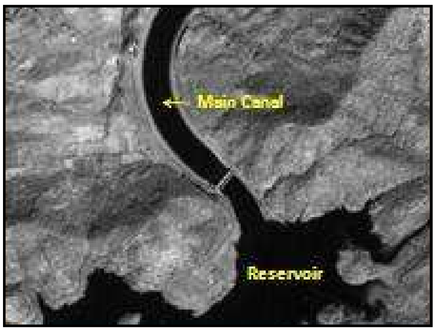
सत्यमेव जयते

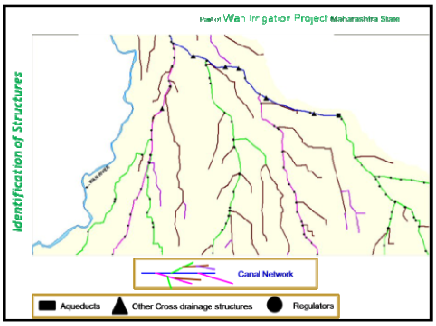
भारत सरकार
जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय
केन्द्रीय जल आयोग
राष्ट्रीय जल अकादमी

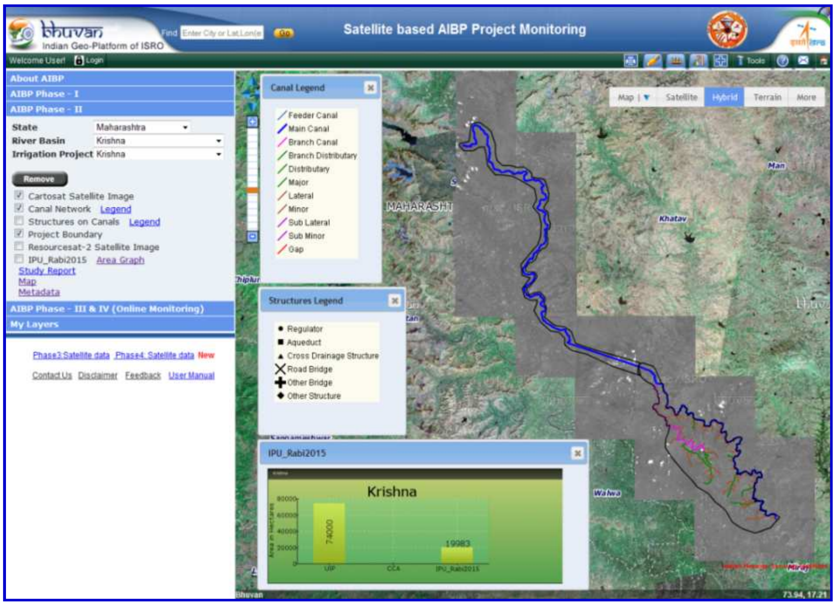
Training Program on

MONITORING OF IRRIGATION PROJECTS USING BHUVAN PLATFORM

(01– 05 Feb 2016)







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मनीष राठौर, उप निदेशक
राष्ट्रीय जल अकादमी, पुणे

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GOVERNMENT OF INDIA

CENTRAL WATER COMMISSION

NATIONAL WATER ACADEMY

TRAINING PROGRAM

ON

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01-05 February, 2016

Program Co-ordination

Shri Manish Rathore, Deputy Director, NWA

NATIONAL WATER ACADEMY,

PUNE,

February 2016

BASIC CONCEPTS OF GIS

Introduction

Geographic Information System (GIS) is a computer based system designed to accept large volume of spatial data derived from a variety of sources and to store, retrieve, analyse, manipulate and display these data according to use specifications. Geographical objects include natural phenomena such as railways, canals, roads, rivers, soil type etc. Geographical data describe objects from the real world in terms of their position with respect to known co-ordinate system, their attributes that are unrelated to position and their spatial interrelations with each other, which describe how they are linked together. Conventionally, mapping map analysis, measurements were done manually. With the advent of computer technology software were written to handle geographic data on the computers. This has resulted in GIS which represents now rapidly developing field lying at the intersection of many disciplines namely cartography, computing, geography, photogrammetry, remote sensing, statistics, surveying and other branches concerned with handling and analysing spatially referenced data.

Basics of GIS

Mapping Concepts, Features

A map represents geographic features or other spatial phenomena by graphically conveying information about locations and attributes. Locational information describes the position of particular geographic features on the Earth's surface, as well as the spatial relationship between features, such as the shortest path from a fire station to a library, the proximity of competing businesses, and so on. Attribute information describes characteristics of the geographic features represented, such as the feature type, its name or number and quantitative information such as its area or length. Thus the basic objective of mapping is to provide

- descriptions of geographic phenomenon
- spatial and non spatial information
- map features like Point, Line, & Polygon.

Map Features

Locational information is usually represented by points for features such as wells and telephone pole locations, lines for features such as streams, pipelines and contour lines and areas for features such as lakes, counties and census tracts.

Point feature A point feature represents as single location. It defines a map object too small to show as a line or area feature. A special symbol of label usually depicts a point location.

Line feature A line feature is a set of connected, ordered coordinates representing the linear shape of a map object that may be too narrow to display as an area such as a road or feature with no width such as a contour line.

- Points (cities, wells, villages)
- Line (rails, roads, canals)
- Area (reservoir, watersheds, land use class)

Data Model

Geographic data are represented in GIS in a particular manner and the approach is called model. There are two models- raster and vector

Raster: The geographic data are divided in grid cells
Data Structure-run length encoding, chain coding and quad tree

Vector: represented by points and lines
Data Structure -spaghetti & topological

To know why and how a GIS can help us, we must know what a GIS is and what it can be used for

What is a GIS?

–*Questions a GIS can answer*

– *Applications of GIS*

–*The elements of GIS*

What Is a GIS

- An organised collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information
- A programme is a GIS only if it permits spatial operations on the data
- A GIS typically links data from different sets. A GIS can perform this operations because it uses geographic or space as the common key between the data sets

Questions A GIS Can Answer

- Location (What is at particular location?)
- Condition (where is it…..?)
- Trends (What has changed since….?.)
- Patterns (What spatial patterns exist ?)
- Modelling (What if…….?)

Application Areas

- Water resources planning
- Land use planning
- Geodesic mapping
- Environmental applications
- Cadastral mapping
- Urban and regional planning
- Route selection of highways
- Mineral exploration
- Census and related statistical mapping
- Automatic cartography
- Natural resources mapping
- Surveying

Components of GIS

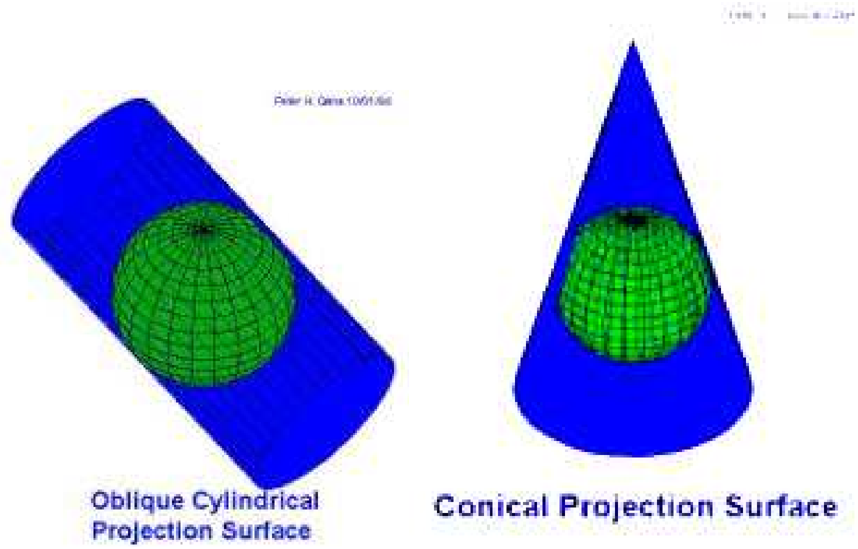
- Data encoding and input processing - (Digitizer, scanner, computer files)
- Data manipulation
- Data management
- Data retrieval
- Data analysis, modelling and cartographic manipulations
  (Overlay, intersection, identity, union, search, neighbourhood, distance, dissolve, classification reclassification, query etc)
- Data output(maps, graphs, photographs)

Map projection-
Map Projection is a systematic drawing of parallels of latitude and meridians of longitude on a plane surface for the whole earth or part of it on a certain scale so that any point on

the earth surface may correspond to that on the drawing. A network of latitude and longitude is called ***graticule.***

- Map Projection is preparation of *graticule* on a flat surface.
- *Projection* means the determination of points on the plane as viewed from a fixed point.
- A flat surface will touch globe <u>only at one point</u> and other sectors will be projected over the plane in a distorted form. The amount of distortion increases with the distance from tangential point.

- Equal area or *homolographical* Projections
  (In this case graticule is prepared in such a way that every quadrilateral on it may appear proportionately equal to in area to the corresponding spherical quadrilateral.)
- Correct shape or *orthomorphic or Conformal* Projections
- True bearing or *azimuthal* Projections



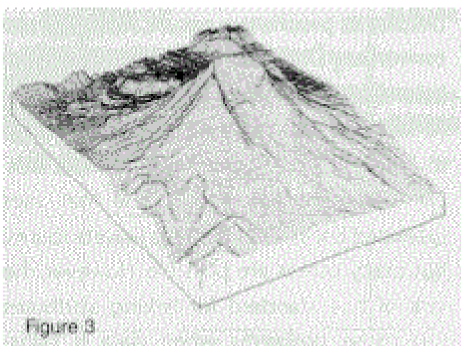
Polyconic, UTM etc.

Geometric rectification/ geo-referencing

Statistics- measurement, summary

DEM and Visualisation

Contouring, Hill shading, Perspective viewing, Fly through
Slope and aspect, extracting drainage



DEM

GIS packages

ARC/INFO (1969-ESRI Redlands California, USA), PAMAP GIS, SPANS (spatial analysis System- TYDAC Tech, USA,)

Modular GIS Environment (MGE)

IDRISI, GRASS, MAP/INFO, PROGIS

Indigenous GIS Packages- ISROGIS (12 modules) such as
Create, Edit, Make, Analyse, Attr-DB, Layout, Query, Map mosaic, 3D Module, Symbol Manager, Graphic User Interface (GUI)
GRAM^{++}, GEO-SPACE – RRSSC

Geographic Database

- A GIS does not hold maps or picture-it holds a database
- If one has to go beyond making pictures, one need to know three things about every feature stored in the computer; what it is, where it is, and how it relates to other features
- GIS gives the ability to associate information with a feature on a map and to create new relationships

Hardware and Software Resources

- The rapidly increasing power and the relative affordability of workstations now provide the user access to powerful machines for GIS operation dealing with large and complex data set and other decision-support tools such as hydrologic models, statistical packages, and optimisation programs
- With advancement in software development relating to GIS application more and more features are getting available on PC version of GIS packages
- Commercial GIS packages like Arc-Info, MapInfo, Intergraph, Spans etc. available in the market
- Most of the packages function under open GIS system
- Before a GIS package or peripheral is acquired, inter-compatibility should be confirmed.

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Issues Pertinent to WRD&M

- Critical role of water in human and natural environment. Role of GIS is important in management of the precious resource
- Water related data can have high precision (canal location) or can be Fuzzy (wetland perimeter)
- surface representation by DEM using GRID, TIN or contours required for hydro-geologic application of GIS
- Length, area and quantity computation, overlay of thematic layers and buffer zone generation important for WRD application

Application in Water Resources

1. Hydrologic/hydraulic modelling for basin Planning
2. WR and Irrigation potential assessment
3. Identification of WRD project sites
4. EIA studies and environmental monitoring
5. Command area monitoring
6. Disaster management

Network Analysis

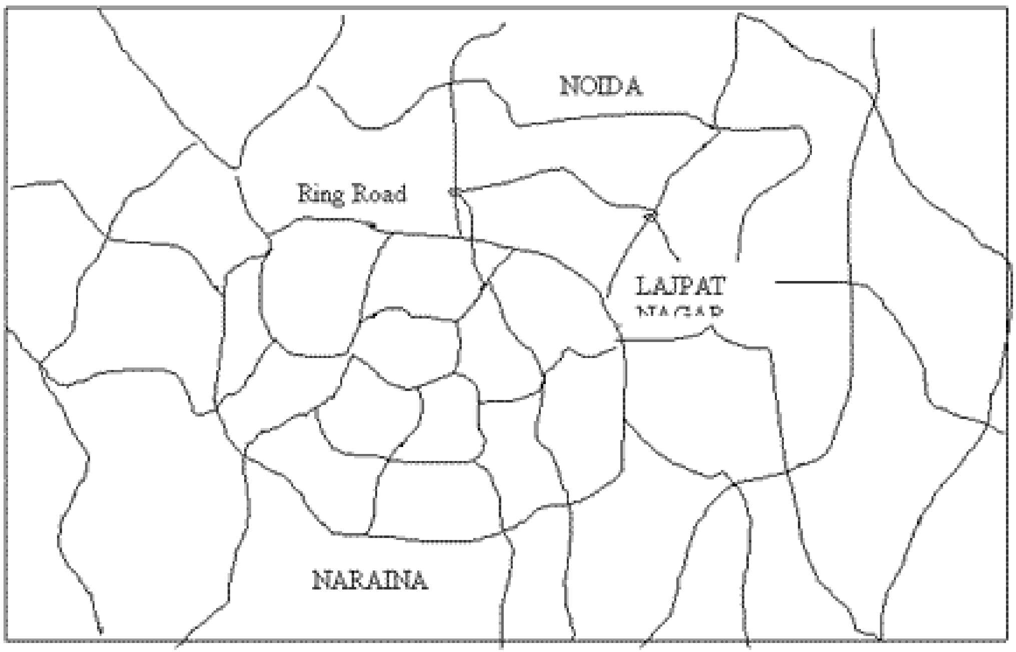
Network models are based on interconnecting logical components, of which the most important are:

1. "Nodes" define start, end, and intersections
2. "Chains" are line features joining nodes
3. "Links" join together points making up a chain.

