INVESTIGATIONS ON THE ACCURACY ASPECTS IN THE LAND USE/LAND COVER MAPPING USING REMOTE SENSING SATELLITE IMAGERY –A CASE STUDY

By

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INTRODUCTION:

- Different methods of land use/land cover
- Conventional methods
- Modern methods- RS,GIS,GPS
- Classification of satellite image
- Accuracy aspects

Need for land use maps:

- Now a days due to rapid growth in urbanization and industrialization, there is increasing pressure on land, water and environment. Urban sprawl may be found everywhere in major cities.
- There are many problems related with conversion of agricultural land in to urban use. Every city is expanding in all directions resulting in large-scale changes in urban land use.

Land cover and Land use :

- Land cover is that which covers the surface of the earth and land use describes how the land cover is modified.
- Land cover includes: water, grassland, forest, bare soil etc.
- Land use includes agricultural land, recreation area, built up land, etc.

The function of Land use maps:

- To make property maps and to do settlement.
- To conduct topographic survey for infrastructure development.
- To keep database records related to property.
- To evaluate the property value.
- To divide the property in case of disputes.
- To work with Board of Revenue, Public works departments, Utility companies etc.

Conventional Methods:

- Chains to measure distances
- Old mechanical Theodolites
- Vernier Theodolites
- Paper maps etc.

Disadvantages of using Conventional Method:

- Chains data can be taken only in perpendicular direction, while actually land/fields is of Zig Zag shape.
- Chain data is always inaccurate. The land cost of today demands a more accurate method.
- The maps generated by manual methods can not be reproduced at user required scale. If scale has to be changed then whole map has to be redrawn.
- Attribute data for a field can not be attached on a paper map.
  (i.e.The name of the owner, the area , the cost etc. has no relation with the map.)
- Decision making process using old paper maps becomes very cumbersome and some time it leads to wrong decision.

Modern methods:

- Making a map using Coordinates rather than by Angles and distances.
- Area computation can be done using Total Stations as well as GPS then and there itself.
- Using Total Stations and Mapping Software the maps can be created automatically.
- Map at any scale can be created because of availability of data in electronic format.
- A full-fledged GIS can be generated so that just be click of a key all the attributes corresponding to a land piece can be obtained.

Developments in the Surveying Techniques and advantages of new mapping Techniques:

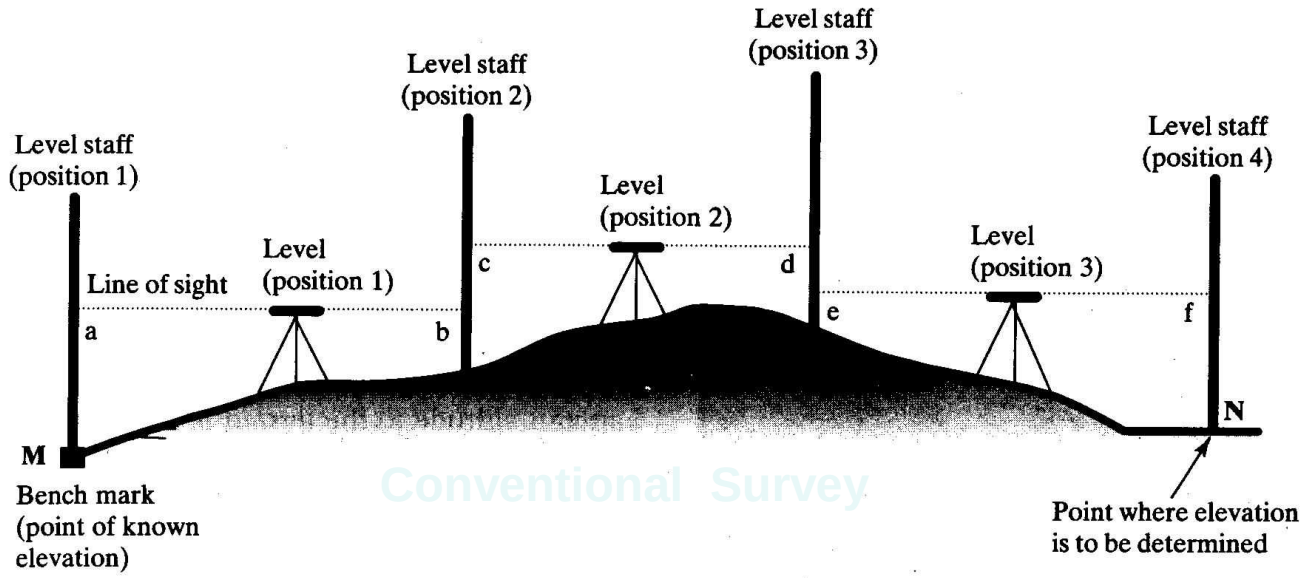
- Conventional Survey Methods are very tedious and time consuming.
- Large Number of measurements are required to prepare a map.
- Automated Survey Techniques are simpler and easy to record survey measurements.

AUTOMATED SURVEYING TECHNOLOGY

- Automatic and Laser level
- Total Stations
- Global Positioning Systems (GPS)
- Photogrammetric Survey
- Remote Sensing Methods (RS)

Ground based technique limitations and advantages of satellite based techniques.

