# Remote Sensing Application in Agriculture and Forestry

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# The tools

## Geomatics

1.GIS technology

2.Remote Sensing Technology

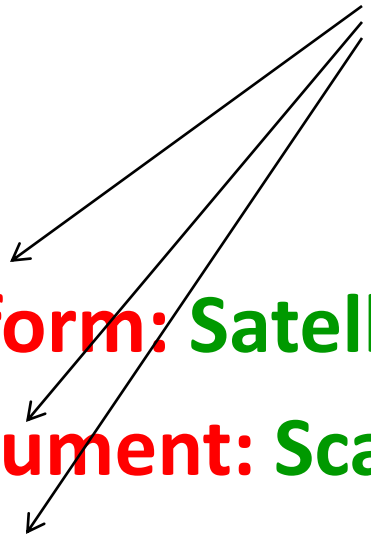
3.GPS Technology

# 2. Remote Sensing – as a tool

# for baseline data gathering …. ?

REMOTE SENSING
IS THE ART AND SCIENCE
OF ACQUIRING INFOFRMATION
ABOUT
AN OBJECT WITHOUT MAKING
ANY PHYSICAL CONTACT

**Information is gathered by instruments carried on suitable platforms. The information is used to study targets of interest on the Earth's surface**



**Platform: Satellite**

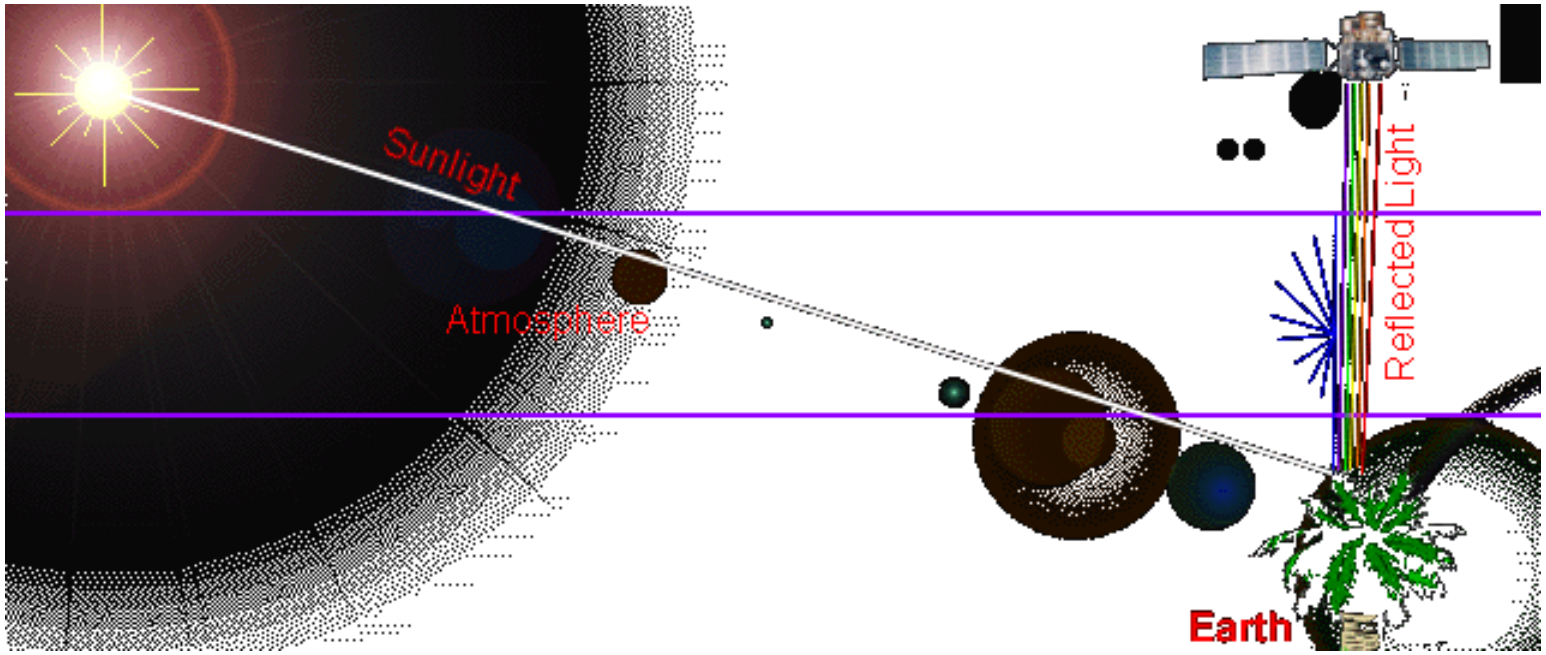
**Instrument: Scanner**

**Target: Land-Water**

Based on Reflected Energy Source

↓

***ELECTROMAGNETIC SPECTRUM***



# MULTIDICIPLINARY ACTIVITY DEALING WITH

***INVENTORY***

***ASSESSMENT OF RSOURCES***

**&**

***MONITORING***

***(basic requirements for evaluation)***

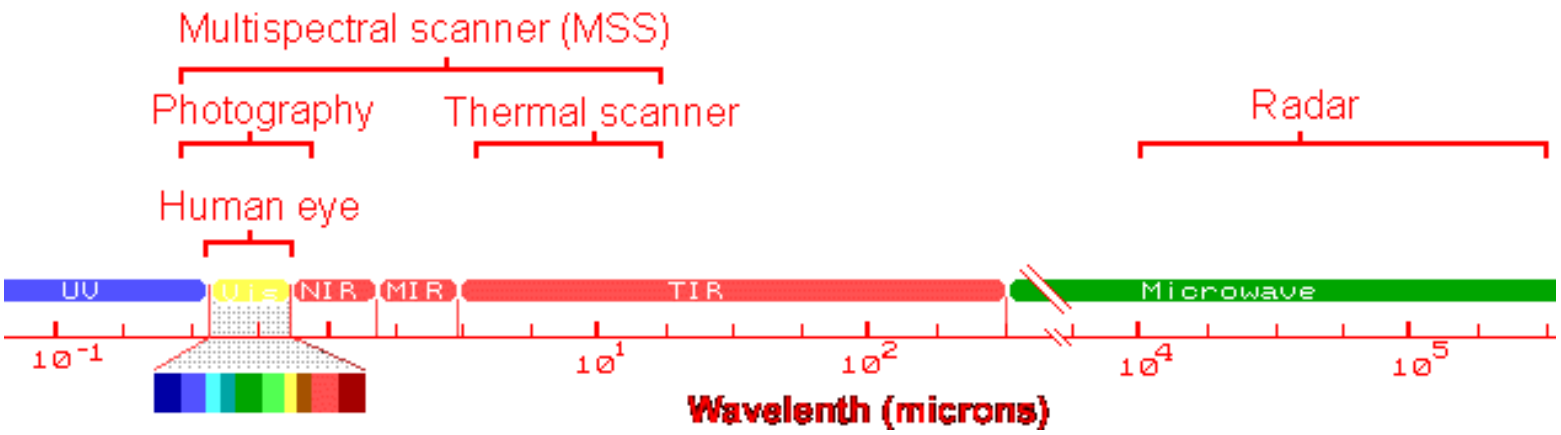
# Characteristic Features

***- Synoptic Nature***

***- Repetitive Coverage of Large Area***

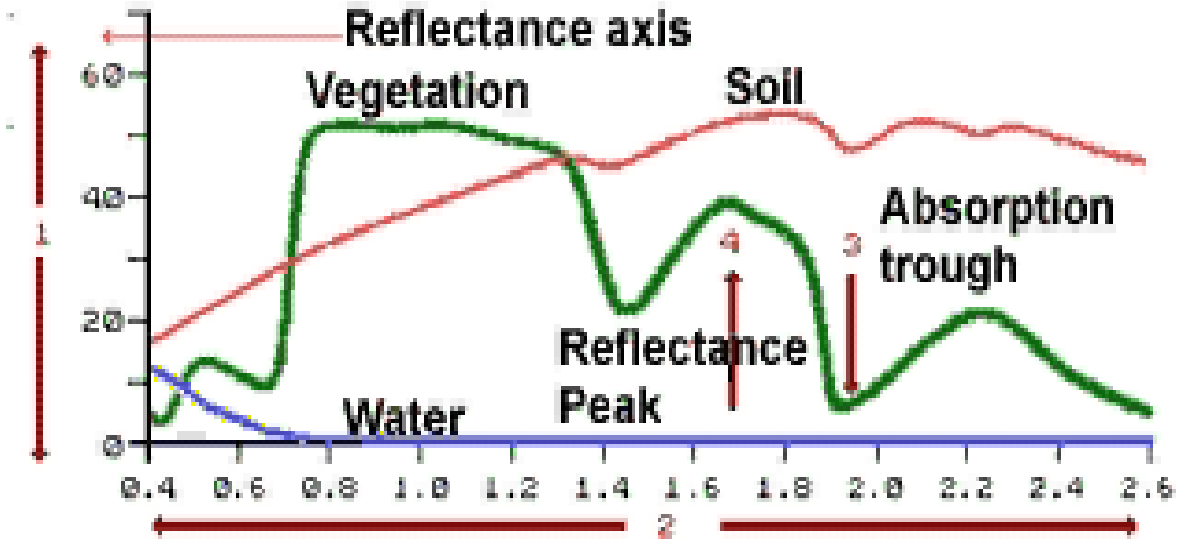
***- Quantifiable Data  Procurement***

# REGIONS OF ELECTROMAGNETIC SPECTRUM

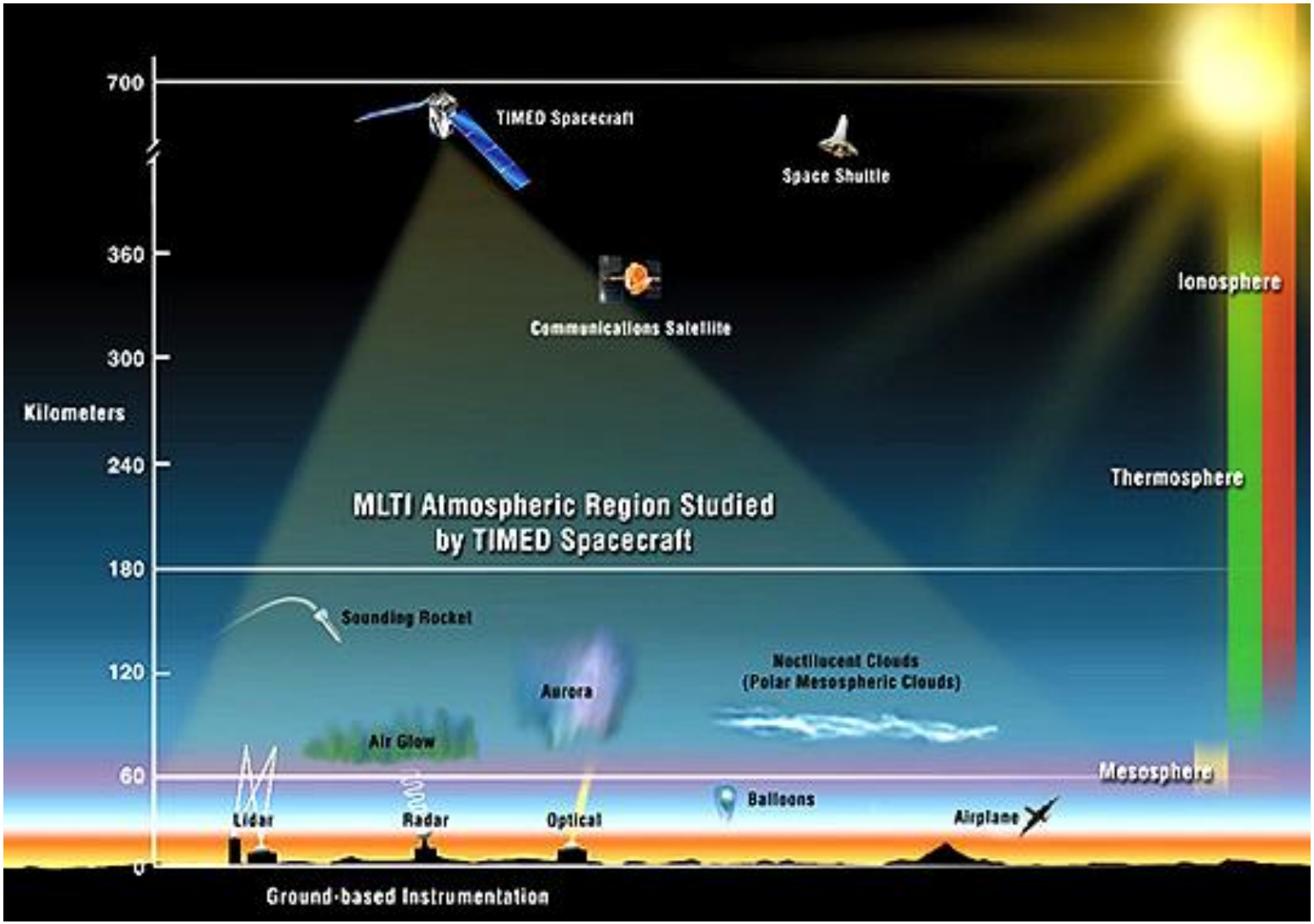



**(covering entire spectrum using appropriate sensor)**

# Spectral reflectance of objects



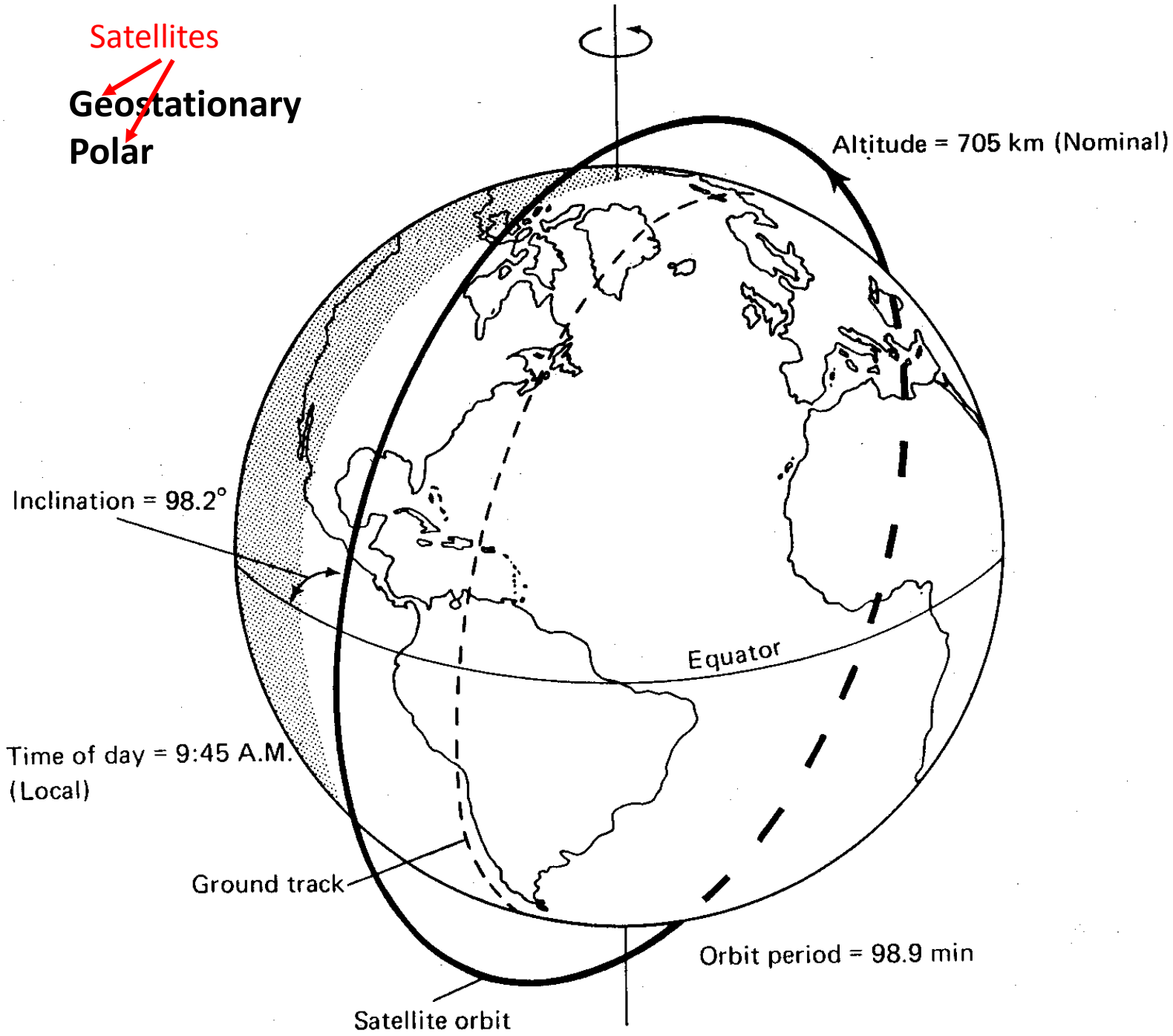
# Multistage Remote Sensing



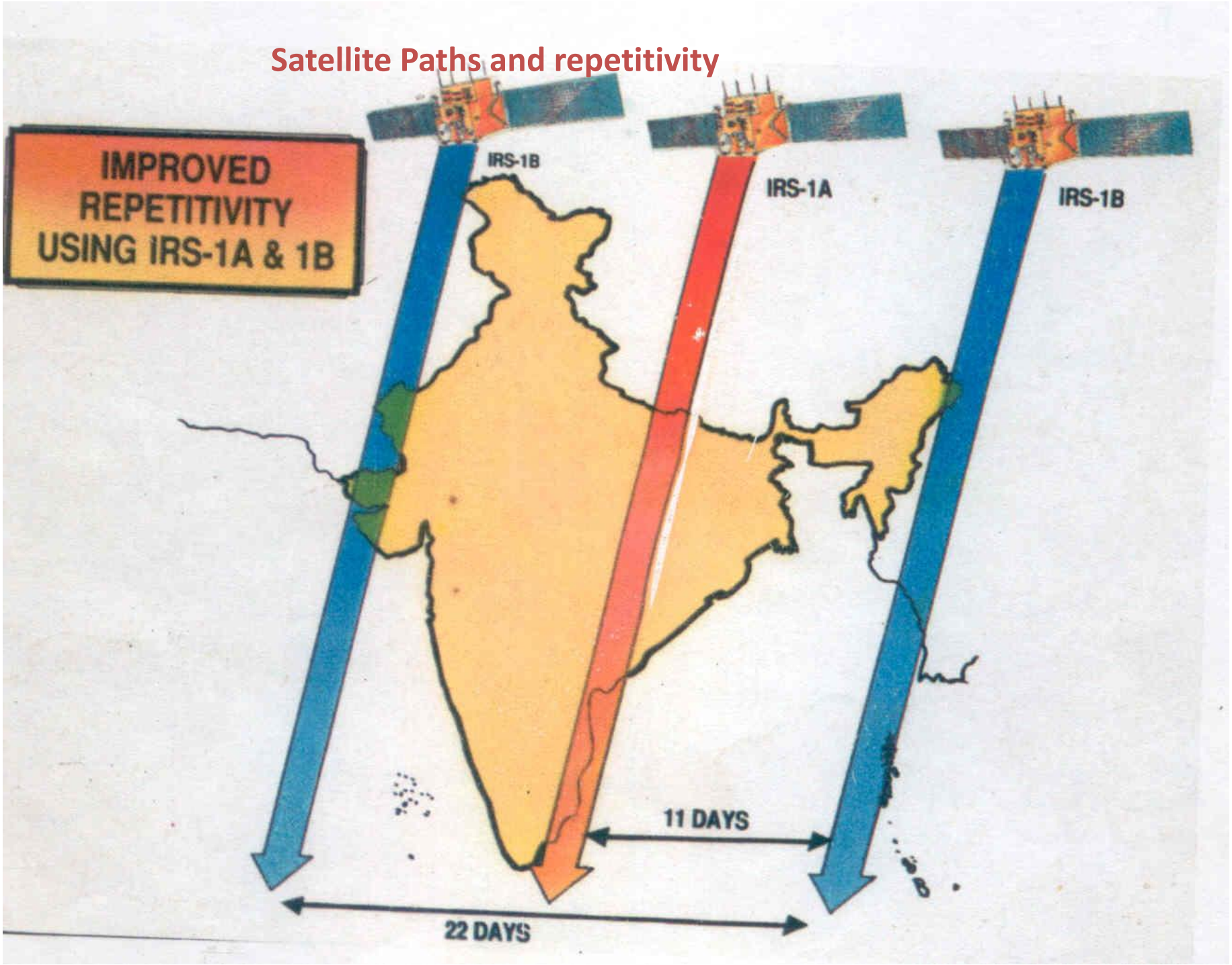
Satellites

**Geostationary**

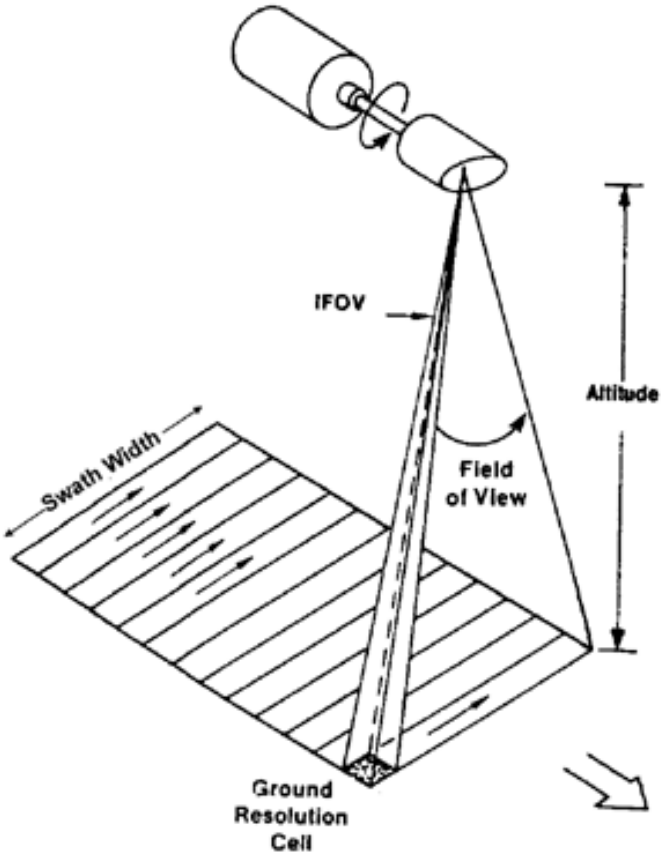
**Polar**

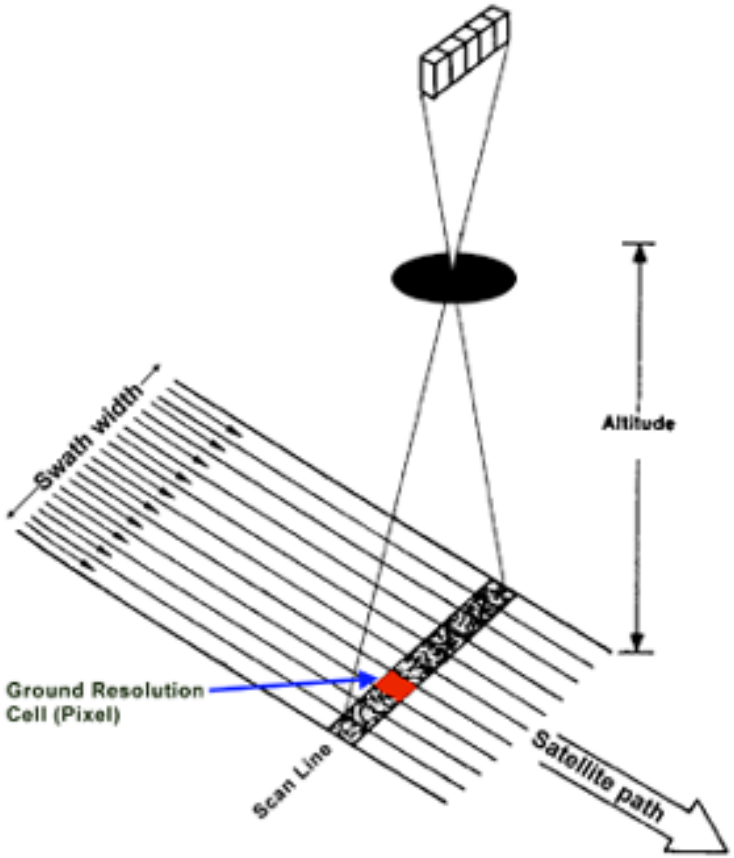


# Satellite Paths and repetitivity



# RECORDING SYSTEMS




WISKBROOM

PUSHBROOM

# Sensor resolution

1. Spatial resolution
2. Spectral resolution
3. Radiometric resolution
4. Temporal resolution

# SENSORS IN INDIAN REMOTE SENSING SATELLITES


LISS II (36.5M)

