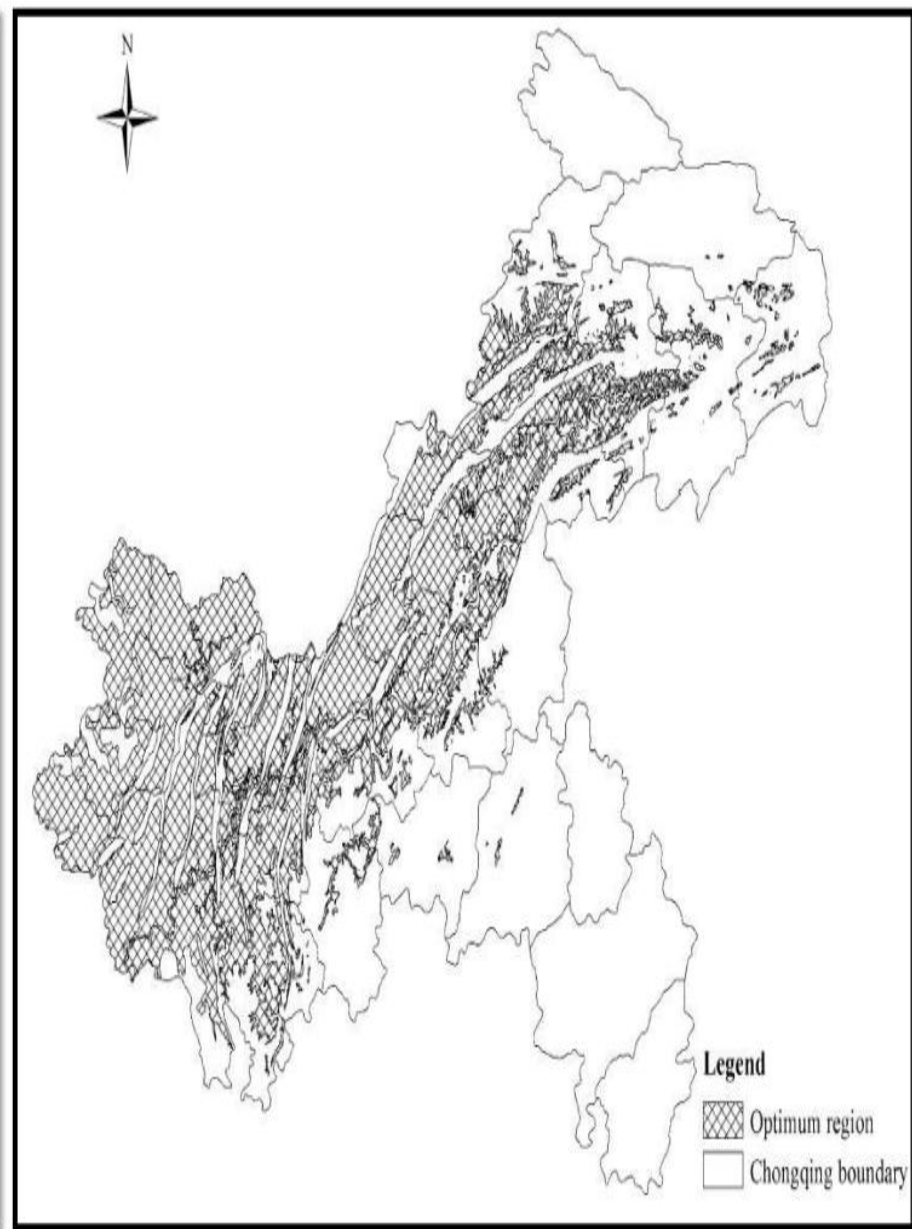


Fig. 3 (f). The optimum Citrus growing region in Chongqing



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4. Application of Remote Sensing Technology For Land Use/Land Cover Change Analysis

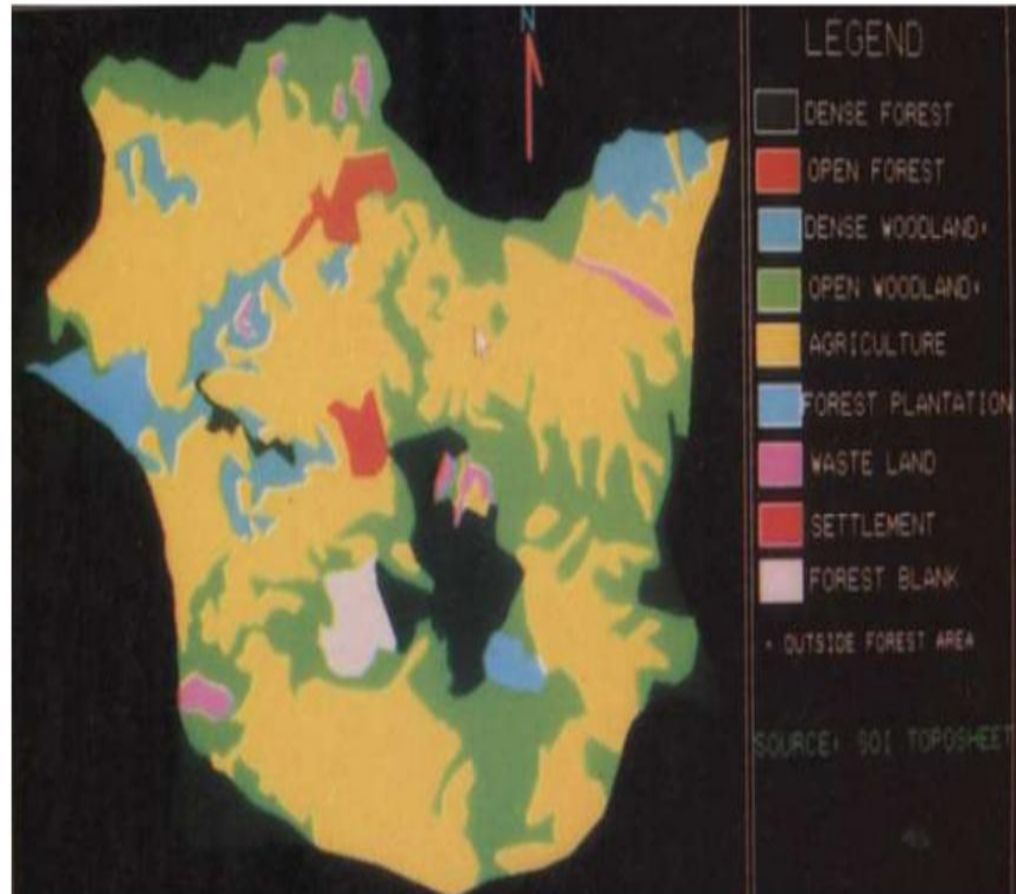


Fig. 4 (a). Land use/land cover map (1967) of a part of Shahdol district M.P.



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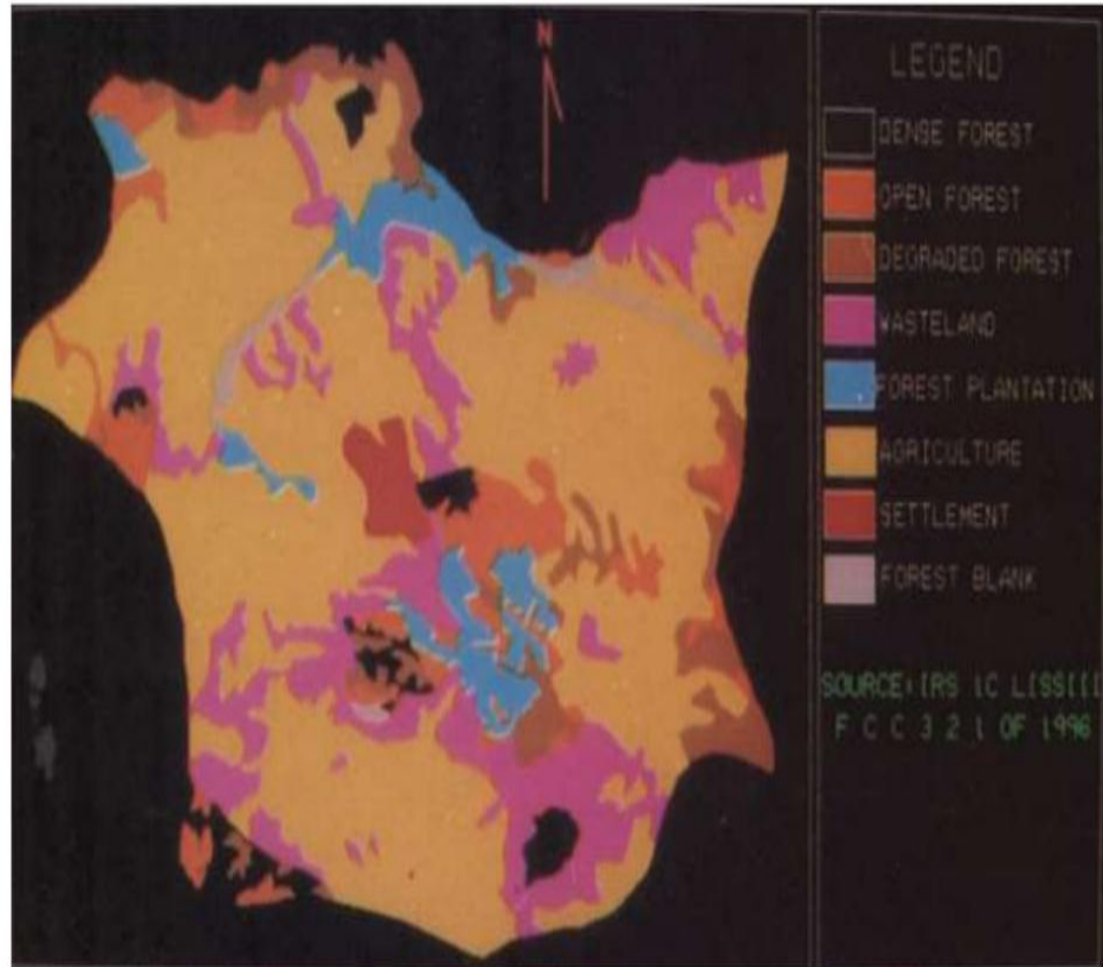


Fig. 4 (b). land use/land cover map (1996) of a part of Shahdol district M.P.



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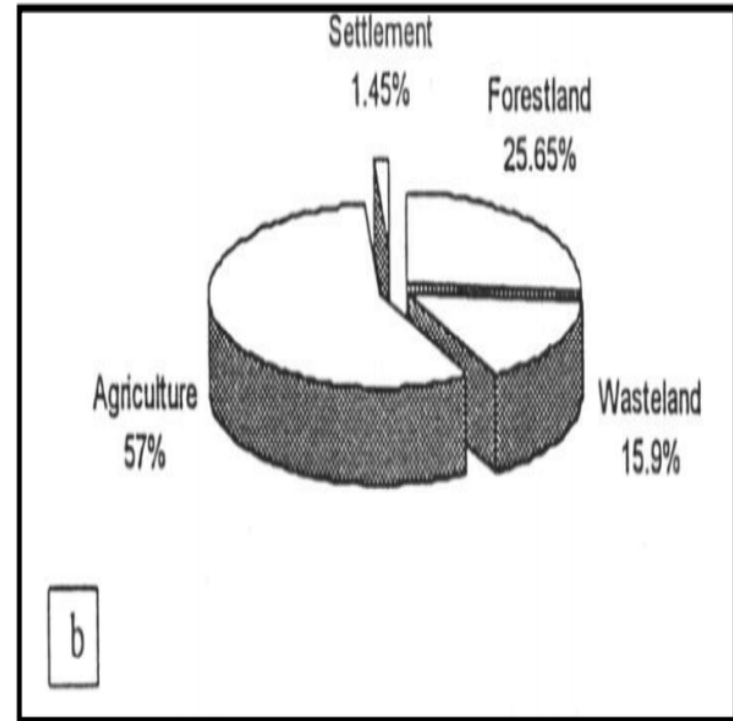
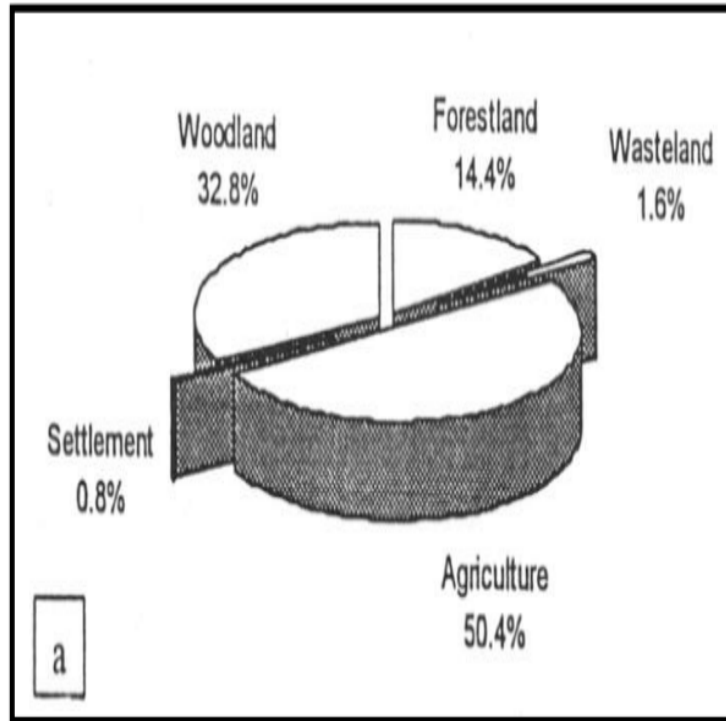