- **In Conventional Survey** all the field values are to be noted down in the field book and plotting is done manually in the office.
- **In GPS based surveys**, the GPS Receiver records the Satellite signal. GPS receiver can be attached to computer and automatically plots the maps..

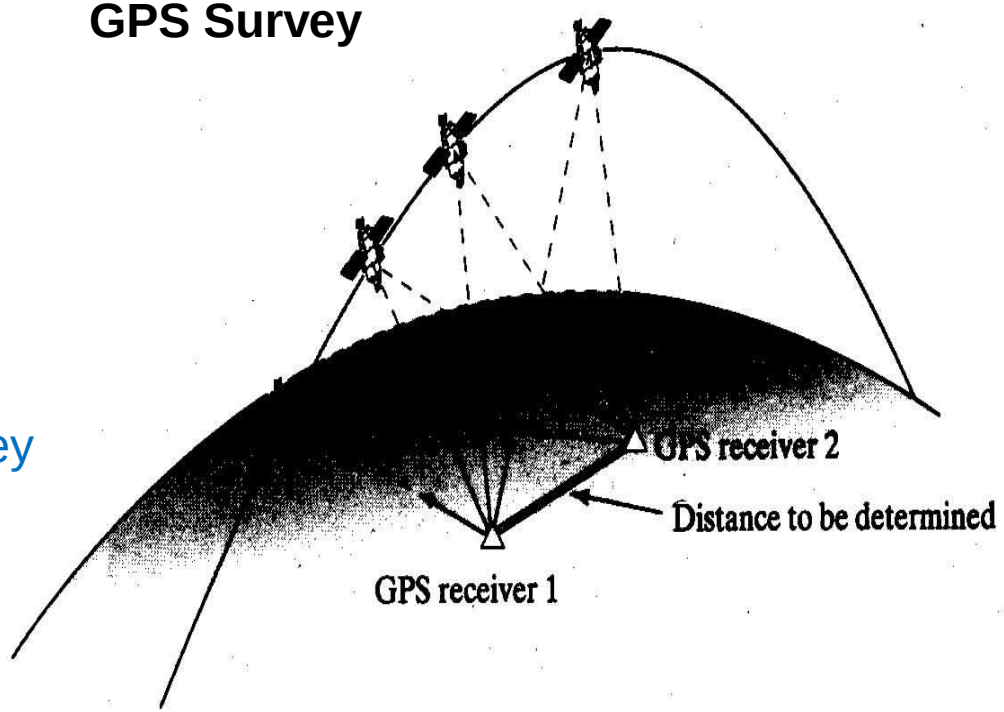


Conventional Survey

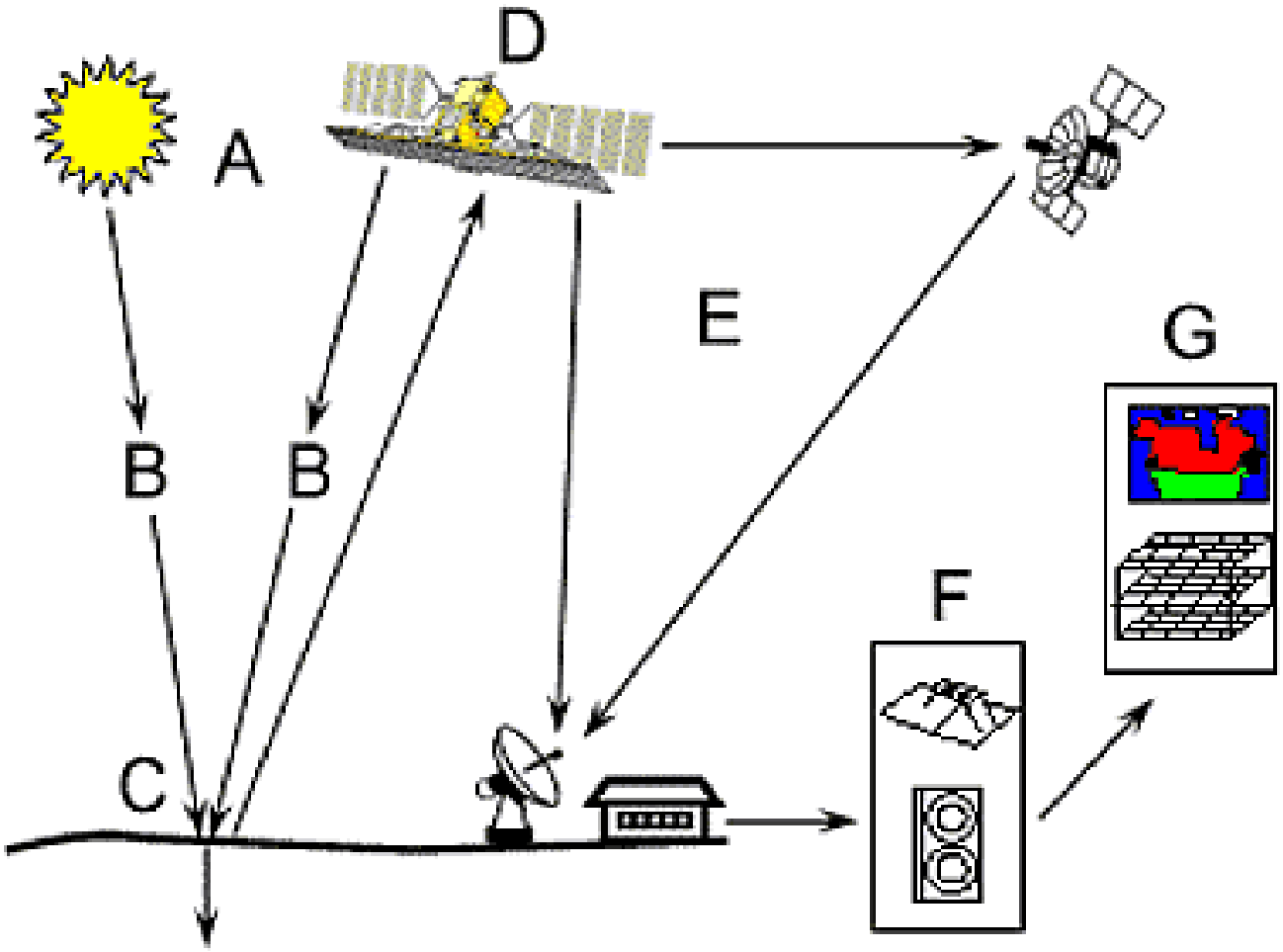
Elevation of N = elevation of M + a + (c − b) − (d − e) − f