LISS III (23.5M)

PAN (5.8M)

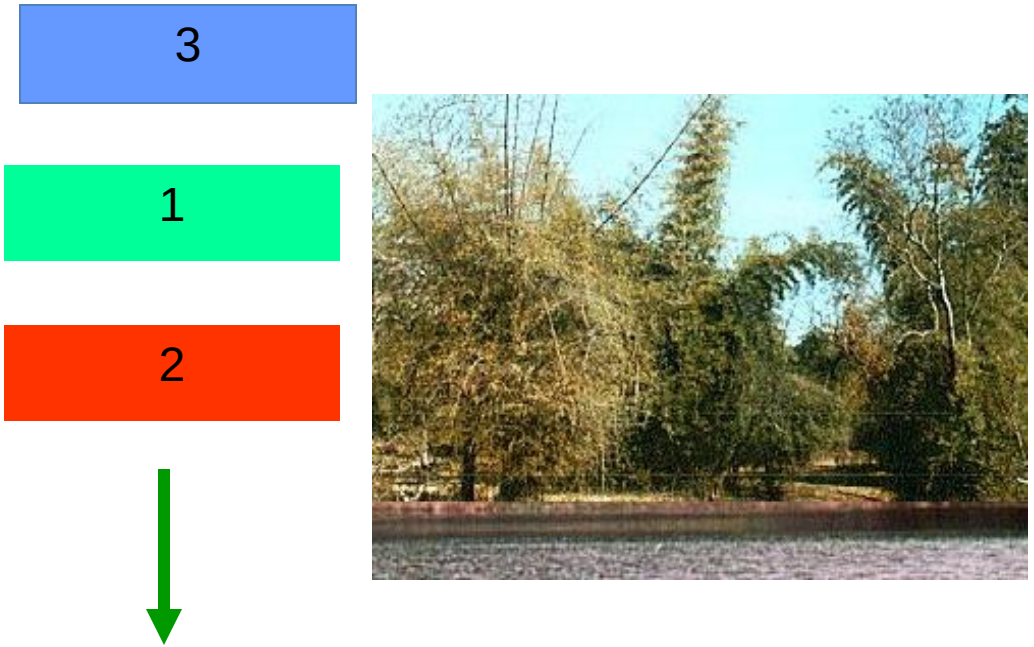
WiFS (188.3M)

**Sensor Resolution - ?**

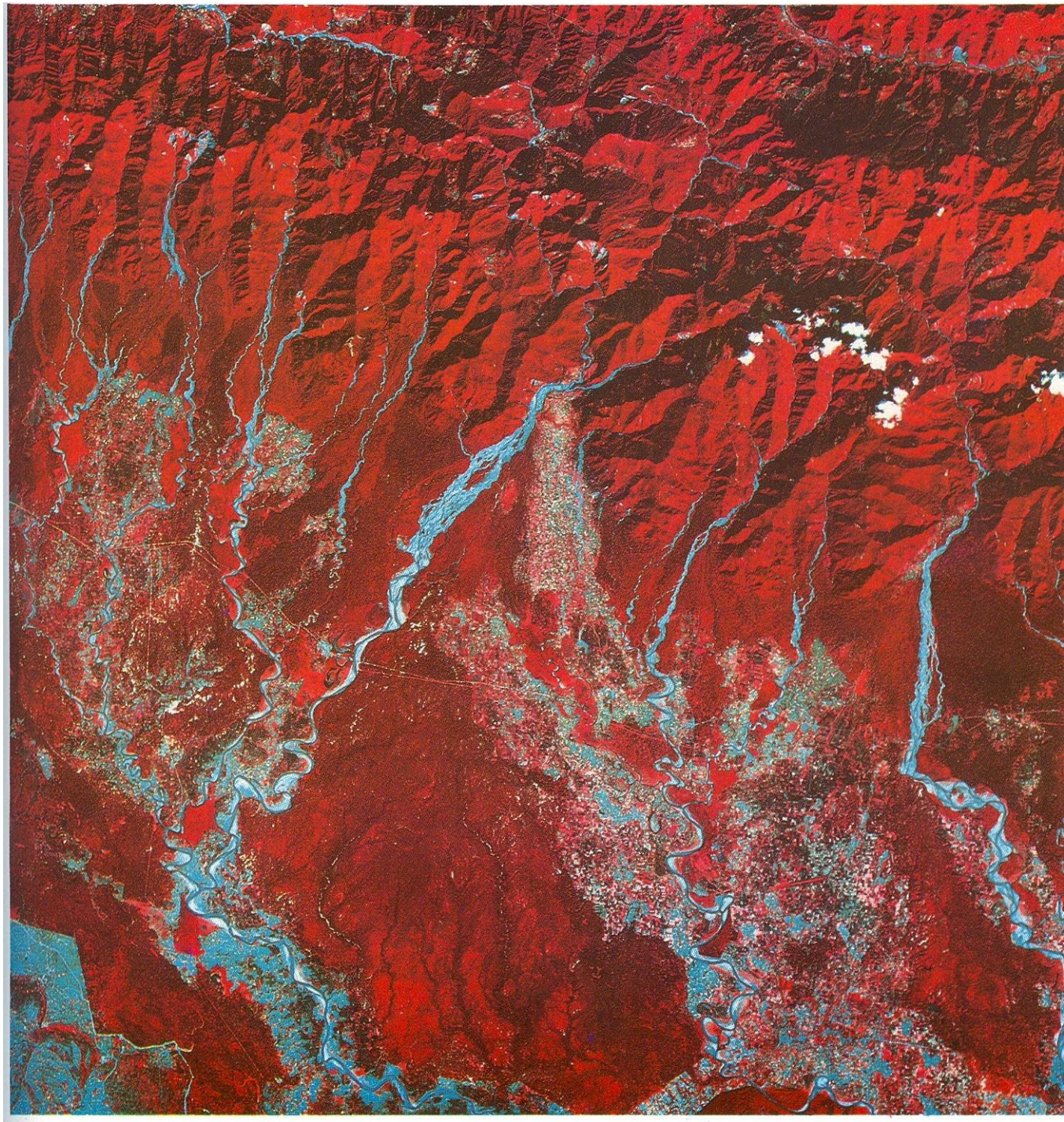
Spatial, spectral, radiometric, temporal

Pan image of Moscow

# Basics of Satellite Remote Sensing



FCC of Shiwalik hills
(Liss3 image)

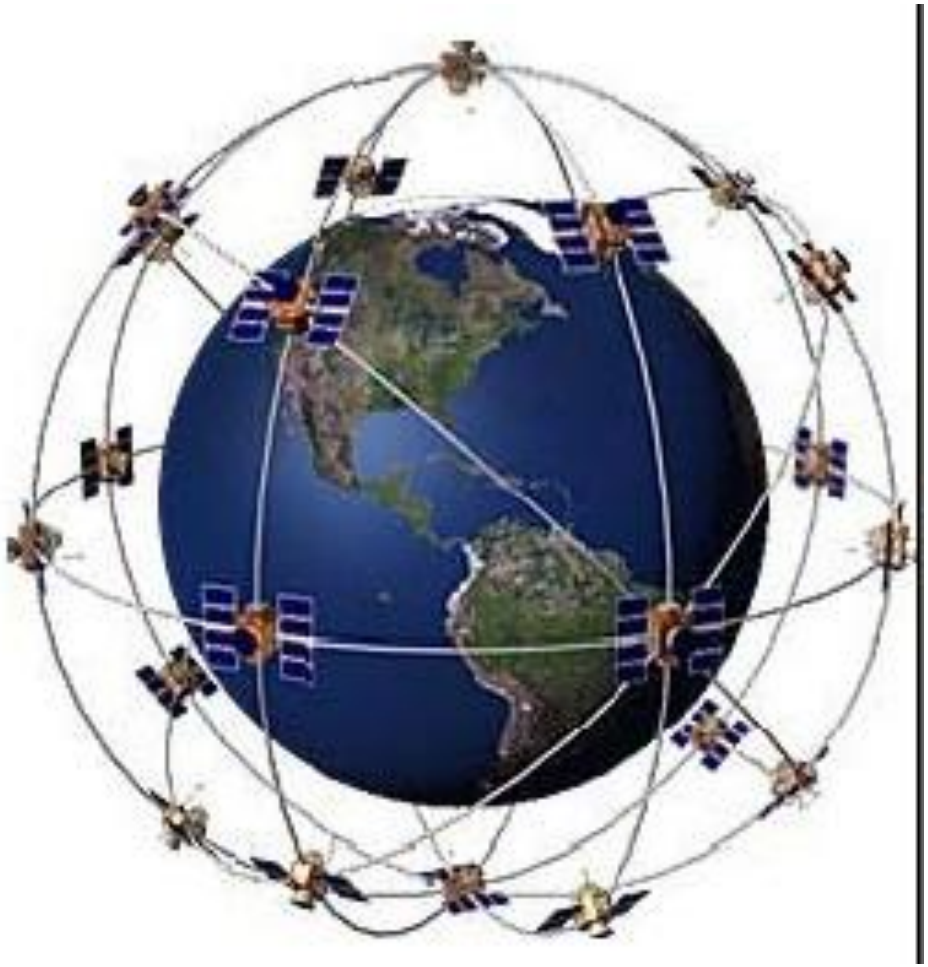


## 2. GPS technology as a tool for accuracy evaluation & mapping

**Geographical Position Fixing:**
**-- using high altitude satellites**
**GPS satellites**

**– using the principles of Trilateration**

GPS satellites



**GPS satellite**

24 numbers
6 orbits
22,200km altitude

**Trilateration is a basic geometric principle that allows you to find one location if you know its distance from other, already known locations.**

**Trilateration:** **Receiver must track at least four satellites to calculate 3-D position**

**3-D position is: Latitude, Longitude and Altitude**

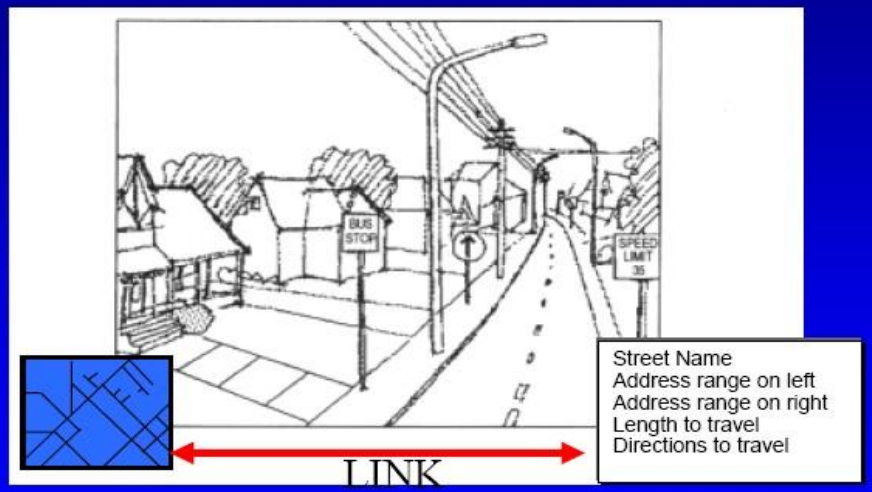
**GPS receiver must "solve" for X,Y,Z and Time**

**If GPS unit is only tracking 3SV, 2-D position will be computed (XY).**

# 3. GIS as a tool for analysis & modeling

## GIS Data

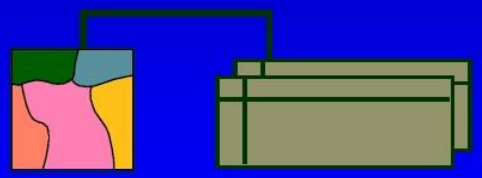
Geographic features are represented by two types of data.




**SPATIAL DATA** **ATTRIBUTE DATA**

## GIS - Technology

- Spatial (Location) Data
- Non Spatial (Attribute) Data
- Linkage
- Query
- Analysis



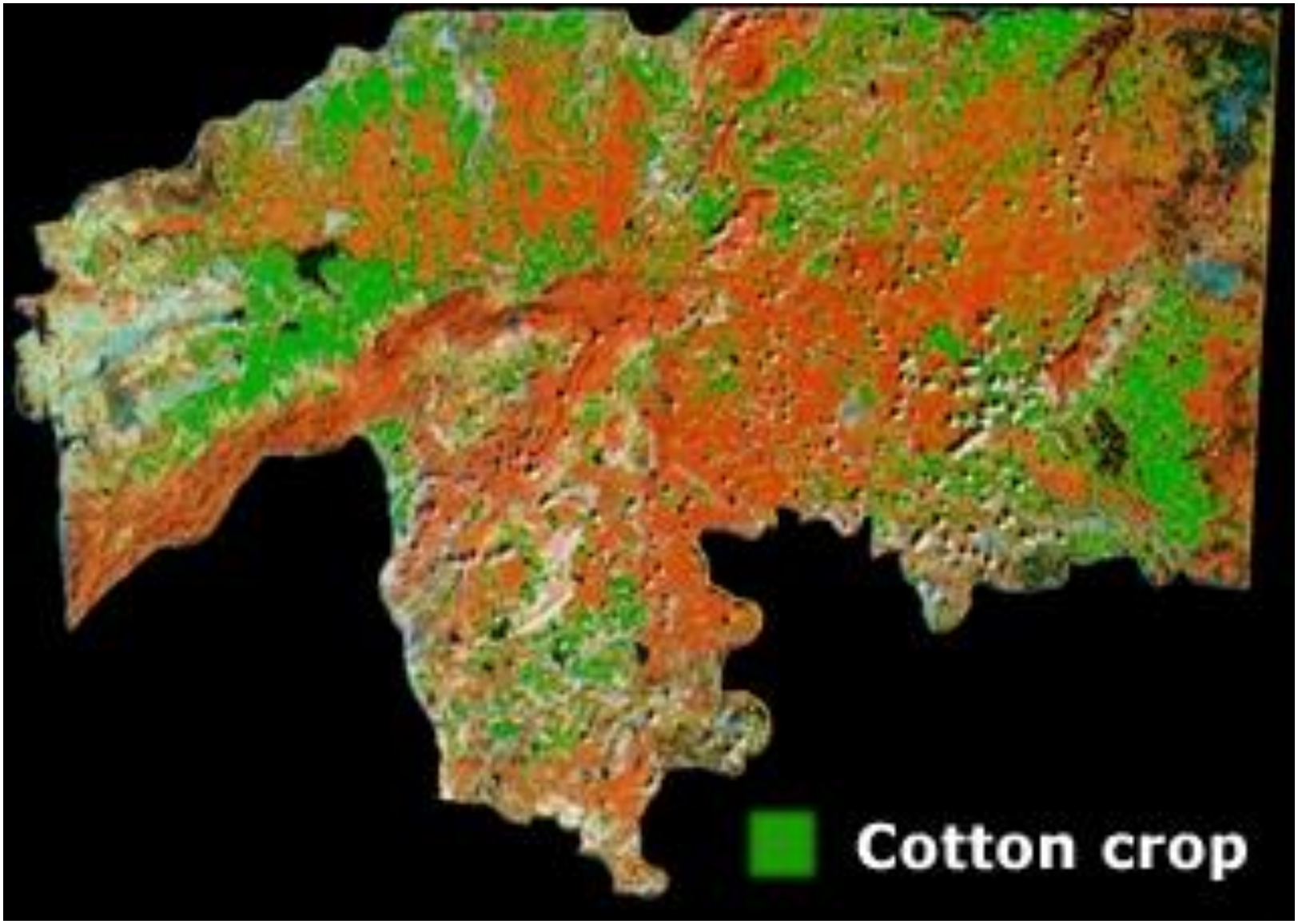
# Agricultural application:

**The utilization of space-bourn multispectral data for crop acreage and production estimation started in seventies with the launching of the Large Area Crop Inventory Experiment (LACIE) jointly by NASA, USDA and NOAA (National Oceanic and Atmospheric Administration) in 1974.**

**In India the satellite remote sensing is mainly used for the crop acreage and production estimation of agricultural crops.**

**The methodology for acreage and production estimation** using Indian Remote Sensing Satellite (IRS1A/1B) has been in operation for **major crops**, namely, **wheat, paddy, sorghum, soybean, groundnut and cotton** in the monocropped areas (Space Application Centre, 1990).

In 1970 ISRO carried out a very interesting and promising experiment for IARI, in detecting **coconut root wilt disease in Kerala** before it was visible on ground.


Cotton crop

# 1. Identification, area estimation and monitoring:

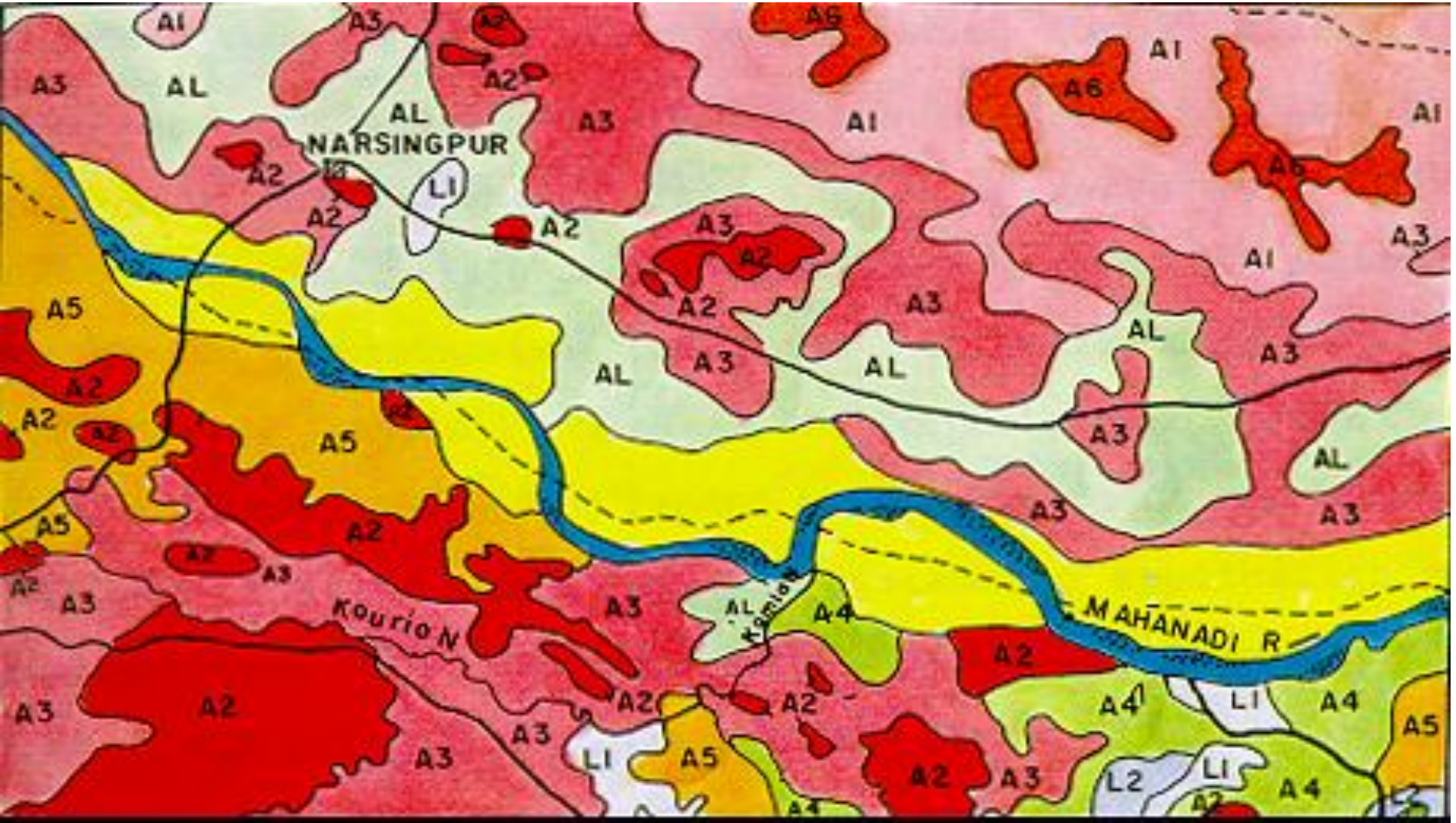
**The specific requirement of climate and soil conditions coupled with the specialized management practices make the distribution of plantation crops** rather more **localized in comparison to other agricultural crops.**

**The identification, estimation of growing stock, analysis of distribution and monitoring at regular intervals are major aspects in plantation crops.**

# 2.Crop nutrient deficiency detection:

**The nutrient deficiency in plants affects the color, moisture content and internal structures of the leaves and as a result their reflecting power changes.**

# 3.Soil mapping




Soil map of part of Orissa State
(Based on LISS - II Data)

# 4.Vegetation indices:

**The green, red and NIR reflectance could be employed as variables to estimate the Leaf Area Index (LAI).**

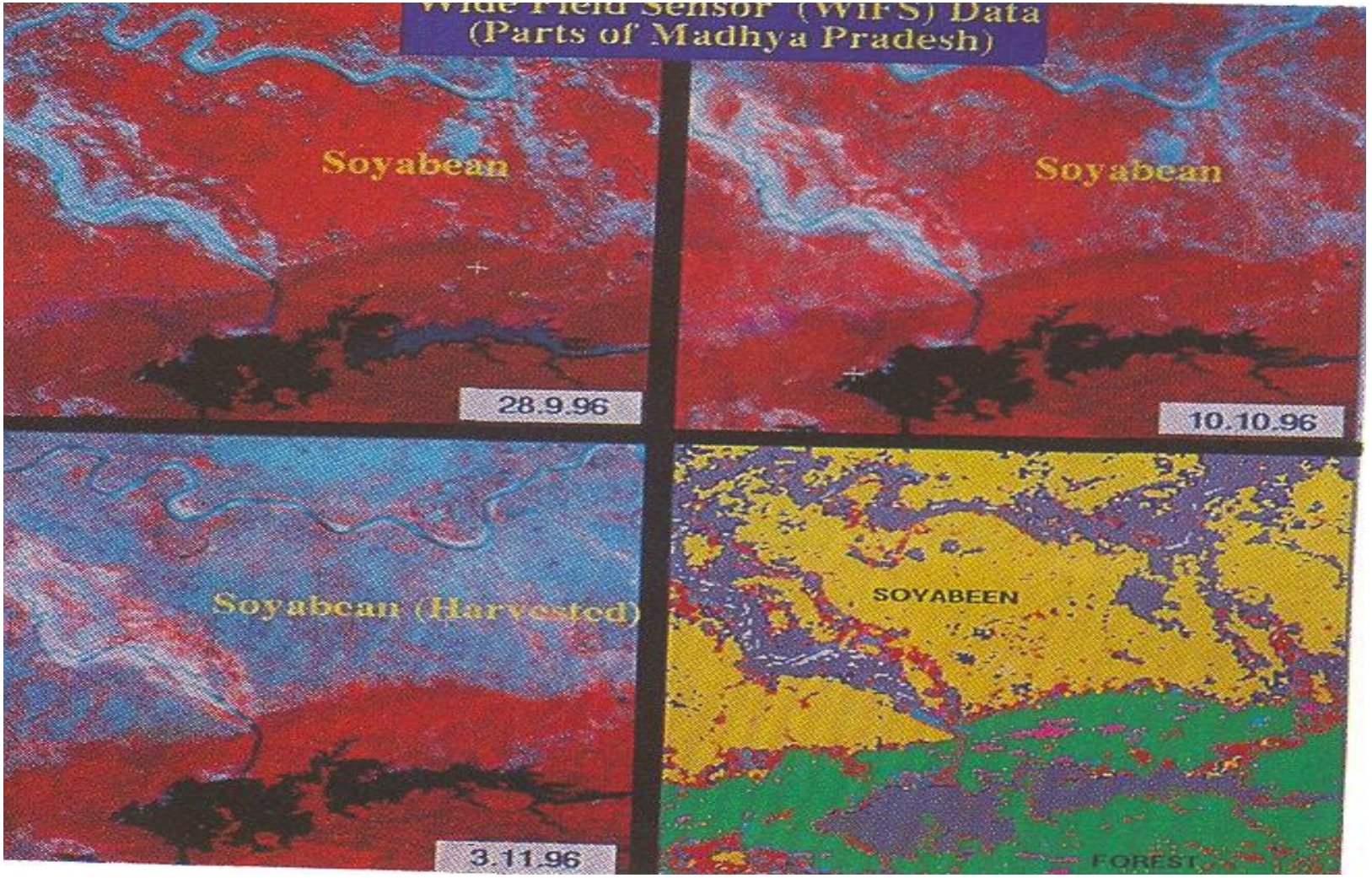
**Many investigations have been conducted to assess crop characteristics, such as biomass, and LAI, by means of combinations of reflectance or digital pixel values in various spectral bands.**

**Such a combination of reflectance values, the vegetation index, also serves to correct for undesirable influences of varying soil reflectance or atmosphere circumstances on the result.**

# 5.Crop condition assessment:

The **physiological changes that occur in a plant due to stress** may change the spectral reflectance/ emittance 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**.