Fig. 4 (c). Land use/land cover in the watershed in (a) 1967 and (b) 1996

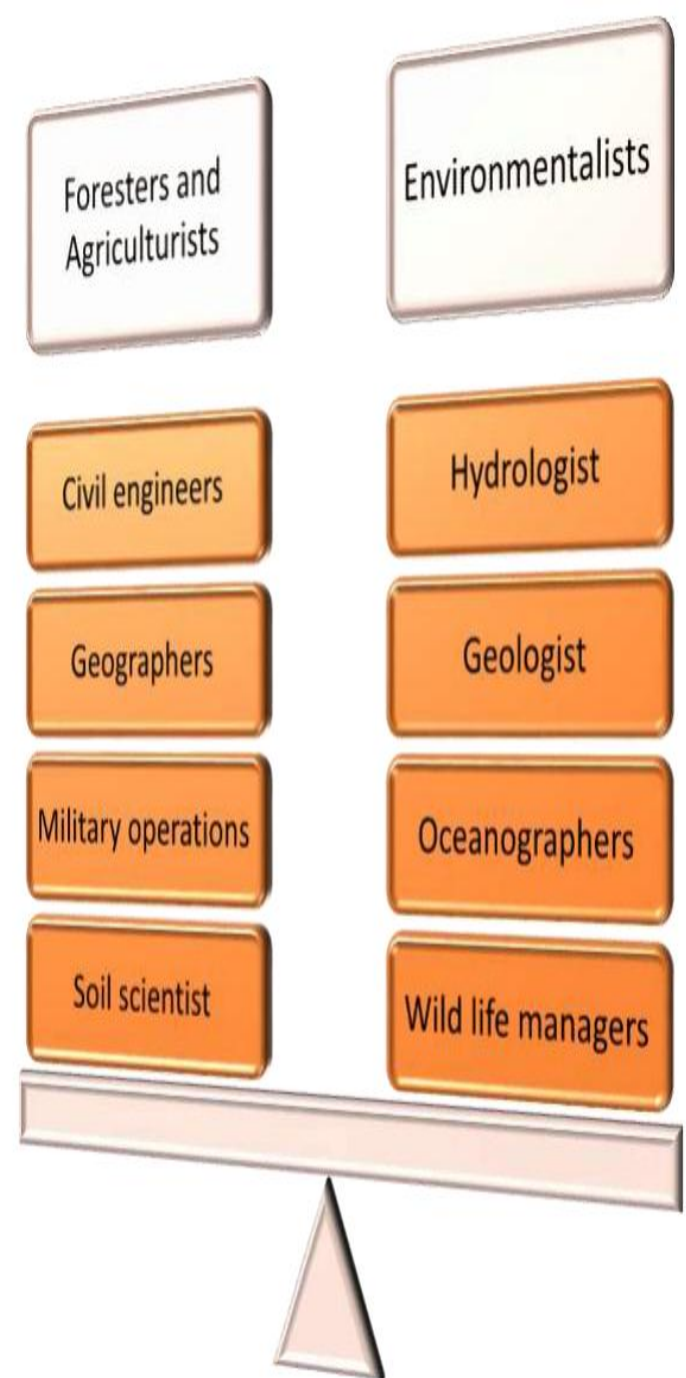


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Scope of Remote sensing

scope of remote sensing





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5. Application of remote sensing and GIS for Artificial recharge zone in Kodaikanal Taluk, TamilNadu, India

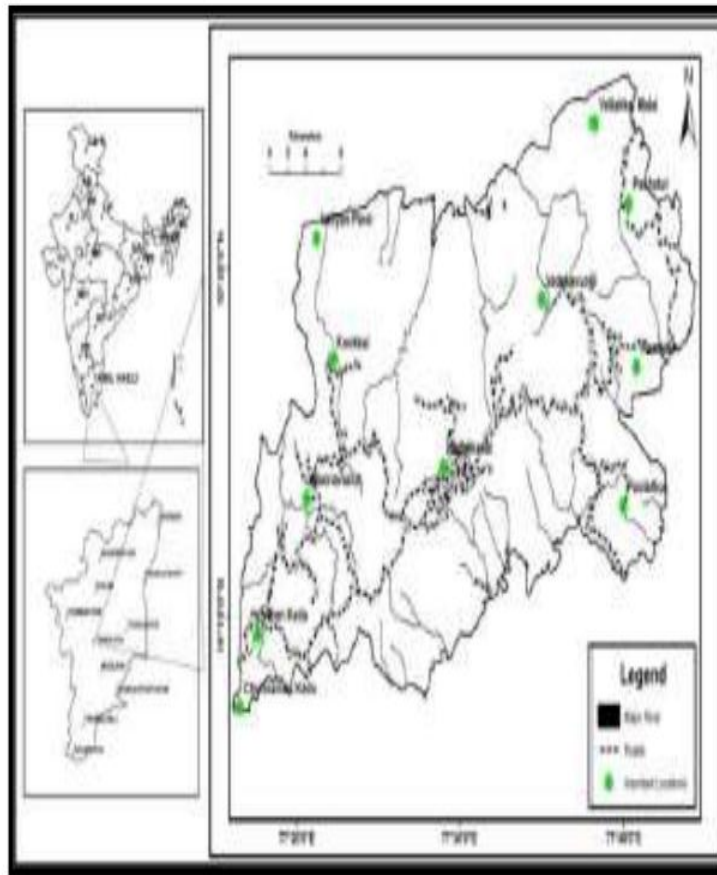


Fig. 5 (a). Study area

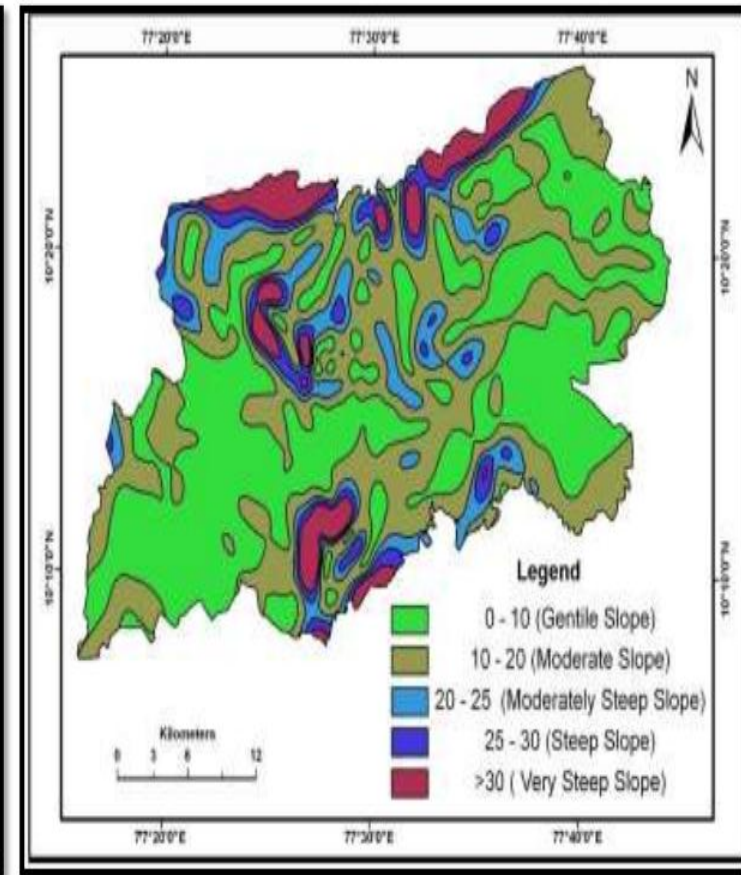


Fig. 5 (b). Slope Map of the study Area.



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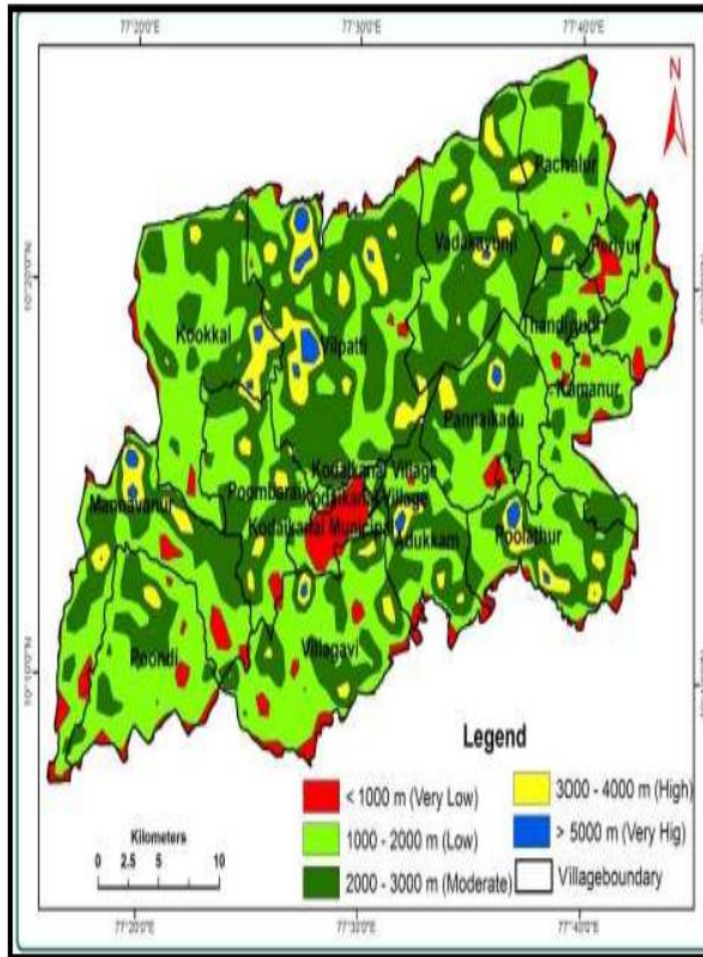