This network can be analyzed using GIS.A simple and most apparent network analysis applications are:

- Street network analysis,
- Traffic flow modelling,
- Telephone cable networking,
- Pipelines etc.

The other obvious applications would be service centre locations based on travel distance. Basic forms of network analysis simply extract information from a network. More complex analysis, process information in the network model to derive new information. One example of this is the classic shortest-path between two points. The vector mode is more suited to network analysis than the raster model.



A Road Network *Image*

Capabilities of GIS

- Presentation Graphics
- Data Query
- Spatial Query
- Routing and Minimum path
- Buffering
- Overlay
- Distance, Adjacency and Proximity analysis
- Misc. analysis likes neighbour analysis, network analysis, 3D Analysis etc.

Presentation Graphics

- Thematic mapping is a means offered by GIS to draw map elements using patterns or colour based on a particular attribute
- Thematic mapping can be classified as
  - Polygon thematic
  - Line thematic
  - Point thematic
- Thematic maps usually involve only a few map layers and limited amounts of data

Data Query

- Much of the data collected by businesses are spatially referenced
- Non GIS user querying such a data base are limited to tabular views of the results of query
- A GIS user can view the results on a map apart from the regular tabular view
- Most important benefit is that the GIS user can see the spatial distribution which is hidden for the non GIS user
- Thus the GIS user is offered a "*powerful lens*" which makes hidden data visible to him
- This type of data base query is also called the "*show-me*" query
- Most available GIS packages are designed to effortlessly perform data queries

Spatial Query

- In this form of a query the user relies on the map as a querying tool
- Typically the data base is accessed by pointing to specific map feature
- GIS will then search the data base, and find those records that qualify, for presentation
- Spatial queries can be through
  - Pointing a feature
  - Spatial windows (Circular/Rectangular)
- Spatial queries are also called "tell-me" queries

Routing and Minimum Path

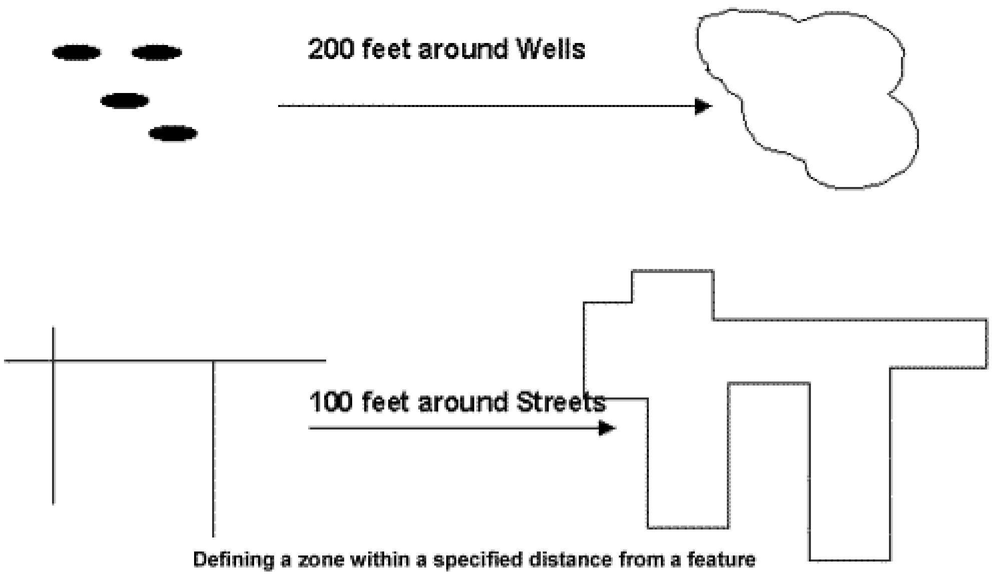
- Answer lies in the ability to find the shortest-path along a transportation network
- Routing involves "legal" travel from one point to another along a designated network
- Minimum path analysis involves finding out the shortest, fastest or most appropriate route

Buffering

– A buffer is a zone of fixed width around a map feature
– Buffer around a point takes the shape of a circle
– Buffer around a line takes the form of a corridor
– Buffer around a polygon taken the form of a bigger polygon
– Most of the GIS packages can buffer points, lines and polygons
– Very few packages are capable of handling concave polygons

Using these operations, the characteristics of an area surrounding in a specified location are evaluated. This kind of analysis is called proximity analysis and is used whenever analysis is required to identify surrounding geographic features. The buffer operation will generate polygon feature types irrespective of geographic features and delineates spatial proximity. For example, what are the effects on urban areas if the road is expanded by a hundred meters to delineate a five-kilometer buffer zone around the national park to protect it from grazing.

Using Buffer



Defining a zone within a specified distance from a feature

Overlay Operations

The hallmark of GIS is overlay operations. Using these operations, new spatial elements are created by the overlaying of maps. There are basically two different types of overlay operations depending upon data structures:

Raster overlay It is a relatively straightforward operation and often many data sets can be combined and displayed at once.

Vector overlay The vector overlay, however is far more difficult and complex and involves more processing.

Logical Operators The concept of map logic can be applied during overlay. The logical operators are Boolean functions. There are basically four types of Boolean Operators: viz., OR, AND, NOT, and XOR.With the use of logical, or Boolean, operators spatial elements / or attributes are selected that fulfill certain condition, depending on two or more spatial elements or attributes.

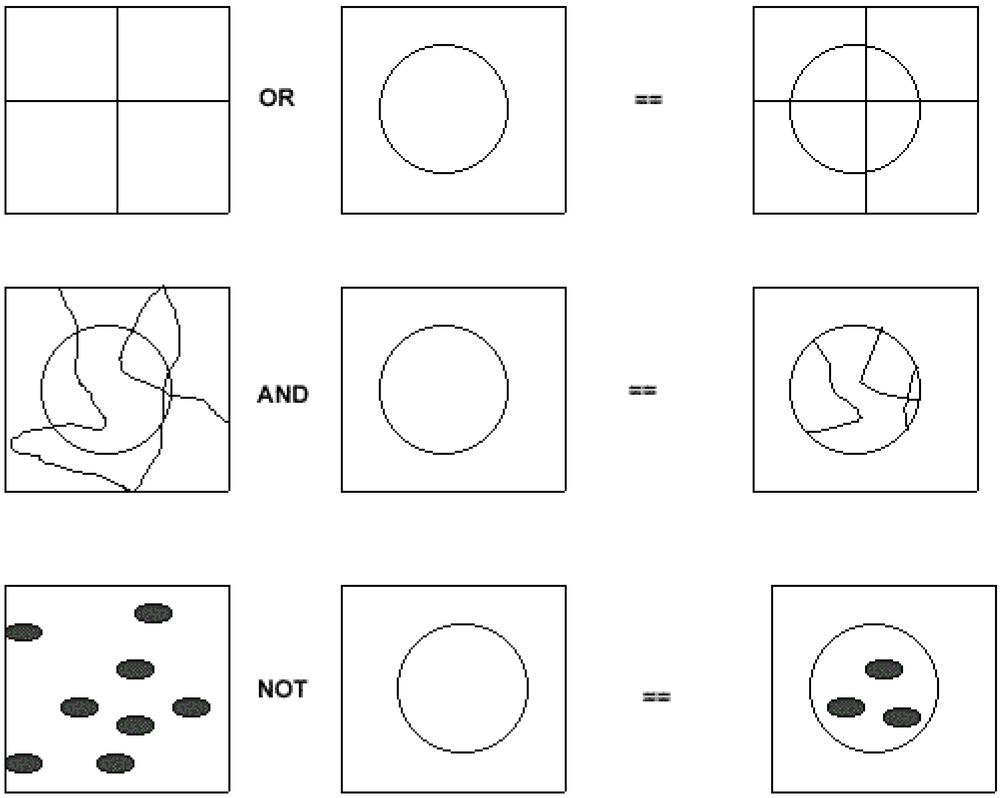
Vector Overlay During vector overlay, map features and the associated attributes are integrated to produce new composite maps. Logical rules can be applied to how the maps are combined. Vector overlay can be performed on different types of map features: viz., Polygon-on-polygon overlay

Line-in-polygon overlay

Point-on-polygon overlay.

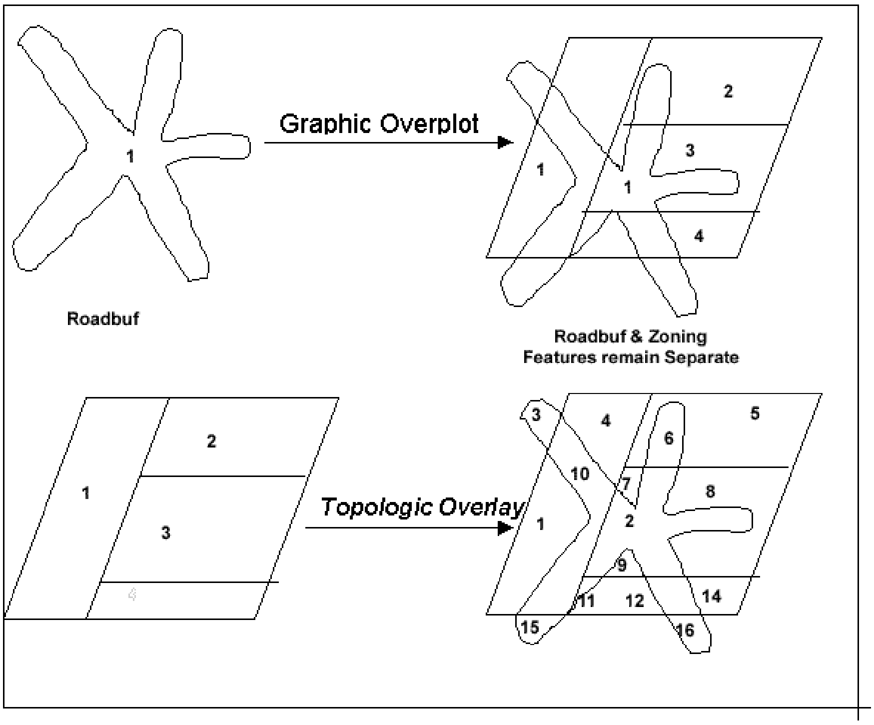
During the process of overlay, the attribute data associated with each feature type id merged. The resulting table will contain both the attribute data. The process of overlay will depend upon the modelling approach the user needs. One might need to carry out a series of overlay procedures to arrive at the conclusion, which depends upon the criterion.

Polygon-on-Polygon Overlay



Polygon-on-Polygon Overlay

Difference between a Topologic Overlay and a Graphic Over plot



Distance, Adjacency and Proximity Analysis

- Distance analysis refers to the ability to calculate *distances* from a map or along a transportation network
- Adjacency analysis refers to the ability to determine which of the map features TOUCH or are adjacent to other map features
- Proximity analysis refers to the ability to determine which of the map features are NEAR or in the neighbourhood of the referred map features
- All available GIS packages can estimate aerial distances
- A more limited set can estimate distances along road network
- Very few GIS packages can "*directly*" perform adjacency/ proximity analysis

Analysis of Geographic Data

ANALYSIS - What? & Why? The heart of GIS is the analytical capabilities of the system. What distinguish the GIS system from other information system are its spatial analysis functions. Although the data input is, in general, the most time consuming part, it is for data analysis that GIS is used. The analysis functions use the spatial and non-spatial attributes in the database to answer questions about the real world. Geographic analysis facilitates the study of real-world processes by developing and applying models. Such models illuminate the underlying trends in geographic data and thus make new information available. Results of geographic analysis can be communicated with the help of maps, or both. The organization of database into map layers is not simply for reasons of organizational clarity, rather it is to provide rapid access to data elements required for geographic analysis. The objective of geographic analysis is to transform data into useful information to satisfy the requirements or objectives of decision-makers at all levels in terms of detail. An important use of the analysis is the possibility of predicting events in the another location or at another point in time.

ANALYSIS - How? Before commencing geographic analysis, one needs to assess the problem and establish an objective. The analysis requires step-by-step procedures to arrive at the conclusions. The range of geographical analysis procedures can be subdivided into the following categories.

- Database Query.
- Overlay.
- Proximity analysis.
- Network analysis.
- Digital Terrain Model.
- Statistical and Tabular Analysis.

Spatial Analysis

It helps us to:

- Identify trends on the data.
- Create new relationships from the data.
- View complex relationships between data sets.
- Make better decisions.

Geographic Analysis

Analysis of problems with some Geographic Aspects.