where M = point of known height and a through f are level staff readings

GPS Survey



REMOTE SENSING [RS]

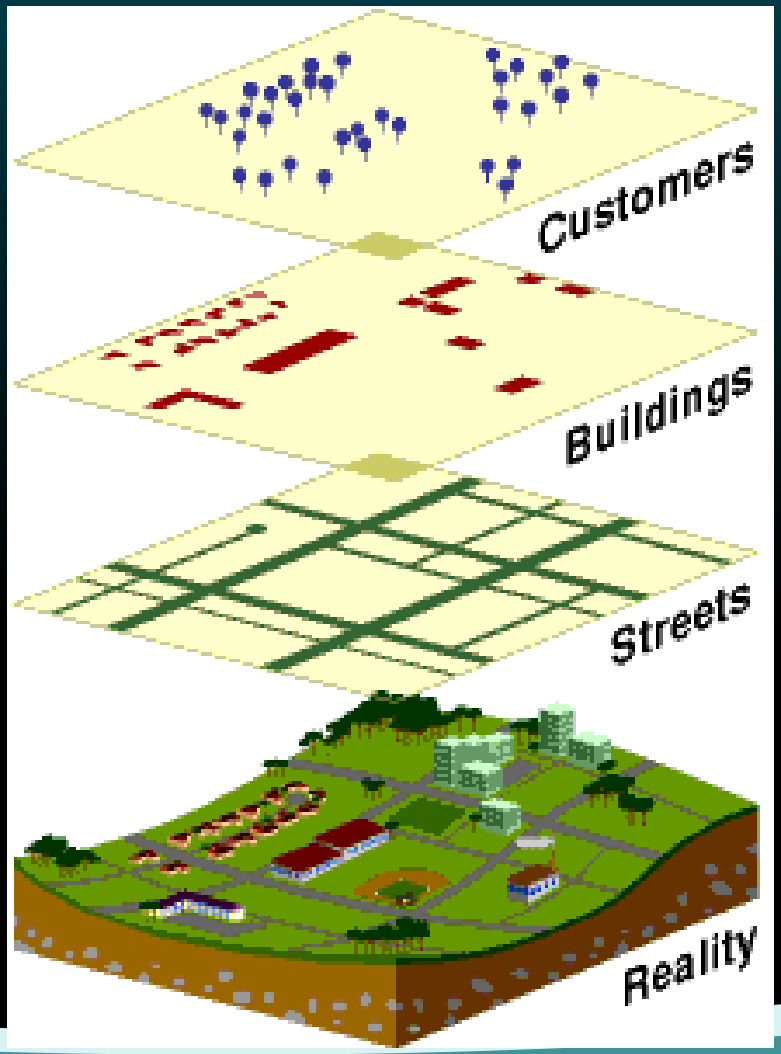


A-Energy Sources
B-Radiation & Atmosphere
C-Interaction with Target
D-Recording of Energy by the Sensor
E-Transmission, Recording and Processing
F-Interpretation and Analysis
G-Application