Fig. 5 (c). Drainage Density of the area

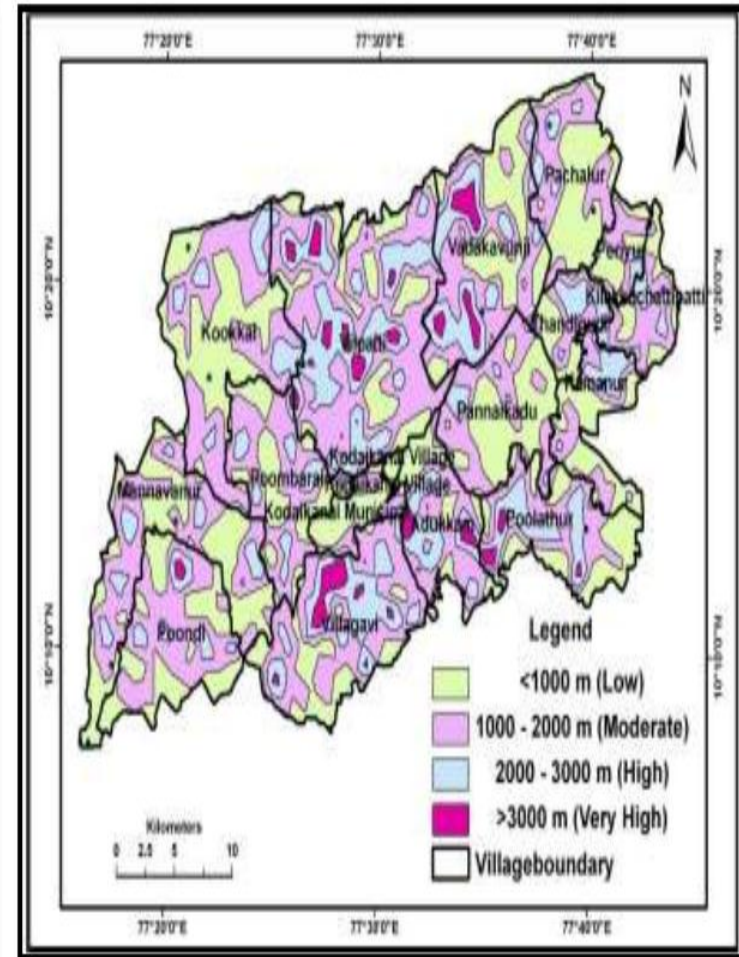


Fig. 5 (d). Lineament Density of the area



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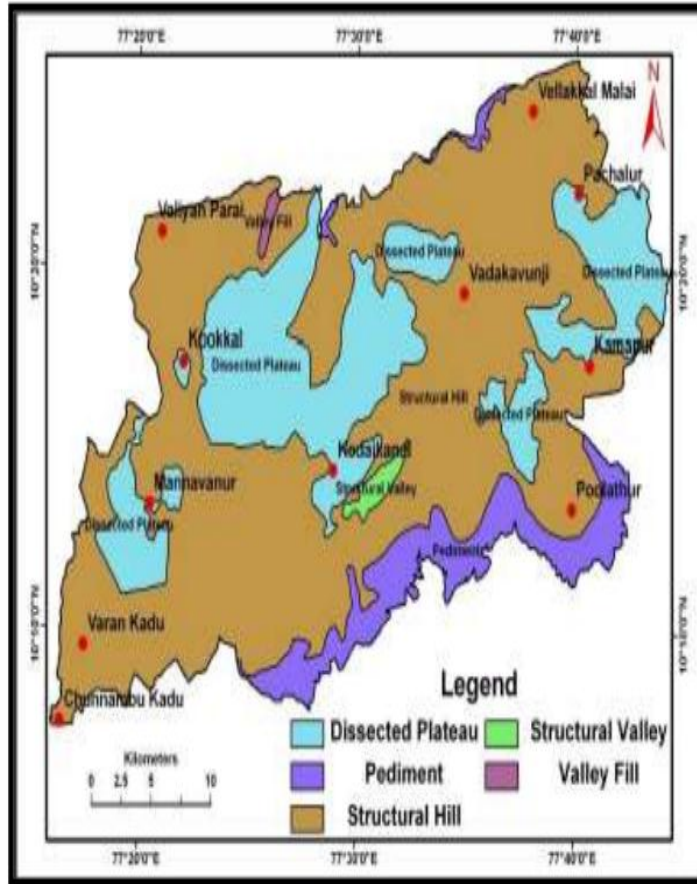


Fig. 5 (e). Geomorphology of the Area

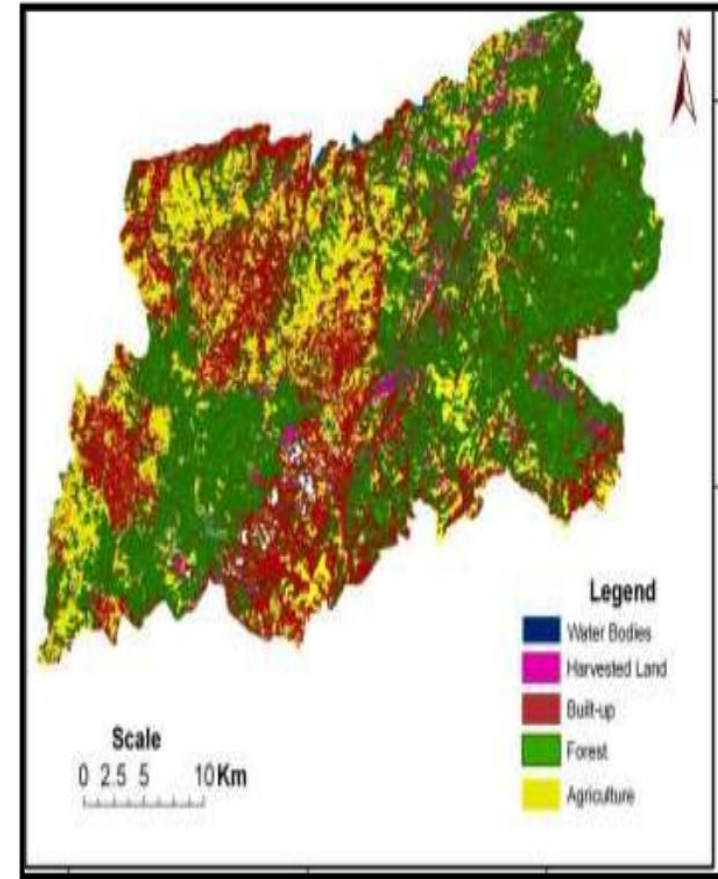


Fig. 5 (f). Land use/Land cover Map of the area



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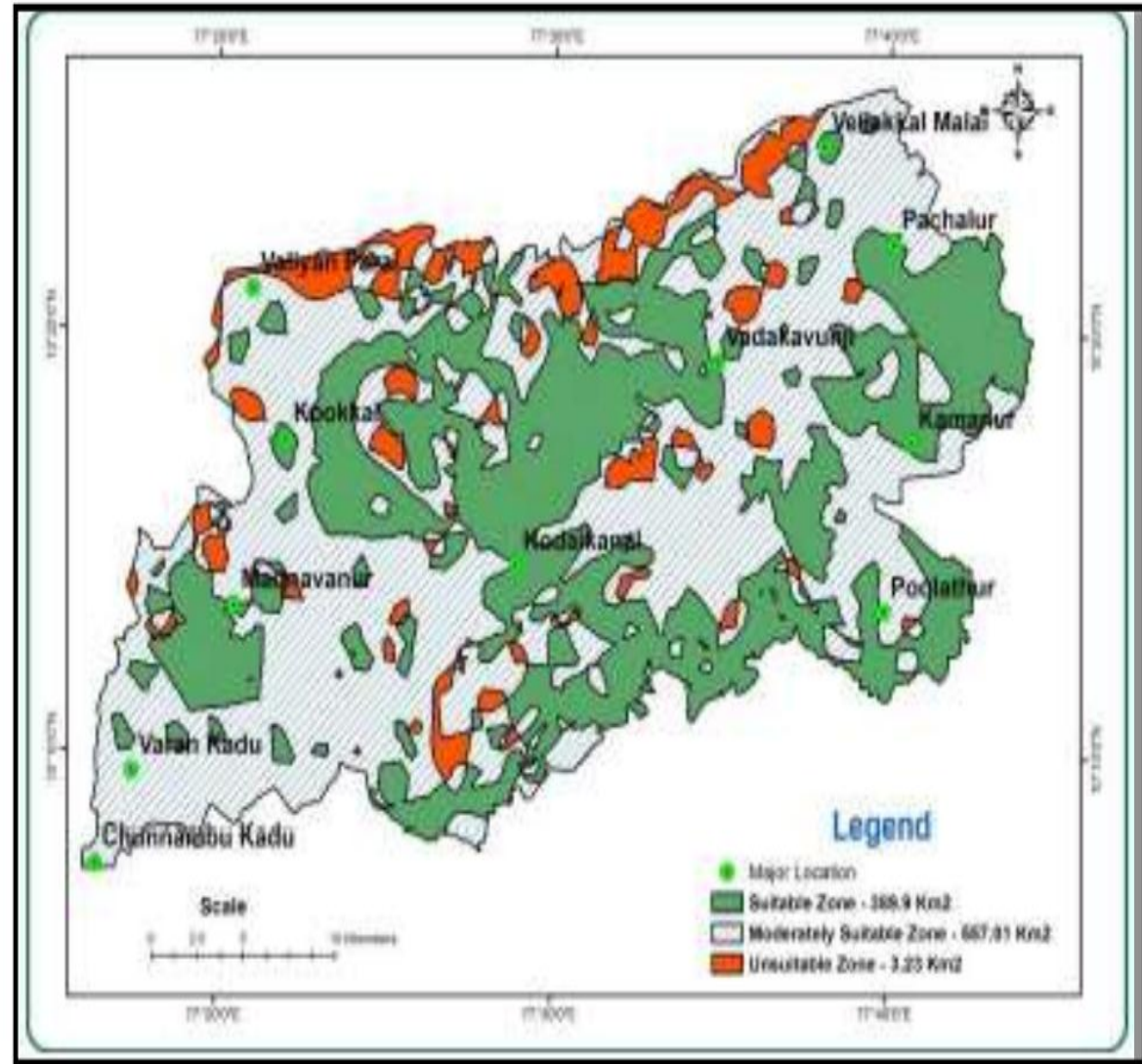


Fig. 5 (g). Artificial Recharge zone Map.



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6. Integrating Remote sensing and GIS for prediction of rice protein contents

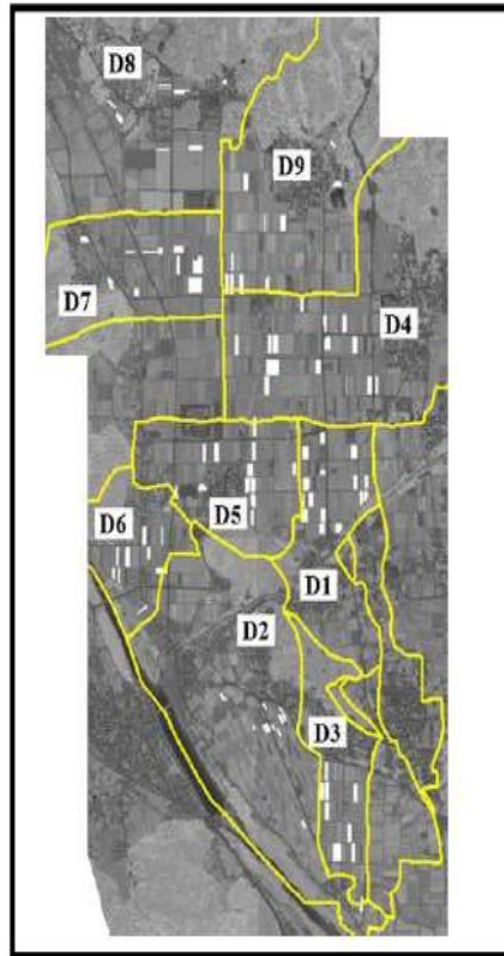


Fig. 6 (a). Sampling fields and districts at Yagi town

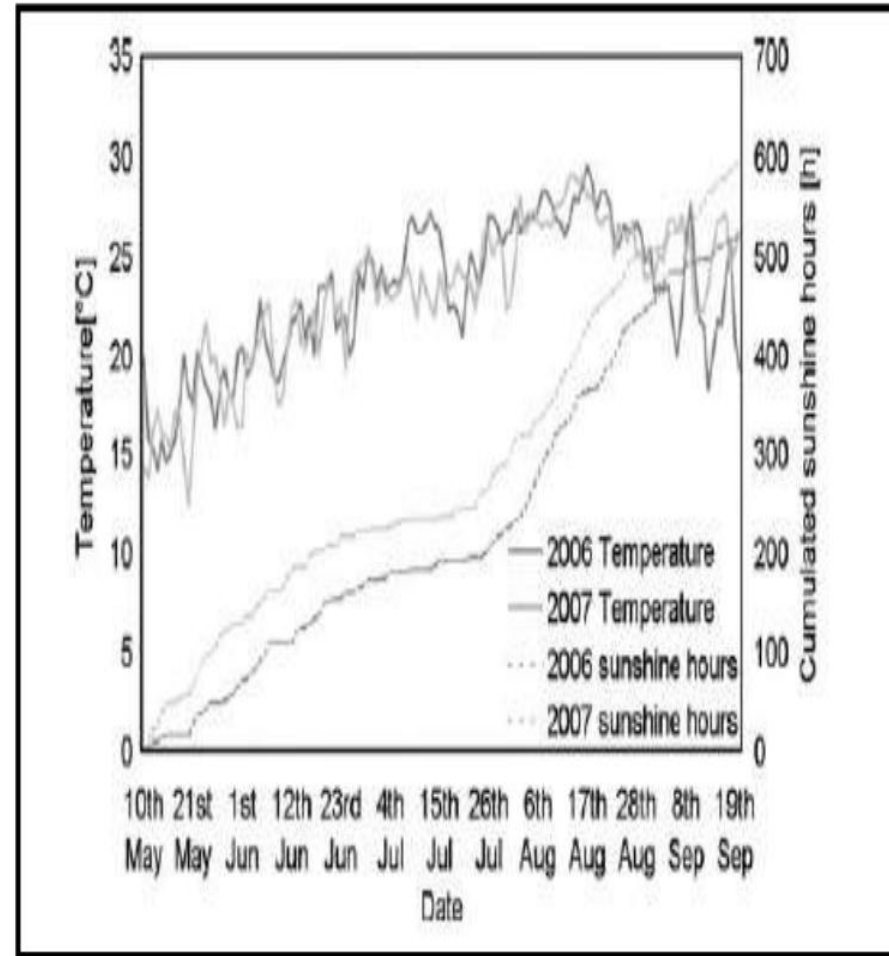


Fig. 6 (b). Average temperature and cumulated sunshine hours from transplanting to harvest in 2006 and 2007