- Alternatives are geographic locations or areas.
- Decisions would affect locations or areas.
- Geographic relationships are important in decision-making or modelling.

Some examples of its application:

- Nearest Neighbour.
- Network distances.

Planar distances

Tabular Statistical Analysis

If in the above road network we have categorised the streets then in such a case the statistical analysis answers questions like

- What unique categories do I have for streets?
- How many features do I have for each unique category?
- Summarize by using any attribute?

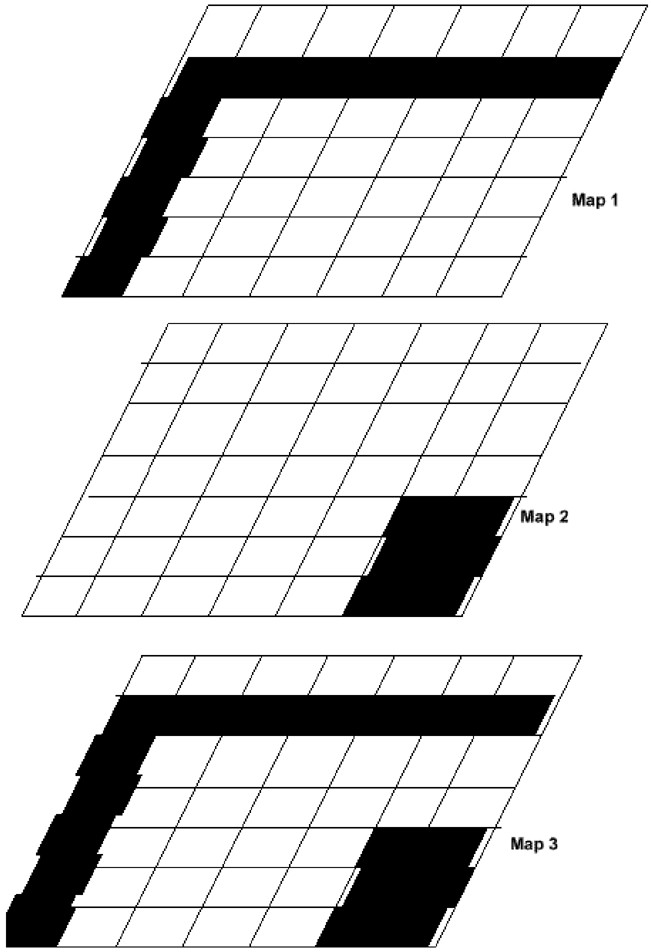
Database Query The selective display and retrieval of information from a database are among the fundamental requirements of GIS. The ability to selectively retrieve information from GIS is an important facility. Database query simply asks to see already stored information. Basically there are two types of query most general GIS allow: viz., Query by attribute,

Query by geometry. Map features can be retrieved on the basis of attributes, For example, show all the urban areas having the population density greater than 1,000 per square kilometer, Many GIS include a sophisticated function of RDBMS known as Standard Query Language (SQL), to search a GIS database. The attribute database, in general, is stored in a table (relational database mode.) with a unique code linked to the geometric data. This database can be searched with specific characteristics. However, more complex queries can be made with the help of SQL. GIS can carry out a number of geometric queries. The simplest application, for example, is to show the attributes of displayed objects by identifying them with a graphical cursor. There are five forms of primitive geometric query: viz., Query by point, Query by rectangle, Query by circle, Query by line, Query by polygon, A more complex query still is one that uses both geometric and attributes search criteria together. Many GIS force the separation of the two different types of query. However, some GIS, using databases to store both geometric and attribute data, allow true hybrid spatial queries.

Conditional Operators

Conditional operators were already used in the examples given above. The all evaluate whether a certain condition has been met.

= eq 'equal' operator<> ne 'non-equal' operator< lt 'less than' operator<= le 'less than or equal' operator> gt 'greater than' operator>= ge 'greater than or equal' operator. Many systems now can handle both vector and raster data. The vector maps can be easily draped on to the raster maps.



Raster Overlay

Current and Future Role of GIS

- Users should periodically examine the requirement for GIS and whether their system continues to meet those needs
- GIS is yet to be used in a large way for terrain visualisation, 3-D analysis, resource information and organisation planning.

Reference

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REMOTE SENSING: SATELLITES AND SENSORS

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1.0 REMOTE SENSING

Remote sensing is the science and the art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object (Lillesand and Kiefer, 1987). Remote sensing can be thought of as a reading process. Using various sensors, the data can be collected remotely and analysed to obtain information. The remotely sensed data can be of many forms, including acoustic wave distributions, or electromagnetic wave distributions. Commonly, the remote sensing is referred to the collection and analysis of data regarding earth using electromagnetic sensors, which are operated from airborne and space borne platforms. These sensors acquire data on the way the various earth surface features emit and reflect electromagnetic energy and these data are analysed to provide information about the resources under investigations.

The two basic processes involved in electromagnetic remote sensing are data acquisition and data analysis. The elements of data acquisition process are energy sources, propagation of energy through the atmosphere, energy interaction with the earth surface features, re-transmission of energy through the atmosphere, airborne and/or space-borne sensors, resulting in the generation of sensor data in pictorial and/or digital form. In short, we use sensors to record variations in the way earth surface features reflect and emit electromagnetic energy. The data analysis process involves examining the data using various viewing and interpretation devices to analyse pictorial data, and/or a computer to analyse digital sensor data. Reference data about the resources being studied are used when and where available to assist in the data analysis. The information is then compiled, generally in the form of hard copy maps and tables, or as computer files that can be merged with the other 'layers' of information in a Geographical Information System (GIS).

1.1 Energy Sources and Radiation Principles

Visible light is only one of many forms of electromagnetic wave energy. Radio waves, heat, ultraviolet rays and X-rays are other familiar forms. All this energy is inherently similar and radiates in accordance with basic wave theory. The wave theory describes electromagnetic energy as traveling in a harmonic, sinusoidal fashion at the 'velocity of light' *c*. The distance from one wave peak to the next is the wavelength λ and the number of peaks passing a fixed point in space per unit time is the wave frequency ν From basic physics, wave obey the general equation

$$c = \nu\lambda$$

In remote sensing, it is most common to categories electromagnetic waves by their wavelength location within the electromagnetic spectrum (Figure 1). The most prevalent unit used to measure wavelength along the spectrum is the micrometer (μm). Although names are generally assigned to regions of electromagnetic spectrum for convenience (such as ultraviolet and microwave), there is no clear-cut dividing line between one nominal region and the next. The visible portion of the electromagnetic spectrum is small, since the spectral sensitivity of the human eye extends only from about 0.4 μm to 0.7 μm. The color blue is ascribed to the approximate range of 0.4 to 0.5 μm, green to 0.5 to 0.6 μm, and red to 0.6 to 0.7 μm. Ultraviolet energy adjoins the blue end of the visible portion of the spectrum. Adjoining the red end of the visible portion are three different categories of infrared (IR) waves: near-IR (from 0.7 to 1.3 μm), mid-IR (1.3 to 3 μm) and thermal IR (beyond 3 μm). At much longer wavelengths (1mm to 1m) is the microwave portion of the spectrum.

Most common sensing systems operate in one or several of the visible, IR, or microwave portions of the spectrum. Within the IR portion of the spectrum, only thermal IR energy is directly related to the sensation of heat.

According to the quantum theory, the electromagnetic radiation is composed of many discrete units called photons or quanta and the energy of quantum is inversely proportional to its wavelength. The longer the wavelength involved the lower its energy content. This has important implications in remote sensing from the standpoint that naturally emitted long wavelength radiation, such as microwave emission, is more difficult to sense than radiation of shorter wavelengths, such as emitted thermal IR energy.

The sun is the most obvious source of electromagnetic radiation for remote sensing. However, all matter at temperatures above absolute zero continuously emits electromagnetic radiation. The energy emitted from an object is a function of its temperature. The earth radiates the maximum energy at a wavelength of about 9.7 μm. Because this radiation correlates with terrestrial heat; it is termed as 'thermal infrared' energy. This energy can neither seen or photographed, but can be sensed with radiometers. The sun emits maximum energy at about 0.5 μm. Our eyes are sensitive to energy of this magnitude and wavelength. Thus, when the sun is present, we can observe earth features by virtue of reflected solar energy. The general dividing line between reflected and emitted IR wavelength is about 3 μm. Below this wavelength, reflected energy predominates; above it emitted energy prevails.

Certain sensors, such as radar systems, supply their own source of energy to illuminate features of interest. These systems are termed as 'active' systems, in contrast to 'passive' systems that sense naturally available energy.

1.2 Data Acquisition and Interpretation

The detection of electromagnetic energy can be performed either photographically or electronically. In remote sensing, the term photograph is reserved exclusively for that are detected as well as recorded on film. The more generic term image is used for any pictorial representation of image data. Because the term image relates to any pictorial product, all photographs are images. Not all images however are photographs.

The data interpretation aspects of remote sensing can involve analysis of pictorial and/or digital data. Visual interpretation of pictorial image data has long been the workhorse of remote sensing. Visual interpretation techniques have certain disadvantages. They require extensive training. Spectral characteristics are not always fully evaluated in visual interpretation efforts. In applications where spectral patterns are highly informative, it is preferable to analyse digital, rather than pictorial, image data.

The digital image data is composed of a two dimensional array of discrete 'picture elements' or 'pixels'. The intensity of each pixel corresponds to the average brightness or radiance measured electronically over the ground area corresponding to each pixel. In the digital image data each pixel in a grid stores a Digital Number (DN). The DN values are positive integers that result from quantizing the original electrical signal from the sensor into positive integer values using a process called as analog-to-digital signal conversion. Typically the DN values of digital image range between 0 to 255, the range representing the set of integers that can be recorded using 8-bit binary computer coding scale.

The use of computer assisted analysis permits the spectral patterns in remote sensing data to be more fully examined. However, visual and numerical techniques are complimentary.

1.3 Digital Image Data

Remotely sensed image data are digital representation of objects on the earth. Image data are stored in data files, called as image files, on a magnetic tape, computer disks or other media. The data consists of only numbers, which are called as pixels. Each pixel represents an area of the earth at a specific location. The location of a pixel in a file is expressed using a two-dimensional co-ordinate system formed of rows and columns. Image data organised into such a grid are known as raster data. Image data may include several bands of information sometimes called as layers.

Image data can be arranged in several ways on a tape or other media. The most common storage formats are:

a) BIL (Band Interleaved by Line)
b) BSQ (Band Sequential)
c) BIP (Band Interleaved by Pixel)

Band interleaved by line (BIL) BIL is one of three primary methods for encoding image data for multiband raster images in the geospatial domain, such as images obtained from satellites. BIL is not in itself an image format, but is a scheme for storing the actual pixel values of an image in a file band by band for each line, or row, of the image. For example, given a three-band image, all three bands of data are written for row one, all three bands of data are written for row two, and so on. The BIL encoding is a compromise format, allowing fairly easy access to both spatial and spectral information. The BIL data organization can handle any number of bands, and thus accommodates black and white, grayscale, pseudocolor, true color, and multi-spectral image data. In BIL format, each record in the file contains a scan line (row) of data for one band. All bands of data for a given line are stored consecutively.

Band Sequential BSQ format is a very simple format, where each line of the data is followed immediately by the next line in the same spectral band. This format is optimal for spatial (x,y) access of any part of a single spectral band. The BSQ data organization can handle any number of bands, and thus accommodates black and white, grayscale, pseudo-colour, true color, and multi-spectral image data. In BSQ format, each band is contained in a separate file. This format is advantageous because one band can be read and viewed easily and multiple bands can be loaded in any order.

Band Interleaved by Pixel (BIP) Images stored in BIP format have the first pixel for all bands in sequential order, followed by the second pixel for all bands, followed by the third pixel for all bands, etc., interleaved up to the number of pixels. In BIP format, the values of each band are ordered within a given pixel. The pixels are arranged sequentially on the tape. For a single band of data, all formats (BIL, BSQ, and BIP) are identical.

2.0 SATELLITES AND SENSORS

Launching of a Landsat 1 satellite, originally known, as Earth Resource Technology satellite (ERTS) by NASA on 23 July 1972 was the beginning of a modern remote sensing application for earth resource studies. It was followed by Landsat-2, 3, 4 and 5 in the subsequent years. Three different types of sensors were flown in various combinations of these missions. These are the Return Beam Vidicon (RBV) camera systems, The Multispectral Scanner (MSS) systems and the Thematic Mapper (TM). In latter years, SPOT satellites were launched with different sensors for various applications.

2.1 Indian Earth Resources Satellites

During the 1970's and 80's, India's remote sensing data needs were being addressed by foreign satellites like LANDSAT, NOAA, SPOT etc., where NRSC procured the satellite data products from foreign agencies and supplied it to the users. With the setting up of an Earth Station at Hyderabad in 1979, satellite data reception started, first from USA's LANDSAT satellite.

The launch of India's first civilian remote sensing satellite IRS-1A in March 1988, marked the beginning of a successful journey in the course of the Indian Space Programme. The two LISS sensors aboard IRS-1A beamed down valuable data that aided in large scale mapping applications. Subsequently, IRS-1B, having similar sensors, was launched in August 1991, and together, they provided better repetivity. The LISS-III, PAN and WiFS sensors on IRS-1C (December 1995) and IRS-1D (September 1997) further strengthened the scope of remote sensing, with increased coverage and foray into application areas like resources survey and management, urban planning, forest studies, disaster monitoring and environmental studies.