http://sedac.ciesin.org/tg/guide_glue.jsp?rd=rs&ds=3

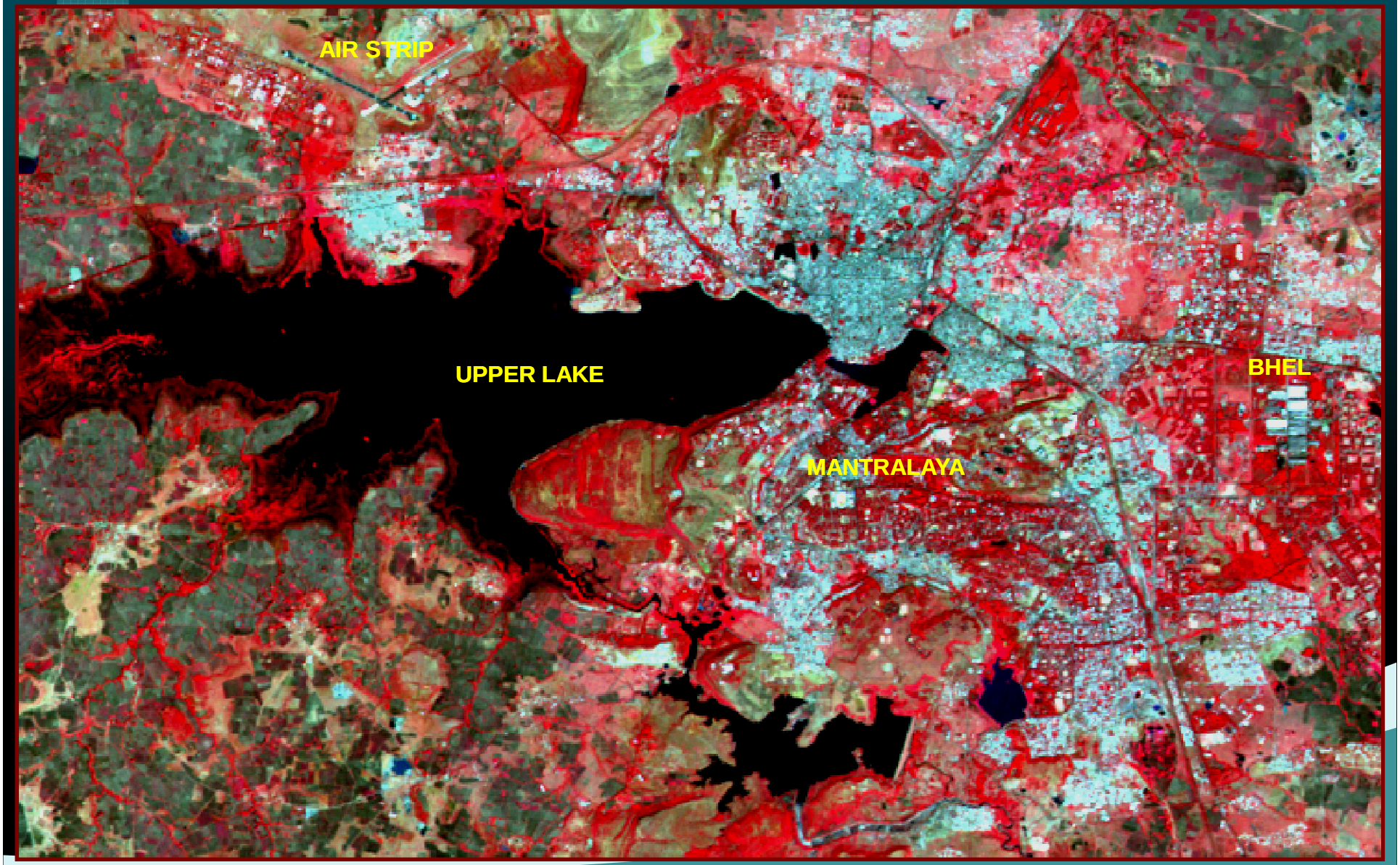
Introduction Cont…

GIS AND ITS COMPONENTS



Component

IRS-1D LISS-III DATA (23.5 M RESOLUTION)



BHOPAL AS SEEN ON 25th NOV 1998

IRS-1D PAN & LISS III MERGED DATA (5.8 M RESOLUTION)

BHOPAL AS SEEN ON 14th NOV 2002

Accuracy aspects in land use/land cover maps:

- Land cover maps derived from remotely sensed data inevitably contain error of various types and degrees. It is therefore very important that the nature of these errors be determined, to gauge their appropriateness for specific uses.
- Identifying and correcting the sources of errors may increase the quality of map information. Classification accuracy assessment is necessary for comparing the performance of various classification techniques.

- Today, the error matrix has become the standard medium for reporting the accuracy of maps derived from remotely sensed data (Congalton and Green, 1993).
- More recent research into classification accuracy assessment has focused on factors influencing the accuracy of spatial data, such as sampling scheme and sample size, classification scheme, and spatial autocorrelation (Congalton and Green, 1993).
- Other important considerations in classification accuracy assessment include ground verification techniques, and evaluation of all sources of error in the spatial data set.

Accuracy aspects :

- Assessing the accuracy of maps generated from remotely sensed data requires evaluating both positional accuracy and thematic accuracy. While these two accuracies can be assessed separately, they are very much interrelated and failure to consider both of them is a serious mistake.

Positional Accuracy:

- Positional accuracy, a measure of how closely the imagery fits the ground, is the most common measure of map accuracy. In other words, positional accuracy is the accuracy of the location of a point in the imagery with reference to its physical location on the ground.

Thematic Accuracy:

- Thematic accuracy refers to the accuracy of a mapped land cover category at a particular time compared to what was actually on the ground at that time. Clearly, to perform a meaningful assessment of accuracy, land cover classifications must be assessed using data that are believed to be correct.