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Advantages of Remote sensing

- **Extent of coverage**
- **Permanent and reliable record**
- **Speed and consistency of interpretation of data**
- **Reliable information**
- **The data are available to multi-disciplinary use**
- **The process of data acquisition and analysis is faster**



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Disadvantages of Remote sensing

- **Satellite data are too expensive.**
- **Remotely sensed data are too complicated to use.**
- **Remotely sensed data are not readily available.**
- **Satellite based remote sensing does not have sufficient resolution.**



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Problems of Remote sensing in Indian conditions

- **Small size of plots.**
- **Diversity of crops sown in a particular area.**
- **Variability of sowing and harvesting dates in different fields.**
- **Inter cropping and mixed cropping practices.**
- **Extensive cloud cover during the rainy season.**



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Application of Remote sensing in Agriculture

- **Crop identification**
- **Crop acreage estimation**
- **Crop condition assessment and stress detection**
- **Identification of planting and harvesting dates**
- **Crop yield modeling and estimation**
- **Identification of pest and disease infestation**



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Contnd.....

- **Soil moisture estimation**
- **Irrigation monitoring and management**
- **Soil mapping**
- **Monitoring of droughts**
- **Land cover and land degradation mapping**
- **Identification of problematic soils**



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7. Sectioning remote imagery for characterization of *Avena sterilis* infestations.

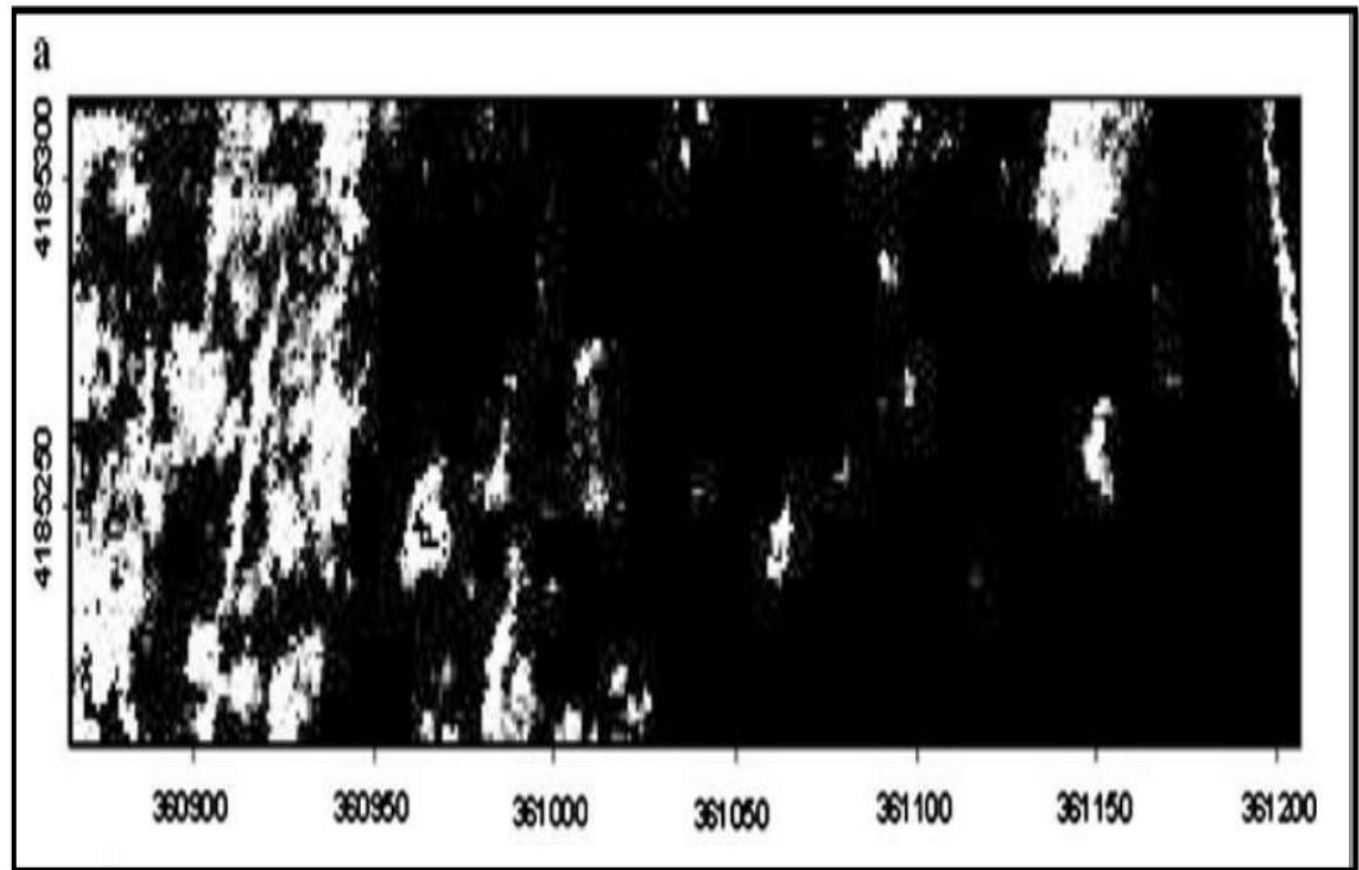


Fig. 7 (a). NDVI image view of Navajas (320 x 91 m) where wheat crop is shown in black and wild oat patches in white.

David *et al.*, (2012)



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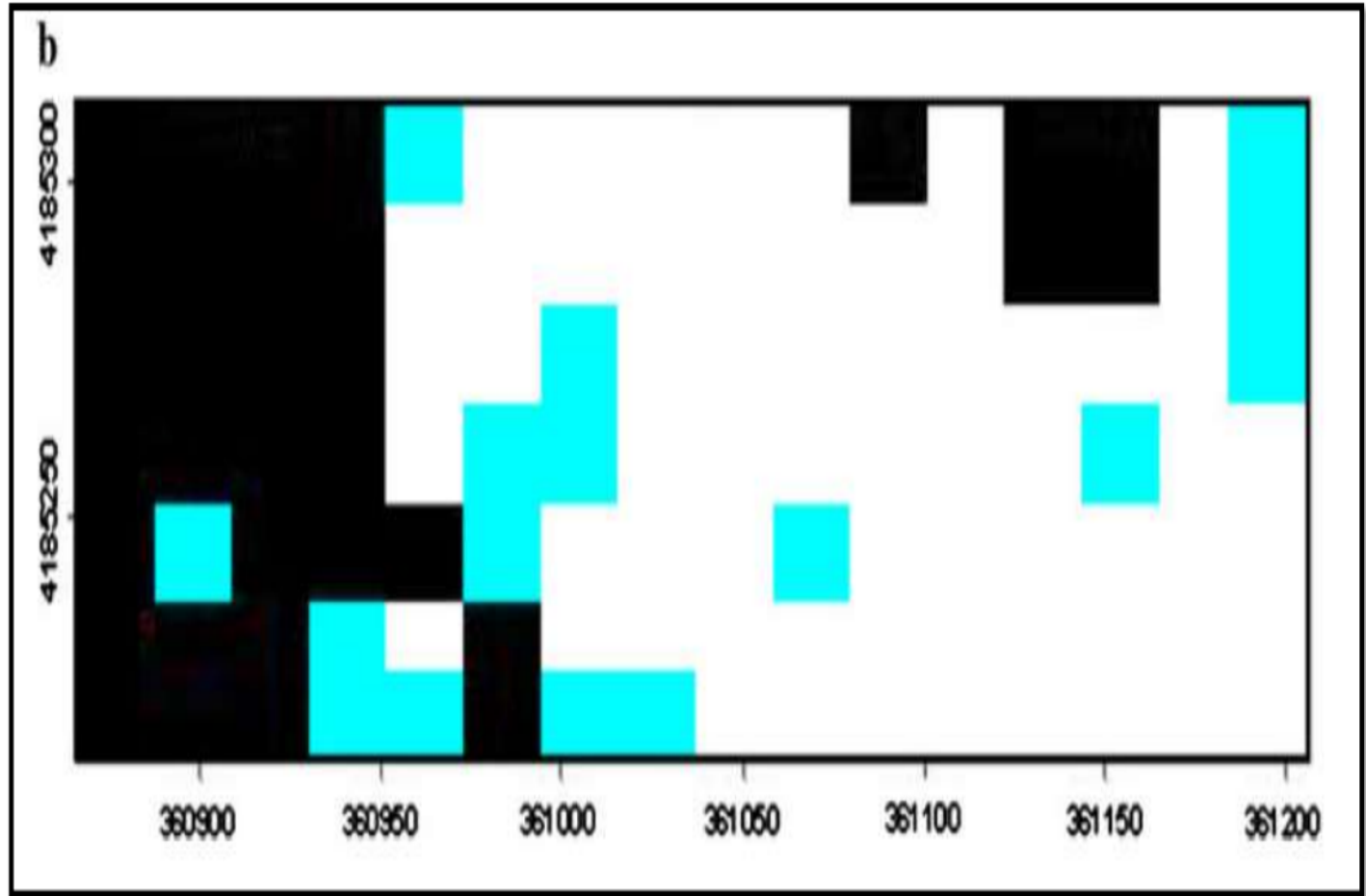


Fig. 7 (b). Herbicide prescription map: image processing characteristics and micro-plot classification criteria are described in the SARI Software.



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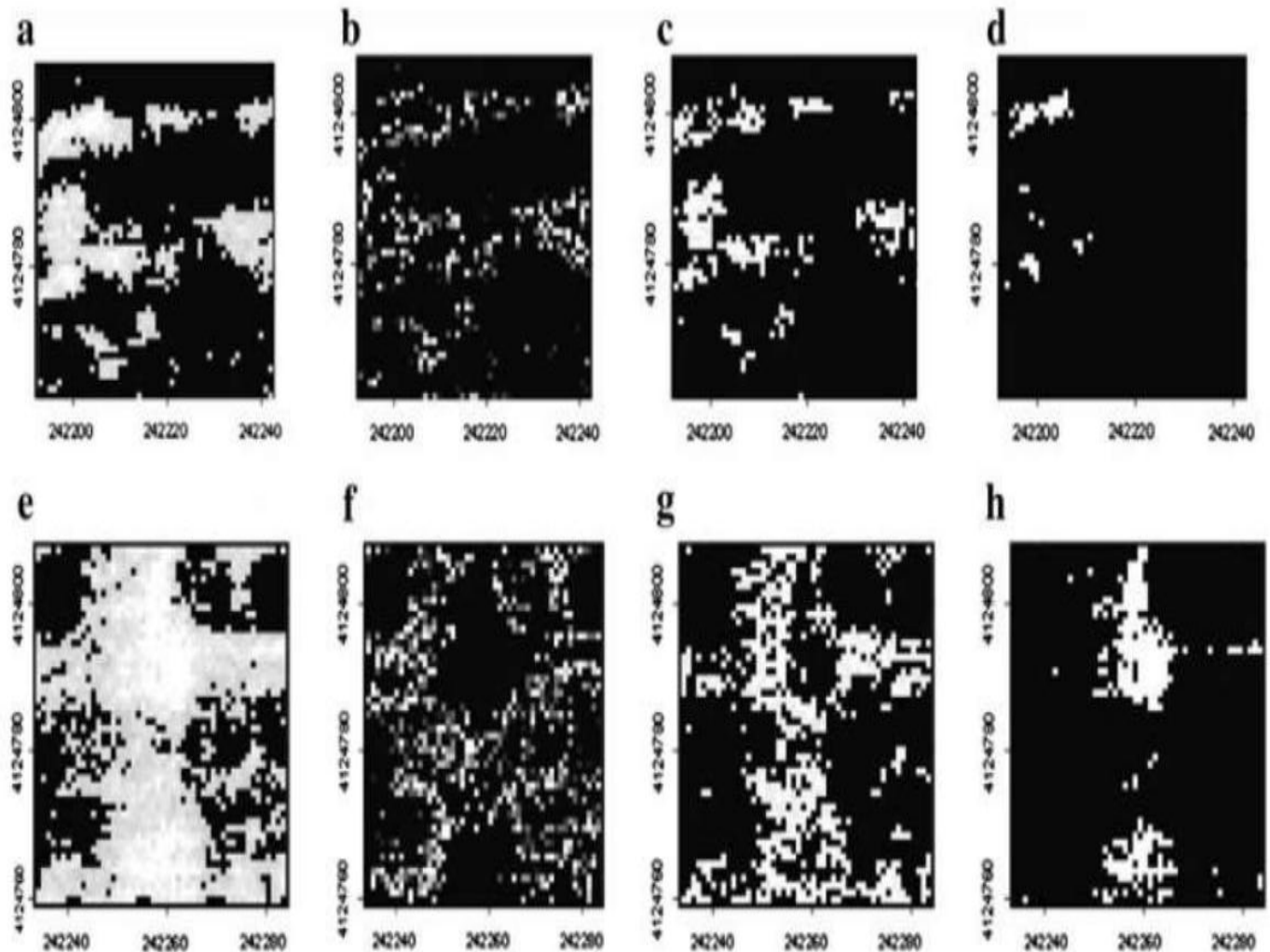