IRS-P5 (Cartosat-1), launched on May 5, 2005, catapulted the Indian Remote Sensing program into the world of large-scale mapping and terrain modeling applications.

Foreign Satellites

Apart from the Indian Remote Sensing Satellites, NRSC acquires and distributes data from a number of foreign satellites. Currently, NRSC is acquiring data from NOAA-17, NOAA-18, TERRA, AQUA and ERS. Apart from acquiring NRSC also distributes data collected by RADARSAT, IKONOS, QUICKBIRD , ORBIMAGE and ENVISAT.

2.2 IRS-1A and IRS-1B

These are the operational first generation Indian Remote Sensing Satellites launched in March 1988 and August 1991 respectively. They have been put into a polar sun-synchronous orbit at an altitude of 904 km. In the sun-synchronous orbit, the orbit plane rotates at the same speed as the speed of rotation of earth around the sun (0.986 deg/day). Thus, the satellite passes over particular latitude at the same local time. It enables study of the earth surface at various seasons under the same illumination conditions. Both of these satellites carry two Linear Imaging Self-Scanning Sensors (LISS), one with a spatial resolution of 72.5m (LISS-I) and the other with a spatial resolution of 36.25m (LISS II). The swath (ground coverage) is 148 km. The repeativity of scanning is 22 days. LISS-I and II sensors provide multispectral data collected in four bands of visible and near IR region (0.45 to 0.86 μm). The details of these bands are given in Table – 1.

Table – 1 : LISS-I and LISS-II Bands and Applications

Band Number	Spectral Range	Application Area
B1	0.45 – 0.52 μm	Designed for water body penetration, making it useful for coastal water mapping. Also useful for soil/vegetation, forest type mapping and cultural feature identification.
B2	0.52 – 0.59 μm	Designed to measure green reflectance peak of vegetation. Useful for vegetation discrimination, cultural feature identification and turbidity of water.
B3	0.62 – 0.68 μm	Discrimination of plant species and cultural feature identification.
B4	0.77 – 0.86 μm	Delineation of water bodies, vegetation type, soil moisture and land form studies

Although the design life was three years, IRS-IA was in service until October 1992 and IRS-1B is still in service providing good quality data.

2.3 IRS-1C

IRS-1C is the first of the second generation, operational, multi-sensor satellite with improved sensor and coverage characteristics besides having an On Board Tape Recorder (OBTR) for obtaining data outside the visibility of receiving stations. IRS-1C was launched on 26 December 1995. The three sensors on-board IRS-1C Satellite are:

a) Panchromatic (PAN) sensor with a resolution of 5.8m in one band in the visual region with a swath of 70 km with 26 deg across track tilt capability,
b) LISS-III multispectral sensor with a resolution of 23.5 m in three spectral ranges viz. visible, near infrared and Shortwave Infra-Red (SWIR) bands with swath of 141 km.
c) Wide Field Sensor (WiFS) with a resolution of 188 m in two bands in the visible\near infra-red region with a swath of 810 km.

2.4 IRS-1D

IRS-1D is identical to the IRS-1C satellite with a continuous data supply. IRS-1D was launched in September 1997 by Polar Satellite Launching Vehicle (PSLV). The IRS-1D has a sun synchronous orbit at height of 817 km with repeativity of 24 days (341 orbits). The payload consists of three sensors, the details of which are given in Table – 2.

Table – 2 : IRS-1D Sensor Characteristics

	LISS-III	PAN	WiFS
Spectral Bands	B2) 0.52 - 0.59 µm B3) 0.62 - 0.68 µm B4) 0.77 - 0.86 µm B5) 1.55 - 1.70 µm	0.50 - 0.75 µm	B3) 0.62-0.68 µm B4) 0.77-0.86µm
Ground Resolution	23.5m (B2, B3 & B4) 70.5m (B5)	5.8 m	188.3 m
Swath	141 km (B2, B3 & B4) 148 km (B5)	70 km	810 km

2.5 IRS P5

The CARTOSAT-1 (IRS-P5) is envisaged as a mission to meet the stereo data requirements of the user community. The objectives of the mission was to design, develop, launch and operate an advanced space based mission with enhanced spatial resolution (2.5m) with along track stereo viewing capability for large scale mapping applications (up to 1:5000 scale) . To further stimulate newer areas of cartographic applications, urban management, disaster assessment, relief planning and management, environmental impact assessment and GIS applications. CARTOSAT-1 is a global mission. The nominal life of the mission is planned to be five years. The satellite was launched by the indigenously built Polar Satellite Launch Vehicle on May 05, 2005.

2.6 IRS P6

The RESOURCESAT-1 (IRS-P6) is envisaged as the continuity mission to IRS-1C/1D, with enhanced capabilities both in the payload and the platform, to meet the increasing demands of the user community. The objectives of the mission are to provide continued remote sensing data services on an operational basis for integrated land and water resources management at micro level, with enhanced spectral and spatial coverage and stereo imaging. Carry out studies in advanced areas of user applications like improved crop discrimination, crop yield, crop stress, pest/disease surveillance, disaster management etc.,.

The payload system of IRS-P6 consists of three solid state cameras :
1. A high resolution multispectral sensor - LISS-IV
2. A medium resolution multispectral sensor - LISS-III
3. An Advanced Wide Field Sensor – AWiFS

2.7 IKONUS

Ikonus satellite is launched in 1999.
Resolution: 0.82 meters Panchromatic.
3.2 meters Multi-spectra

Spectral Range: Blue: 445-516 nm
Green: 506-595 nm
Red 632-698 nm
NIR: 757-853 nm
Pan: 450-900 nm

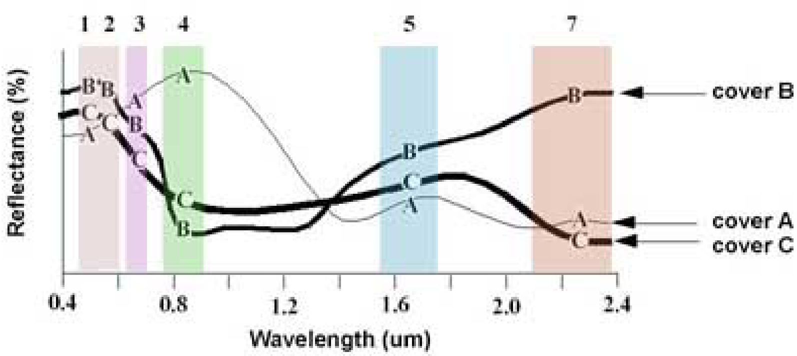
3.0 DIGITAL IMAGE PROCESSING

Digital image processing involves the manipulation and interpretation of digital image with the aid of a computer. The central idea behind digital image processing is simple. The digital image is fed into a computer. The computer is programmed to insert these data into an equation, or series of equations, and then store results of the computation for each pixel. These results form a new digital image that may be displayed or recorded in pictorial format or may be manipulated by additional programs. Thus, Image processing is a technique for improving image quality for interpretation. The image processing procedures may be categorised into one of the following three broad types of computer assisted operations:

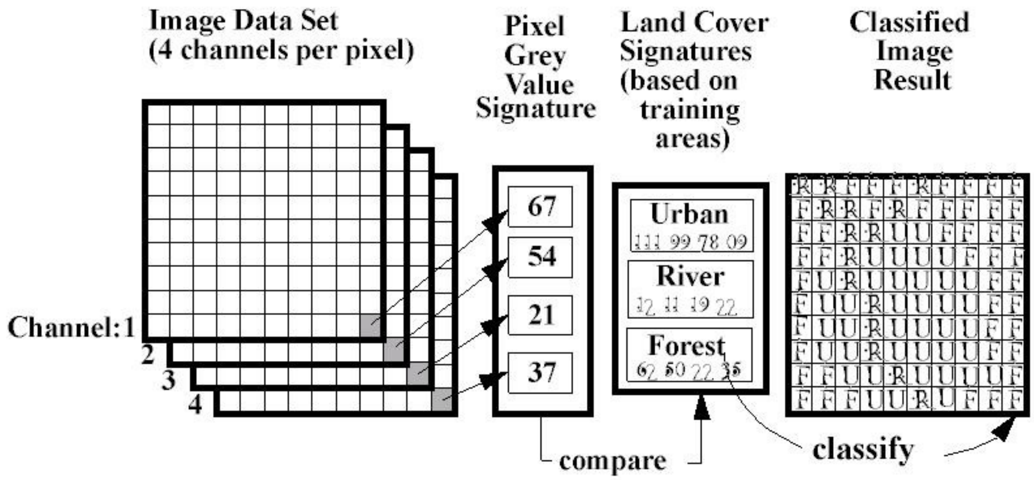
3.1 Pre-processing (Image rectification and restoration): Image rectification is a transformation process used to project two-or-more images onto a common image plane. It corrects image distortion by transforming the image into a standard coordinate system. Image rectification in GIS converts images to a standard map coordinate system. This is done by matching ground control points (GCP) in the mapping system to points in the image. These GCPs calculate necessary image transforms.

3.2 Image enchantement : the process of improving the quality of a digitally stored image by manipulating / enhancing the image with software. It is quite easy, for example, to make an image lighter or darker, or to increase or decrease contrast. Advanced image enhancement software also supports many filters for altering images in various ways. Programs specialized for image enhancement are sometimes called image editors.

3.3 Image classification : The intent of the classification process is to categorize all pixels in a digital image into one of several land cover classes, or *"themes"*. This categorized data may then be used to produce thematic maps of the land cover present in an image. Normally, multispectral data are used to perform the classification and, indeed, the spectral pattern present within the data for each pixel is used as the numerical basis for categorization (Lillesand and Kiefer, 1994). The objective of image classification is to identify and portray, as a unique gray level (or color), the features occurring in an image in terms of the object or type of land cover these features actually represent on the ground.



3.3.1 **Supervised Classification** With supervised classification, we identify examples of the Information classes (i.e., land cover type) of interest in the image. These are called *"training sites"*. The image processing software system is then used to develop a statistical characterization of the reflectance for each information class. This stage is often called "*signature analysis"* and may involve developing a characterization as simple as the mean or the rage of reflectance on each bands, or as complex as detailed analyses of the mean, variances and covariance over all bands. Once a statistical characterization has been achieved for each information class, the image is then classified by examining the reflectance for each pixel and making a decision about which of the signatures it resembles most.

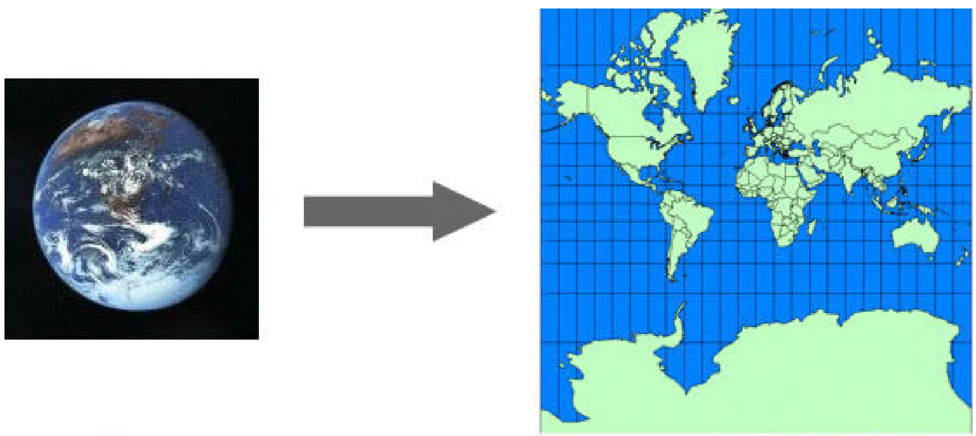


3.3.2 **Unsupervised Classification:** Unsupervised classification is a method which examines a large number of unknown pixels and divides into a number of classed based on natural groupings present in the image values. unlike supervised classification, unsupervised classification does not require analyst-specified training data. The basic premise is that values within a given cover type should be close together in the measurement space (i.e. have similar gray levels), whereas data in different classes should be comparatively well separated (i.e. have very different gray levels) The classes that result from unsupervised classification are spectral classed which based on natural groupings of the image values, the identity of the spectral class will not be initially known, must compare classified data to some from of reference data (such as larger scale imagery, maps, or site visits) to determine the identity and informational values of the spectral classes. Thus, in the supervised approach, to define useful information categories and then examine their spectral separability; in the unsupervised approach the computer determines spectrally separable class, and then define their information value.

3.3.3 **Sub-setting:** Many images used in IMAGINE cover a large area, while the actual area being studied can only cover a small portion of the image. To save on disk space and processing time, you can make new images out of a subset of the entire data set.

3.3.4 **Mosaicing:** Mosaicing is the seamless joining or stitching of adjacent imagery. Joining Landsat / IRS imagery that was collected along the same satellite path (one image taken after the other) is straightforward with very little time elapsing between imagery collection, the atmosphere and sensor properties do not change (that much). However, when joining adjacent imagery from different paths, several days to a couple of weeks can pass. As such, here is a need to adjust the radiometric differences between the images in an effort to make the join appear seamless.