Accuracy aspects :

- A classification is not complete until its accuracy is assessed.
- A classification error matrix is prepared based on training data.
- Error matrix compares the ground truth and the corresponding results of an automated classification.
- Overall accuracy and individual accuracy is calculated.

Need of reliable calibration and ground truthing in the map extraction.

- KAPPA is a technique developed by Cohen (1960) and has been utilized for land cover and land use accuracy assessment derived from remotely sensed data (Congalton et al., 1983; Rosenfield and Fitzpatrick-Lins, 1986; Gong and Howarth, 1990).
- The result of performing a KAPPA analysis is the KHAT statistic (an estimate of KAPPA) which is another measure of accuracy or agreement.

Trend in map extraction from imagery using classification and feature extraction.

- In order to obtain unbiased ground reference information to compare with the remote sensing classification map and fill the error matrix values, we need to determine the most appropriate (i.e., minimum) sample size acceptable for a valid statistical testing of accuracy of the land cover map. In addition, an appropriate sampling scheme must be used to locate the sample points.

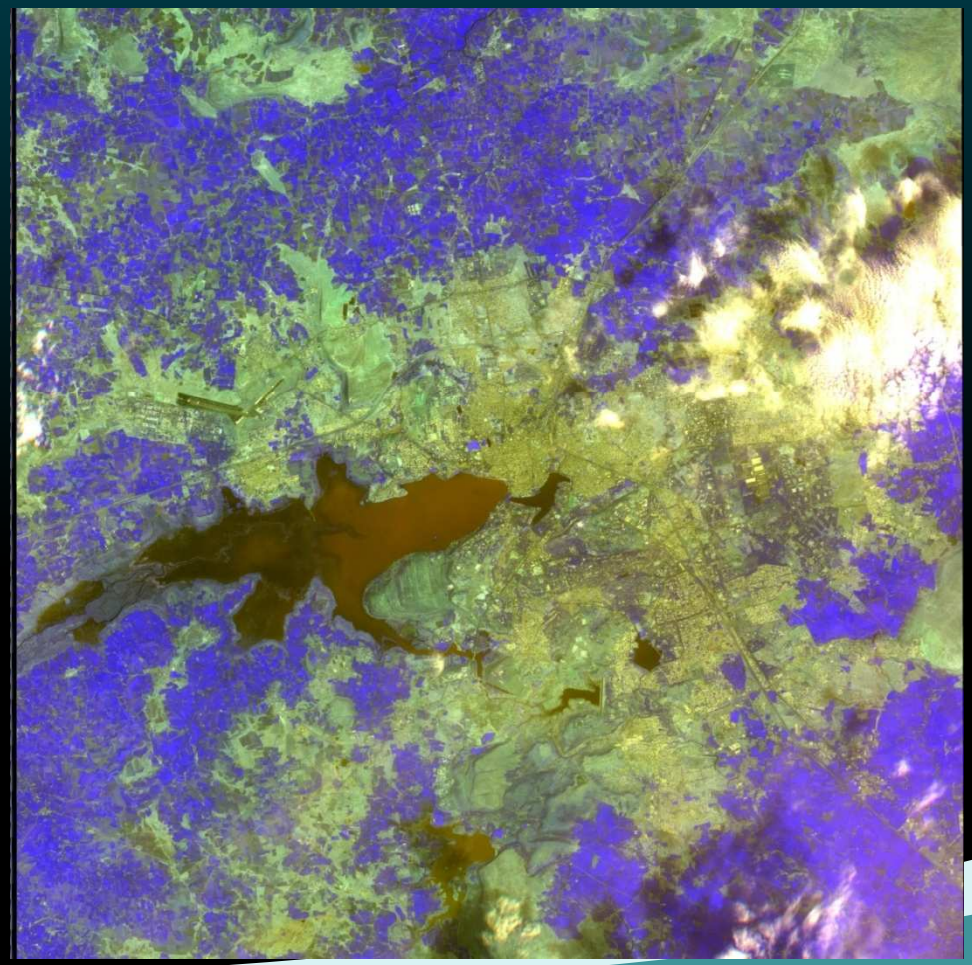
METHODOLOGY:

- Select various feasible land use categories in and around Bhopal city.
- Classify images by using ERDAS software and selecting different supervised methods as well as unsupervised methods.
- Verify classification accuracy by ground truthing with the help of GPS as well as Google images.
- Digitize each class boundary on Google image as well as different classified images and superimpose then in ERDAS to verify accuracy.

Study area and Data Resources:

- Bhopal City & adjoining area
- Some data of LISS-4 were purchased from NRSA Hyderabad for the date of field work done.

LISS -4 Image of Bhopal



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- After acquiring the satellite images of the study areas, classification of LISS 4 Image of Bhopal was applied to the four methods of classification.
- These are: Unsupervised classification in which the applied algorithm is Iterative Self-Organizing Data Analysis Technique (ISODATA)
- Three different supervised methods which include Maximum likelihood, Mahalanobis Distance, and Minimum Distance.

Contd.