# 6.Phenological studies



# 7.Spatial signature library:

**Spatial signature evaluation** of the species and the reflectance properties of different species in **different phonological stages and growth stages** are yet to be explored.

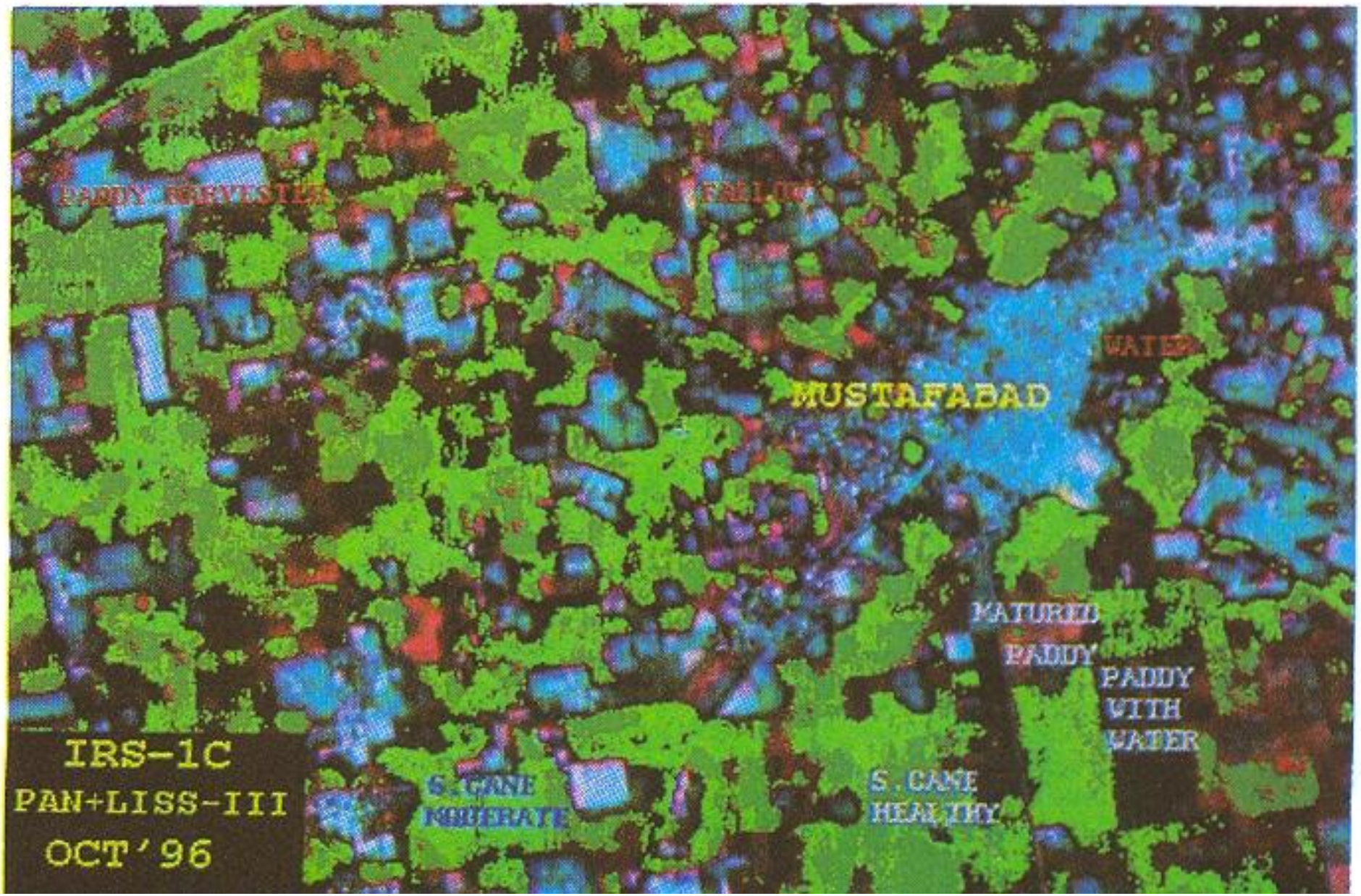
The work on this line on **crop reflectance properties** are conducted by organizations like Space Application Center, Ahemadabad.

# 8.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.

# Crop evaluation



# 9.Pest management:

**Integrated pest management is an important component of sustainable agriculture**.

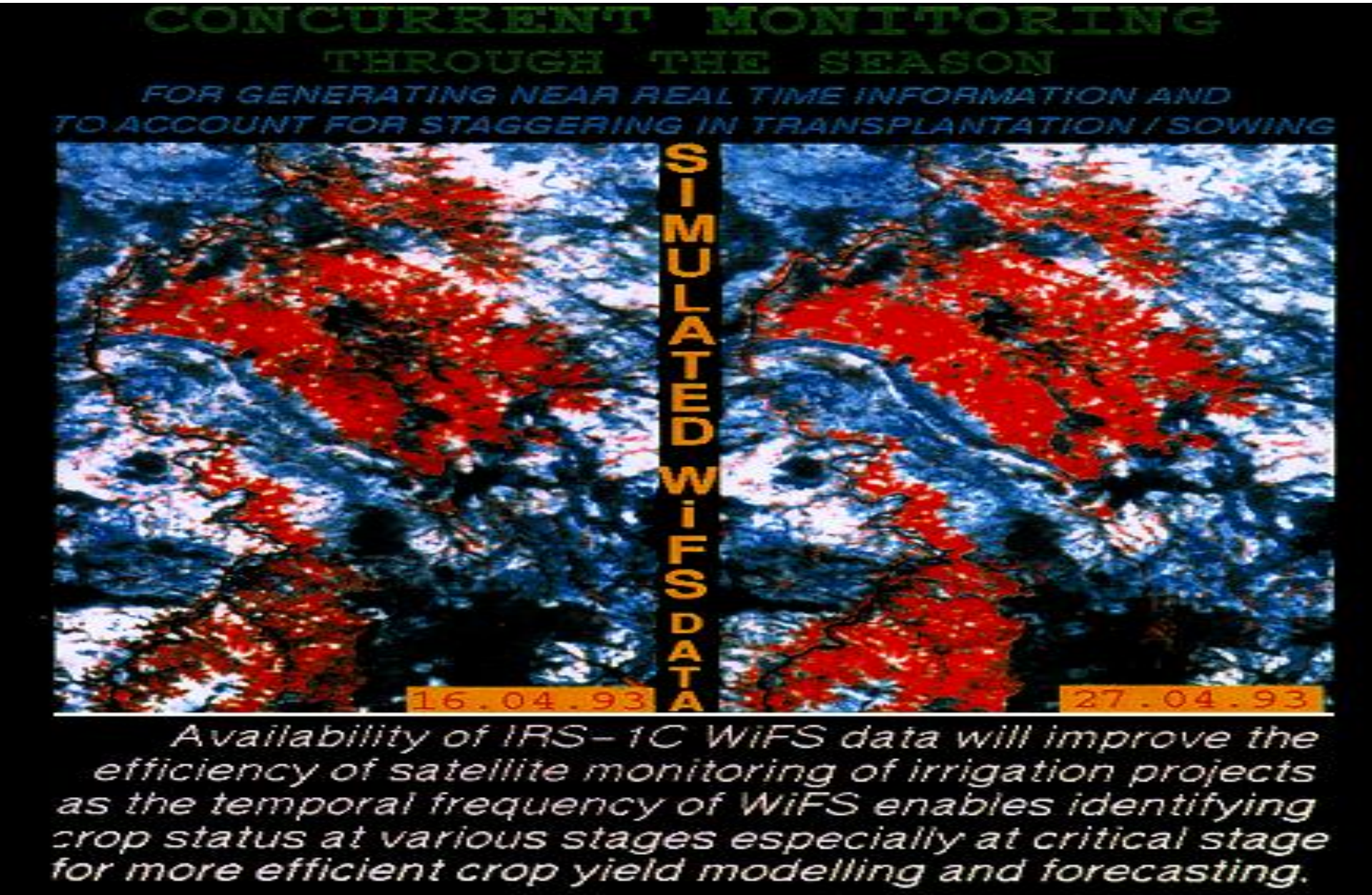
Methodologies need to be perfected for identification of locust breeding grounds based on vegetation or moisture status, thereby developing strategies for preventing their spread and effective control measures.

## 10.Agricultural draught assessment:

**Draught assessment is yet another area wherein remote sensing data has been used at operational level.**

The district level drought assessment and monitoring using NDVI generated from NOAA-AVHRR data helps in taking timely preventive and corrective measures for combating drought.

# 11.Temporal data for irrigation studies



# 12.Reflectance modeling:

Physical reflectance models for crops serve the important purpose of understanding the complex interaction between **solar radiation and plant canopies.**

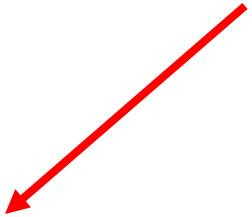
In order to obtain a reliable yield prediction, growth of crops has to be modeled by means of crop growth models. **Crop growth models** describe the **relation between physiological process in plants and environmental factors** such as solar irradiation, temperature, water and nutrient availability.

# “The solution”

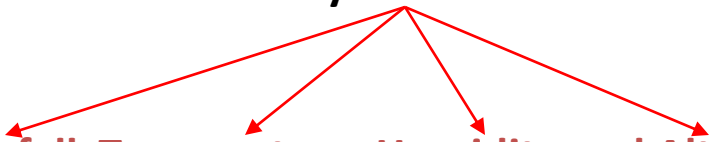
To effectively utilize the information on crops for improvement of economy, there is a **need to develop state/ district level information system** based on available information on various crops **derived both from conventional and remote sensing approaches in GIS environment.**

# Forestry Applications

# Forests types of Kerala

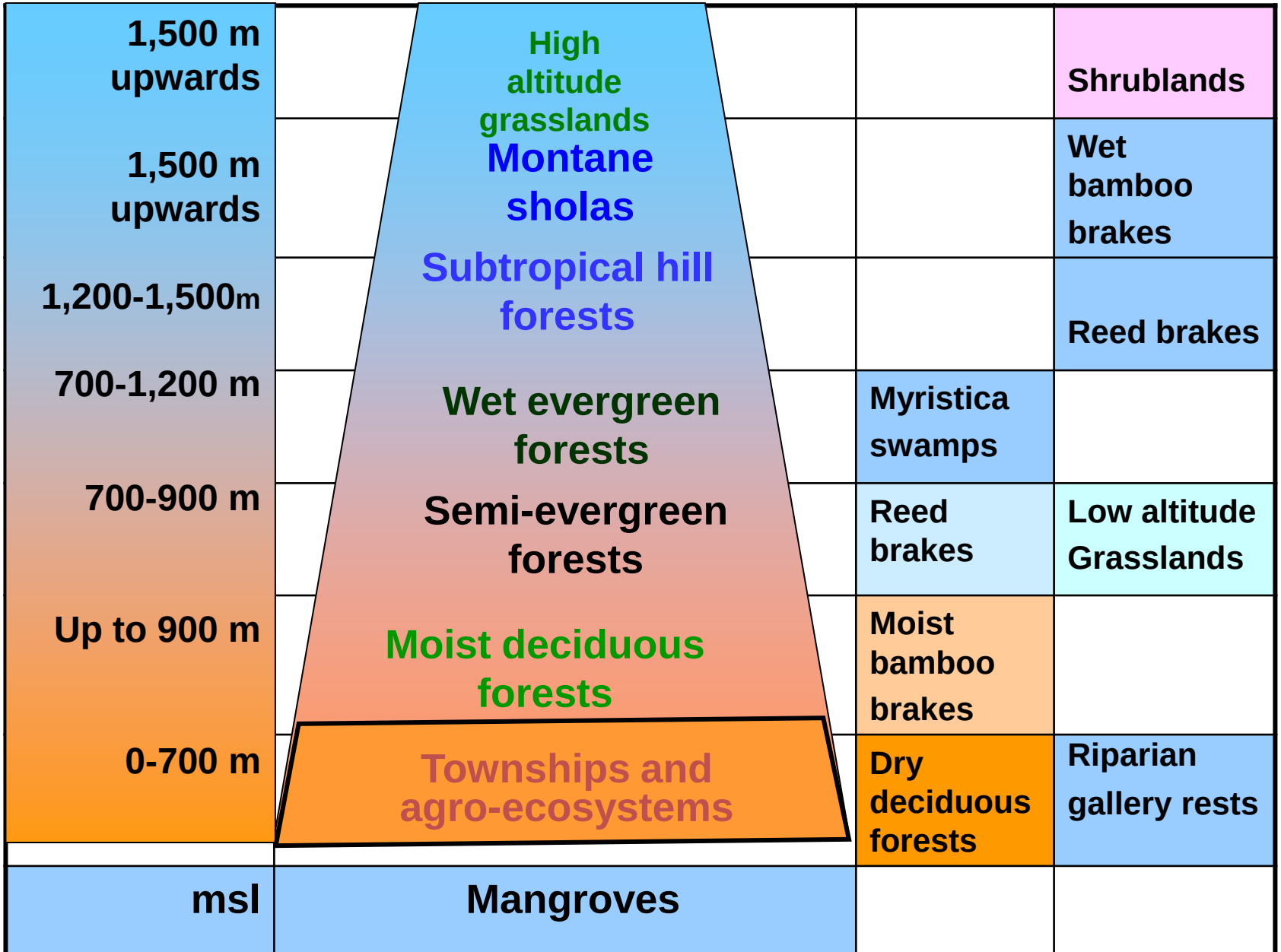


**Classification: mainly based on**



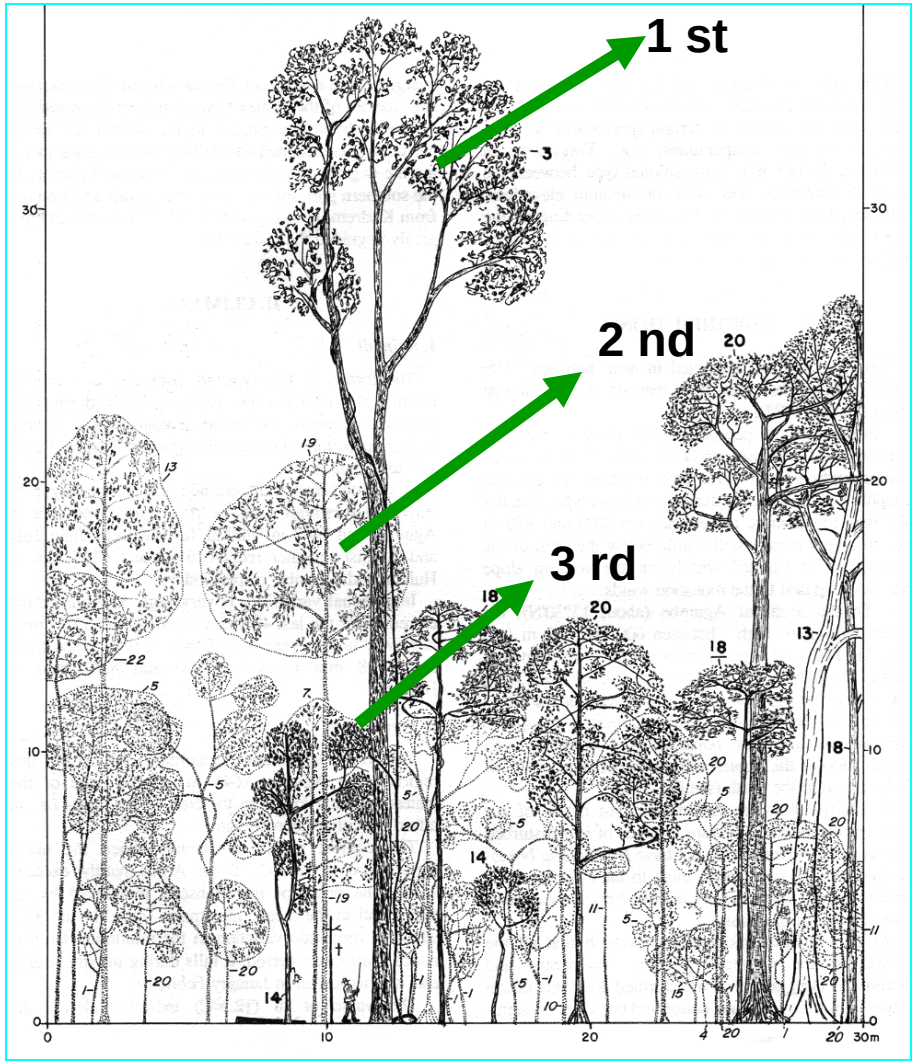
**Rainfall ,Temperature, Humidity and Altitude**

# Forest types of Kerala



# Wet evergreen forests

## Stratification




## Aerial view


Semi Evergreen Forests


Moist deciduous forest after rains

# Grasslands

# Shola forests

## Subtropical hill forests

•Commercially inferior to the Evergreen forests. •Found from 1200 to 1900 m •Stands 15-20 m only. •Profusion of Lauraecae: *Cinnamomum, Neolitzea, Phoebe, Actinodaphne, Litsea*, etc. •Other trees: *Calophyllum elatum*, *Elaeocarpus munroii*, *Dimocarpus longan*, *Garcinia* spp., *Memecylon* spp., *Mesua ferrea*, *Syzygium* spp.

Encroaching tea estate

A transitional type between Evergreen forests and Montane Sholas.

Tea estates

Tea estates cut the forests into patches

- **Mangroves: ( ± 50 $km^2$)**

**Specialized ecosystems rich in indigenous flora and fauna.**

**It serves many ecological and biological functions.**

## Myristica swamps

- Edaphic facies of EGFs in flat-bottomed
- Water-logged valleys at low elevations.
- Trees with stilt and breathing roots.
- Abundance of Myristicaceous trees: *Myristica magnifica, M. malabarica, Gymnacranthera canarica*, *Knema atten*
- Undergrowths of *Pandanus* and *Calamu*
- These ecosystems are endangered
- Much of the swamps have already been converted to rice fields.
- The remaining patches largely located i S Kerala.

# Riparian forests

- **Edaphic formations of the dry deciduous forests**
- **Distributed along the river courses**
- **Stands 30-32 m, composed of evergreen and deciduous trees:**
  ***Mangifera indica, Terminalia arjuna, Calophyllum elatum, Bassia sp.***
- **The forest type is very restricted**
- **Abode of the grizzled giant squirrel, *Ratufa macroura dandolena***


# Bamboo and cane brakes

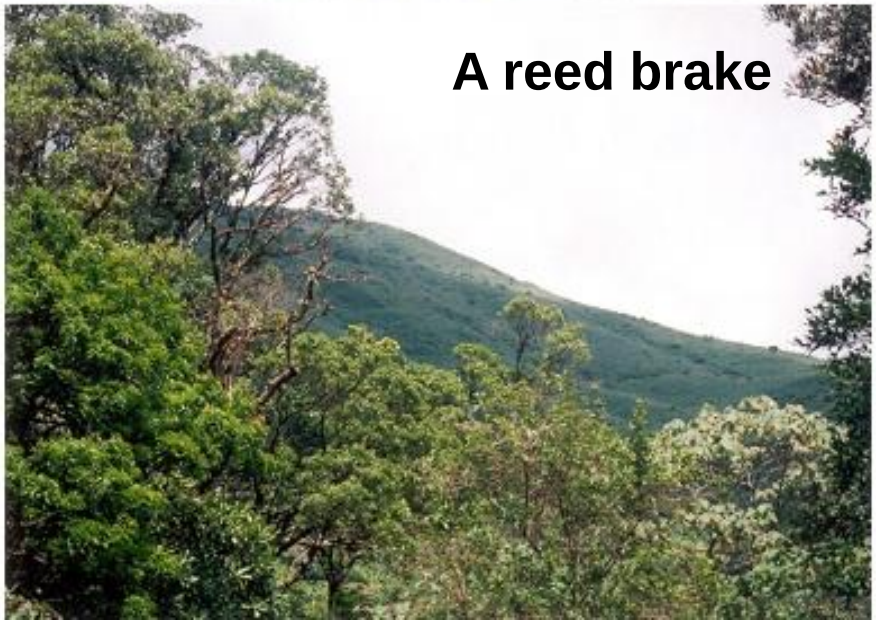

A bamboo brake

## Bamboo brakes

- Important raw materials for cottage industry, and pulp industry.
- 25 species under 7 genera.
- 2 bamboos: *Bambusa bambos* *Dendrocalamus strictus*
  *D. strictus* restricted to the rain shadow areas.
- 13 species of reed bamboos belonging to the genera,
  *Ochlandra, Pseudoxytenanthera* and *Sinarundinaria*.

## Cane brakes

- 16 species rattans mostly used for cane furniture.
- Some of them are gregarious as cane brakes


A reed brake


Bambusa bambos


Cane brake

# Forest plantations: 1701 km$^2$ (18.1%)

Teak

Eucalypts

Tea, etc.