3.3.5 **Map Projection:** A map projection is a mathematical expression that is used to represent the round, 3D surface of the earth on a flat, 2D map. In other terms. Map projection is a systematic transformation of the latitudes and longitudes of locations on the surface of a sphere or an ellipsoid into locations on a plane. Map projections are necessary for creating maps. All map projections distort the surface in some fashion. Depending on the purpose of the map, some distortions are acceptable and others are not; therefore different map projections exist in order to preserve some properties of the sphere-like body at the expense of other properties. There is no limit to the number of possible map projections.



1 2

1. 3D earth 2.Mercator Projection

This process always results in distortion to one or more map properties, such as area, scale, shape, or direction. Because of this, hundreds of projections have been developed in order to accurately represent a particular map element or to best suit a particular type of map.

Data sources for maps come in various projections depending upon which characteristic the cartographer chooses to represent more accurately (at the expense of other characteristics). In the example above, the Mercator projection preserves the right angles of the latitude and longitudinal lines at the expense of area, which is distorted at the poles, showing the land masses there to be larger than they actually are.

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Overview and Current Interventions in Indian Irrigation Sector

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1.0 Introduction

Until nineteenth century, Indian irrigation system was mainly confined to harvesting ponds, diverting rain water through inundation canals, or dug wells in shallow aquifers. During mid-nineteenth century, the British Government decided to promote irrigation in a systematic manner. With the onset of many famines and subsequently, a number of famine commissions recommended the development of various irrigation works to contain famines. Moreover, First Irrigation Commission (1901) also considered irrigation as a means of protection against famine. During this period civil works of many canal system started such as Upper Ganga Canal, the Upper Bari Doab Canal, Krishna and Godavari Delta Systems, Sirhind, the Lower Ganga, Mutha Canals, and the Periyar Dam and canals, Betwa Canal etc. By 1950s India has already developed irrigation potential of about 22 million Ha which is 110 million Ha by now.

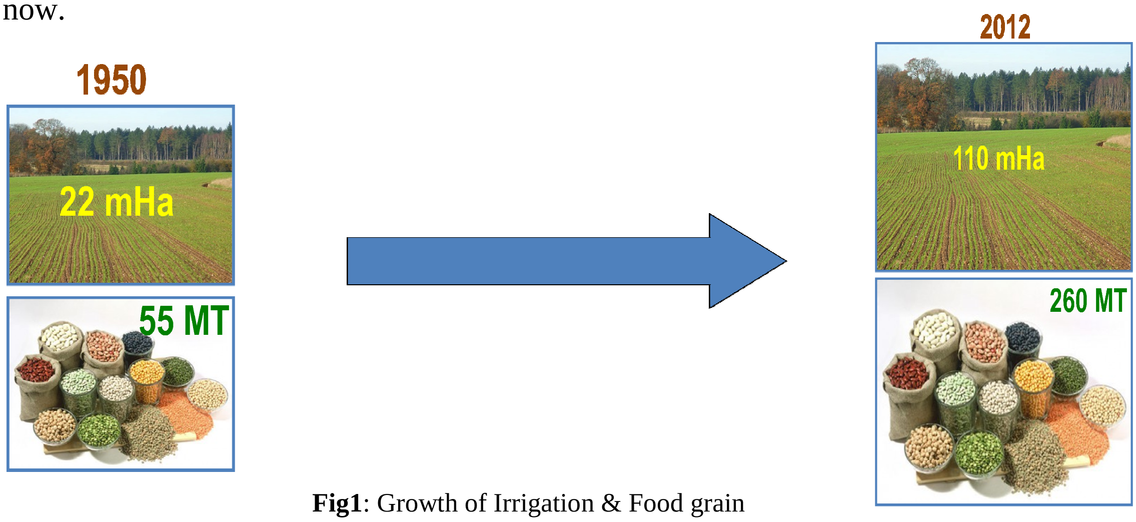

Fig1: Growth of Irrigation & Food grain

The planned development of irrigation sector started in a big way since the First Five Year Plan (1951–56). New projects were taken up in the Second Five Year Plan, the Third Five Year Plan, and the Annual Plans 1966–69. During the Fourth Five Year Plan emphasis was shifted to the completion of ongoing schemes. The widening gap between potential creation and utilization was felt in the Fifth Plan (1974– 78) and accordingly Command Area Development (CAD) programme was launched. The Annual Plans 1978–80 and the Sixth Plan witnessed new starts and then the focus was shifted towards completion of irrigation projects. By the end of the Eighth Plan (1996–97), central assistance was provided under AIBP to help the State Governments in early completion of the projects.

2.0 Glossary of Terms

2.1 Evapotranspiration (ET)

The total water lost due to evaporation from soil and transpiration from crop for a particular area during a specified time. It is generally expressed as depth of water in millimetres with respect to time. It is practically equal to consumptive water use by a crop.

2.2 Field Capacity

Field Capacity is the amount of soil moisture or water content held in the soil and downward movement of excess water has practically ceased.

2.3 Watershed

Water shed is the area above the given point on a stream that contributes water to the flow at that point. Catchment, basin or drainage basins are synonymous with it.

2.4 Gross Command Area (GCA)

The area of the command up to the farthest point in a command that can be supplied water. It includes un-culturable area, ponds,house, barren lands etc

Fig2: Gross Command Area (GCA)

Fig3: Culturable Command Area (CCA)

2.5 Culturable Command Area (CCA)

The area on which crops can be grown satisfactorily. It excludes the un-culturable area from Gross Command Area.

2.6 Ultimate Irrigation Potential (UIP)

UIP is defined as maximum area that can be provided with irrigation by most optimal utilisation of the available water resources duly accounting for the multiple cropping patterns; provided irrigation facility is fully developed.

2.7 Irrigation Potential Created (IPC)

IPC is the Gross area that can be irrigated annually by the quantity of water that could be made available by all the connected and completed works up to the end of the water courses or the last point in the water delivery system. It is generally the Area that can be irrigated from a project in a design agriculture year that is, from the 1st July to 30th June next year for the projected cropping pattern and accepted water allowance on its full development. Theoretically it should match Gross Irrigated Area.

2.8 Irrigation Potential Utilised (IPU)

Irrigation Potential Utilized (IPU) is the Total area for which water is actually delivered to the outlet up to 40 hectare blocks as planned.

2.9 Types of Irrigation Projects

Irrigation projects with Culturable Command Area (CCA) more than 10,000 ha., between 2000 ha. and 10,000 ha. and less than 2,000 ha. are classified as major, medium and minor projects respectively.

Ongoing Irrigation Schemes

3.0 Accelerated Irrigation Benefit Programme (AIBP)

Irrigation is a state subject and irrigation projects are formulated, executed and funded by the State Governments themselves from their own resources. Central assistance is released in the form of block loans and grants not tied to any sector of development or project. A large number of major and medium irrigation projects in the country are languishing due to various reasons, the most important of them being inadequate provision of funds by the concerned State Governments. As a result, large amount of funds spent on these projects are locked up and the benefits envisaged at the time of formulation of project reports could not be achieved. This is a cause for concern to the nation and initiative is required at the national level to remedy the situation. Since the irrigation projects are capital intensive, and states with limited resources at their disposal find themselves unable to meet the desired fund demands of all the projects, the implementation of these projects get delayed.

Keeping the above in view, Central Govt., during 1996-97, launched an Accelerated Irrigation Benefits Programme (AIBP) under Ministry of Water Resources to provide Central Assistance to the irrigation projects in the country, with the objective to accelerate the implementation of those projects which were beyond resource capability of the states or were in advanced stage of completion.

The main features of the Programme are as under:

3.1 Types of Projects under AIBP:

- Major and Medium Irrigation Projects having investment clearance of Planning Commission, are in advanced stage of construction and can be completed in the next four financial years can be considered for inclusion.
- New projects could also be included under AIBP on completion of an ongoing project on one to one basis (hereafter called as 1:1 criteria) except for projects benefiting (a) drought-prone areas (DPAP areas) & Desert Prone Area(DDPareas); (b) tribal areas*; (c) States with lower irrigation development as compared to national average; and (d) districts identified under the PM's package for agrarian distress districts
- In case of new projects, the AIBP works for creation of irrigation potential and implementation of Command Area Development (CAD) are taken up simultaneously (pari-passu implementation).
- The advanced stage of construction would imply that at least 50% of latest approved estimated project cost already incurred and at least 50% of physical progress of essential works of the project has taken place
- The Major/Medium ERM Projects having investment clearance of Planning Commission and Projects already completed and commissioned at least 10 years earlier from the proposed year of inclusion in AIBP will qualify for inclusion subject to fulfillment of various criteria of Guidelines.
- Central Assistance under AIBP could also be extended to minor surface irrigation projects of special category states (N.E. States & Hilly States of H. P., Sikkim, J&K, Uttaranchal and projects benefiting KBK districts of Orissa) subject to fulfillment of various criteria of Guidelines.

MONITORING CONCEPTS, INTRODUCTION TO AIBP SCHEME

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1. INTRODUCTION:

The development of irrigation in the country has received priority in the overall planning and has consumed bulk of the investment under the public sector through successive 5 year plans. Water is a state subject and all irrigation schemes are being planned and executed by the State Governments. While funding of these projects is normally done by states from their own resources, the central assistance is provided to the states in the form of loans and grants. Continuous slippages in completion of irrigation projects over the successive plan periods and resultant shortfall in achieving the targeted irrigation potential from the projects had been a matter of concern to the Planning Commission, MoWR and Govt. of India.

Out of the ultimate irrigation potential of 140 mha (million hectare) of the country so far reported cumulative irrigation potential created up to 2004-05 is around 105 mha. However, large number of major and medium irrigation projects in the country are still languishing due to various reasons. As a result, large amount of funds spent on these projects are locked up and the benefits envisaged in relevant project reports could not be achieved. Out of total 1722 major, medium and ERM projects contemplated up to IX Plan, so far completion of 1270 projects have been reported. The remaining 452 projects (50% of which have investment clearance of the Planning Commission) are still in various stages of construction. Apart from these 300 new projects (only 25 projects have so far received investment clearance of the Planning Commission) were proposed in X Plan. In addition a few new projects are also being introduced in XI Plan proposals of various States. Even for approved ongoing projects major constraint in desired progress in execution is, by and large, paucity of funds.

2. NEED FOR MONITORING:

The major causes for not achieving the targeted potential are identified as: delay in initial start of the projects, frequent changes in scope of the projects, shortage of essential construction materials, inadequate funding, land acquisition, non-transfer of forest land, delay in decision making on contracts, delay in procurement of construction equipment and above all poor coordination amongst various implementation agencies. To keep close watch on project implementation to complete them in a time bound manner and to achieve targets of creation of irrigation potential, need for monitoring was realized. While reviewing the status of irrigation projects during the first and second state irrigation ministers' conference held in 1975 and 1976, the continuous slippage in the completion targets of the projects were noted. Therefore, a need to exercise more control over the implementation of the irrigation projects was felt and a 3 tier system of monitoring of major and medium irrigation projects at project, state and central levels was recommended. At central level, this work was entrusted to Central Water Commission. Accordingly, CWC started with the monitoring of 25 projects on a selective basis in 1976 and in the very next year (1977), increased it to 66 projects.

Subsequently, the scope of monitoring was enlarged and the functions like review of states' annual plans and CWC's participation in the working group discussions in the Planning Commission, preparation of annual review reports of the monitored projects on physical and financial status, were added. Annual report on irrigation development from major and medium projects in each state was also added in the scope. In 1986-87, the projects receiving external assistance and inter-state projects were also included in the ambit of monitoring. On the basis of the marked improvement in the performance of the projects due to effective monitoring, it was desired that more and more irrigation projects be taken up for monitoring by Central Water Commission. In order to undertake the huge task of monitoring of major and medium projects in the country, project monitoring by CWC was made a plan activity in VIII Plan w.e.f.1995-96.

3. MONITORING OBJECTIVES:

The main objective of monitoring is to ensure the achievements of set targets of schedule for completion of the irrigation projects, identification of the inputs required, analysis of the reasons for shortfalls, if any, and suggest remedial measures. Briefly, the monitoring covers.

- Ensuring detailed and integrated construction planning of the project task to be accomplished.
- Collection of information regarding progress of execution.
- Comparison of past and anticipated future progress with targets and plans both on physical and financial side.
- Identification of deviations, shortfalls, lagging areas etc. occurred so far and those anticipated, analyzing causes, their effects on targets of the given projects as well as other inter-related projects/activities.
- Initiating corrective actions for overcoming the difficulties and problem areas so as to achieve targets; modifying targets where necessary so as to be realistic.
- Ensuring that corrective action is taken; reviewing its effect, carrying out any modifications in the action which may be needed.
- Building a progress data bank for future use.
- Sending necessary monitoring information to the concerned authorities and inter-related projects.

4. USEFULNESS OF PROJECT MONITORING BY CWC:

Monitoring has been recognized as a useful management tool for ensuring timely completion of irrigation projects in the country for creation and utilization of desired potential. Monitoring at central level by CWC is effective in achieving physical and financial targets of the monitored projects. This is feasible because of timely identification of bottlenecks, shortfalls impeding the progress and imparting suggestions on various critical issues ranging from construction planning, project staffing, land acquisition problems, contractual problems, rehabilitation and resettlement plans to quality control aspects etc. During the monitoring visits, the issues affecting the progress of works are discussed threadbare with the project authorities and action points are identified. Follow-up action on these points by the concerned agencies is also monitored continuously for speedy implementation.