Fig. 7. (c). View of the two selected wild oat patches of LaFlorida II (a to d and e to h) classified by infestation intensity: a, e overall (NDVI values 0.56-0.80); b, f low (0.56-0.60); c, g intermediate (0.61-0.67); and d, h high (0.68-0.8).



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8. Remote sensing of soybean canopy as tool to map high pH, calcareous soils at field scale



Fig. 8 (a). Aerial photograph showing spatial patterns in soybean growth

Blackmer *et al.*, (2009)



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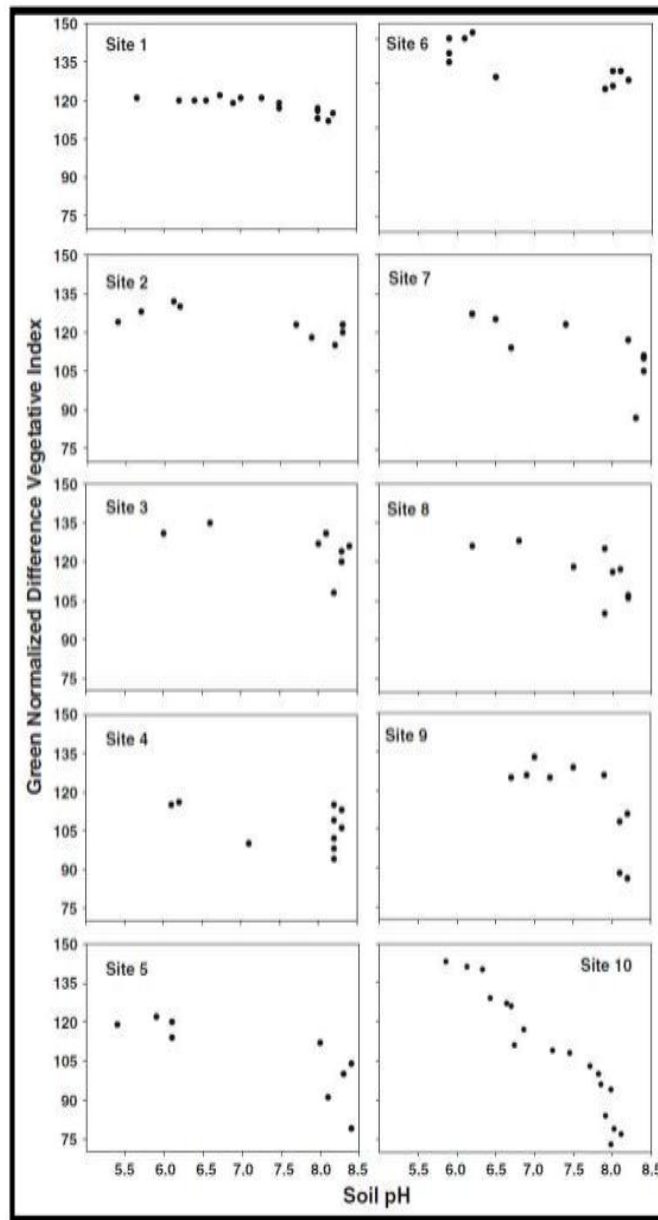


Fig. 8 (b). Relationship between soil pH and GNDVI values



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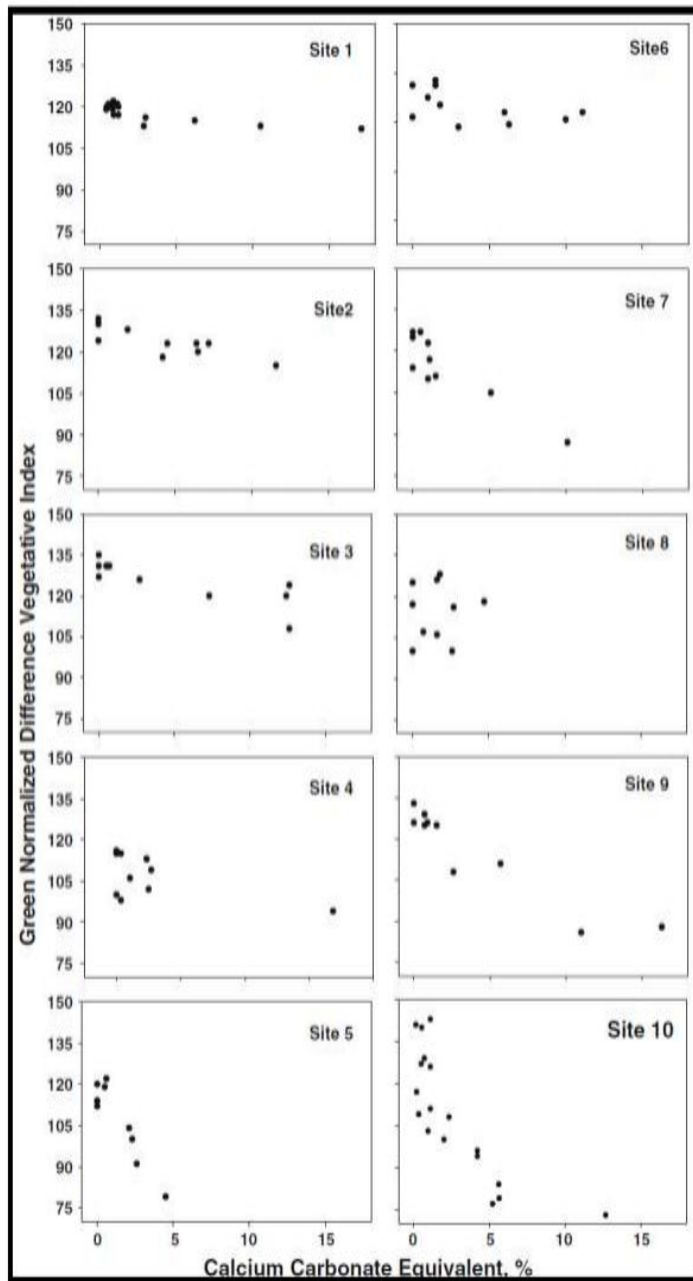


Fig. 8 (c). Relationship between CCE and GNDVI values

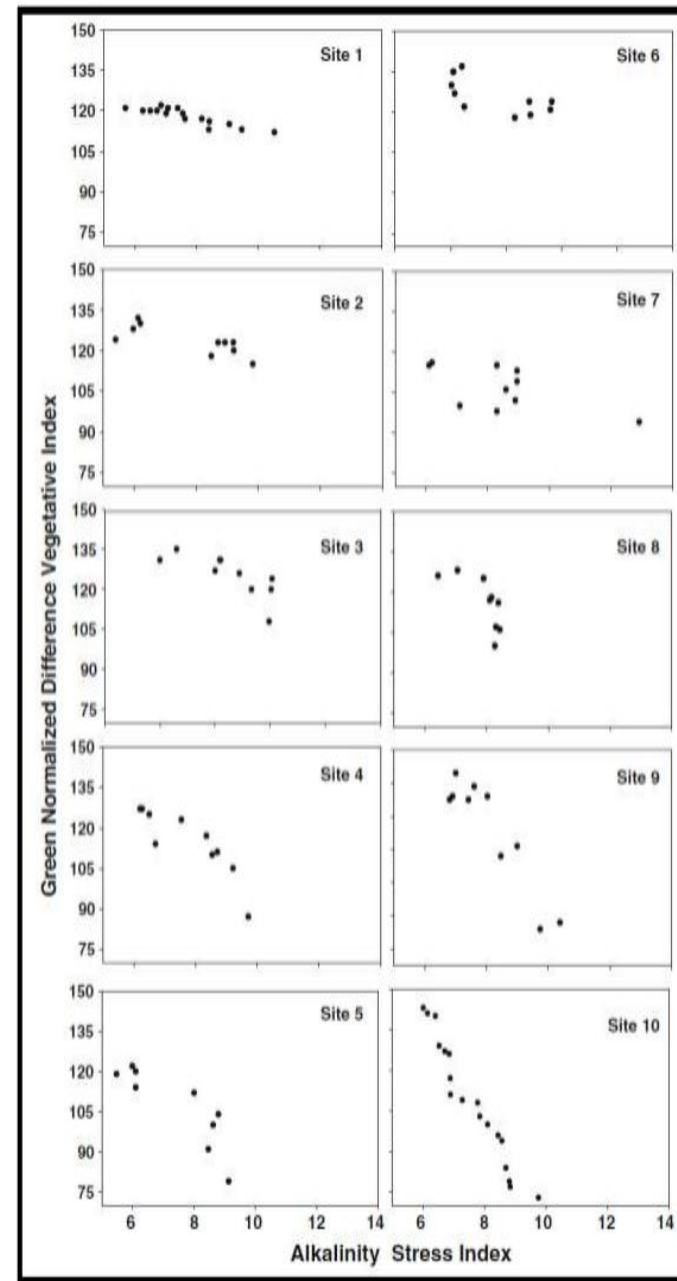


Fig. 8 (d). Relationship between values ASI and GNDVI values



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9. Application of remote sensing and GIS in land use and land cover change detection