- After classified thematic maps were developed, accuracy was tested by different methods of accuracy assessment, and the post- classification process was the last process in classification.

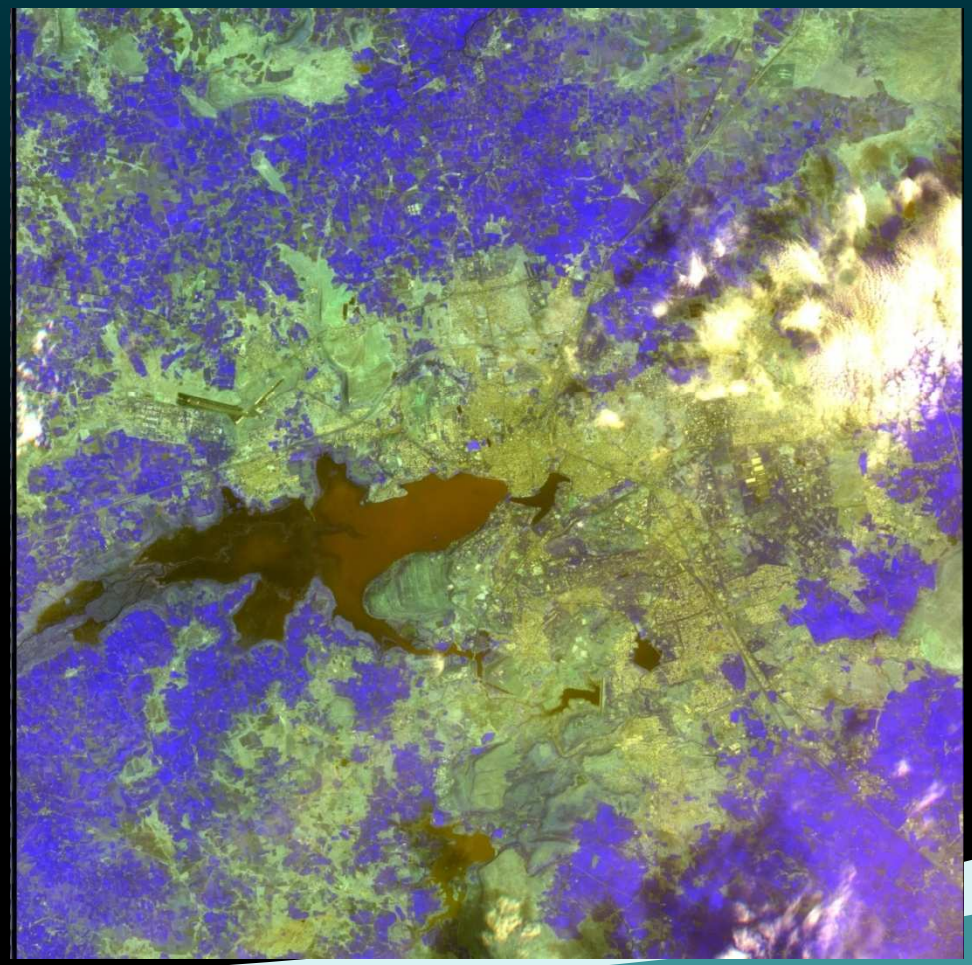
- The software packages used for classification

  was ERDAS IMAGINE 11.

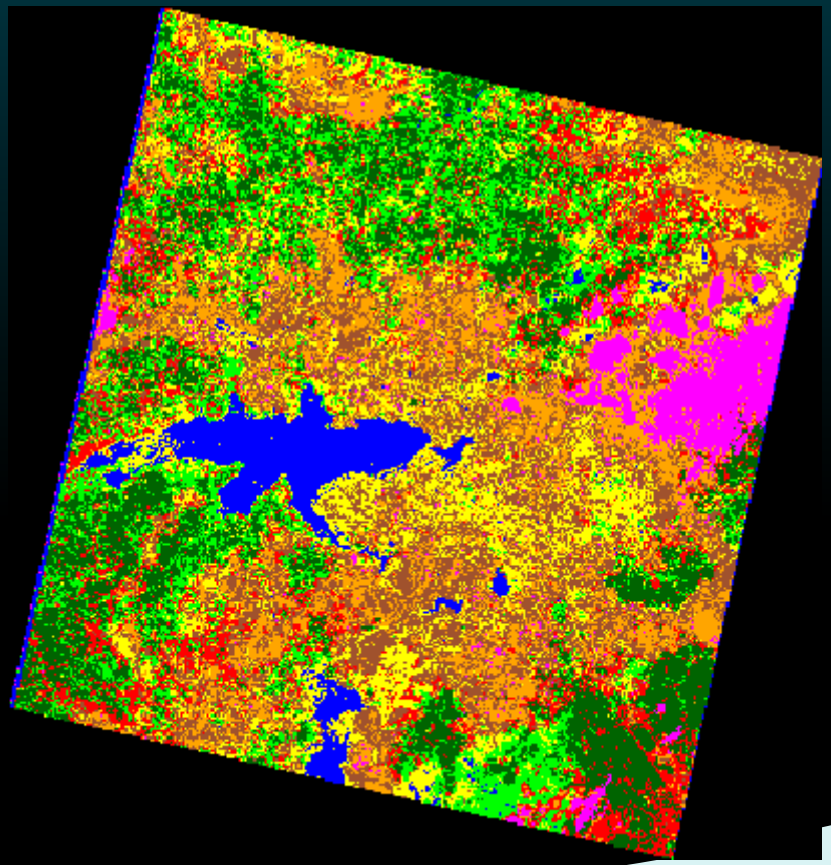
Signature file for Clssification

Class No.	Name of class
1	Water bodies
2	Agricultural fields
3	Clouds/error
4	Urban buildings
5	Barren land
6	Forest