# Plantation Species

Teak

Albizia

Gmelina

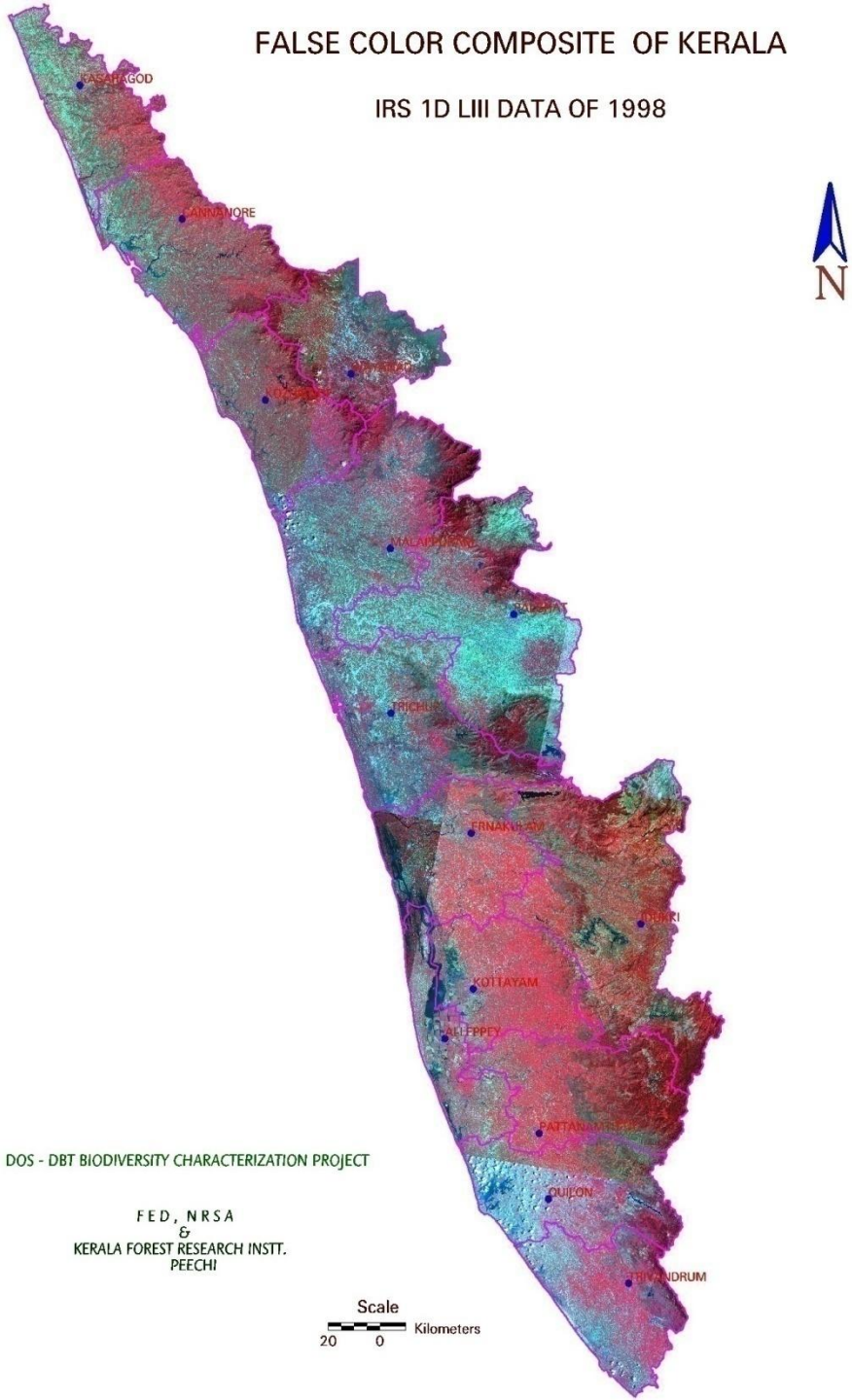
Grevillea

Acacia

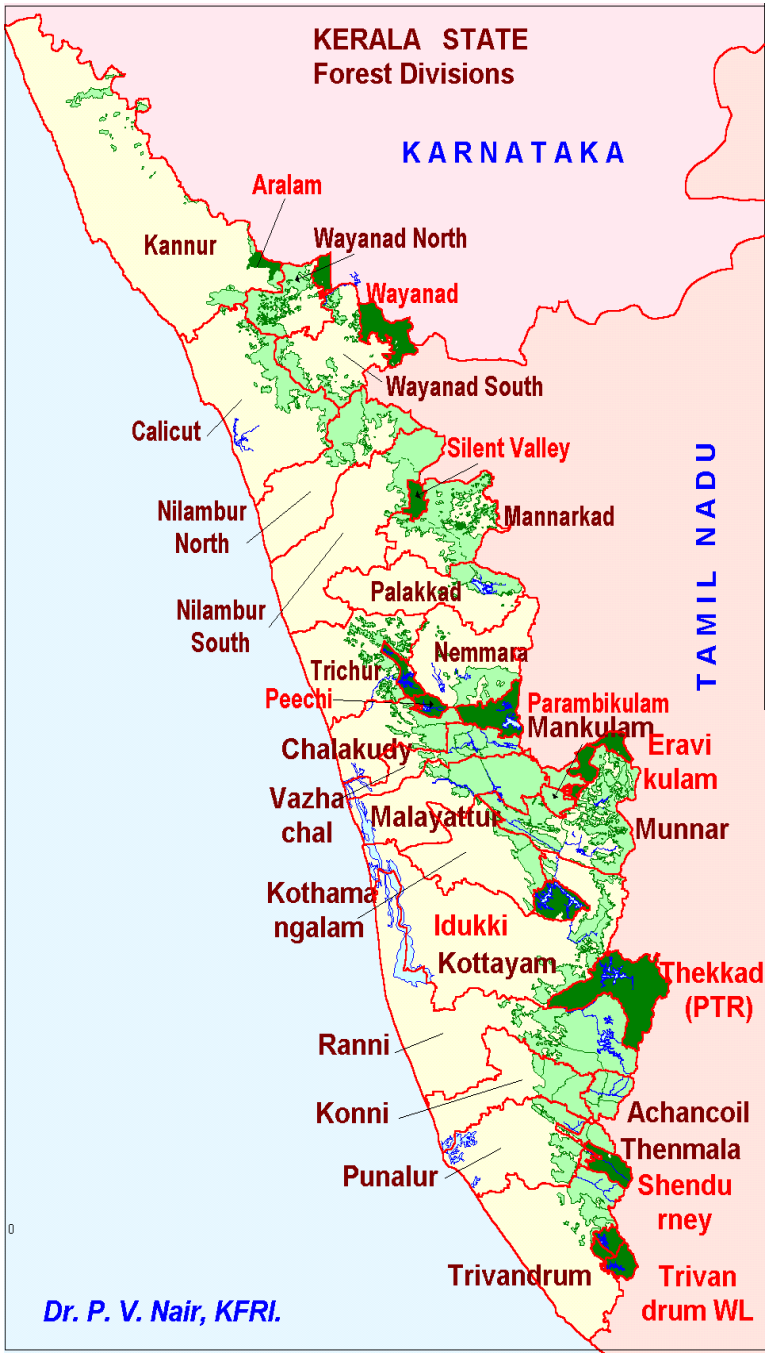
Eucalypts

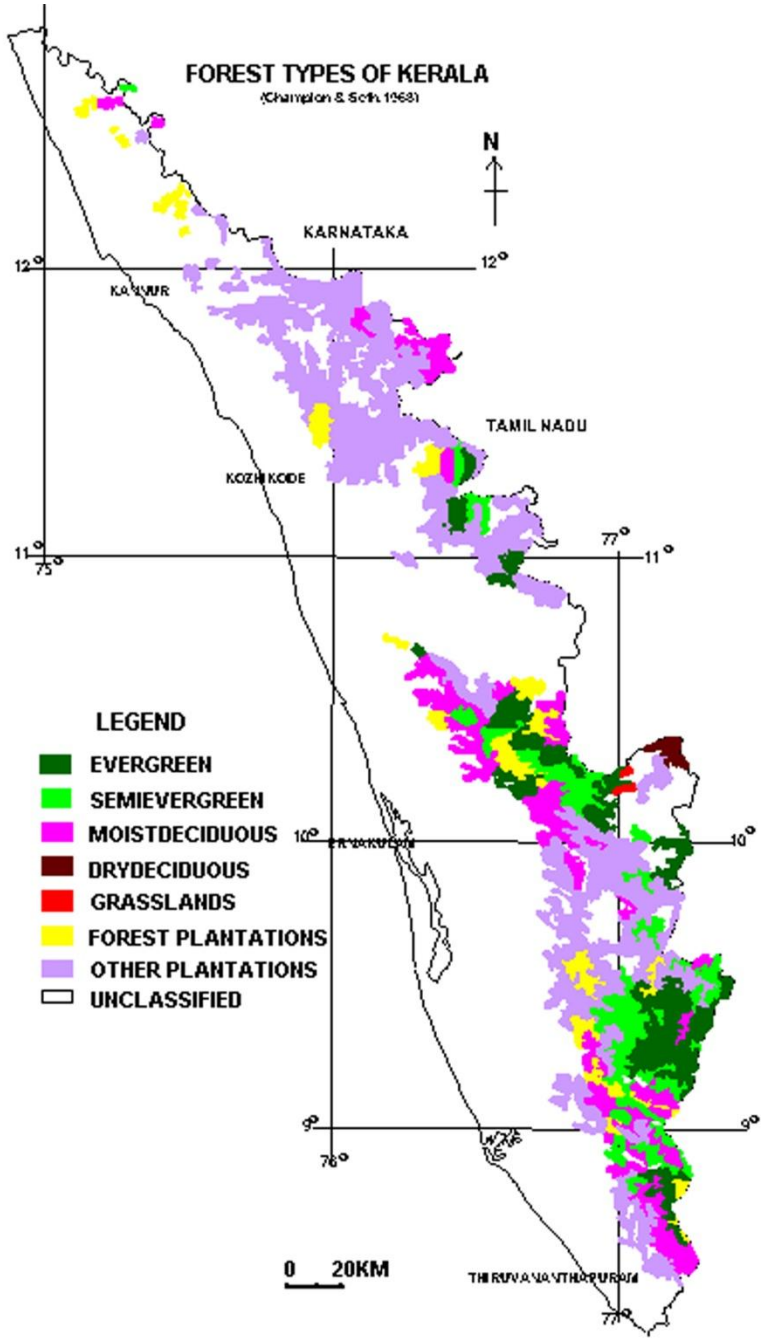
Ailanthus

Casuarina

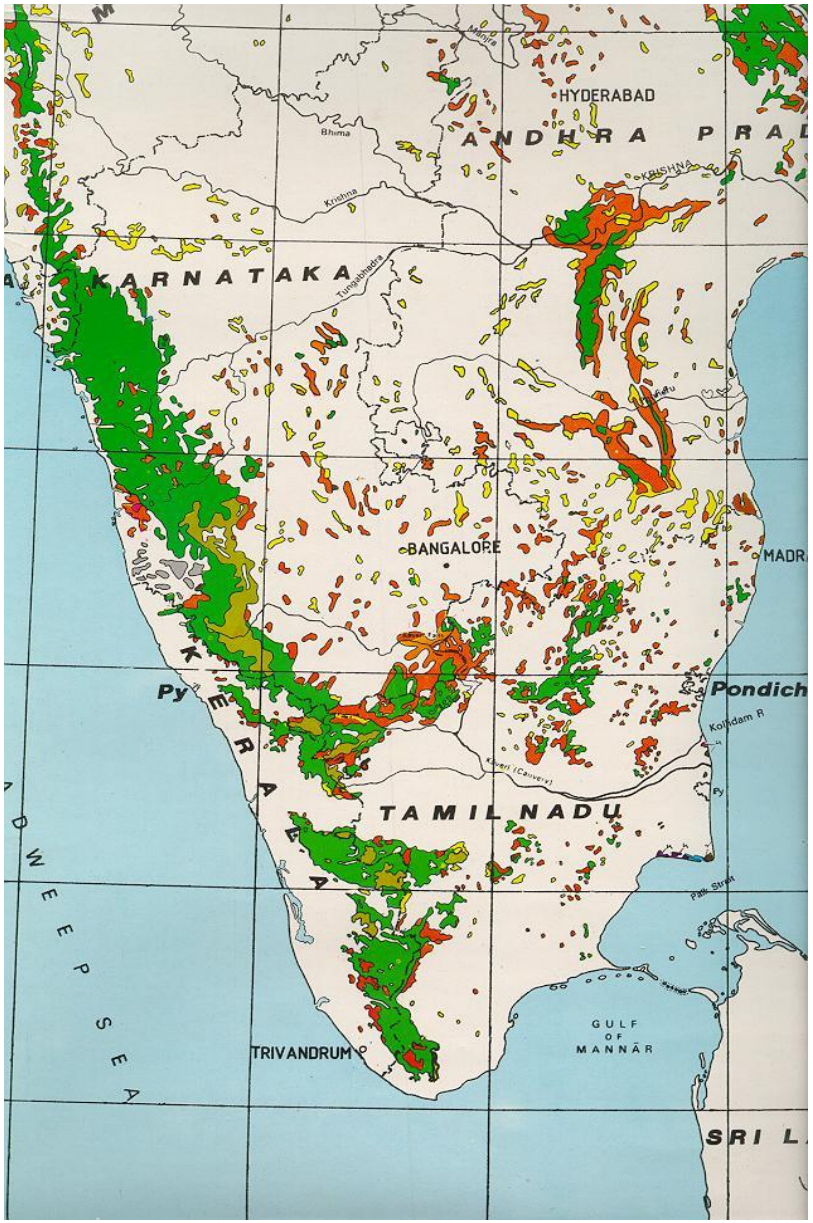



***Satellite Image of Kerala (IRS 1D)***


KERALA STATE
Forest Divisions
KARNATAKA
TAMIL NADU
Aralam
Kannur
Wayanad North
Wayanad
Wayanad South
Calicut
Silent Valley
Mannarkad
Nilambur North
Nilambur South
Palakkad
Nemmara
Trichur
Peechi
Parambikulam
Mankulam
Chalakudy
Eravi kulam
Vazha chal
Malayattur
Munnar
Kothama ngalam
Idukki
Kottayam
Thekkad (PTR)
Ranni
Konni
Achancoil
Thenmala
Punalur
Shendu rney
Trivandrum
Trivan drum WL
Dr. P. V. Nair, KFRI.


FOREST TYPES OF KERALA
(Champion & Seth 1968)
N
KARNATAKA
TAMIL NADU
KOZHIKODE
12°
11°
10°
9°
75°
76°
77°
LEGEND
EVERGREEN
SEMIEVERGREEN
MOISTDECIDUOUS
DRYDECIDUOUS
GRASSLANDS
FOREST PLANTATIONS
OTHER PLANTATIONS
UNCLASSIFIED
0 20KM

# EXTENT OF FOREST




- **Total geographic area of Kerala - 38863 sq.km**
- **Forest area in the state-10336 sq km (26% of total geographic area).**
- **Total area of Sanctuaries and National Parks in the state-2324.72 sq. km.**
- **This forms the 22.49% of the forest area and 5.98% of the geographical area of the State**

# Forest Biodiversity

## Biodiversity conservation

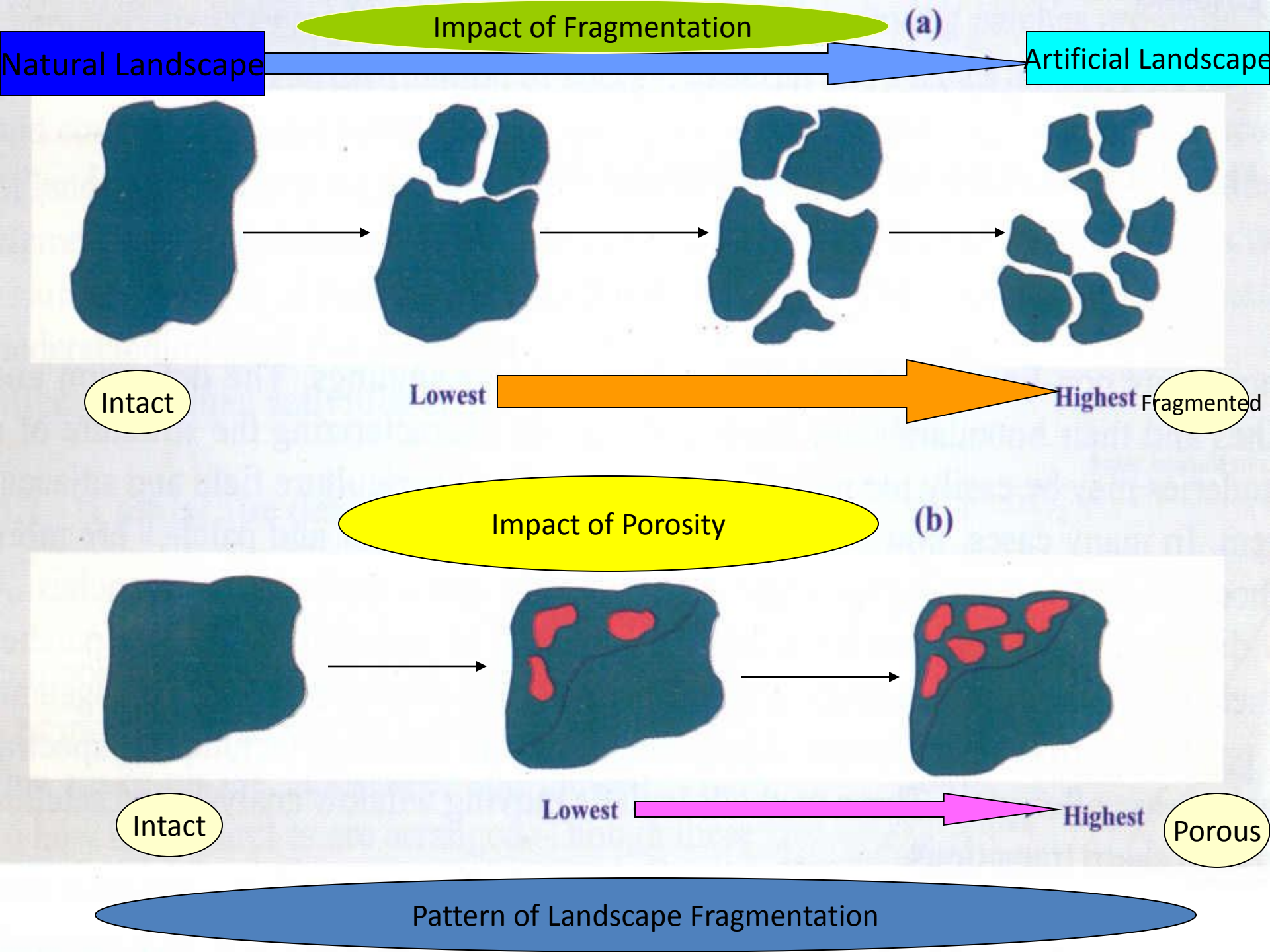
Identification of Priority area for conservation is required

Solution: Bio-prospecting of Resources

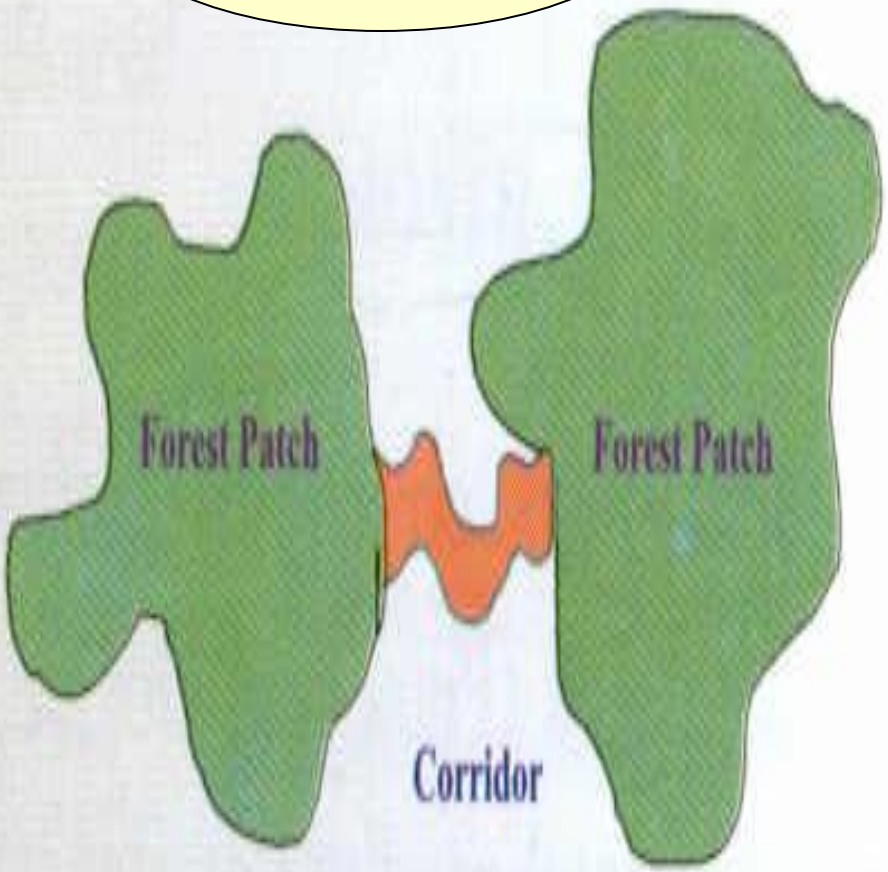
# Remote Sensing Technology

in biodiversity measure at landscape level

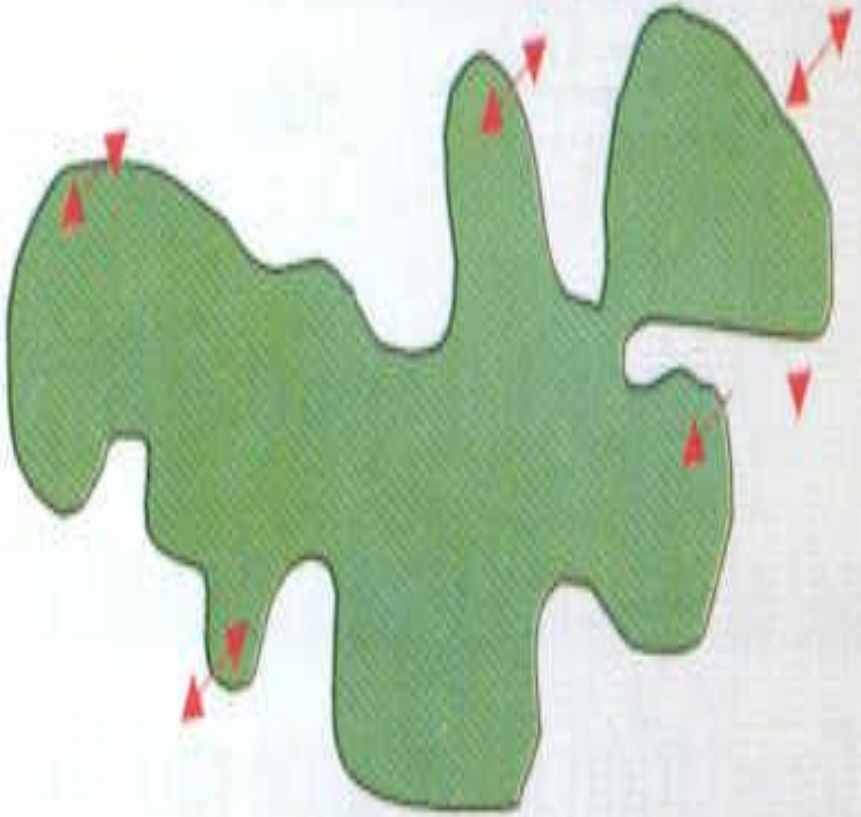
gives a perspective horizontal view and helps in delivering different landscape elements and their spatial characteristics


Impact of Fragmentation
(a)
Natural Landscape
Artificial Landscape
Intact
Lowest
Highest
Fragmented
Impact of Porosity
(b)
Intact
Lowest
Highest
Porous
Pattern of Landscape Fragmentation

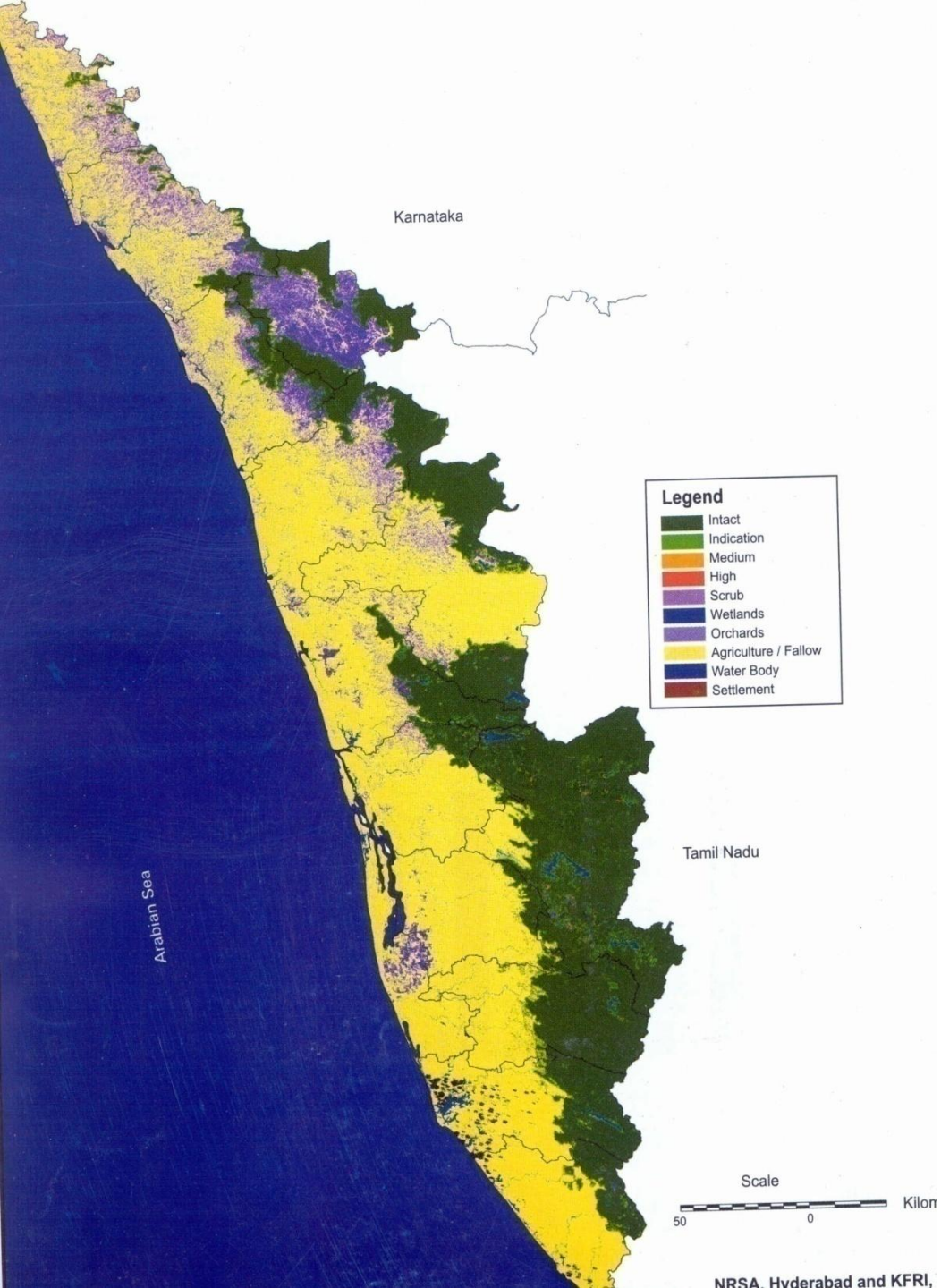
Loss of Corridors



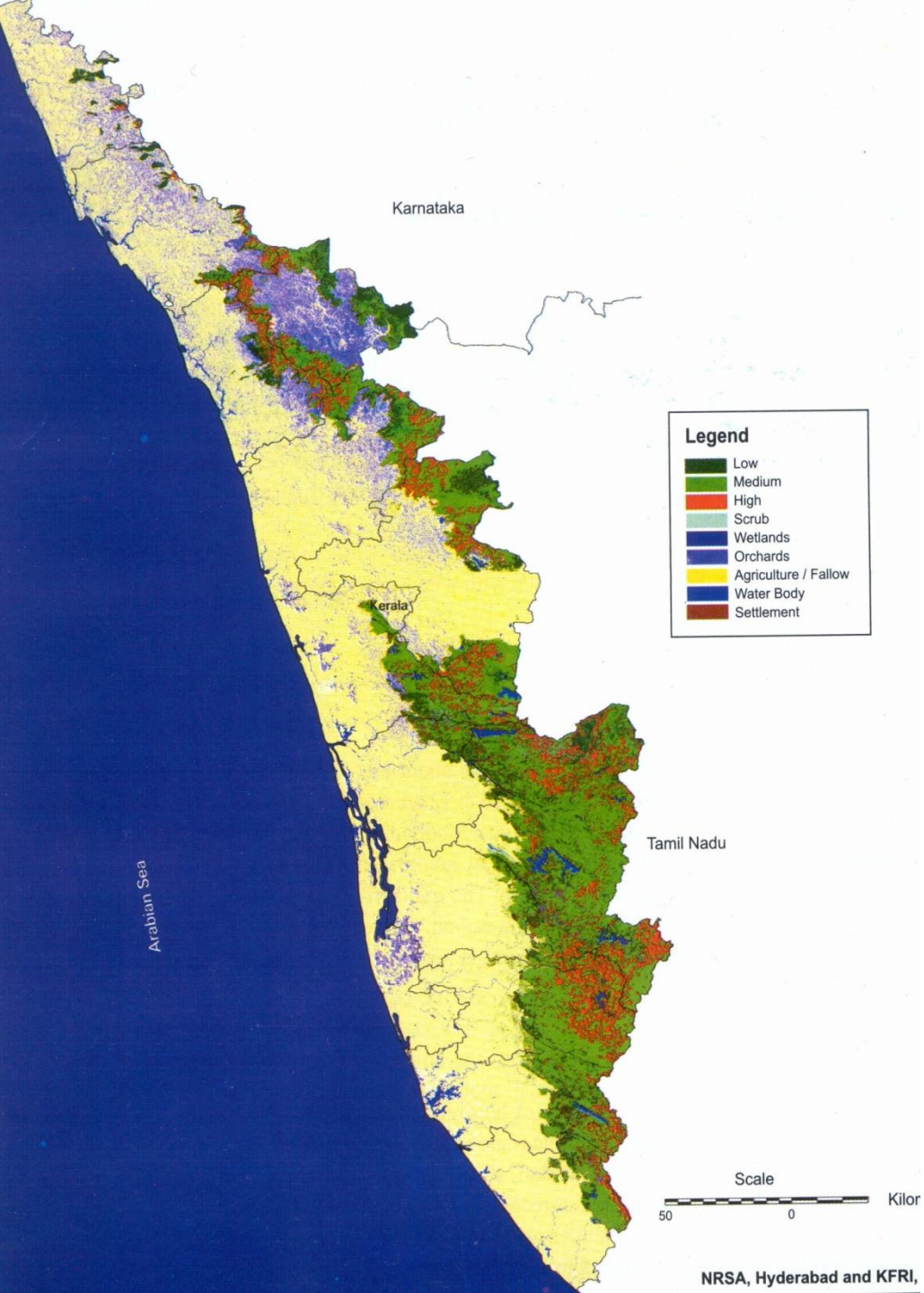

Impact of Forest Edges



Transitional Stage




# *Fragmentation Map of Kerala*




# *Biological Richness map of Kerala*

Remote sensing forms a valuable tool in mapping and monitoring of biodiversity and provides valuable information to quantify spatial patterns, biophysical patterns, ecological process that determine species richness and anthropogenic factors causing loss of species richness and for predicating response of species to global changes.