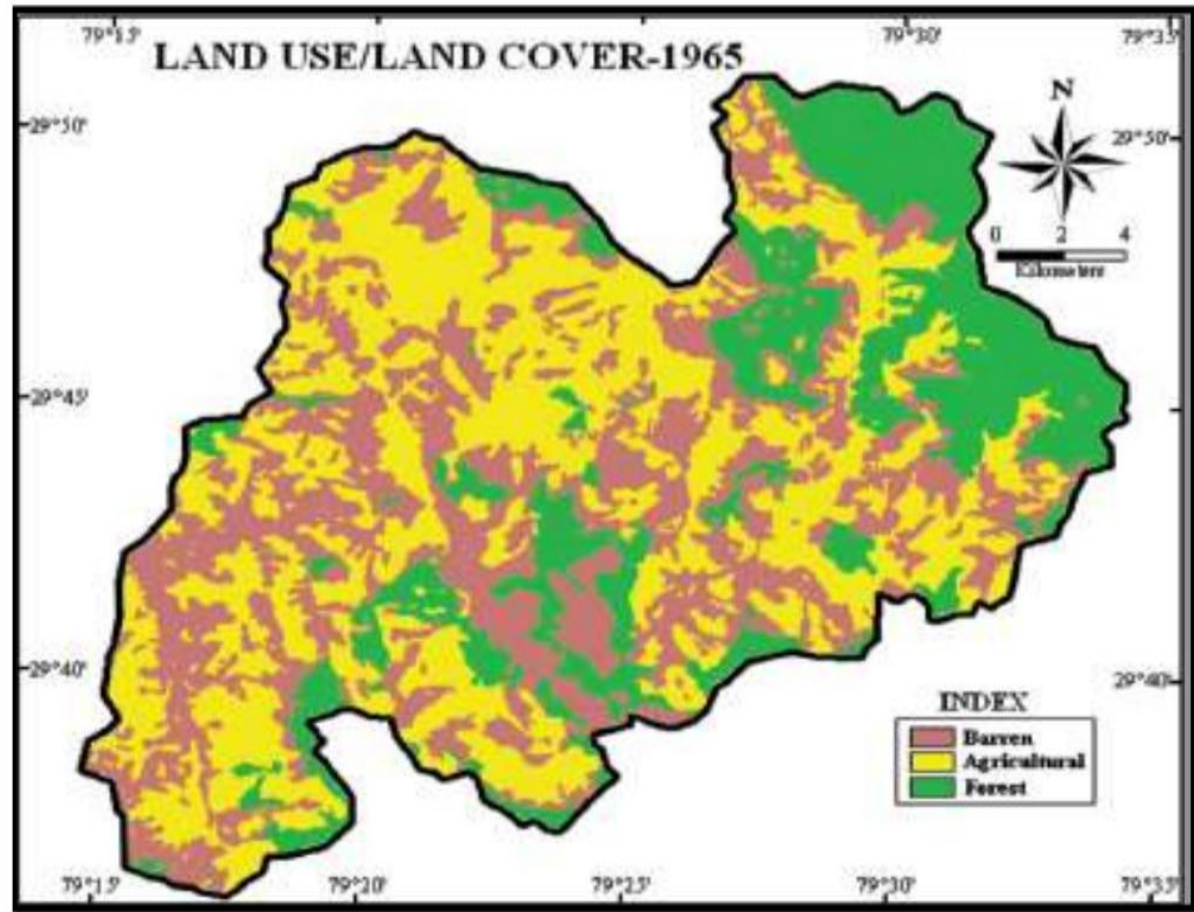


Fig. 9 (a). Land use/land cover pattern in Gagas watershed in 1965



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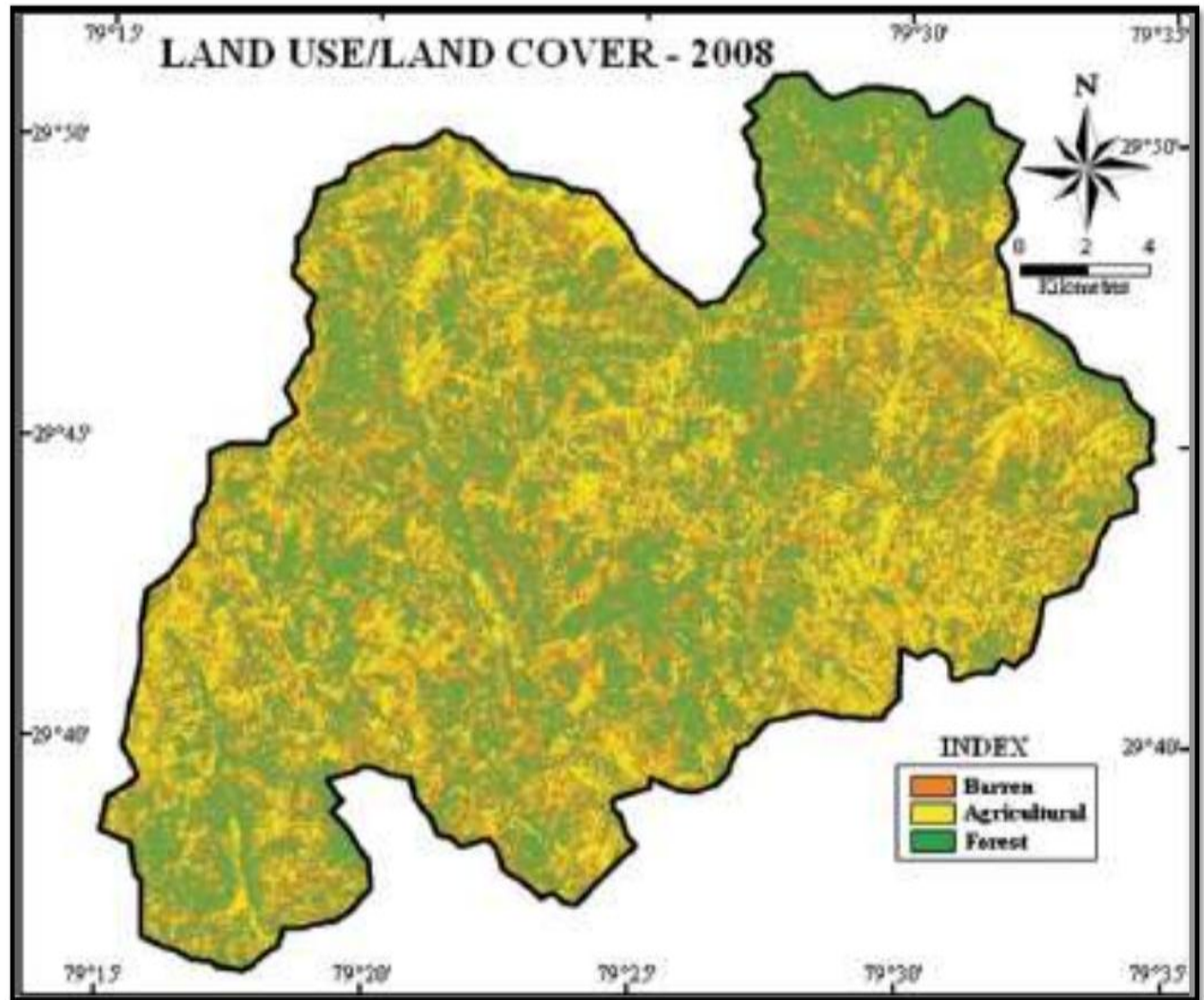


Fig. 9 (b). Land use/land cover pattern in Gagás watershed in 2008



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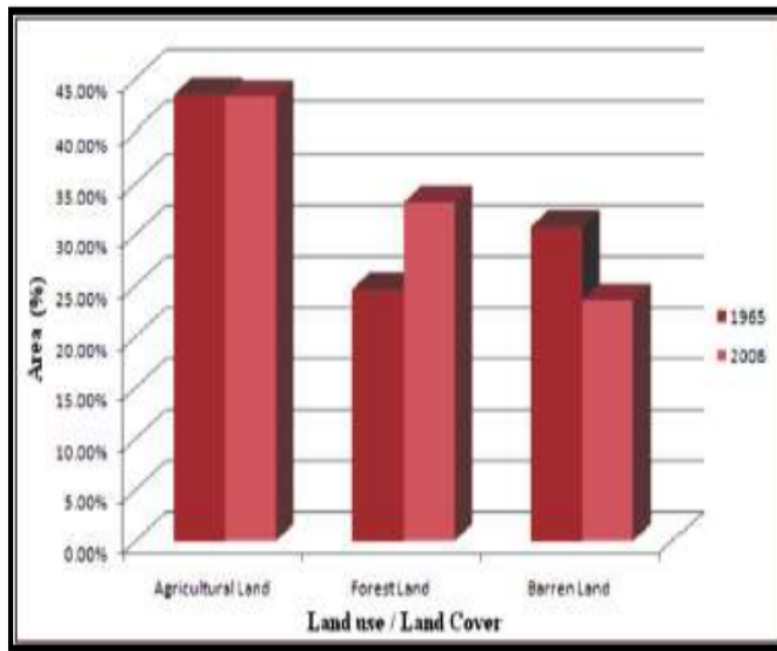


Fig. 9 (c). Distribution of land use/land cover in 1965 and in 2008

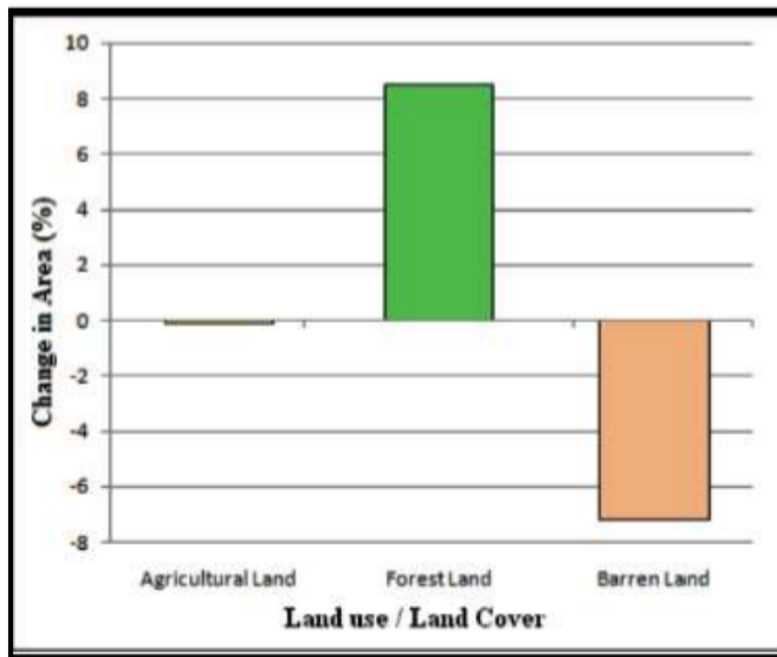


Fig. 9 (d). Percentage change during the last four decades (1965-2008) in land use/land cover in Gagans watershed



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Geographic Information System (GIS) technique

- “It is a computer assisted information system for the acquisition, storage and display of geographic data in a desired manner”.
- GIS is a technology to integrate various social, economical and environmental informations for decision making process.
- GIS is designed to work with data referenced by geographical coordinates.
- **Remote sensing** are powerful tools for the collection of the classified spatial data and **GIS** are powerful tools for the management and analysis of spatial data.

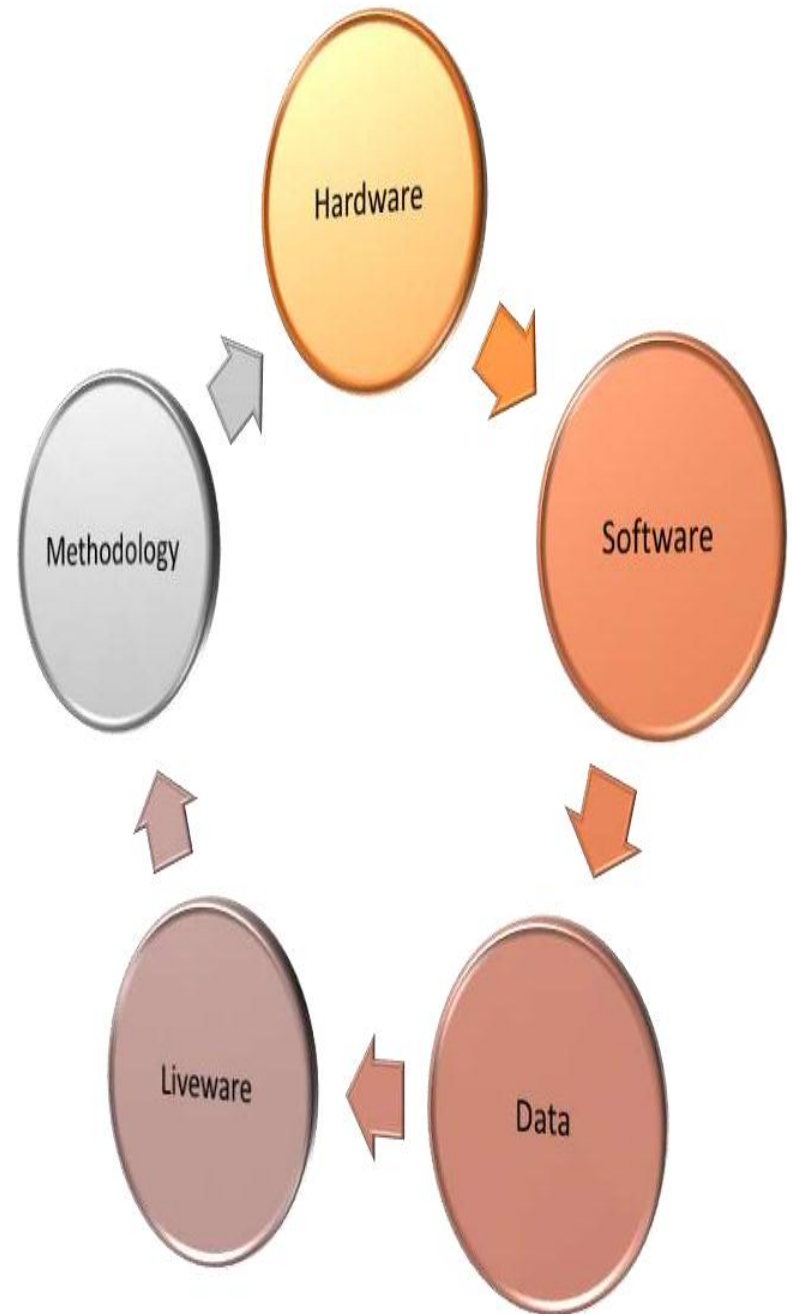


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Components of GIS

Components of GIS





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Objectives of the GIS

- Maximize the efficiency of planning and decision making.
- Provide efficient means for data distribution and handling.
- It minimize data base duplication.
- Geospatial data are better maintained in a standard format.
- Revision and updating are easier.
- Data and information are easier to search and analysis.
- Data can be shared and exchanged freely.
- Better decision can be made.