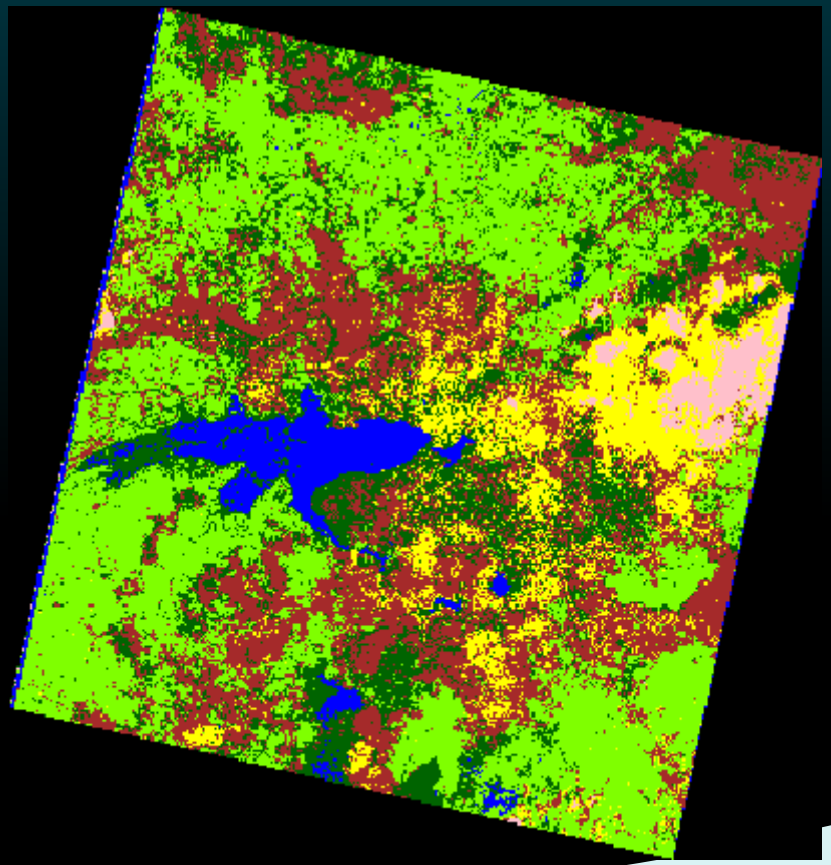
LISS -4 Image of Bhopal



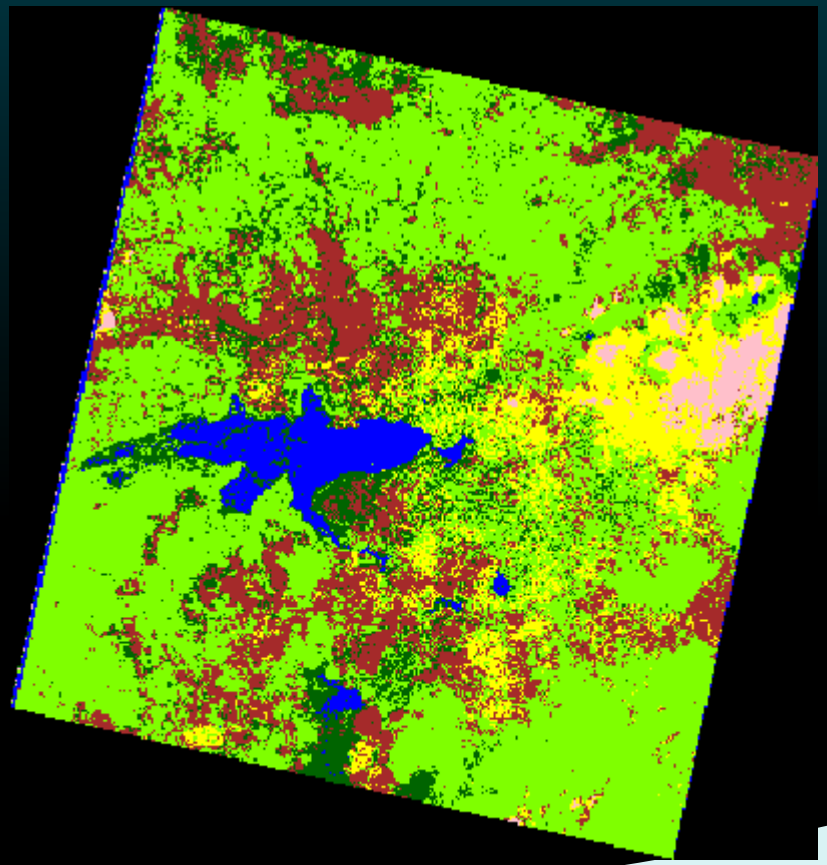
Unsupervised classification



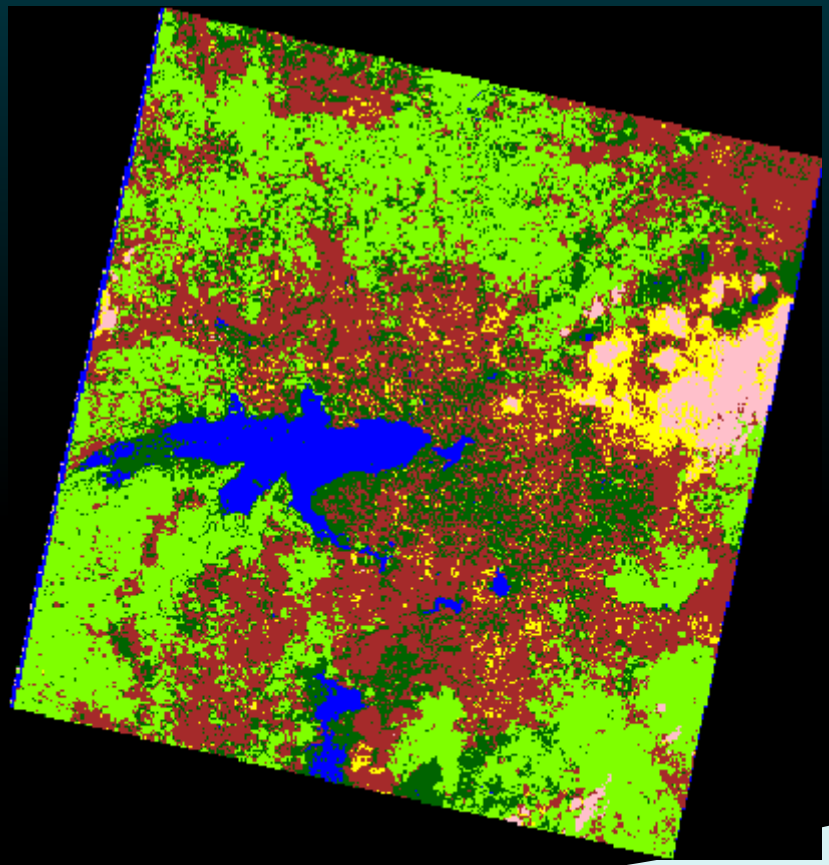
Maximum Likelihood Method



Mahalanobis Distance Method



Minimum Distance Method



Error Matrix

Ground Reference

Image Classification

	1	2	3	4	5	6	Row Total
1	**12**	1	0	0	1	1	15
2	2	**18**	1	2	0	1	24
3	0	2	**12**	2	1	1	18
4	0	0	1	**16**	1	2	20
5	0	1	2	1	**16**	1	21
6	0	0	0	0	2	**30**	32
Column Total	14	22	16	21	21	36	**130**

.Overall Accuracy= (104/130) x100=80%

Calculate Producer's Accuracy for each class and User's Accuracy for each class .

User's Accuracy(Rows)

- Class 1=(12/15)x100=80.00%
- Class 2=(18/24)x100=75.00%
- Class 3=(12/18)x100=66.67%
- Class 4=(16/20)x100=80.00%
- Class 5=(16/21)x100=76.19%
- Class 6=(30/32)x100=93.75%

Producer's Accuracy(Columns)

- Class 1=(12/14)x100=85.71%
- Class 2=(18/22)x100=81.81%
- Class 3=(12/16)x100=75.00%
- Class 4=(16/21)x100=76.19%
- Class 5=(16/21)x100=76.19%
- Class 6=(30/36)x100=83.33%

Error Matrix

Ground Reference