Realizing the importance of monitoring and its positive impact on monitored projects, Planning Commission had suggested that the major projects should be monitored right from the investment stage up to the operation stage by CWC and Planning Commission. While this is the basis for overall monitoring of projects, the minimum need of the construction monitoring for speedy completion of the projects is being taken care of by the monitoring units set up in CWC. For this purpose, the monitoring units should be strengthened in CWC to cover all irrigation projects which would yield more benefits during the future plan periods. The effective monitoring of all the major ongoing projects by the strengthened monitoring units would be instrumental in timely completion of projects, ensuring creation of targeted irrigation potential and early returns from the projects.

Ministry of Water Resources and its apex technical body, Central Water Commission which are responsible for planned development of the irrigation sector in the country do have with them the first hand information about the status of all the projects and overall picture of the sector.

Monitoring activity covering all ongoing major projects of the country at a time has enabled Ministry of Water Resources/Central Water Commission to have better control to deal with any situation arising in the irrigation sector at any point of time like that of inter-state projects.

The Government of India and Planning Commission are in a better position to appreciate the utilization of huge investments being made on irrigation projects which are costly in nature and consume a big chunk of the national resources.

The water sector as a whole has benefited with large monitoring network at the central level.

Monitoring of "Accelerated Irrigation Benefits Programme(AIBP)" for providing central loan assistance to needy projects as announced in 96-97 has been possible through the network of CWC monitoring units created at state level and closer to the project sites.

FUNCTIONS OF HQ MONITORING DIRECTORATE OF CWC:

Each Monitoring Directorate is responsible for monitoring of projects in a specified region of the country. The basic functions of each Directorate are as under:

i) Monitoring visits to the projects at regular intervals for on-the-spot study of progress of works. Identification of bottlenecks, shortfalls in progress with suggestions for remedial measures and bringing them to the notice of project managers and State Governments through issue of Status Reports for taking necessary action. The Status Reports are also sent to the Ministry of Water Resources and Planning Commission for information.

ii) Critical monitoring of potential targets and utilization during the construction period.

iii) Monitoring of activities related to rehabilitation and resettlement programme and progress and that of environmental safeguards.

iv) Construction programme for total implementation of the projects with network techniques.

v) Based on the total implementation programme, annual construction programme of projects is prepared by the project authorities in consultation with the Monitoring Units.

vi) Feed-back information on Annual Construction Programme in the form of QPRs which are studied in depth, slippages and reasons for shortfalls identified and remedial measures suggested to accelerate the progress.

vii) Data bank on management, information on overall development of water resources in a State through major and medium projects and preparing a Status Report on this aspect for each State once in every year.

viii) Review of Annual Plan and Five Year Plan proposals for major and medium sector of the State and participation in Annual Plan discussions in the Ministry of Water Resources and Planning Commission. Also processing of additional plan assistance for projects for expediting progress. Furnishing materials for Working Group Report on five Year Plan of major and medium irrigation after interaction with the State Governments.

ix) Furnishing material for Parliament Questions and VIP references etc. to the Ministry of Water Resources in respect of major and medium irrigation projects in the States.

FUNCTIONS OF FIELD MONITORING DIRECTORATES OF CWC:

Each Monitoring Directorate is responsible for monitoring of projects in a specified region of the country. The basic functions of each Directorate are as under:

i) Monitoring visits to the projects at regular intervals for on-the-spot study of progress of works. Identification of bottlenecks, shortfalls in progress with suggestions for remedial measures and bringing them to the notice of project managers and State Governments through issue of Status Reports for taking necessary action. The Status Reports are also sent to the Ministry of Water Resources and Planning Commission for information.

ii) Critical monitoring of potential targets and utilization during the construction period.

iii) Monitoring of activities related to rehabilitation and resettlement programme and progress and that of environmental safeguards.

iv) Construction programme for total implementation of the projects with network techniques.

v) Based on the total implementation programme, actual construction programme of projects is prepared by the project authorities in consultation with the Monitoring Units.

vi) Feed-back information on Annual Construction Programme in the form of QPRs which are studied in depth, slippages and reasons for shortfalls identified and remedial measures suggested to accelerate the progress.

vii) Feed-back to monitoring unit at HQs about the Status of the projects, irrigation development in the State as a whole for coordination at HQs.

viii) Monitoring of AIBP Projects and preparation of AIBP Status Reports, obtaining proposals for Central Assistance from States under AIBP, pursuing submission of monthly and quarterly physical and financial progress of AIBP works.

5. VARIOUS SCHEMES OF MOWR, GOI

1. BHARAT NIRMAN YOJANA

BACKGROUND:

The hon'ble president of India, in his address to the parliament on 25.02.2005, outlined the over-arching vision to build India called " Bharat Nirman".In his budget speech, Hon'ble finance Minister of India on 28.02.2005,conceived" Bharat Nirman" as a business plan illustrated over a period of four years for building infrastructure. especially in rural India with six components viz. Irrigation, roads, water supply, housing, rural electrification and rural telecommunication. In each of these areas targets have been set for achieving this goal.

Under the Irrigation Component of Bharat Nirman, the target of creation of additional irrigation potential of 1 crore hectare in 4 years (2005-06 to 2008-09) is planned to be met largely through expeditious completion of identified ongoing major and medium irrigation projects. Irrigation potential of 42 lakh hectare is planned to be created by expeditiously completing such ongoing major and medium projects.

There is a definite gap between irrigation potential created and the potential utilized. Under Bharat Nirman it is planned to restore and utilize irrigation potential of 10 lakh hectare through implementation of extension, renovation and modernization of schemes alongwith command area development and water management practices.

There are considerable areas in the country with unutilized ground water resources. Irrigation potential of 28 lakh hectare is planned to be created through ground water development.

The remaining target for creation of irrigation potential of 10 lakh hectare is planned to be created by way of minor irrigation schemes using surface flow.

10 lakh hectare of irrigation potential is also planned by way of repair, renovation and restoration of water bodies and extension, renovation and modernization of minor irrigation schemes.

A. Major & Medium Irrigation :Target 52 lac ha.

- Completion of On-going Projects – 42 lac ha.
- Extension, Renovation. Modernisation of Major & Medium Irrigation Projects - 10 lac ha.

B. Minor Irrigation :Target 48 lac ha.

- Surface Water - 10 lac ha.
- Ground Water - 28 lac ha.
- Repair, Renovation & Restoration of Water bodies/ ERM of MI Schemes - 10 lac ha.

Total: 1 crore ha.

II. ACCELERATED IRRIGATION BENEFIT PROGRAMME (AIBP):

BACKGROUND:

A large number of river valley projects, both multipurpose and irrigation have spilled over from Plan to Plan mainly because of financial constraints being faced by the State Governments. As a result of this, despite a huge investment having already been made on these projects, the country is not able to derive the desired benefits. There were 171 Major, 259 Medium and 72 ERM on-going Irrigation projects in the country at various stages of construction at the end of VIII Plan(i.e. end of March,1997) with spillover cost of Rs. 75690 crore. This was a matter of grave concern for the Union Government and remedial measures for expeditious completion of some of the projects which were in advanced stage of completion became necessary.

The AIBP was conceived in the year 1996 by the Government of India in order to provide financial assistance to States to complete various ongoing projects in the country so that envisaged irrigation potential of the project could be created and thereby extend irrigation to more areas. Since its formulation, the terms of the programme have been widened and liberalized over the time.

Central Government, during 1996-97, launched the Accelerated Irrigation Benefit Programme (AIBP) to provide Central Loan Assistance (CLA) to approve major/medium irrigation projects in the country with the objective to accelerate the implementation of those projects which were beyond resource capability of the States or were in advance stage of completion. Subsequently the programme was also extended to minor surface irrigation projects and ERM Projects satisfying some specified conditions.

The Accelerated Irrigation Benefits Programme (AIBP) extends financial assistance to the States for creation of irrigation potential by completion of identified ongoing irrigation projects. As per the present pattern of assistance under the AIBP, the Center is providing grant to the irrigation projects as an incentive to the States for creating irrigation infrastructure in the country. At present, the AIBP has to meet the demands of the ***Bharat Nirman programme*** and also to provide assistance to the irrigation projects under the Prime Minister Package for agrarian distressed districts.

GUIDELINES FOR AIBP:

Since inception of AIBP in 1996-97 the guidelines have undergone several modifications. Initially 50% of the outlay for the balance cost of works was being provided as Central Loan Assistance (CLA) to States. Subsequently it was recognized that the North-eastern and other hilly States could have difficulty in meeting the State share and thus a distinction was drawn between Special Category States and General Category States for granting increased CLA to Special Category States. Presently North-eastern States, Sikkim, Himachal Pradesh, Jammu & Kasmir and Uttaranchal are treated as Special Category States. It was also decided to treat projects in the undivided Koraput, Bolangir and Kalahandi (KBK) districts of Orrissa at par with special category States. For these districts even new projects could be considered for funding under AIBP as in the case of Special Category States. Further it was thought necessary to provide an incentive to States for bringing about the reforms in the Irrigation sector, in particular to increase the water rates so as to meet operation and maintenance (O&M) cost of various irrigation projects. Accordingly, the States which agreed to rationalize water rates in phases over a period of 5 years to recover full O&M cost were termed as the Reforming states. These States were given more attractive offer of assistance under AIBP. Seven States namely Gujarat, Maharashtra, Andhra Pradesh, Madhya Pradesh, Orissa, Rajasthan and Jharkhand were declared reforming but only Gujarat could fully meet the requirement.

As stated above, initially it was envisaged in AIBP to provide CLA to approved major/medium irrigation projects in the country in advanced stage of completion. From 1999-2000 CLA under AIBP was extended to minor surface irrigation projects of special category states. However later on from 2005-2006 assistance was extended to minor surface irrigation projects of General Category States provided irrigation potential is more than 100 hectare and to Extension, Renovation & Modernization (ERM) Projects if States having no major and medium projects to pose under AIBP and other States limited to 10% of annual allocation under AIBP provided they are reforming or have enabled PIM legislation or whose ERM projects also contemplate new potential. Further special dispensations of loan/grant have also been extended to drought prone, flood prone and tribal areas at par with special category States under consultation with the Planning Commission.

From February 2002, a Fast Track Programme (FTP) was introduced under AIBP for major/medium irrigation projects likely to be completed in two Working Seasons. The completion schedule of projects under AIBP was also revised time to time based on feedback received. Presently projects/project components under normal AIBP are required to be completed in four financial years and those under Fast Track are to be completed in two financial years leaving the year in which they are introduced. Considering that large water projects often take 15-25 years to plan, design and construct and while under execution normal completion period for major projects is about 10-15 years and for medium projects about 5-7 years, the above completion schedule decided on the advice of State Governments appears quite practical and reasonable.

The projects proposed for AIBP assistance were receiving Central Assistance as loan till March 2004. From 2004-2005, grant component was introduced and both loan and grant components were released in that year. Interest likely being less than that on loan under AIBP (9%), from 2005-06 only grant component is being provided to States on their request and the States are allowed to get the balance by market borrowing. The current funding pattern is as under:

Category	Normal		Fast Track	
	Centre:State Ratio in Budget	Central Share Loan #:Grant	Centre:State Ratio in Budget	Central Share Loan #: Grant
1. General Category	2:1	70:30	1:0	70:30
2. General Category Reforming*	4:1	70:30	1:0	70:30
3. Special Category	3:1	10:90	1:0	10:90
4. Special Category Reforming*	1:0	10:90	1:0	10:90

Note: # Loan component is to be raised by the States from market borrowing.

At present there are 144 approved projects of 19 states serving tribal and/or drought prone districts. Leaving the projects in Special Category States which are already receiving liberal grant under AIBP, there are about 77 projects under AIBP spread to 13 States, which are serving completely or partially the drought prone/tribal areas. In case these projects are provided liberal grant at par with Special Category States the amount of grant component is likely to be huge and beyond the budgetary provision for AIBP. The liberal grant as envisaged needs to be selectively provided to those components of these projects which are required for extending irrigation facilities to drought prone/tribal districts and not for the entire project. Even with this concept the grant component will increase by about six thousand crore in a span of say three years i.e., an additional budgetary provision of around Rs.2000 crore per year has to be kept in the budget of Union Ministry of Water Resources.

AIBP AND BHARAT NIRMAN :

Under the Bharat Nirman Plan targets have been set for creation of 52 Lakh ha through major, medium and ERM schemes. The targeted potential creation under AIBP during Bharat Nirman period (Based on MoUs) is as under.

Year	Potential in lakh ha
2005-2006	14.27
2006-2007	15.50
2007-2008	9.37
2008-2009	5.23
Total	44.27

Considering 20% slippages, expected potential creation is around 35.5 lakh ha. In case additional around 40 new projects are included under AIBP, further potential addition of around 7 lakh ha is expected from Major and Medium Irrigation sector. Thus from AIBP alone around 42 lakh ha potential is likely to be created under Bharat Nirman and addition of around 10 lakh ha is expected from other source. Thus, with liberalization of grant for drought prone/tribal areas, further increase in potential creation under AIBP is expected.