# Forest degradation in Kerala

Status:

**45% 0f Evergreen forests are degraded**

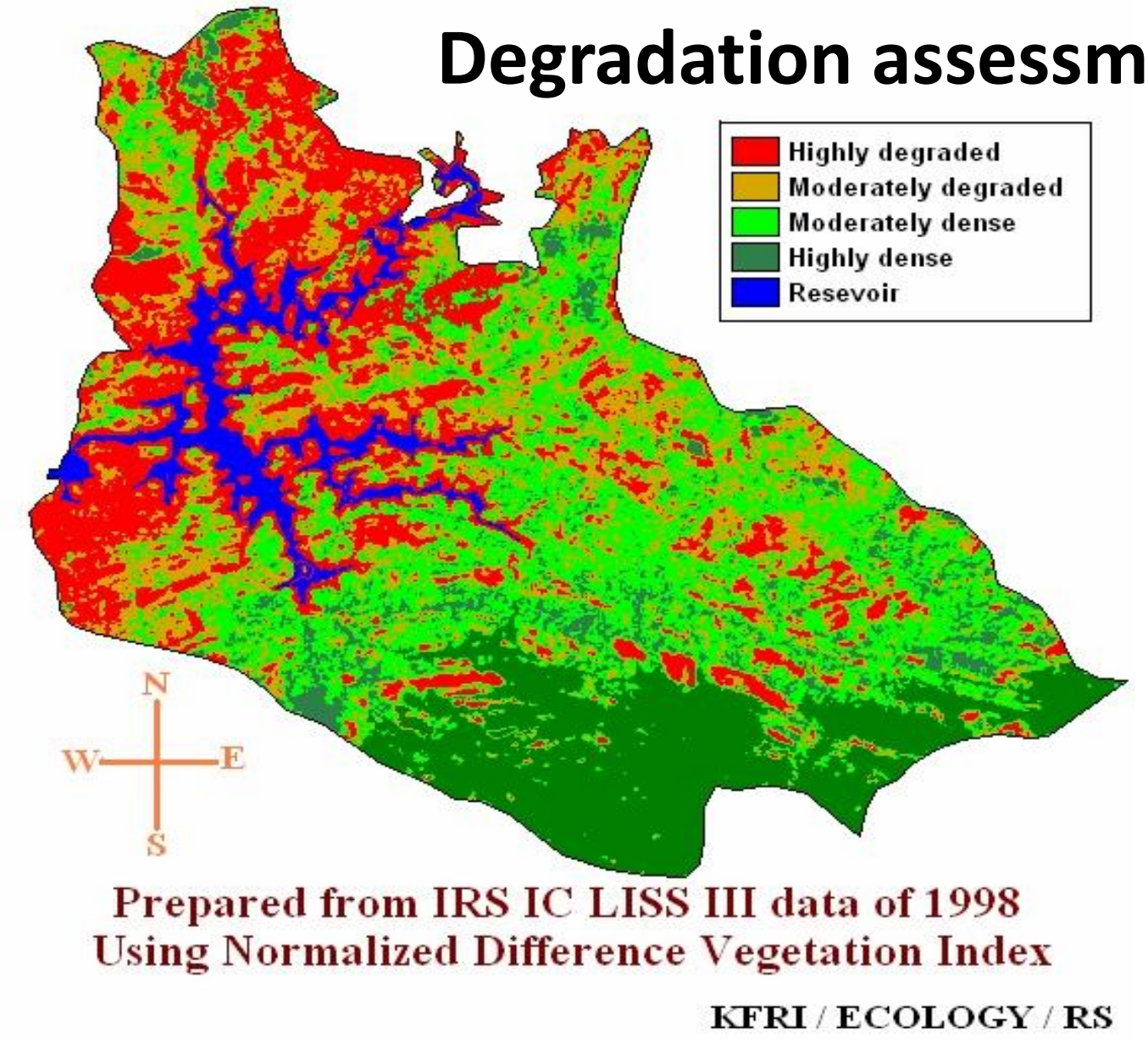
**78% of Moist deciduous forests are degraded**

**64% of Dry deciduous forests are degraded**

**24% of Subtropical hill forests are degraded**

**62% overall degradation**

# Degradation assessment



**The rapid depletion of forests made it essential to know the rate and trend of this degradation so that timely measures could be taken to prevent further loss of forest resources.**

**Timely and accurate information for detecting changes over a period of time is required for forest ecosystems.**

# CHANGE DETECTION STUDIES

## DATA USED

LANDSAT 5 TM FCC OF 1973, 1975 AND 1983

## TECHNIQUES

VISUAL INTERPREATION

## STUDY AREA

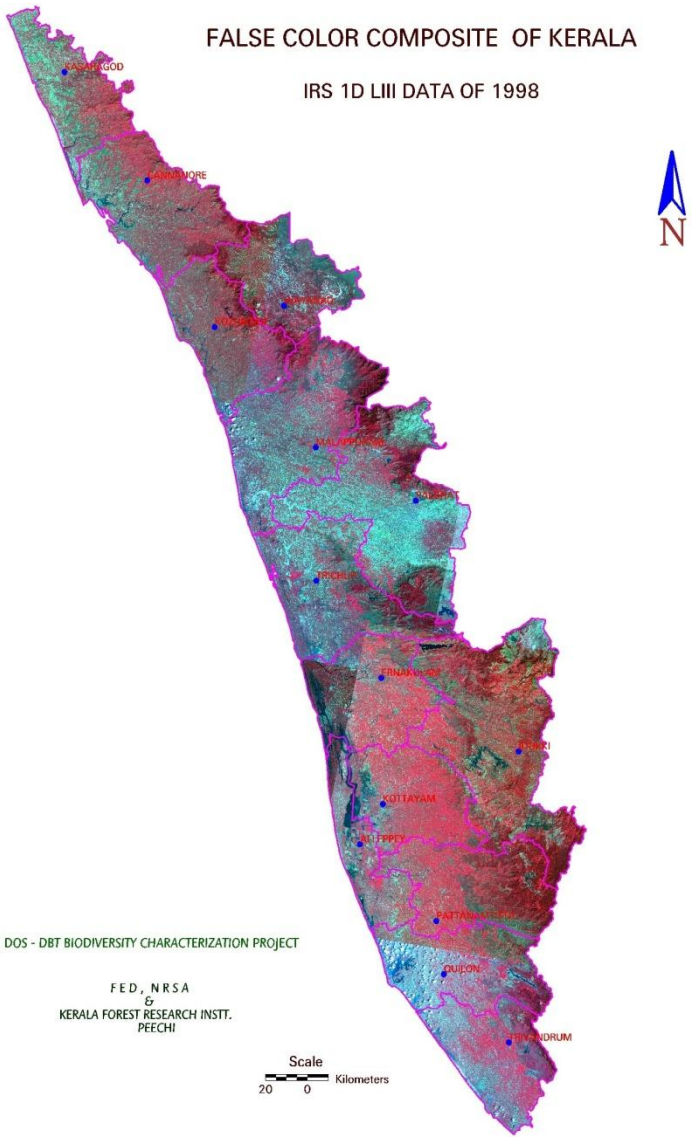
IDUKKI REGION

## OUTPUT

LANDCOVER MAPS

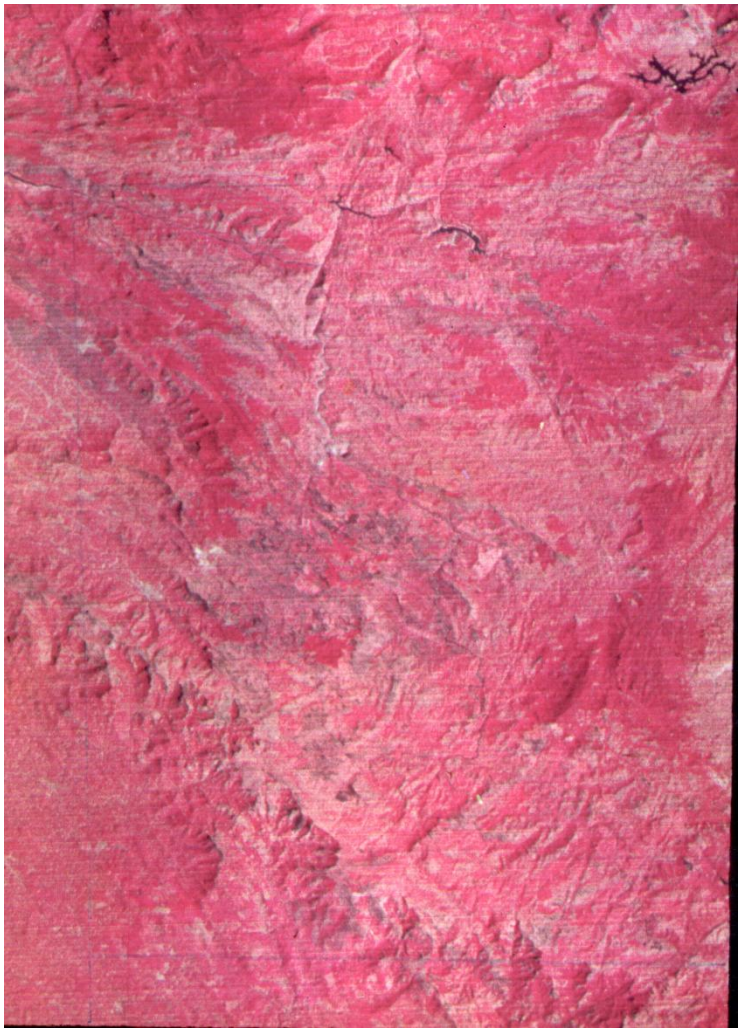
CONTINUITY CHANGES

AREA STATISTICS



# LANDSAT 5 TM FCC OF IDUKKI REGION

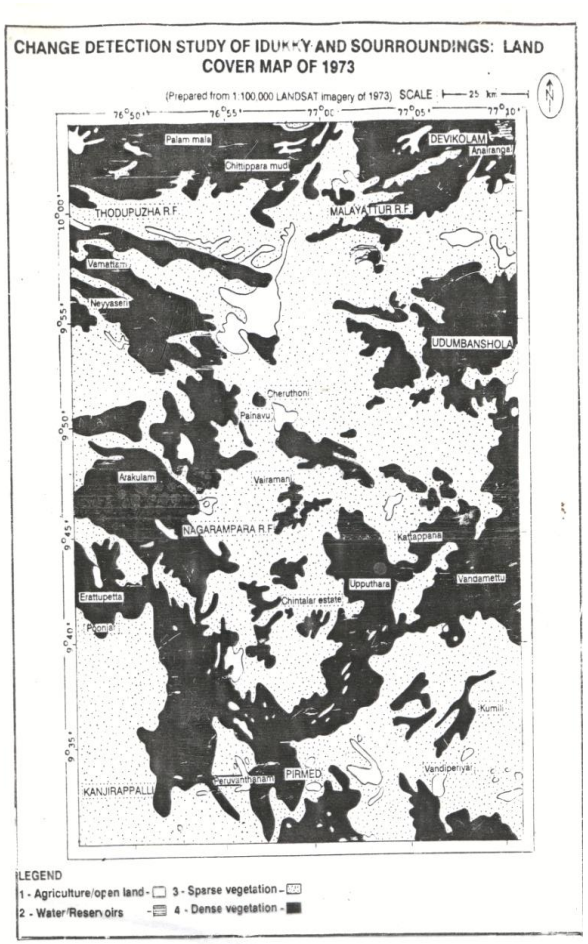
*1973*



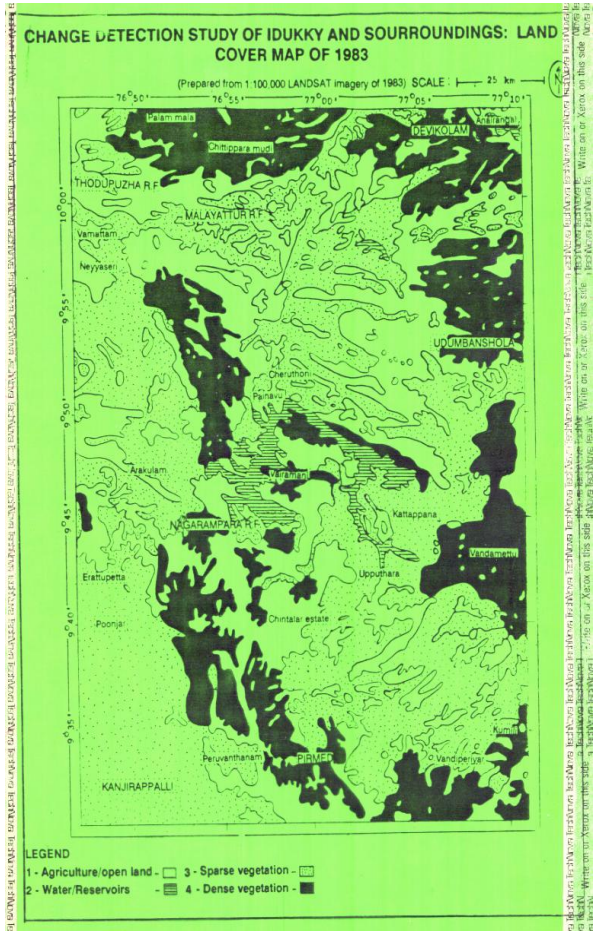
*1975*

# CHANGE DETECTION STUDY OF IDUKKI AND SURROUNDINGS

***1973*** ***1975*** ***1983***







# CHANGE DETECTION: IDUKKI REGION

(AREA IN $KM^{2)}$

| *Year* | *Dense Vegetation* | *Sparse Vegetation* | *Agriculture* | *Barren* |
|---|---|---|---|---|
| 1973 | 1338.2 | 974.2 | 83.0 | 36.1 |
| | 15.61% Reduction | 32.16% Reduction | 86.57% Reduction | 53.19% Reduction |
| 1975 | 1135 | 660.9 | 618.4 | 16.9 |
| | 21.71% Reduction | 23.64% Reduction | 38.99% Reduction | 30.61% Reduction |
| 1983 | 888.8 | 504.6 | 1013.7 | 24.3 |

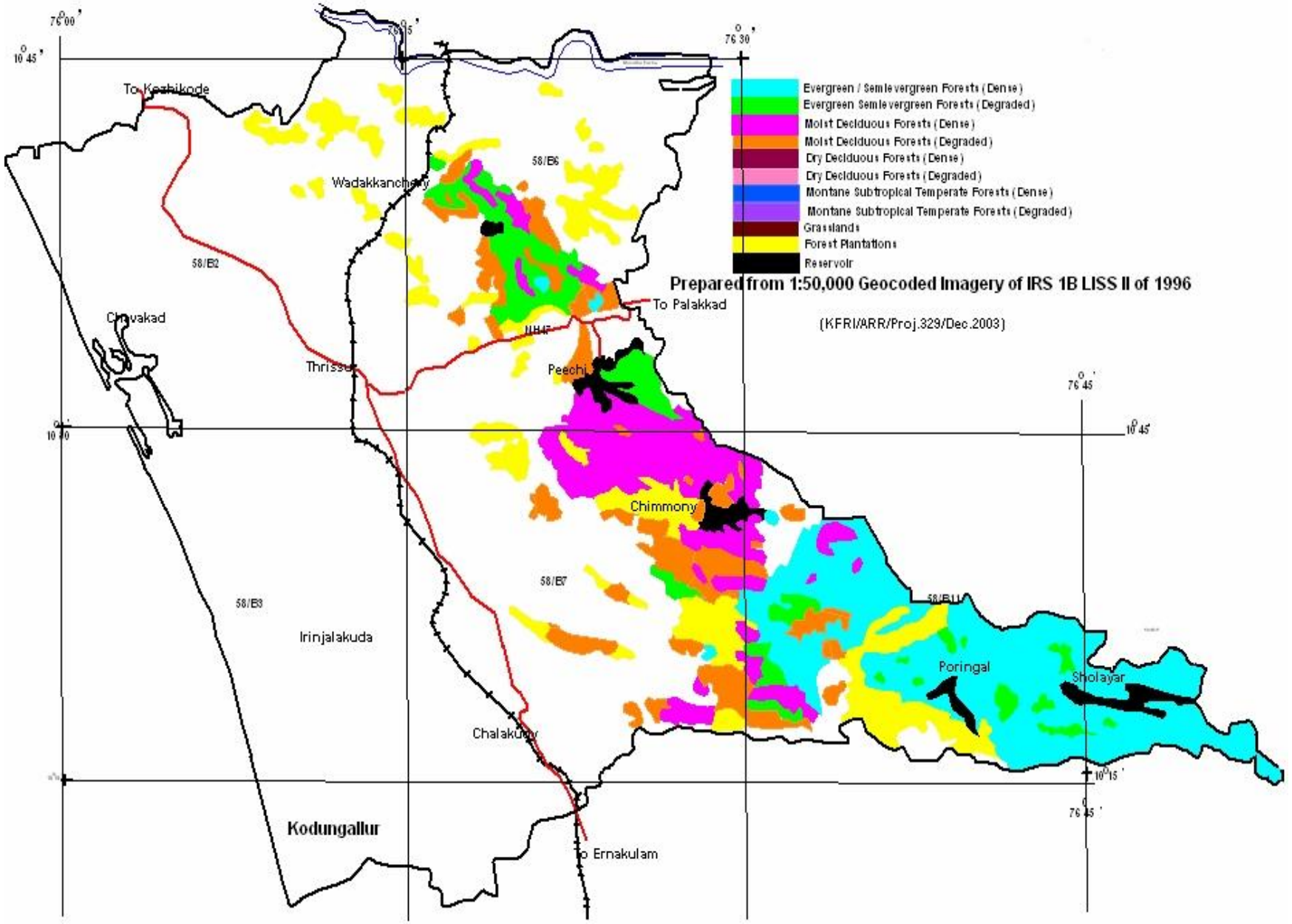
# CHANGE DETECTION: IDUKKI

**Overall Changes**

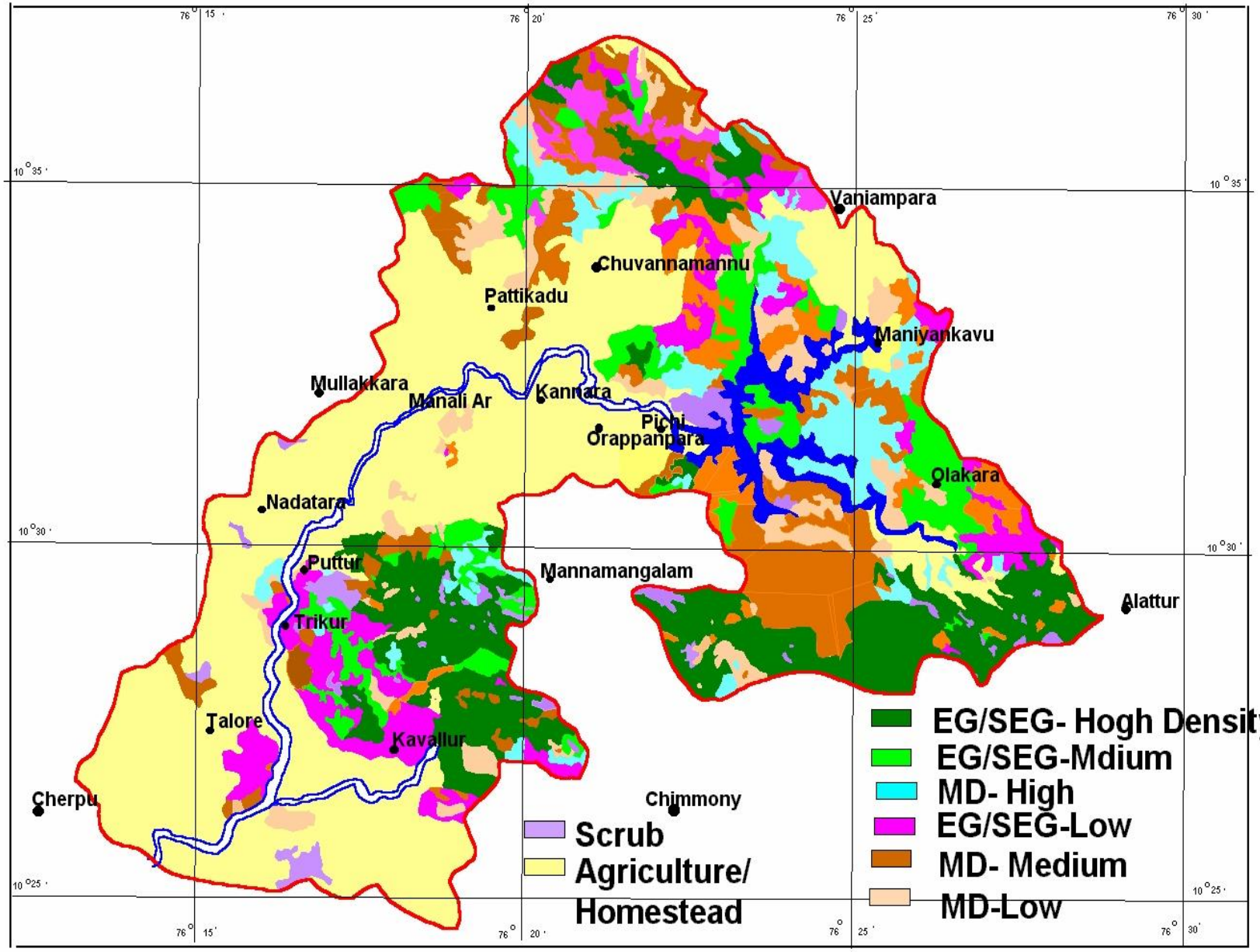
**Period 1973 – 1983**

| | | |
|---|---|---|
| **Dense Vegetation** | → | **33.58 % Reduction** |
| **Sparse Vegetation** | → | **48.2 % Reduction** |
| **Agricultural Land** | → | **91.81 % Increase** |