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Application of GIS technique

- Cadastral, topographic and thematic mapping.
- Surveying.
- Remote sensing, image processing and photogrammetry.
- Earth sciences and geographical application.
- Assist in decision makers to select alternatives resources.
- Environmental pollution and natural hazards management.
- Planning for urban area management, transportation, architecture, conservation and landscaping.
- To locate wild life habitat and migrational study.



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10. Application of Remote sensing & GIS in Crop Information System for Paddy monitoring in Jamalpur block

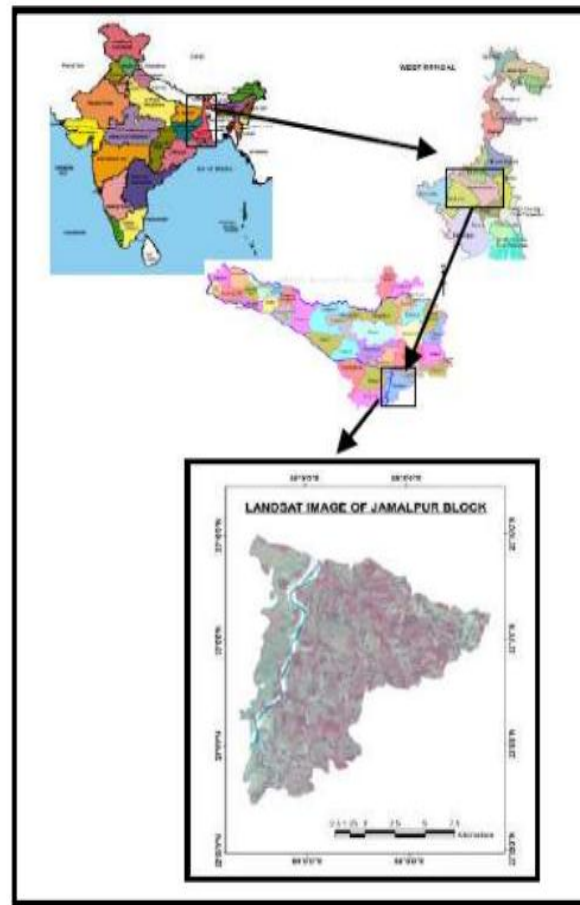


Fig. 10 (a). Location map

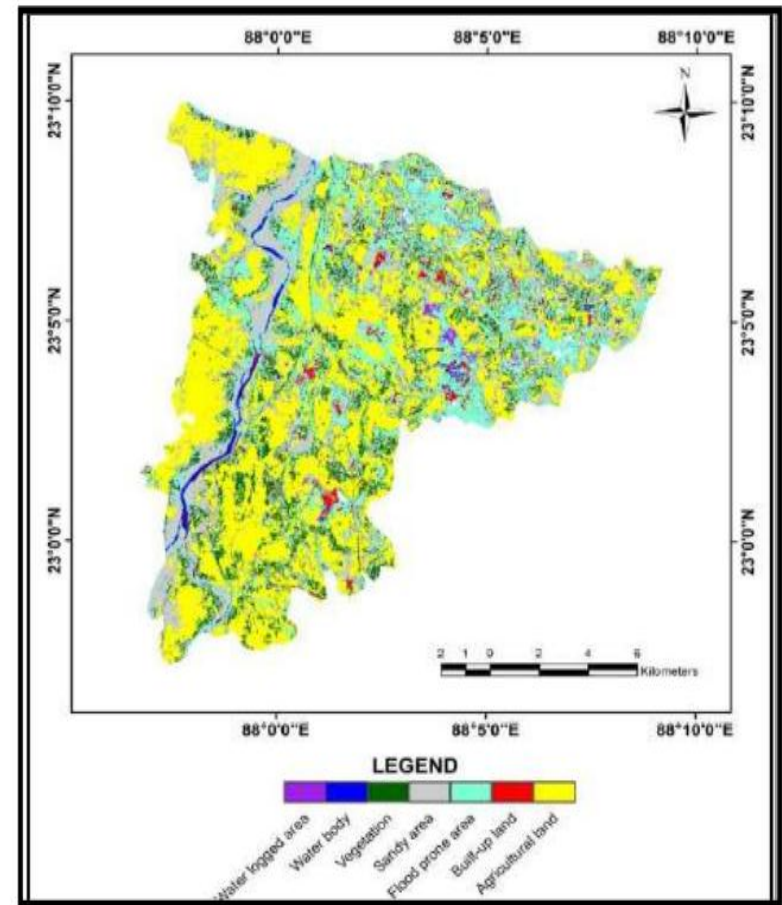


Fig. 10 (b). Land use and Land cover map of Jamalpur Block



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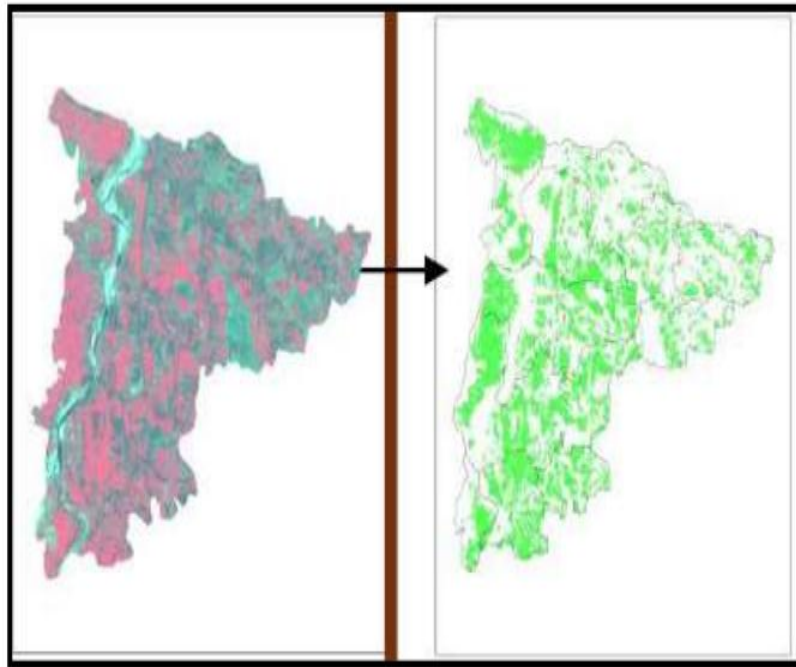


Fig. 10 (c). Spatial distribution of **Aman** derived from January 2010 image

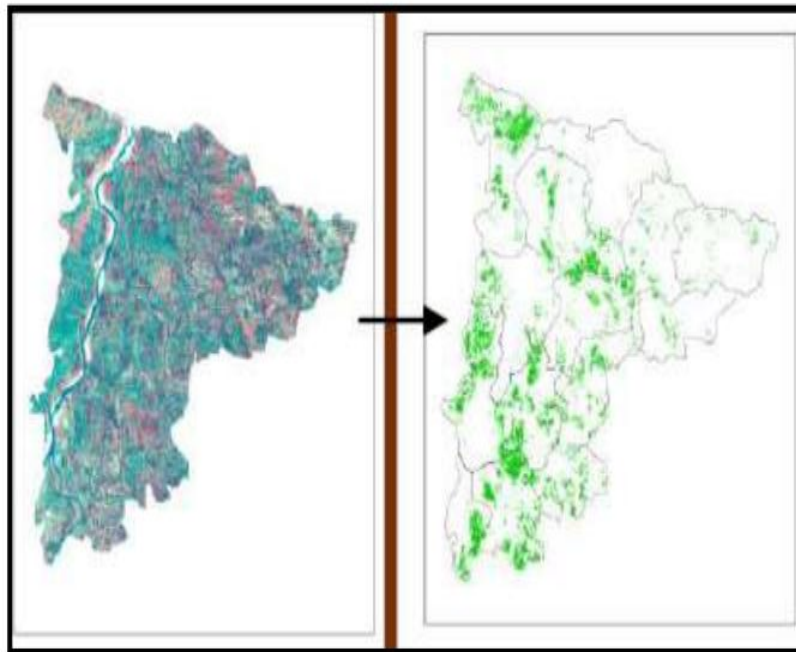


Fig. 10 (d). Spatial distribution of **Aus** derived from July 2010 image



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11. Application of Remote Sensing and GIS for the Assessment of Groundwater Quality