From the above it would be seen that the expected rate of potential creation during the Bharat Nirman period is almost three times the present rate of creation through AIBP. Obviously the budget provision for AIBP has to be accordingly enhanced. The budget provision for 2006-07 for providing grant was Rs.2098.38 crore (against Rs.1900.31 crore released during previous year) and the total outlay including loan was Rs.6856.69 crore. This provision has to be substantially increased to match the pace of expected creation of irrigation potential, particularly considering enhanced provision of grant for projects serving tribal/drought prone areas.

In view of the ambitious target under Bharat Nirman it is desirable to further simplify, widen and liberalize AIBP to encourage the State Government in expediting works on the projects taken under AIBP. Some of modifications suggested in various meetings with State Governments are as under:

(i) The guidelines may be simplified by removing distinction between normal and fast track programme(*This has been done in new AIBP guidelines effective from December,2006*), between reforming and non-reforming States and providing uniform grant based on expenditure incurred. It would be rather better to institute a Water Regulatory Authority in States as Maharashtra has done instead of giving any special treatment under AIBP to the said reforming States.

(ii) Uniform grant may be provided for General Category State under AIBP and similarly uniform grant is to be provided for Special Category States. The present effective grant and proposed grant pattern under normal AIBP are as under:

Category	Grant percentage	
	Present	Proposed
1. General Category	20	25
2. General Category Reforming	30	
3. Special Category	67.5	90
4. Special Category Reforming	90	

MONITORING OF PROJECTS UNDER AIBP:

A comprehensive physical and financial periodical monitoring of major / medium projects is being carried out by Central Water Commission / Ministry of Water Resources with emphasis on quality control. The monitoring mechanism is being further strengthened to achieve better results The release of subsequent installments of grant is based on physical and financial progress of the work. The Central Monitoring Team by visiting the projects twice in a year suggests some measures to the State Governments to improve the speed of construction and help the State Governments in identifying and removing the bottlenecks for completion of projects as per schedule. Since execution of the works in a project is within the jurisdiction of State Government, MoWR/CWC do not intervene in the process of execution, such as award of contract, payment to the contractors, mode of construction, etc. Though the recommendations of the Central Monitoring Teams are advisory in nature, they contribute significantly in identification of bottlenecks and remedial measures and thus in progress of the projects. In view of the increased work load on the monitoring set up, the Ministry of Water Resources is contemplating to enhance the monitoring capability in Central Water Commission by introducing remote sensing techniques and strengthening the monitoring organization to required extent. Monitoring of the minor irrigation (MI) schemes is being done by the State Government. These schemes would also be monitored periodically on sample basis by Central Water Commission.

III. NATIONAL PROJECT FOR REPAIR, RENOVATION AND RESTORATION OF WATER BODIES DIRECTLY LINKED TO AGRICULTURE:

BACKGROUND:

Through the ages, Indian agriculture has been sustained by natural and man-made water bodies such as lakes, tanks, ponds and similar structures. It has been estimated that there are about five lakh water bodies/tanks used for irrigation. Many of them have fallen into disuse and are in urgent need of repairs. These water bodies have been a part and parcel of minor irrigation in the country under which even today two thirds of irrigated agriculture is covered in our country. Such Minor irrigation schemes generally suffer from problem of loss of storage due to silting of the tanks, poor maintenance and management, encroachment etc. Damage to various structures, inadequate surplussing arrangements, silting are some of the reasons for deteriorating conditions in the irrigation system. It is necessary to restore the storage capacity of water bodies with the purpose of recovering their lost irrigation potential.

Union Finance Minister announced in his Budget Speech 2004-05 about launching of a massive scheme to repair, renovate and restore all the water bodies directly linked to agriculture. Under the scheme, it is proposed to restore water bodies throughout India to their original glory which is likely to upgrade the storage capacity significantly. For this purpose, a pilot scheme has been approved by Government of India in January, 2005 at an estimated cost of Rs. 300 crores to be implemented during the remaining period of the X Five-Year Plan.

The objectives of he scheme are : (a) to restore and augment storage capacities of water bodies, and (b) to recover and extend their lost irrigation potential. Once the pilot scheme is completed and validated, it will form the basis for launching of the "National Water Resources Development Project" at much larger scale and spread to be completed in 7 to 10 years.

THE SCHEME:

This is a state-sector scheme and the proposed funding pattern is Centre: State:: 75: 25. Under the scheme, projects are to be taken up in one or two districts each in the states. The states are to take up restoration of water bodies having original irrigation culturable command area of 40 ha up to 2000 ha to revive, augment and utilize their storage and irrigation potential. The projects are to be completed within a period of two years. Water bodies having original irrigation culturable command area of less than 40 hectare are to be covered under other ongoing schemes/existing schemes. For the above purpose, the States may also undertake repair of related structures like check dams, weirs, bunds, and water conveyance systems. Prioritisation of water bodies are to be done by the respective states.

Detailed project Reports are to be prepared by the states as per the guidelines and submitted for approval of MOWR and consideration for funding. The detailed project report (DPR) from the states shall ensure that not more than 50% of a given project cost is earmarked for ancillary works for conveyance system. DPR shall not include works for incomplete minor irrigation schemes or schemes completed within the last 10 years. No proposals for funding establishment costs will be made under the scheme.
The projects are to be completed within a period of two years.

DPRs duly approved by the States' Technical Advisory Committee (TAC) are to be submitted to Central Water Commission. CWC, after examination, will forward the DPRs with their considered views and recommendations to MOWR for approval and funding under the scheme. A high level Selection Committee of the Ministry of Water Resources will select the projects for approval of the Ministry. Central share of funds will be released to states for implementation of the district projects and states will provide 25% share.

DISTINCTIVE FEATURES OF THE SCHEME:

The pilot scheme envisages active community participation for implementation of the projects. Main stipulations of the project are as under :

There will be a district level implementation committee chaired by the District Collector for deciding overall implementation, management issues and supervision. The Panchayati Raj Institutions and Water Users Associations and representative of all stakeholders will be actively involved in the Committee.

The main thrust of the projects will be for increase in storage capacity of the water bodies.

Priority to be accorded by states to areas which are arid, drought-prone, tribal-dominated, backward while selecting districts.

Deciding works to be taken up, implementation issues and operation and maintenance of the projects after the projects have been completed are very important.

Involvement of community and stakeholders in implementation, supervision and monitoring of the scheme.

Detailed surveys are to be undertaken in each district to establish base line data at the village level and also at tank level for performance evaluation. A provision up to 10% of the project cost will be kept for related capacity building & people's participation and survey for collection of baseline data.

Catchment area treatment to be considered after technical appraisal. Wherever this work is required in a *project*, funds upto 15% of project cost can be utilised and are to be provided for in the DPR.

Convergence of the project with related activities under other scheme should be achieved.

Handing over of the project to WUA/Panchayat on completion for operation and maintenance. Deciding provision for O&M funds for WUA/Panchayat during the project implementation period.

Representatives from Water Users Associations(WUAs), Panchayats and NGOs will be involved by the States for finalizing implementation strategy and for management of effective implementation. WUAs will include representative of all stakeholders including those from landless and vulnerable groups and women.

They would also be involved in overall supervision for quality of works, procurement and general monitoring of the project works apart from the graded monitoring system from local level onwards.

Funds to be spent from separate project account upon authorization by Chairman, DLIC as per recommendation of DLIC.

Proper utilization of funds to be examined and certified by DLIC and also at state level for issue of utilization certificate.

There will be a graded and bottom up approach for progressive monitoring and evaluation of the project work at local, district and state levels in the respective states.

Ministry of Water Resources will take up appropriate system of monitoring of the project through CWC and CGWB in the states consisting of on-site examination of works and off-site analysis of states monitoring reports.

PROGRESS:

Ministry of Water Resources has approved 1098 Water Bodies for 26 district projects in 15 States, namely, Andhra Pradesh, Bihar, Chattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu, West Bengal, Himachal Pradesh, J&K, Gujarat, Kerala and Maharashtra at an estimated cost of

Rs. 299.92 crores. The work in 619 Water Bodies has been completed till March, 2007.

The World Bank Loan Agreement signed with Tamil Nadu for Rs.2182 crores to restore 5763 water bodies having a CCA of 4 lakh hectares. The negotiations for the project "Andhra Pradesh Community – Based Tank Management Project" at the cost of about Rs.1000 crores have been completed in March 2007 for restoration of 3000 water bodies with a CCA of 2.5 lakh hectares. The Projects of Karnataka, Orissa and West Bengal are at the different stages of appraisal by the World Bank.

IV. COMMAND AREA DEVELOPMENT AND WATER MANAGEMENT PROGRAMME(CADWM)

BACKGROUND:

During the post independence era, a large number of irrigation projects were constructed for increasing agricultural production in the country. However, during early seventies analysis of irrigation potential created and utilised revealed that there was a substantial gap between them. The Irrigation Commission made specific recommendations in its report in 1972 that systematic development of commands of irrigation projects should be taken up in order to fully utilise the irrigation potential created. Subsequently a Committee of Ministers set up by the Ministry of Irrigation and Power analysed the issue and suggested in 1973 that a broad based Area Development Authority should be set up for every major irrigation project to undertake the work of comprehensive area development. Based on this recommendation, the Government of India initiated a Centrally Sponsored Command Area Development Programme (CADP) in December 1974 to improve irrigation potential utilisation and optimise agricultural production from irrigated land through integrated and coordinated approach of efficient water management.

In tune with objectives of the programme a number of components such as construction of field channels and field drains, enforcement of warabandi, land levelling and shaping, realignment of field boundaries/ consolidation of holdings, introduction of suitable cropping patterns, strengthening of extension services etc. were included in the programme. Subsequently, in view of emergent needs a few more components like farmers' participation and reclamation of waterlogged areas were included in the programme with effect from 1st April, 1996 to make the programme more beneficial to the farmers.

Review of the Programme implementation during the VIII and IX Five Year Plan periods revealed that micro level distribution network for supply of water to individual holdings had been created in about 16 million ha and rotational supply of irrigation water had been enforced in about 11 million ha. A number of constraints such as unreliability of water supply at the outlet due to deficiencies in the irrigation system above the outlet, absence of link and intermediate drains to let out surplus water into main drains, non-inclusion of minor irrigation projects from non- hilly areas, low priority by the State Governments to extension and training activities, non-revision of cost norms for various activities since VIII Plan etc. were also noticed during the review. In view of these constraints the programme was restructured for the remaining period of X Plan (2004-07) and renamed as 'Command Area Development and Water Management Programme (CADWM Programme)' to make it more comprehensive and beneficial to farmers.

Beginning with 60 major and medium irrigation projects in 1974-75, 310 projects (with total CCA of about 28.5 Mha) have so far been included under the Centrally Sponsored Command Area Development Programme. Out of these, Central assistance to 162 projects, has been closed after completion (a few projects fore-closed). Another 23 projects have been clubbed into 8 projects. The restructured CADWM programme thus, was being implemented in 133 projects (with balance CCA of about 8.7 Mha yet to be covered) during the remaining period of X Plan.

PHYSICAL AND FINANCIAL PROGRESS:

An amount of Rs. 2884.14 Crore has been released to the States as Central Assistance under the Programme from the inception till end of March, 2005 out of which amount released during IX plan was Rs.751.66 Crore. During first 3 year of the X plan (i.e. 2002-03, 2003-04 and 2004-05), an amount of Rs.150.2 Crore, Rs.141.44 Crore and 141.51 Crore has been released to the States respectively.

An area of about 16.63 Mha has been covered under the programme since inception up to end of March, 2004 out of which an area of 1.8 Mha has been covered during the IX Plan. During 2002-03 and 2003-04, an area of 0.47 Mha and 0.454 Mha has been covered respectively.

SALIENT FEATURES:

Based on the recommendations of the Working Groups of the Planning Commission on "Command Area Development Programme" and "Private Sector And Beneficiaries Participation in Irrigation Water Management" and the views expressed by the State Governments the existing CAD Programme has been restructured and renamed as "Command Area Development and Water Management" Programme. The restructured programme retains the components of the existing scheme which have been found to be beneficial to the farmers, include a few new components considered necessary for correction of deficiencies in the irrigation system and delete those components which have lost their utility overtime.

Components being continued:

(i) Survey, planning and designing of On Farm Development (OFD) works
(ii) Construction of field channels, now with a minimum of 10% beneficiary contribution
(iii) Full package OFD works including construction of field channels, realignment of field boundaries, land levelling and shaping also with a minimum of 10% beneficiary contribution
(iv) Warabandi (to be continued without central assistance)
(v) Construction of field drains, intermediate and link drains for letting out surplus water
(vi) Reclamation of waterlogged areas of irrigated commands using conventional techniques and including bio-drainage wherever applicable, now with a minimum of 10% beneficiary contribution
(vii) State sponsored software components such as trainings of farmers and field functionaries & officials, adaptive trials & demonstrations, action research for Participatory Irrigation Management, seminars/ conferences/workshops, monitoring & evaluation of the programme etc. through Water and Land Management Institutes (WALMI) and other institutions with 75 percent funding from Government of India
(viii) Institutional support to Water Users' Associations
(ix) Establishment cost - 20% of OFD works items (ii)/(iii), (v), and (vi) and(x) R & D Activities, including training of senior level officers, conferences, workshops, seminars etc. arranged directly by the Ministry.