Image Classification

	1	2	3	4	5	6	Row Total
1	**10**	1	0	0	2	2	15
2	1	**25**	1	1	2	2	32
3	0	2	**14**	2	1	1	20
4	0	1	1	**16**	2	2	22
5	0	1	2	1	**14**	2	20
6	1	2	1	0	2	**25**	31
Column Total	12	32	19	20	23	34	**140**

Mahalanobis Distance Method:.

.Overall Accuracy= (107/140) x100=74.28%

Error Matrix

Ground Reference

Image Classification

	1	2	3	4	5	6	Row Total
1	**10**	2	0	0	2	1	15
2	2	**14**	2	2	2	2	24
3	0	2	**11**	2	1	2	18
4	1	1	1	**14**	1	2	20
5	1	1	2	2	**13**	2	21
6	1	2	1	1	2	**25**	32
Column Total	15	22	17	21	21	34	**130**

Minimum Distance Method:

.Overall Accuracy= (87/130) x100=67%

Conclusion:

- Error matrices produced to evaluate the classification methods show that the best overall classification accuracy method was the maximum likelihood with an average accuracy of about 80%.
- The second best overall classification accuracy method was mahalanobis distance; with an average accuracy of 74% and
- the worst overall classification accuracy method was minimum distance with an average accuracy of 67%.

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THANK YOU.