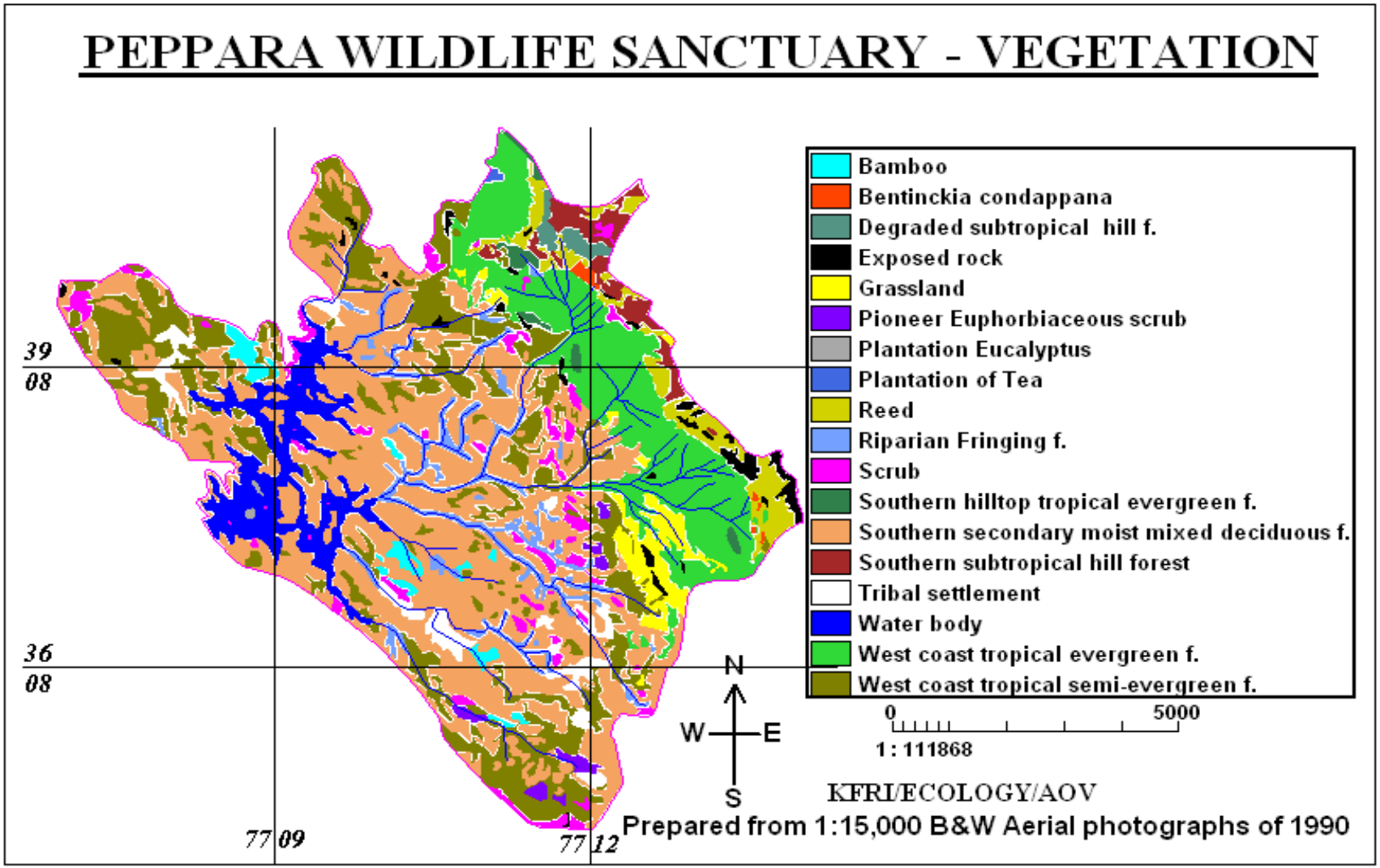
# THRISSUR DISTRICT : FOREST TYPES AND STATUS



# LAND COVER MAP OF MANALI WATER SHED

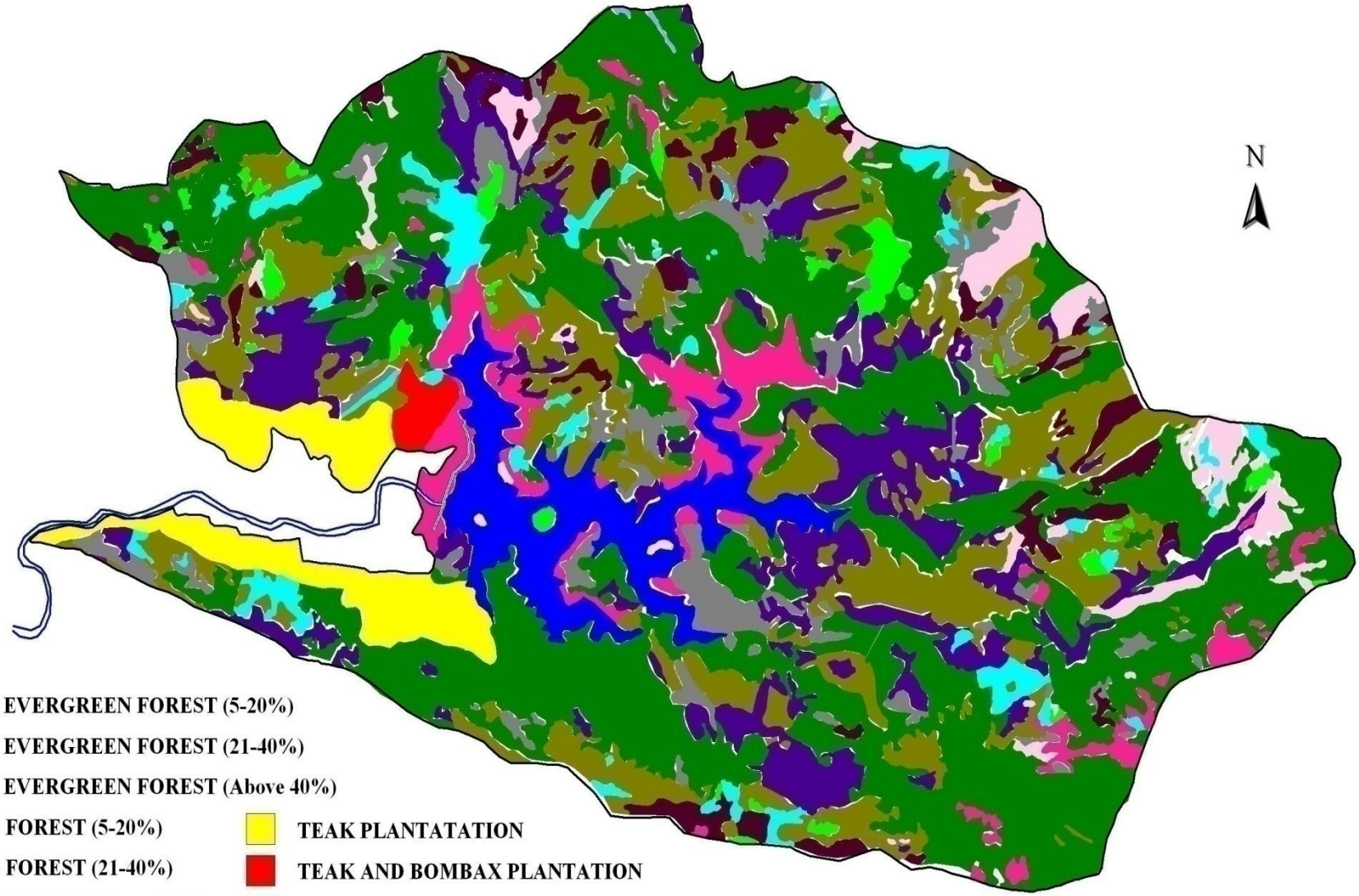


# Vegetation Mapping of Sanctuaries

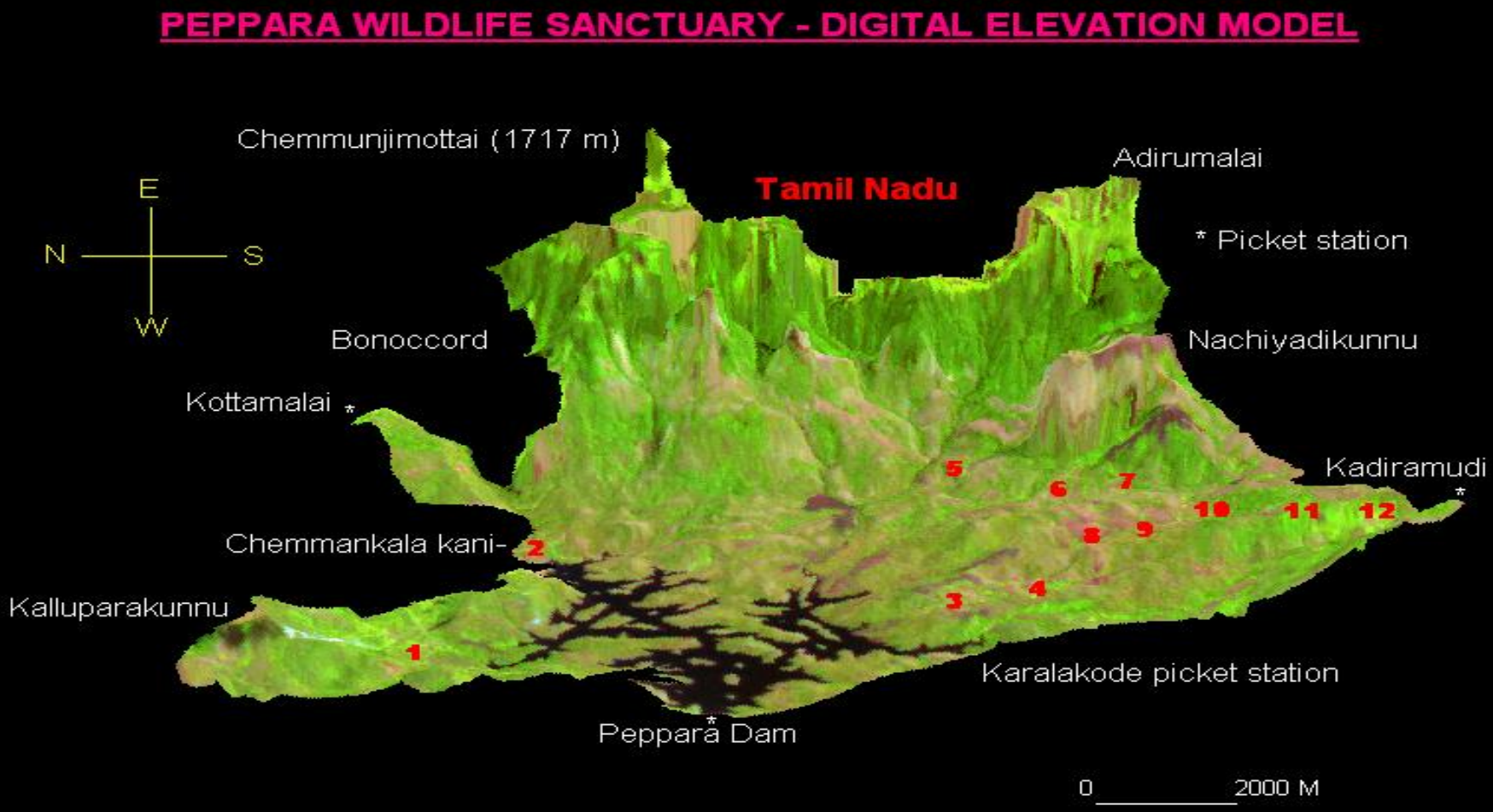



# CHIMMONY WILDLIFE SANCTUARY - VEGETATION

(Prepared from 1:15,000 Black and White Aerial photographs of February 1990 and March 1987)



# Digital Terrain Models



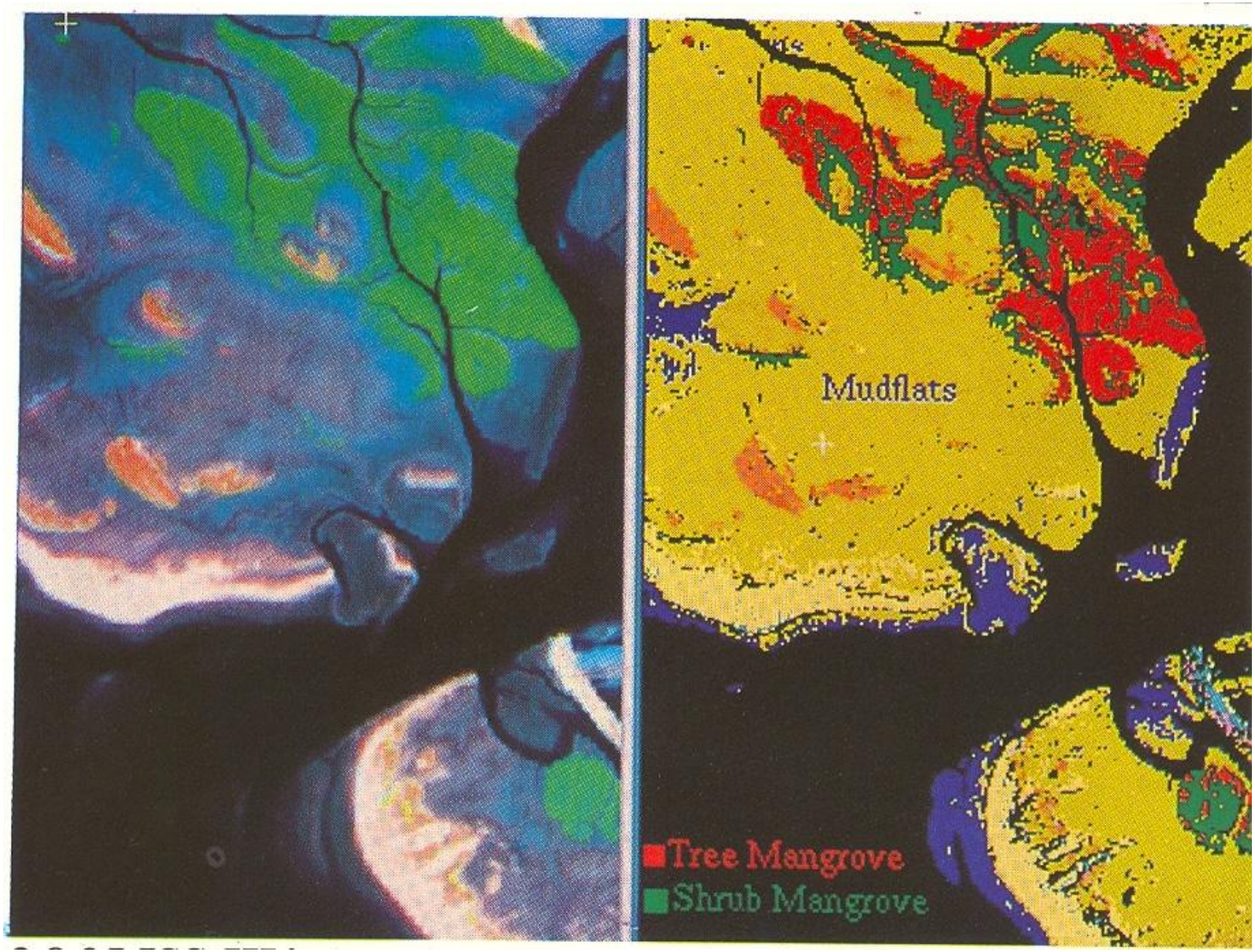

**Prepared from IRS IC LISS III FCC of 1997 (Bands 2, 3 and 4)**

**KFRI/ ECOLOGY/AOV**

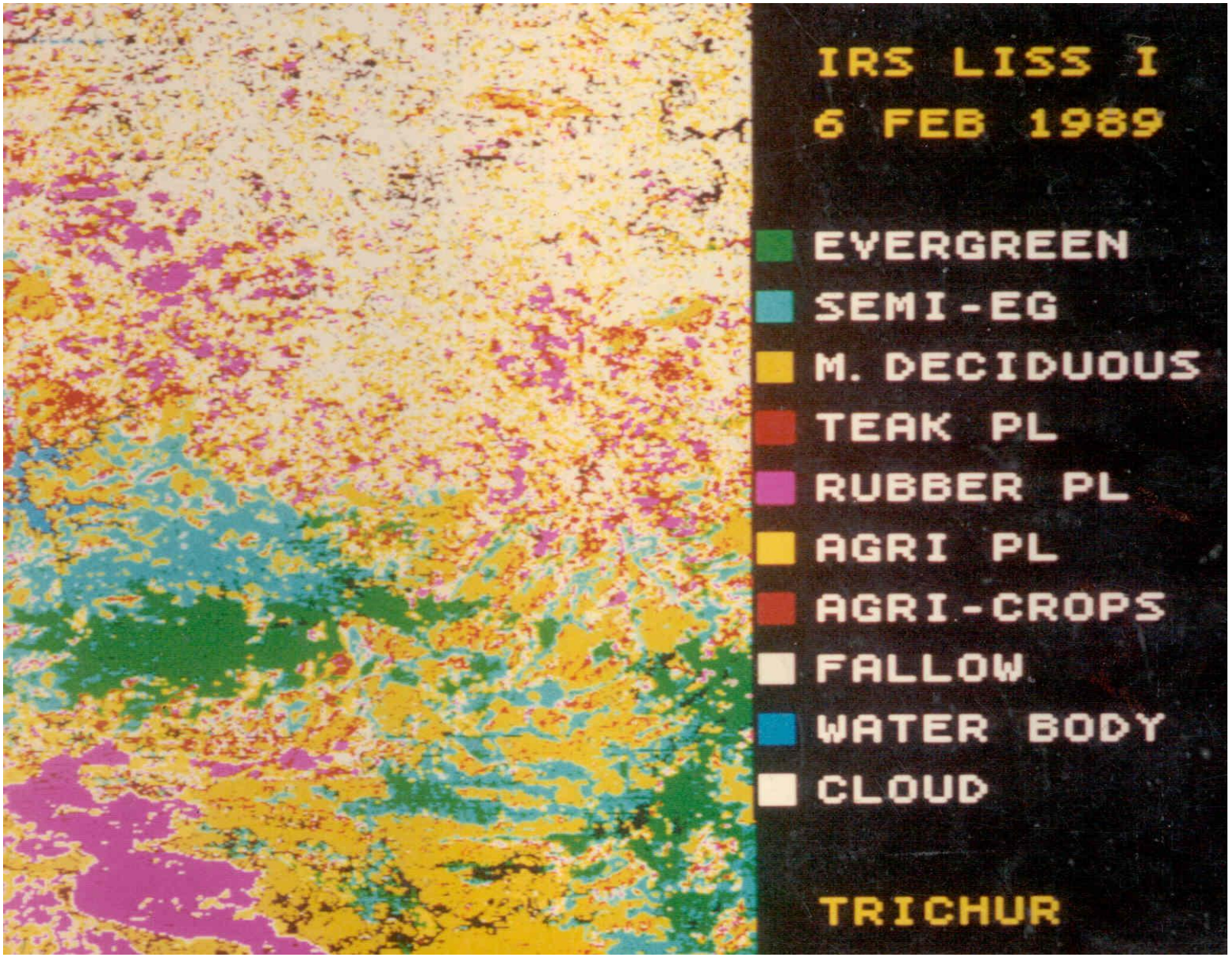
1. Podiyakala 2. Chemmangala 3. Kamalokam
4. Podium and Kompodinjal 5. Pattampara
6. Kunnathery 7. Mlavila 8. Parandodue
9. Amode 10. Cherumangal 11 .Pothode 12. Erampiadu

Evergreen forest
Semi-evergreen forest
Moist deciduous forest
Grassland
Reservior
Reed

# Mangrove ecosystem study



# Digital Mapping of Forests



# VEGETATION DENSITY MAPPING

## DATA USED

IRS 1B FCC (1:50,000)

B&W AERIAL PHOTOGRAPHS (1:15,00

## STUDY AREA

IDUKKI

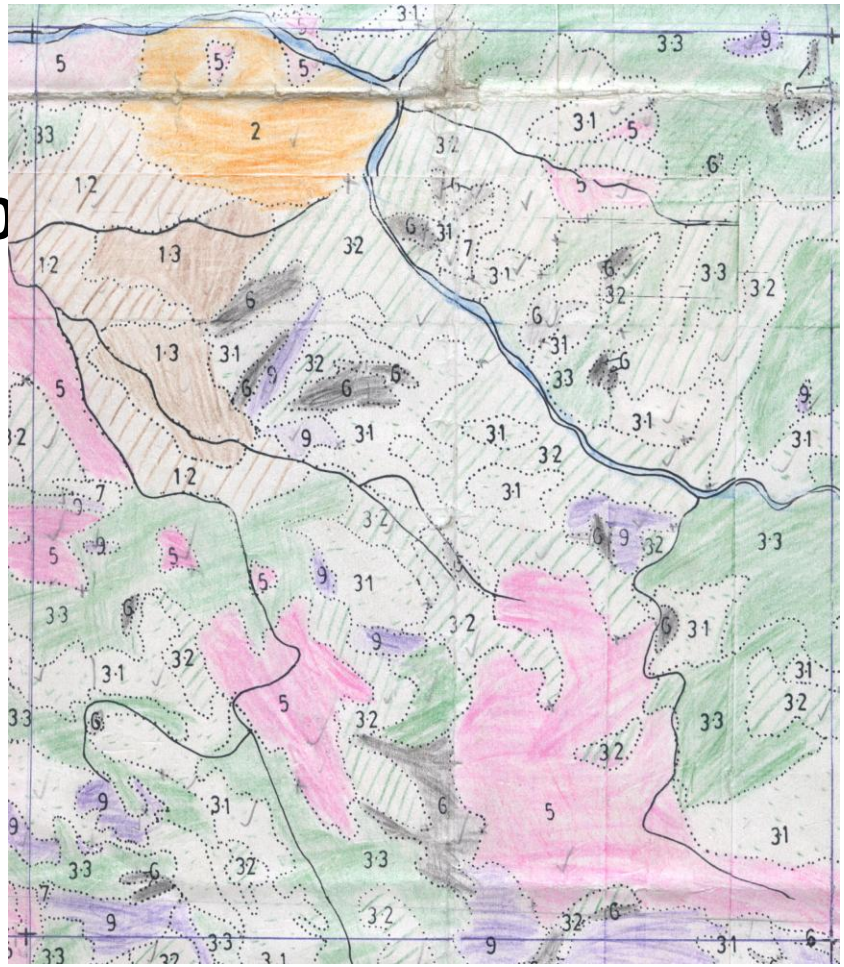
POOYAMKUTTY

## OUTPUT

DENSITY SLICED

(3 LEVEL VIZ. <40%, 40-60% & > 60%)