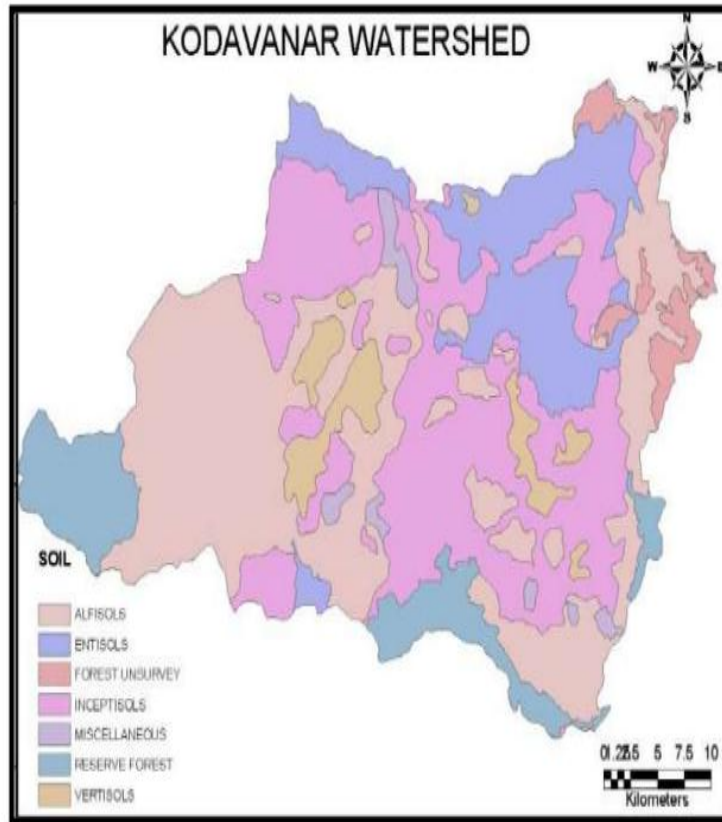


Fig. 11 (a). Soil map of Kodaganar basin

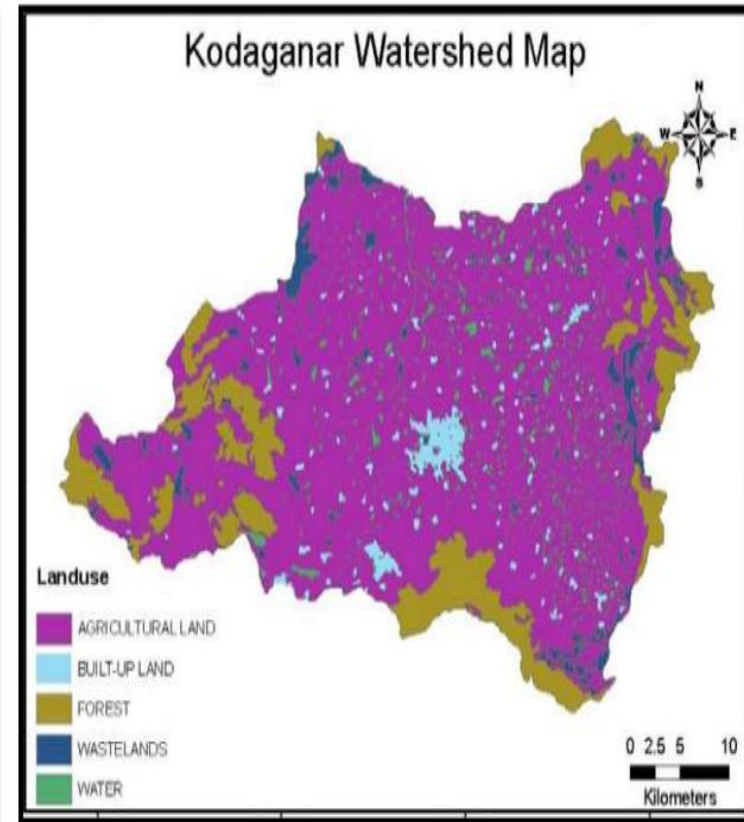


Fig. 11 (b). Land use map of Kodaganar basin



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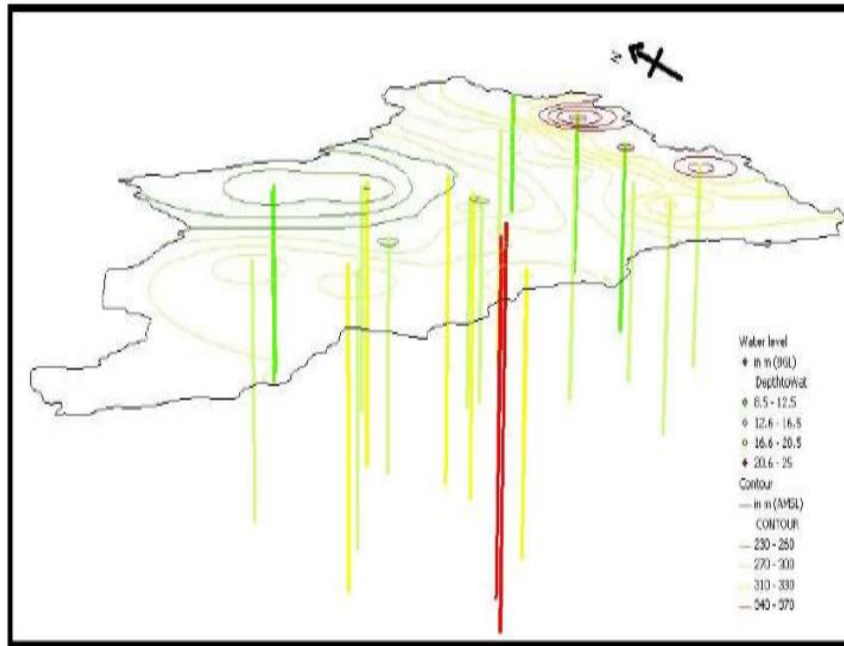


Fig. 11 (c). Terrain and well details of Kodaganar basin

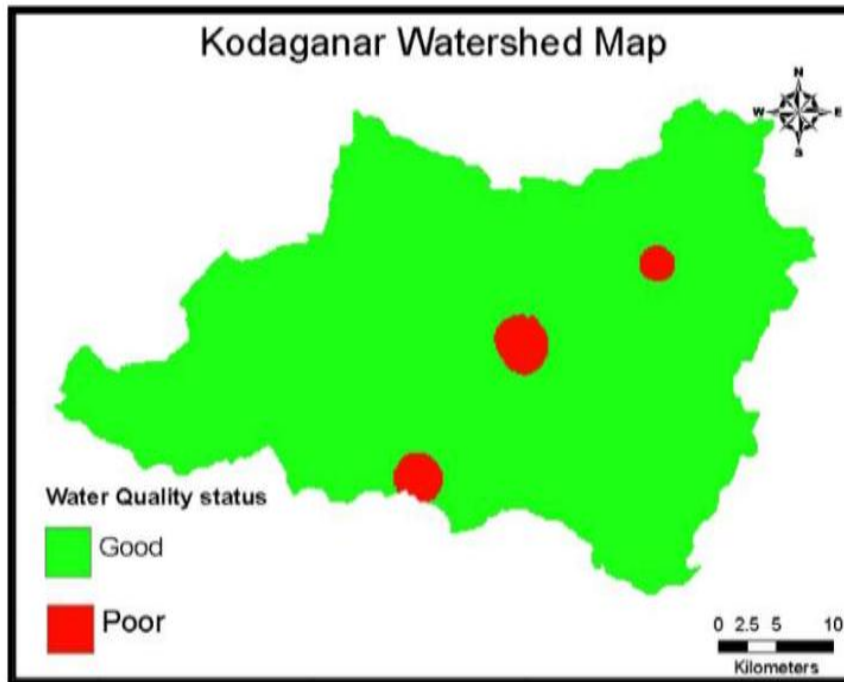


Fig. 11 (d). Groundwater quality map



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12. Variable rate nitrogen fertilizer response in wheat using remote sensing

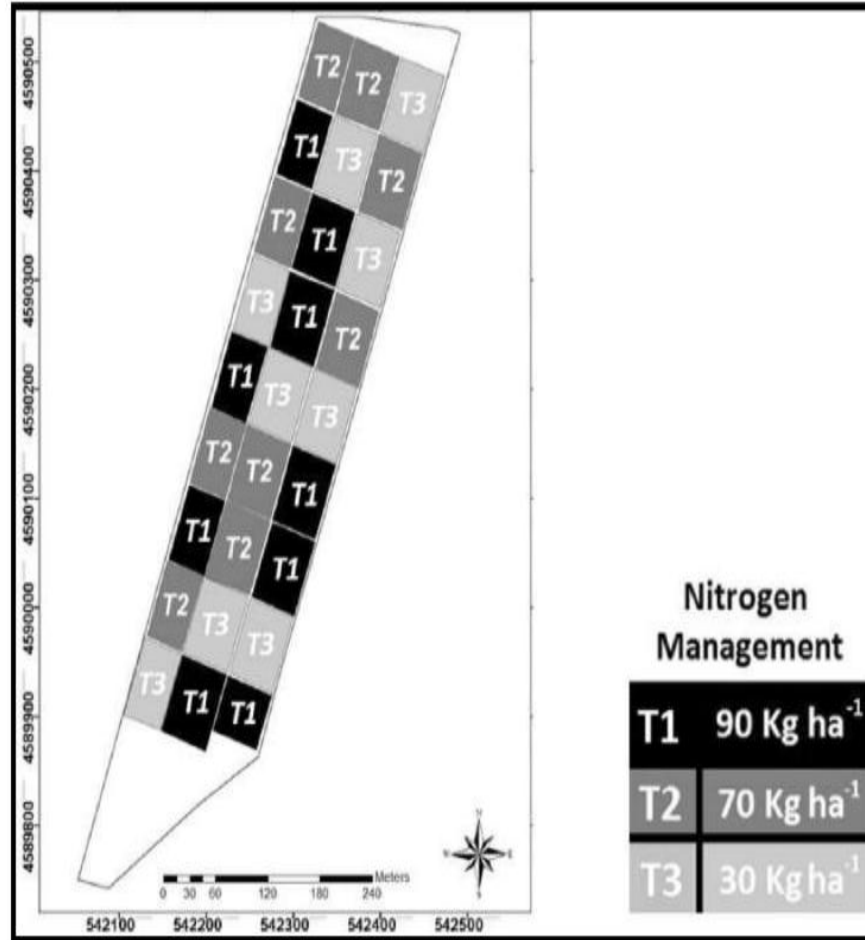


Fig. 12 (a) Spatial distribution of the randomly determined N treatments for the growing seasons 2008/09 and 2009/10

Basso *et al.*, (2016)



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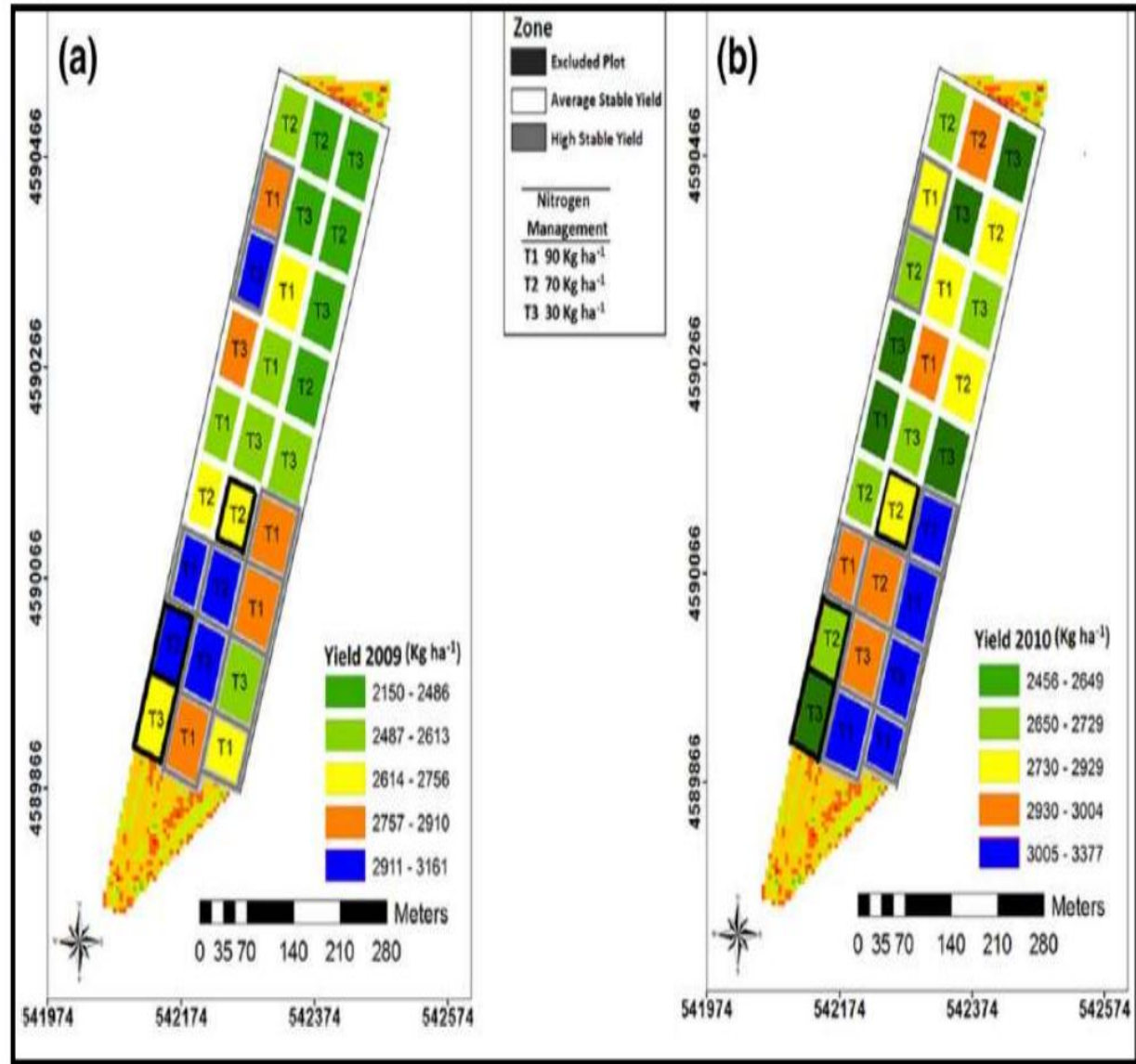


Fig. 12 (b). Map of mean grain yield for each N plot for the 2008/09 growing season, and b the 2009/10 growing season



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Need of GIS....

- Manipulation, Analysis and Modeling can be effectively and efficiently carried out with a GIS.
- GIS are helpful to map and project current and future fluctuations.
- Using technology in making decisions and strategy in the world of intense competition.
- It protects the data from accidental loss.
- Allow efficient storage and retrieval for all the input data.



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Future line of work

- **To effectively utilize the information on crops for improvement of economy there is a need to develop state or district level information system based on available information on various crops derived from remote sensing and GIS approaches.**
- **Hard to raise funds for remote sensing and GIS technology.**
- **Governments can use remote sensing data in order to make important decisions about the policies they will adopt or how to tackle national issues regarding agriculture.**
- **Better communications with remote sensing researchers in government, private and academic institutions.**



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Conclusions

- Remote sensing is a valuable tool in **mapping** and **monitoring** of biodiversity and provides valuable information.
- It is useful for suggesting **action plans** and **management strategies** for agricultural sustainability of any region.
- Remotely sensed images can be used to identify nutrient deficiencies, diseases, water deficiency, weed infestations, insect damage etc.
- Remote sensing technology can be used to assess various abiotic and biotic stresses in different crop.
- These technologies plays an important role in detecting and management of various crop issues even at a small land holding with high resolution.
- Change detection is possible by these technologies in less time with better accuracy.