MAP FOR MANAGEMENT OPTIONS

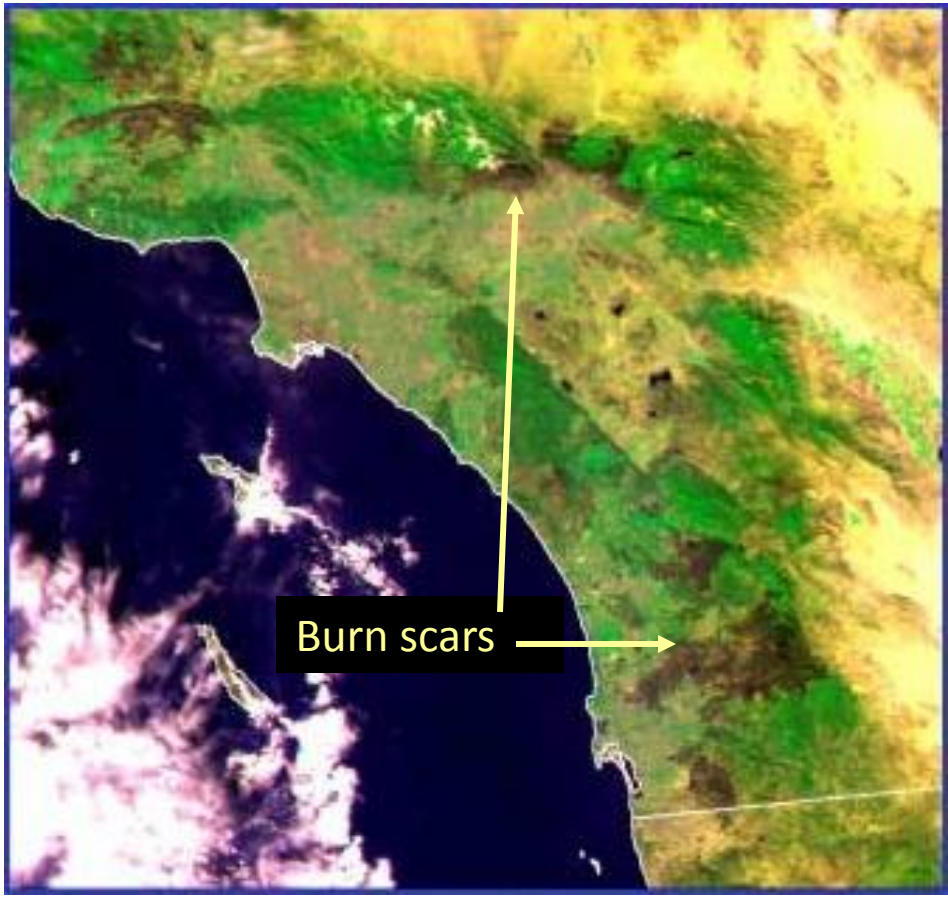


# Forest Fire Disaster

# Forest Fire Assessment

**BEFORE**

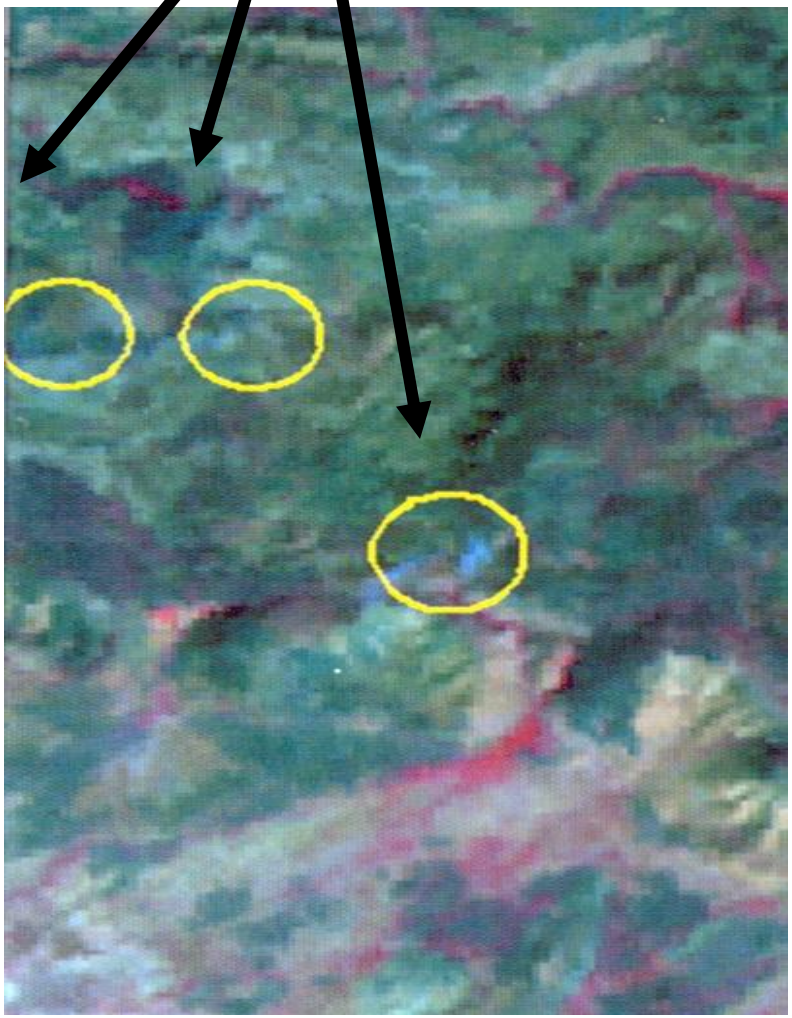
**AFTER**



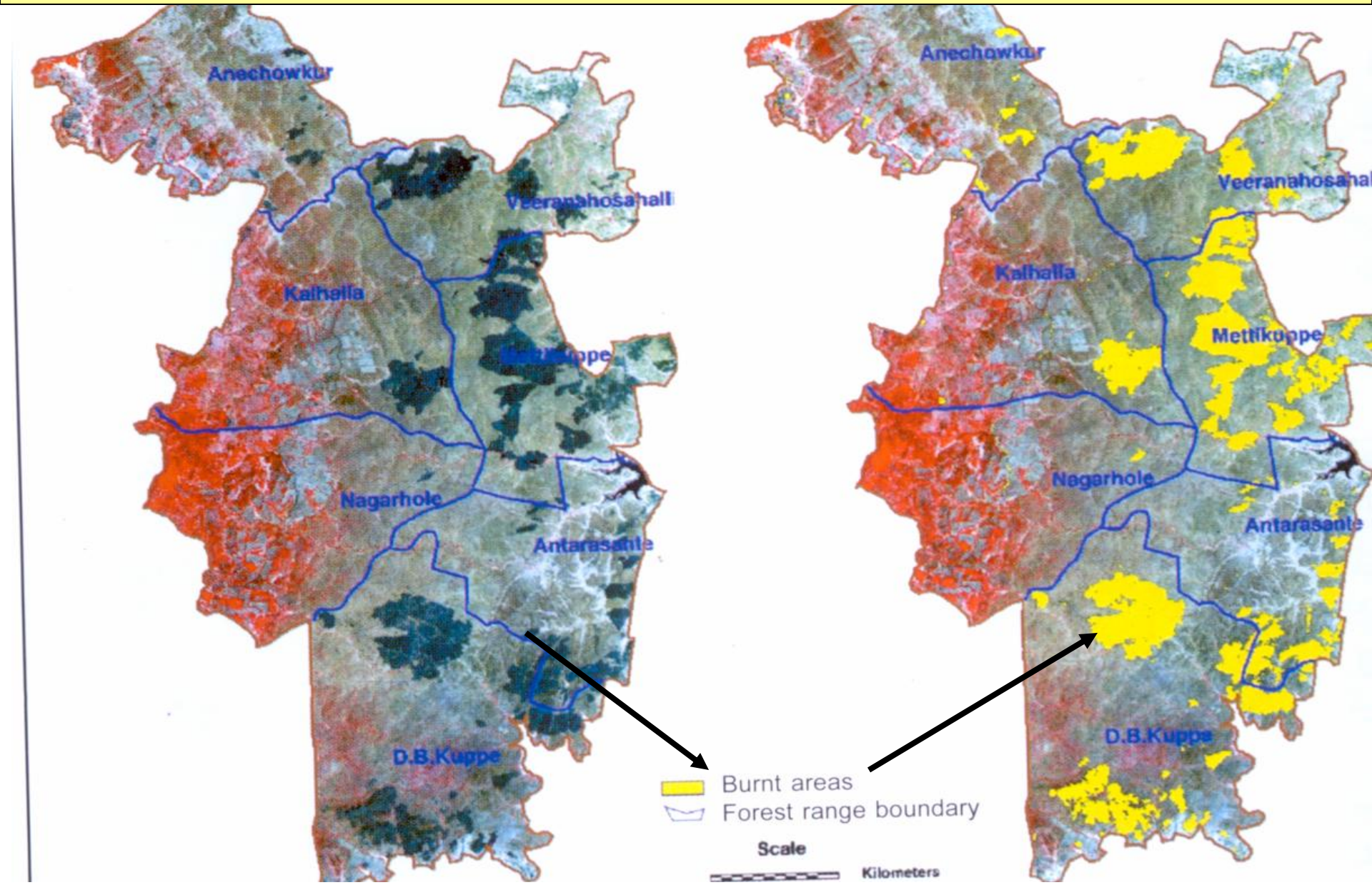
Active Fire Detection

Based on active fire detection algorithm **(pixel brightness status)**

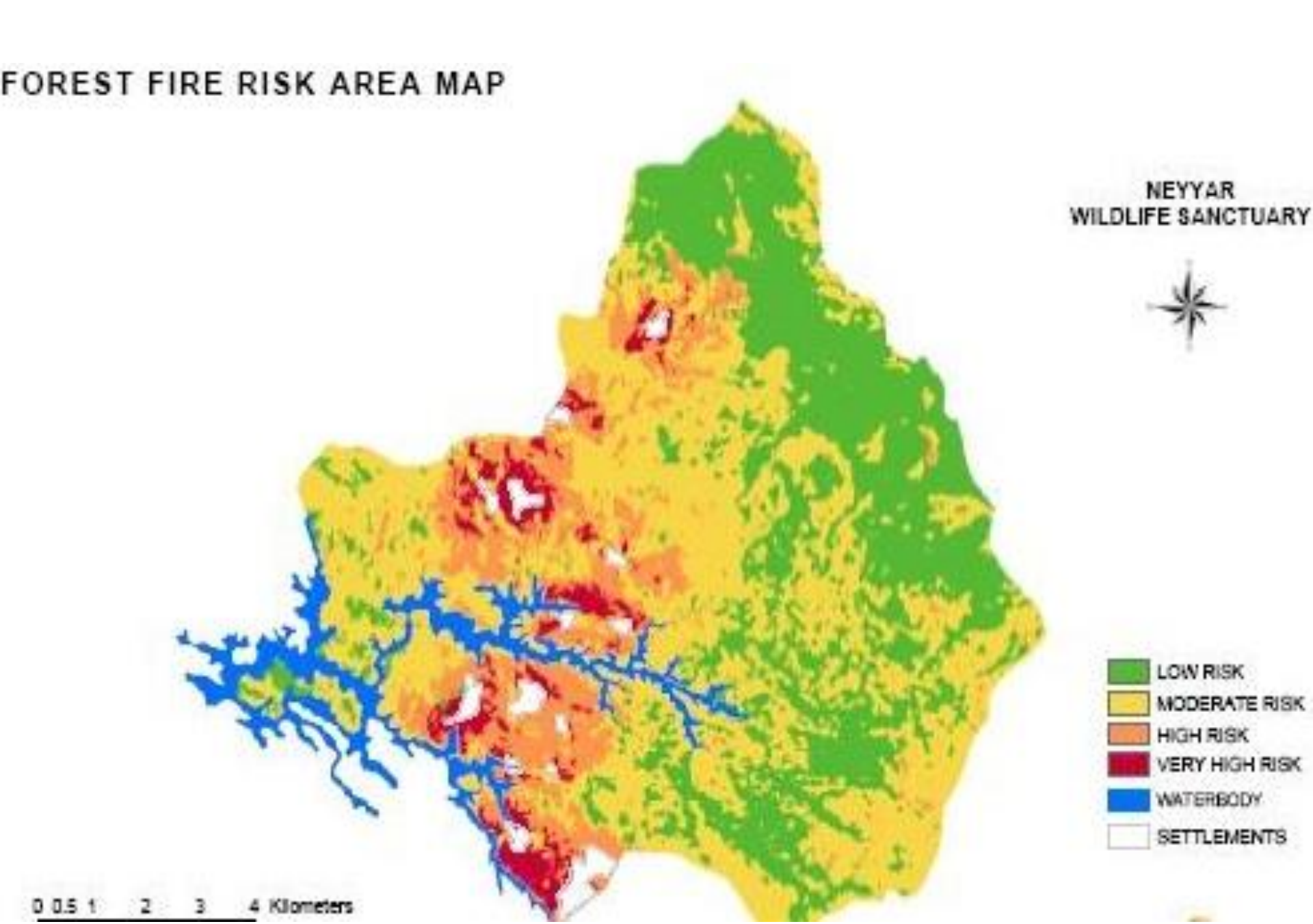
Burnt Scars



# Rajive Gandhi Nat. Park, Nagarhole, Karnataka
## Burnt area – IRS P6 LISS3, 9th Mar.2004



# FOREST FIRE RISK AREA MAP



# 9. FOREST RESOURCE EVALUVATION AND SURVEY

## A. CHECKING OF REED RESOURCES OF KERALA

DATA USED 1:15,000 B&W PHOTOGRAPHS

OUTPUT REED RESOURCE MAP IN 1:25000

## B. RATTAN SURVEY STUDY

DATA USED

IRS 1B LISS 2 CCT

TECHNIQUES

DIGITAL IMAGE PROCEEING

OUTPUT

DELINIATION OF RATTAN / NONRATTAN AREA

# BAMBOO RESOURCE ESTIMATION

**DATA USED**

**IRS 1C LISS 3 CCT**

**TECHNIQUES**

**DIGITAL IMAGE PROCESSING COUPLED WITH AERIAL PHOTO INTERPRETATION**

**STUDY AREA**

**KERALA FORESTS**

**OUTPUT**

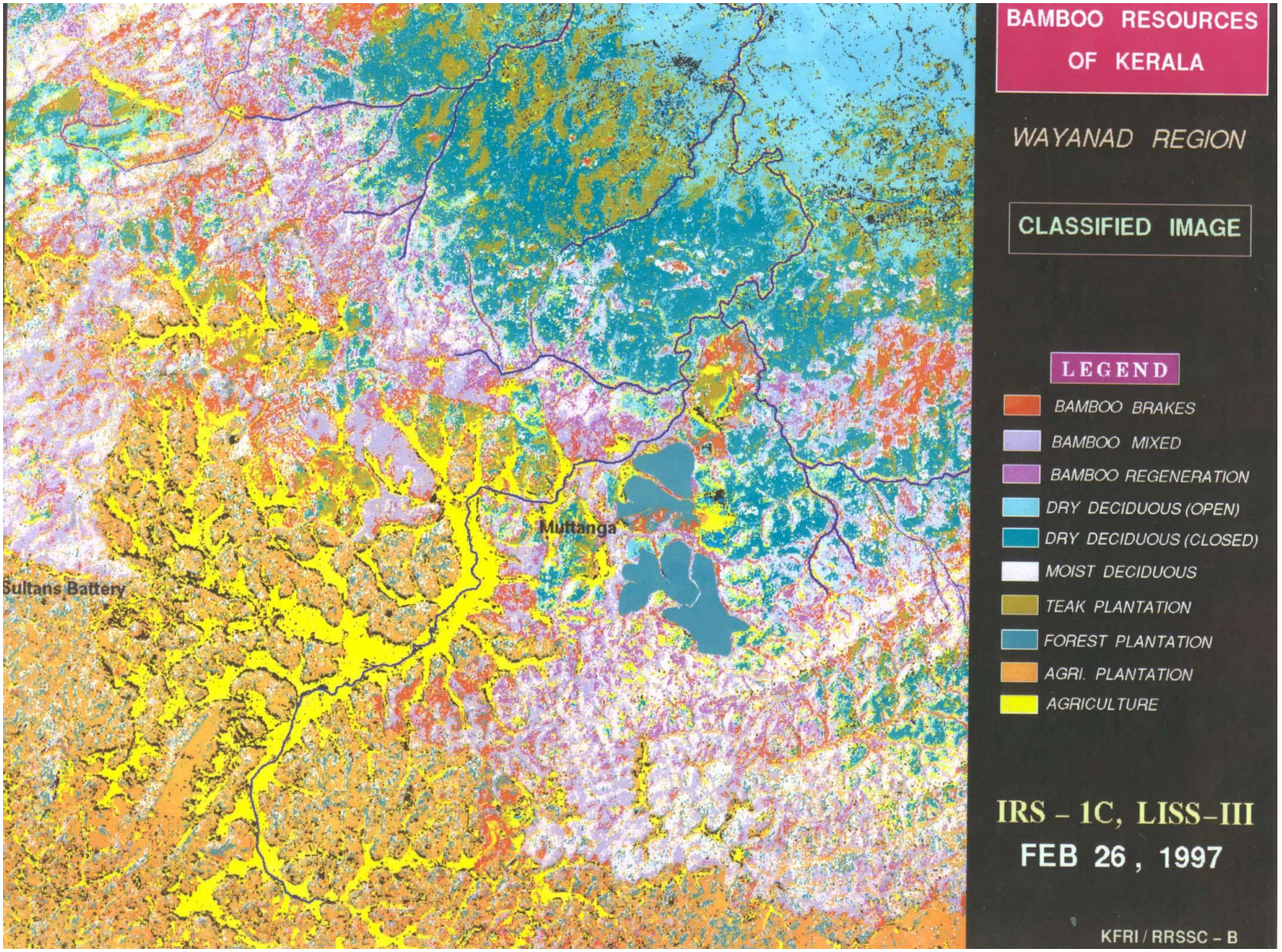
**DENSITY SLICED BAMBOO DESTRIBUTION MAP AND RESOURCE STATISTICS**

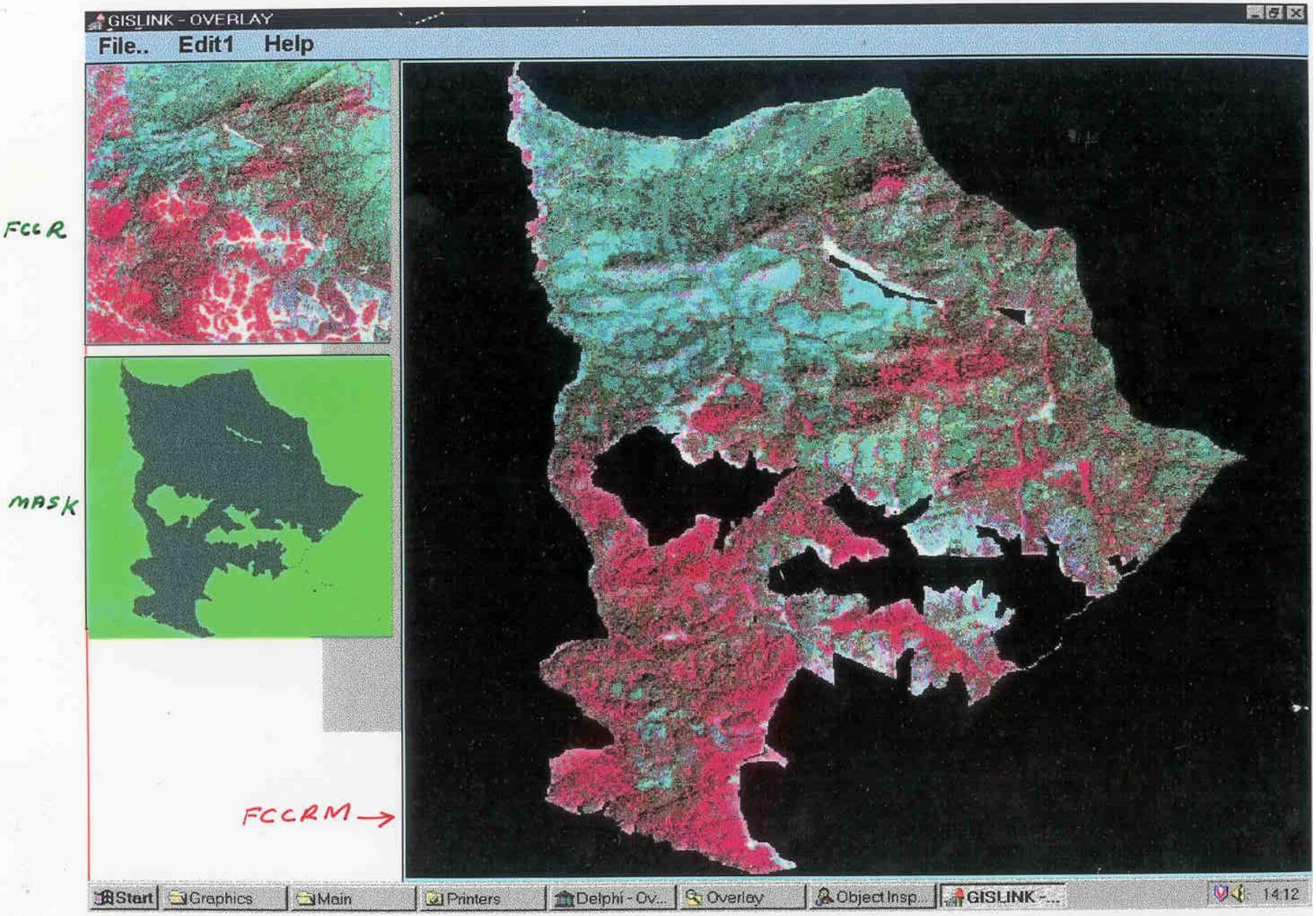
# Supervised classification

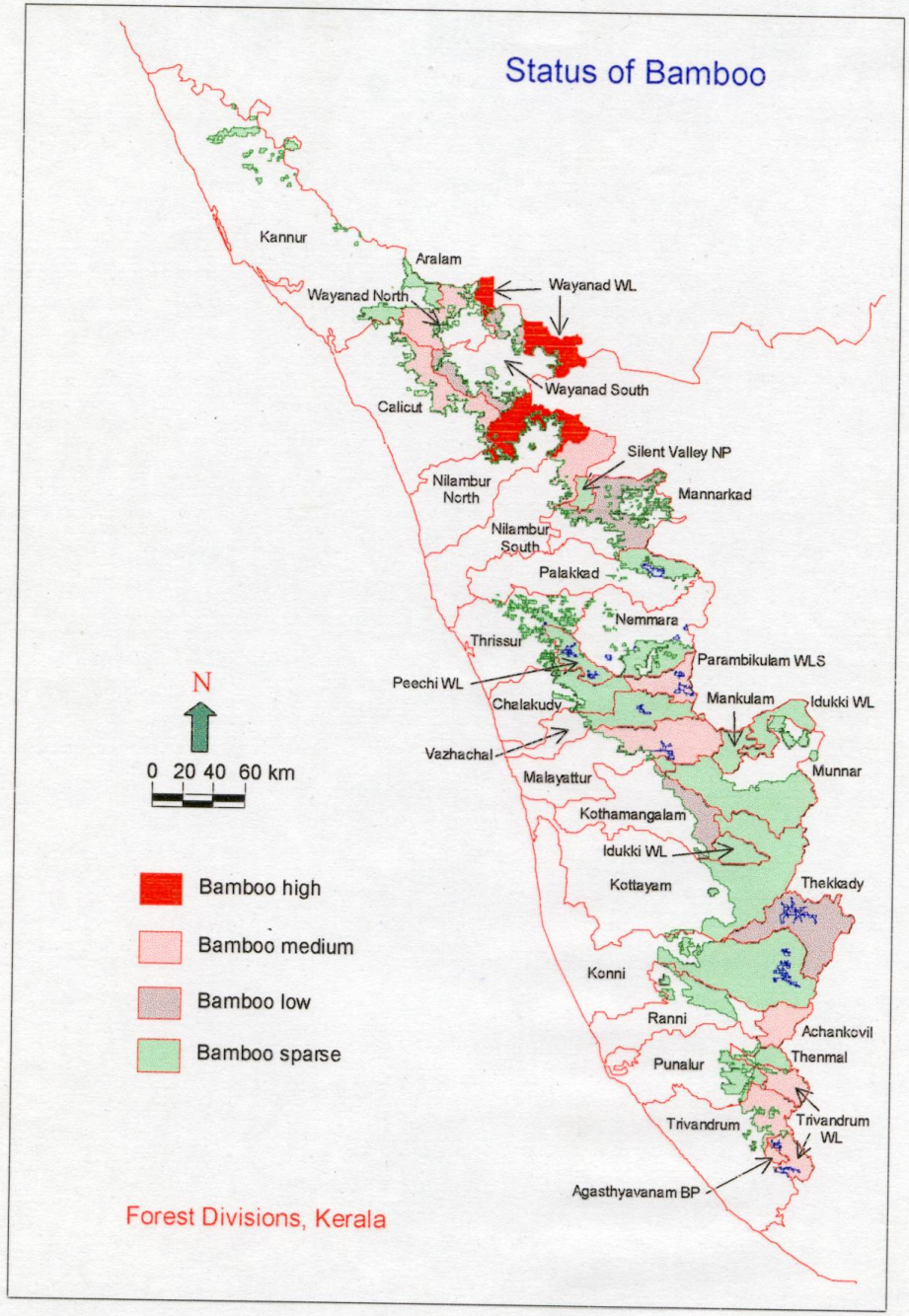
In this method, computer is made to study the **characteristics of distinct objects**. Based on this, the computer is able to generalize characters of objects and come up with **accurate classification**.

In this technique all available spectral bands can be used and hence features normally not visible become clear. **With the help of accurate ground information high classification accuracy can be achieved.**

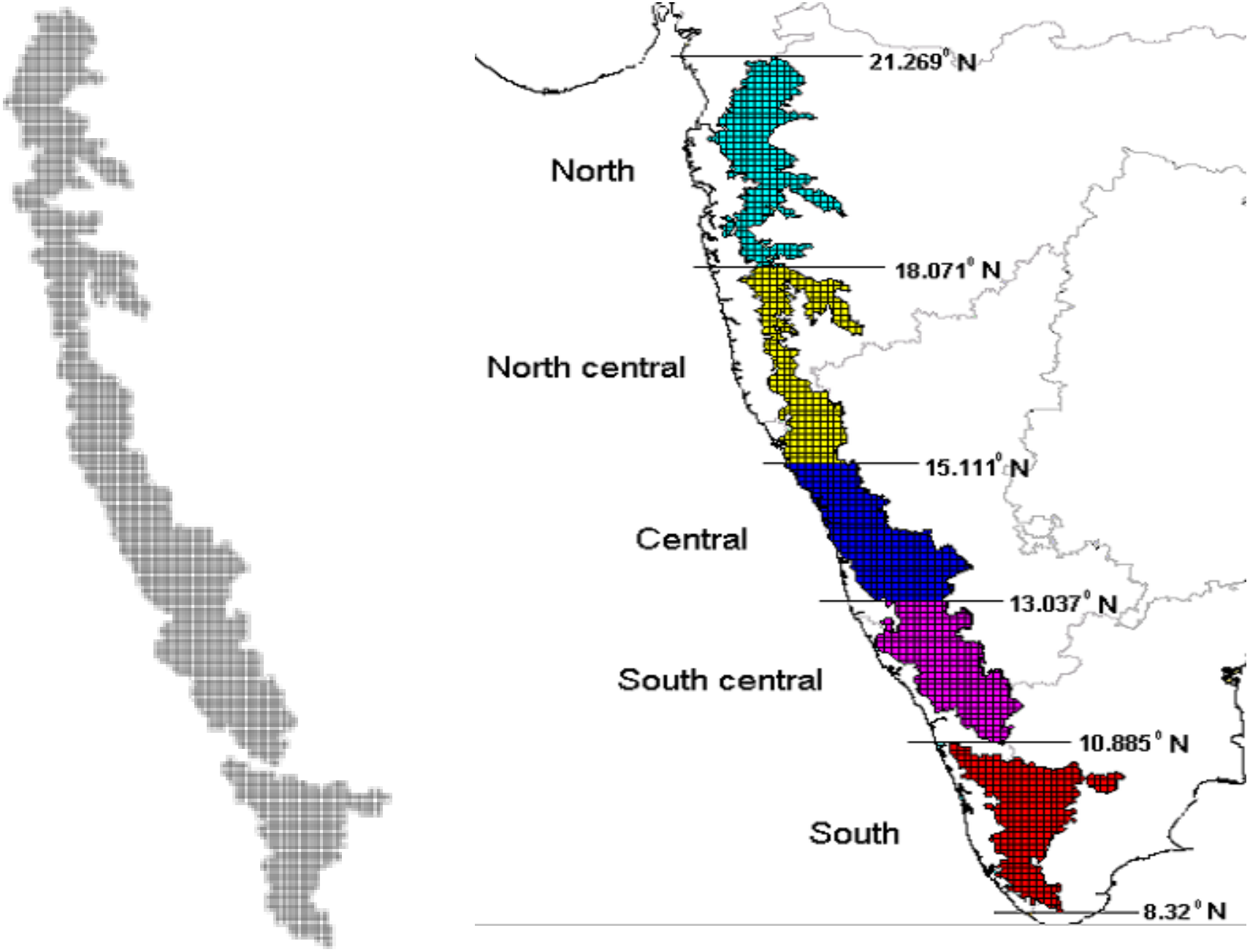
# Bamboo Resource Estimation



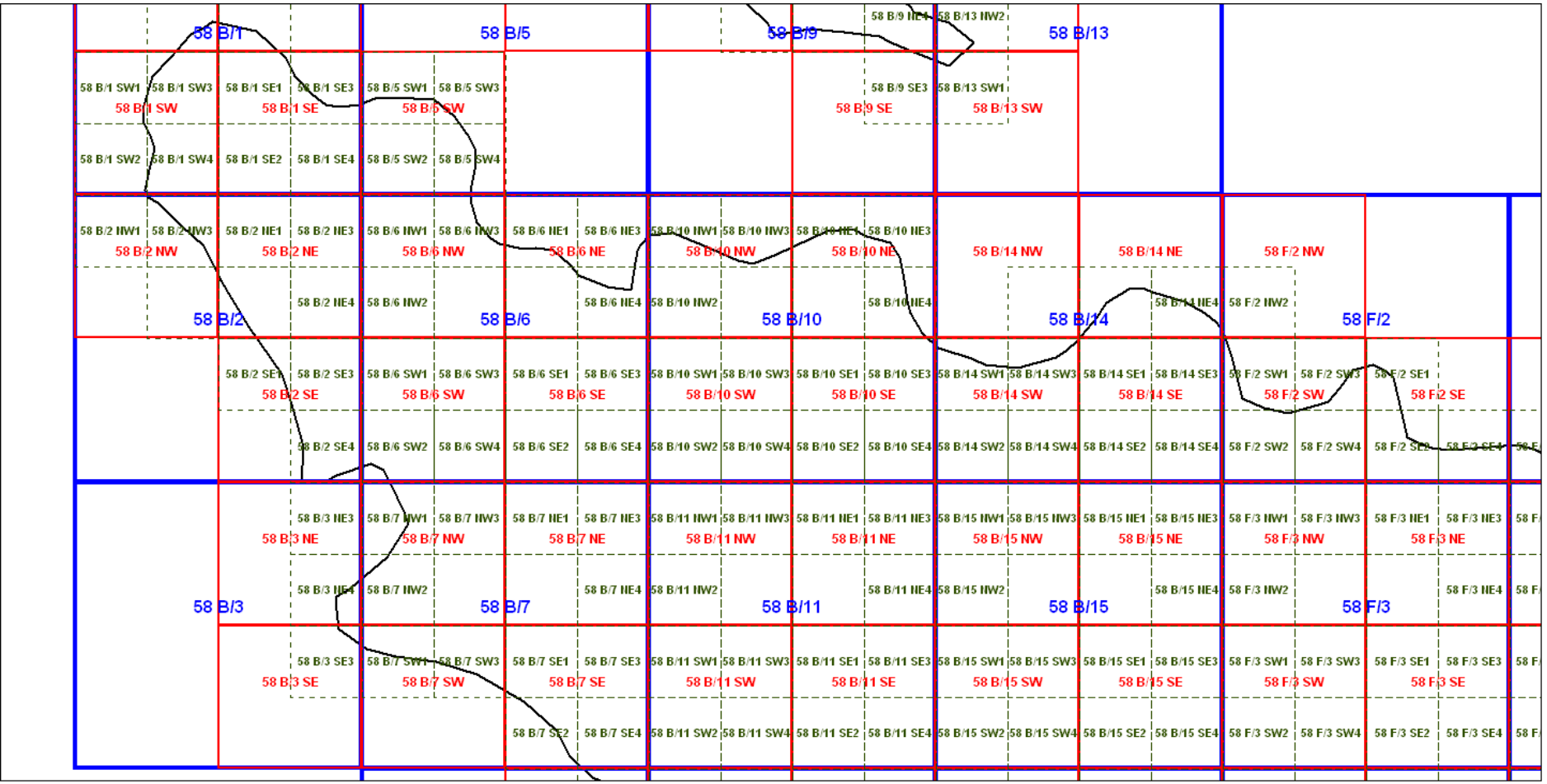

GISLINK - OVERLAY
File..
Edit1
Help
FCCR
MASK
FCCRM
Start
Graphics
Main
Printers
Delphi - Ov...
Overlay
Object Insp...
GISLINK -...
14:12

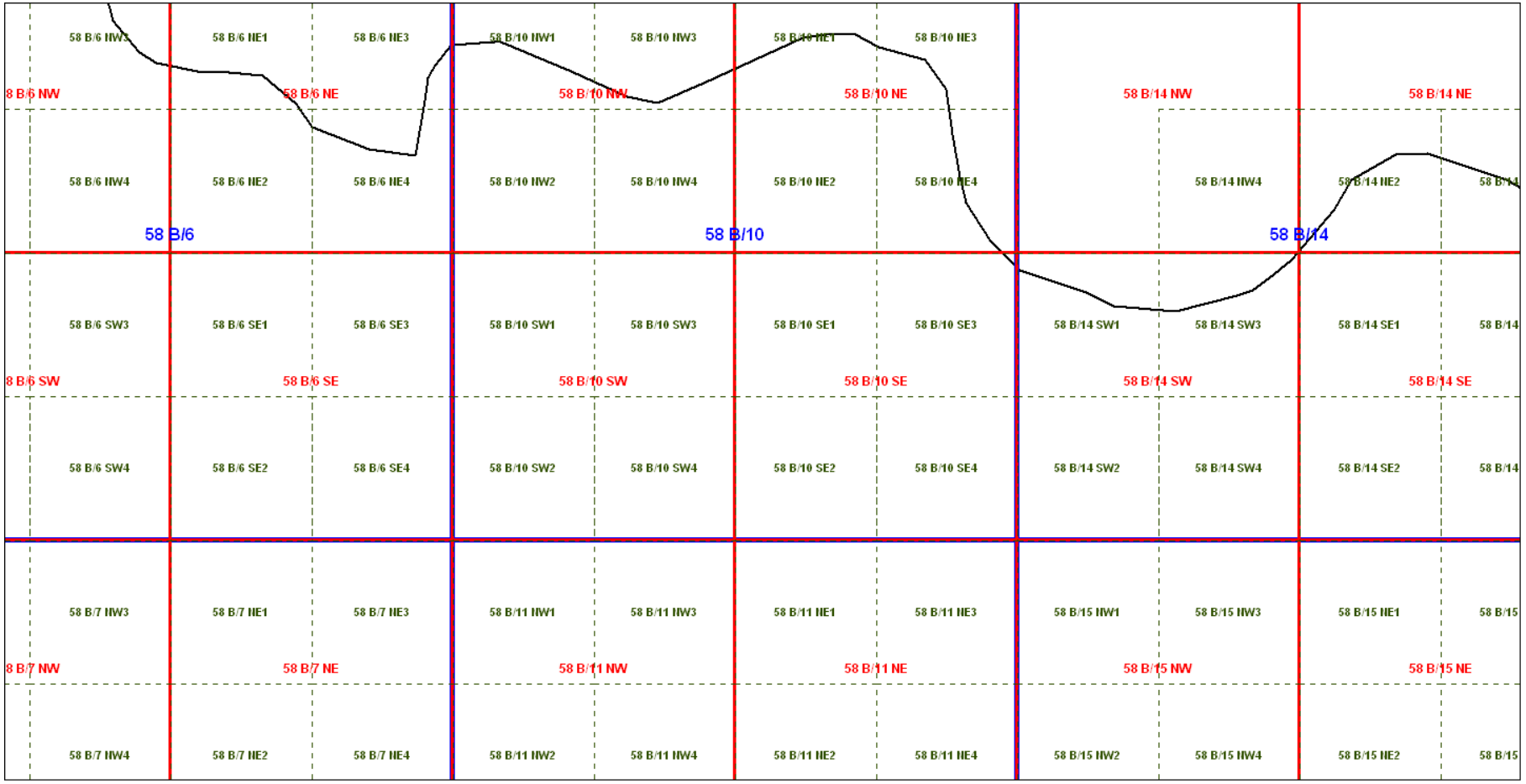

Status of Bamboo
Kannur
Aralam
Wayanad North
Wayanad WL
Wayanad South
Calicut
Silent Valley NP
Nilambur North
Mannarkad
Nilambur South
Palakkad
Nemmara
Thrissur
Parambikulam WLS
Peechi WL
Chalakudy
Mankulam
Idukki WL
Vazhachal
Munnar
Malayattur
Kothamangalam
Idukki WL
Kottayam
Thekkady
Konni
Ranni
Achankovil
Thenmal
Punalur
Trivandrum
Trivandrum WL
Agasthyavanam BP
N
0 20 40 60 km
Bamboo high
Bamboo medium
Bamboo low
Bamboo sparse
Forest Divisions, Kerala

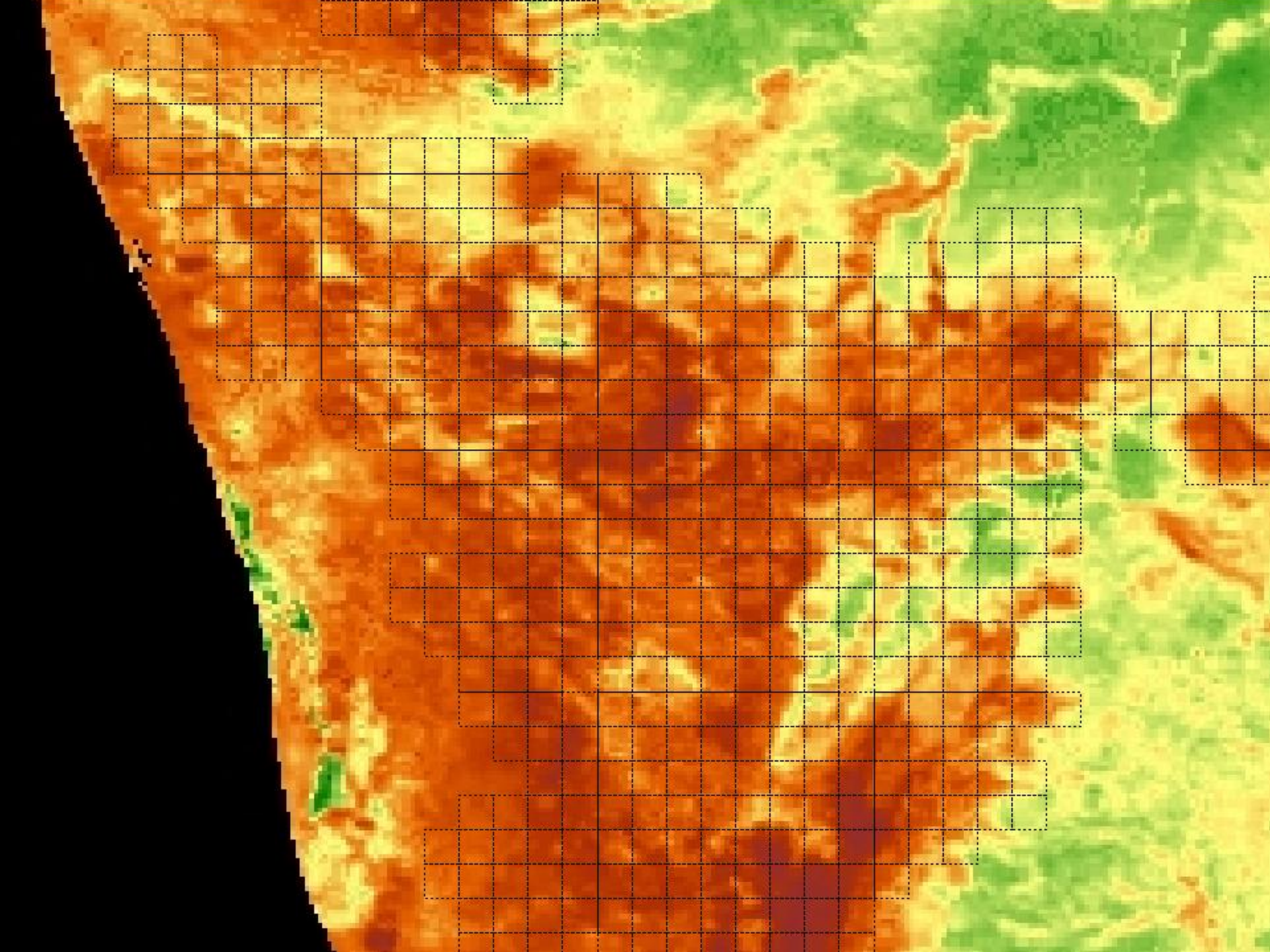
# 12.Mapping and quantitative assessment of geographic distribution and the population status of plant resources of Western Ghats


21.269° N
North
18.071° N
North central
15.111° N
Central
13.037° N
South central
10.885° N
South
8.32° N

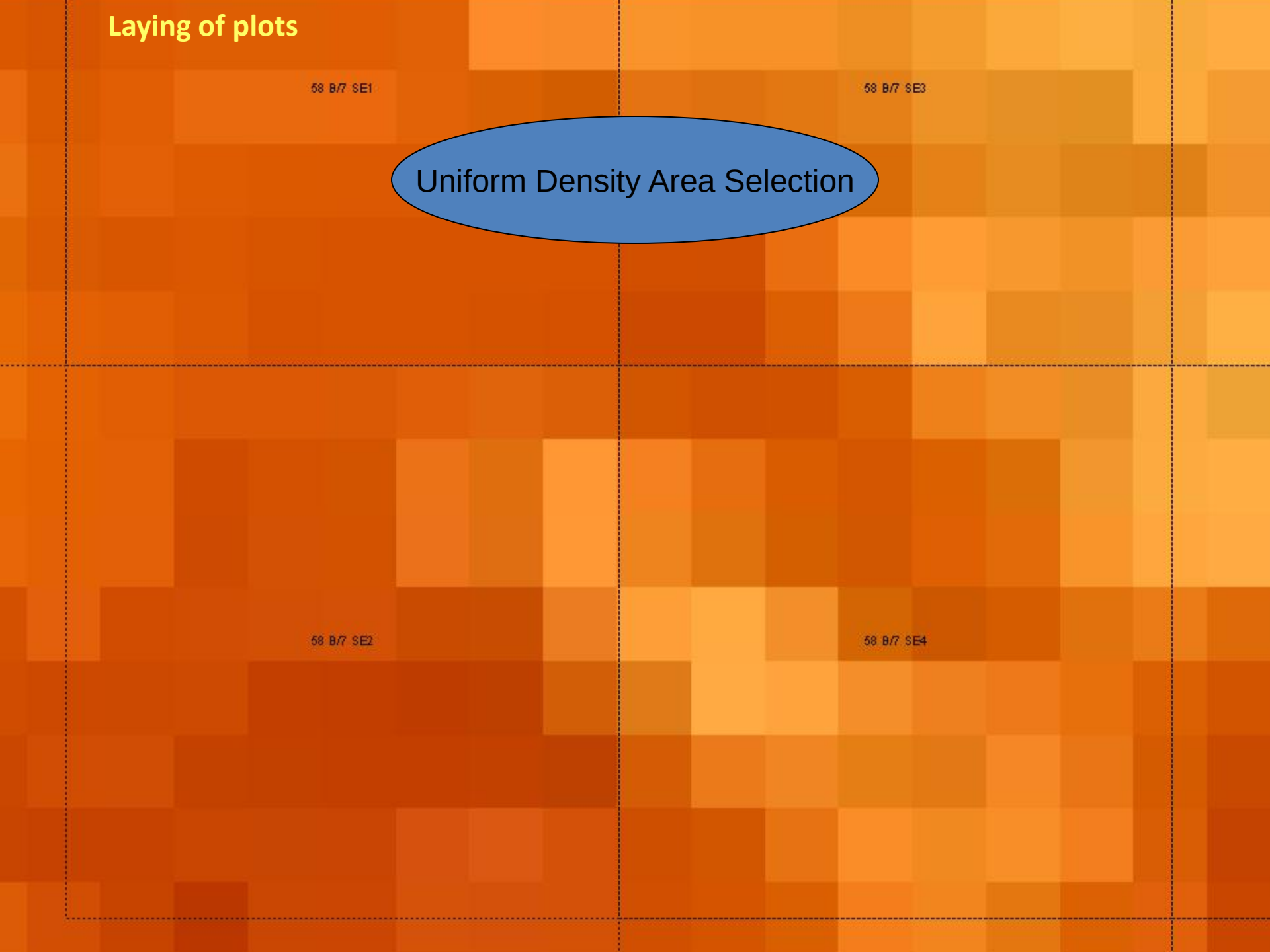
# Sub-division of Grids




58 B/6 NW3
58 B/6 NE1
58 B/6 NE3
58 B/10 NW1
58 B/10 NW3
58 B/10 NE1
58 B/10 NE3
8 B/6 NW
58 B/6 NE
58 B/10 NW
58 B/10 NE
58 B/14 NW
58 B/14 NE
58 B/6 NW4
58 B/6 NE2
58 B/6 NE4
58 B/10 NW2
58 B/10 NW4
58 B/10 NE2
58 B/10 NE4
58 B/14 NW4
58 B/14 NE2
58 B/6
58 B/10
58 B/14
58 B/6 SW3
58 B/6 SE1
58 B/6 SE3
58 B/10 SW1
58 B/10 SW3
58 B/10 SE1
58 B/10 SE3
58 B/14 SW1
58 B/14 SW3
58 B/14 SE1
8 B/6 SW
58 B/6 SE
58 B/10 SW
58 B/10 SE
58 B/14 SW
58 B/14 SE
58 B/6 SW4
58 B/6 SE2
58 B/6 SE4
58 B/10 SW2
58 B/10 SW4
58 B/10 SE2
58 B/10 SE4
58 B/14 SW2
58 B/14 SW4
58 B/14 SE2
58 B/7 NW3
58 B/7 NE1
58 B/7 NE3
58 B/11 NW1
58 B/11 NW3
58 B/11 NE1
58 B/11 NE3
58 B/15 NW1
58 B/15 NW3
58 B/15 NE1
8 B/7 NW
58 B/7 NE
58 B/11 NW
58 B/11 NE
58 B/15 NW
58 B/15 NE
58 B/7 NW4
58 B/7 NE2
58 B/7 NE4
58 B/11 NW2
58 B/11 NW4
58 B/11 NE2
58 B/11 NE4
58 B/15 NW2
58 B/15 NW4
58 B/15 NE2

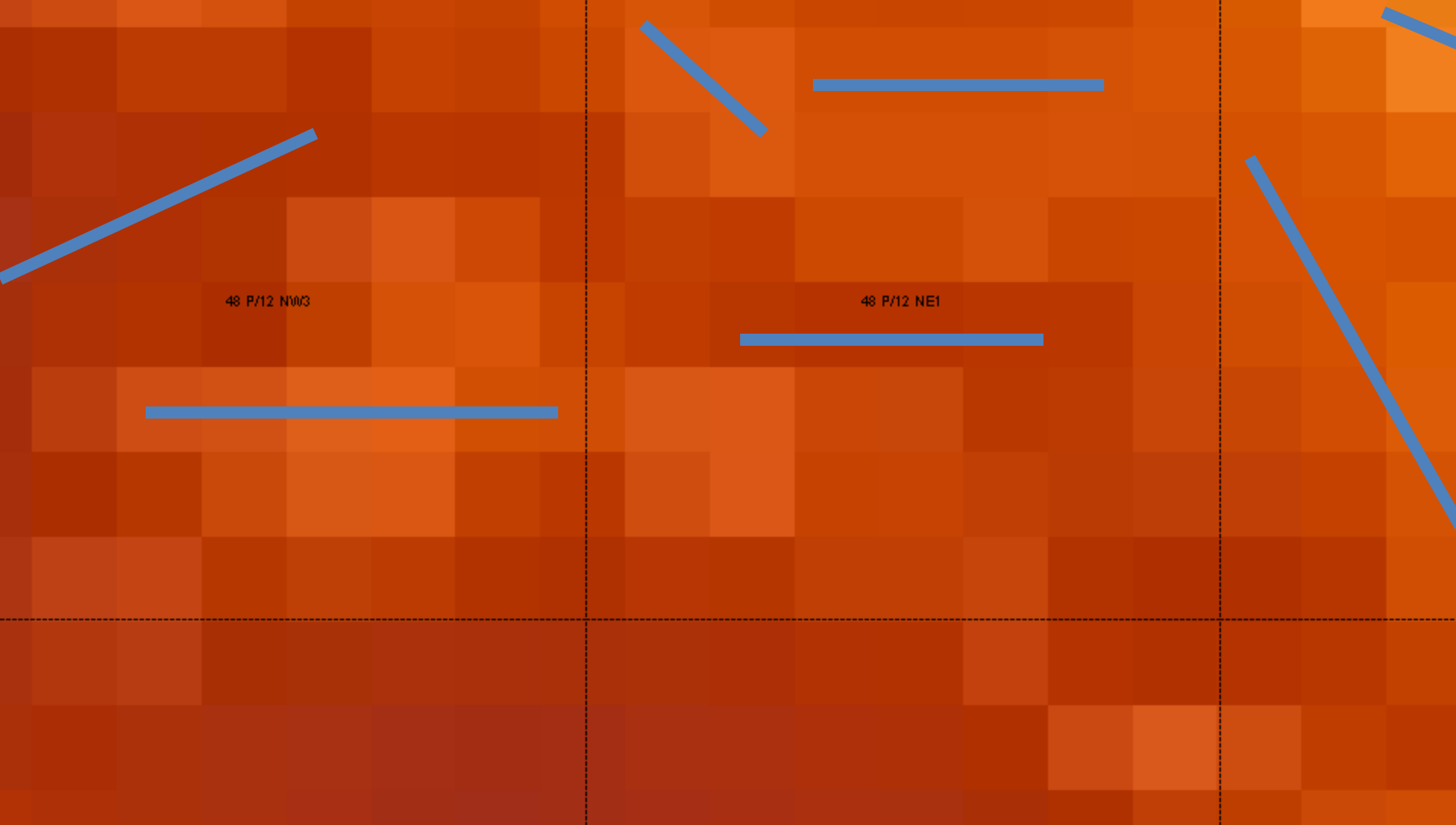


# Laying of plots



## Laying of plots

Transect Studies




Thanks