New components:

(i) Correction of system deficiencies above the outlet up to distributaries of 4.25 Cumec (150 Cusec capacity)
(ii) Renovation and de-silting of existing irrigation tanks including the irrigation system and control structures within the designated irrigation commands with a minimum of 10% beneficiary contribution as maintenance fund, the interest from which has to be used for maintenance in future.
(iii) Use of location specific bio-drainage techniques to supplement conventional techniques for reclamation of waterlogged areas as a part of item (vi) under the continuing components.

Components deleted:

(i) Land levelling & shaping (subsidy)
(ii) Sprinkler & Drip irrigation(subsidy)
(iii) Conjunctive use of surface and ground water(subsidy) and
(iv) Crop compensation and introduction of suitable cropping patterns.

Thus the scheme would encompass all aspects of water management for efficient and equitable distribution of water in the commands of irrigation projects for optimal utilisation and augmentation of water users in a participatory manner.

FUNDING PATTERN AND COST NORMS:

The cost norms for various activities had not been revised since VIII plan. The same have therefore been revised keeping in view the price escalation, suggestions of the working Groups of Planning Commission and the suggestions received from the State Governments.

V.NATIONAL PROJECTS

GUIDELINES FOR IMPLEMENTATION OFNATIONAL PROJECTS

Government of India has approved a scheme of National Projects to be implemented during XI Plan with a view to expedite completion of identified National Projects for the benefit of the people. Such projects will be provided financial assistance by the Government of India in the form of Central grant which will be 90% of the estimated cost of such projects for their completion in a time bound manner. Based on the criteria, the Government of India has already identified 14 projects as National Projects

I CRITERIA FOR SELECTION OF NATIONAL PROJECTS

The criteria for selection of National Project will be as under:
(a) International projects where usage of water in India is required by a treaty or where planning and early completion of the project is necessary in the interest of the country.
(b) Inter-State projects which are dragging on due to non resolution of Inter-State issues relating to sharing of costs, rehabilitation, aspects of power production etc. including river interlinking projects.
(c) Intra-State projects with additional potential of more than 2,00,000 hectare (ha) and with no dispute regarding sharing of water and where hydrology is established.

II PROCEDURE FOR INCLUSION AS NATIONAL PROJECT

(a) New projects could be considered for inclusion as National Projects on receipt of proposals from the State Governments in the prescribed format, clearance from Expenditure Finance Committee/Project Investment Board and on the recommendation thereupon of a high powered Steering Committee constituted for the purpose of overseeing the entire process of selection and implementation of National Projects and the approval by the Union Cabinet.
(b) State Governments may submit proposals in Form-1 for inclusion of project as a National Projects. The proposals should be submitted through the Regional Office of Central Water Commission (CWC) with a copy each of the proposal to the CWC (HQ) and the Ministry of Water Resources.
(c) The projects proposed for inclusion as National Projects should fulfill all the eligibility criteria required for funding under Accelerated Irrigation Benefit Programme (AIBP), including the investment clearance of the Planning Commission.
(d) Only major irrigation/multi-purpose projects shall be eligible for inclusion as National Projects.
(e) On receipt of a proposal from the State Government for inclusion of a project as National Project, the Ministry of Water Resources may send a team of officers to the project site with a view to make assessment of the present status of the project and to firm up the plans for its completion in a specified time-frame.

III FUNDING OF THE NATIONAL PROJECTS

(a) The Project authority should conduct an internal audit and submit the actual expenditure incurred and the balance requirement of funds duly certified by the State Government.
So far as the Central Government is concerned, the commitment to fund these National Projects would be from the date of its inclusion as National Project.
(b) The National Projects will receive central assistance in accordance with the approved guidelines for AIBP except for specific provision as mentioned in para III (c) and III (d).
(c) The National Projects shall be eligible for 90% grant of the balance project cost (cost of work) of irrigation and drinking water components of the project. For the purpose of Central funding, the cost for drinking water component shall not include the works related to transmission and distribution network required exclusively for drinking water component.
(d) The central assistance under the programme will be provided in two installments of 90% and 10% respectively of the annual grant requirement. The 2nd installment during the year will be released on production of utilization certificate of 80% grant released in the first installment along with State share. For the subsequent years, the first installment of grant will be released on utilization of 80% grant released till previous year along with the State share and submission of a report of physical achievements and the benefits from the project as stipulated in the MOU.
(e) All establishment and administrative costs on a National Project shall be entirely borne by the State Government.
(f) The revised estimates for the projects funded as National Projects should be got approved from the Planning Commission at an interval of three years else, Ministry of Water Resources could stop funding to the project.
(g) The central grant released to the State Government will be transferred by the State Government to the project authorities within 15 days of its receipt from the Central Government.
(h) The State Government will submit audited statement of expenditure incurred on National Project within 18 months of release of Central Grant.

IV WORK PLAN AND TIME SCHEDULE FOR COMPLETION OF NATIONAL PROJECTS.

(a) The State Government will provide along with the proposal for inclusion of a project as National Project, detailed year wise physical and financial programme for completion of various activities along with PERT/CPM Chart for the timely completion of various activities. It will also indicate year wise target of the benefits from the project. A Memorandum of Understanding (MoU) will be signed by State Government with the Ministry of Water Resources.
(b) While submitting a proposal for techno-economical appraisal of the project to the Central Water Commission (CWC), the State Government will also indicate the programme for completion of the project in a time bound manner. The CWC will examine techno-economic viability of the project keeping in view the time period proposed by the State Government for completion of the project and the same time frame will be adhered to in completion of the project.
(c) The State Government will ensure timely completion of the project and will adopt appropriate measures such as Turn-Key or fixed time and fixed price contracts for this purpose. The works should be awarded by the State Government in distinct packages so that works of any package are not affected by the progress of works of other packages.
(d) The State Government should consider incorporating provision of strong incentives/disincentives for the contracts for execution of the National Project to facilitate timely completion of the project.
(e) The Command Area Development Programme should get implemented pari passu with project implementation.
(f) Land records in the command of the proposed national projects should be updated, livelihood survey should be conducted and advance planning should be done along with dovetailing the various RD Programmes so that the agricultural produce could be marketed through communication networks in mandis and nearby markets.
(g) The job of soil testing and issue of soil health cards to the farmers of national projects command should be completed before the irrigation benefits starts.

V. MONITORING OF NATIONAL PROJECTS

(a) The progress of work in respect of National Projects shall be closely monitored by the Central Water Commission/Ministry of Water Resources. The monitoring of National Projects will be field based with GIS based project implementation units linked with management information systems.
(b) The State Government will keep close coordination with agricultural departments for the advanced crop planning and extension inputs to farmers of the command.
(c) Achievement of targets of the potential creation from the project may also be got assessed by the Ministry of Water Resources through independent agencies and other means such as remote sensing technique.
(d) The State Government shall send quarterly physical and financial progress reports in the proforma to the CWC/Ministry of Water Resources.
(e) The State Government shall establish independent quality control organization and adequate number of quality control laboratories in the project areas to maintain quality of works. The sampling and testing will be required to be carried out in accordance with relevant BIS Codes.

VI. REVIEW BY STEERING COMMITTEE

The implementation of National Projects will be reviewed from time to time by the High Powered Steering Committee constituted under chairpersonship of the Secretary (Water Resources).

VII. EVALUATION AND IMPACT ASSESSMENT

A concurrent evaluation of the Project and impact assessment of the project on its completion will be conducted by the State Government through a reputed independent organization to find out whether the envisaged objectives, outcomes and targets of the project have been achieved. The Ministry of Water Resources may also get the evaluation and impact assessment done separately. Funding for the evaluation and impact assessment will be provided by the Ministry of Water Resources through its ongoing Plan scheme "Research & Development Programme for Water Sector".

6. PROCESSING CASES FOR CA RELEASE:

The proposals of State Government for Central Assistance under various schemes of Ministry of Water Resources are received in the field monitoring Directorates of Central water Commission. These proposals are examined with respect to existing guidelines of the MoWR. At present, the proposals of State Governments for the following schemes are being processed for Central assistance by the field Monitoring directorates of CWC:

1. CA for AIBP Projects.
2. National Project For Repair, Renovation And Restoration Of Water Bodies Directly Linked To Agriculture
3. CA for CADWM Schemes.
4. CA for Flood protection works.
5. CA for National Projects.

The detailed procedure for processing AIBP proposals:

1. The established channel

- Any proposal of State Government is received in the name of concerned Chief Engineer of CWC in a particular state.
- The proposal is forwarded to concern Director for examination.
- After examination of the proposal as per existing guidelines, it is seen whether proposal is eligible for CA under AIBP.
- If, the proposal is eligible for CA, the observations of Directorate, for any shortcomings in the proposal are communicated to the State Government for compliance.
- Once the observations are complied by the state Government, the proposal is sent to Chief Engineer, CWC by the concerned Director.
- If every thing is found in order, the proposal is sent to Chief Engineer, PMO,CWC,New Delhi.
- Form CWC, New Delhi, the proposal is sent to Commissioner (Projects), MoWR,New Delhi.
- From MoWR, the proposal is sent to planning Commission, and after examination, the funds are released as requested by State Government and recommended by CWC & MoWR.

2. Mandatory Clearances before acceptance:

- Forest clearance by Ministry of Environment & Forest, GoI.
- Techno-economic clearance by State TAC/CWC.
- Investment clearance by State Finance Deptt/Planning Commission of GoI.
- Clearance by TAC chaired by Secretary, MoWR.

3. Necessary Enclosures:

- Form-C
- MOU(Memorandum of Understanding)with Undertaking

- Utilization Certificate
- Budget provision letter for the year from the State Govt.
- Proforma for CA Recommendation
- Annexure-I : Streamlining Procedure
- Annexure-II: Check List
- Audited Statement of Expenditure.
- Reasons for shortfall, if any, in potential creation.

Form-C: Form-C is the project proposal itself in detail mentioning about brief description of the project, physical progress, status of land acquisition and R & R, physical & Financial programme etc.

MOU (Memorandum of Understanding):

MOU is signed between MoWR,GoI and concern state Government for a maximum period of four years for completion of any WR Project/ components**.** It mentions about year wise financial requirement and potential creation. The year wise funds are released in two instalments. The Ist Instalment of 90% is released immediately after recommendations of CWC/MoWR are accepted by Planning Commission. The IInd instalment of 10 % is released after 70% utilization of I^{s}t Instalment.

Undertaking: The State Finance Department gives an undertaking to the MoWR,GoI that the funds released under AIBP would made available to Project authorities within the stipulated time frame.

Utilization Certificate: It is the statement signed by Secretary(WR) of the State Government stating the funds released earlier have been utilized adhering to the terms & Conditions of the Sanction.

Budget provision letter for the year from the State Govt: State Govt. should furnish a statement of matching budgetary provision in the State budget for the particular financial year.

Proforma for CA Recommendation: It is the proforma used by Field office of CWC, HQ and MoWR for arriving at CA amount for recommendation, as per the existing guidelines**.**

Annexure-I: Streamlining Procedure: This is the proforma designed by MoWR for perusal of IFD of MoWR to arrive at quick decision.

Annexure-II: Check List : This is the proforma designed by MoWR for quick review of physical and financial progress of the project.

Audited Statement of Expenditure: Certificate from State Audit/ Finance Department stating that expenditure on AIBP components has been incurred properly, as proposed.

Reasons for shortfall, if any, in potential creation: If achievements in a particular year are not as per the MoU, then for release of the funds for the next year, a proper justification note is to be enclosed giving reasons for not achieving the targets.

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MONITORING OF IRRIGATION PROJECTS USING BHUVAN WEB SERVICES

Manish Rathore
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INTRODUCTION

Monitoring and evaluation of irrigation projects must play a more important role in the future if the irrigation management process is to be improved. The process is complex, since a large number of regular, specific tasks must be performed, both concurrently and sequentially, and coordinated by a variety of professionals within available time and resource constraints. For any evaluation to be used, it must be credible- objective, accurate, and fair. Reports should be clear, unambiguous, balanced in terms of strengths and weaknesses, and contain justifiable conclusions and recommendations. For monitoring and evaluation to succeed, irrigation managers need to develop a new evaluative mind-set that enables them to appraise their projects' performance objectively, reflect on what has been learned for future use, and adjust policies on the basis of that knowledge whenever necessary.

The gainful use of high resolution **CARTOSAT** satellite data for inventory of Irrigation Infrastructure (canal network, conveyance & distribution system), assessment of progress of Irrigation works, closer visualization of spatial irrigation utilization patterns, assessing the impact of irrigation developmental programme on the performance of irrigation command and to address the performance at Water Users level in the participatory irrigation management approach.

DEFINITION OF MONITORING AS PER CWC

Monitoring is the process of collecting information about the actual execution of planned tasks and factors, which might affect their execution; analyzing these in relation to the plan and exercising control, so that the deviations from the plan are minimal. This helps the central authorities to assess the real work done up to a time, so that necessary advises can be given to project authorities.

OBJECTIVES OF THIS TRAINING PROGRAMME

i.) Monitoring of Priyadarshini Jurala Project, Andhra Pradesh through spatial technique

ii.) Digital Image processing involved in the process of monitoring of irrigation projects through Remote Sensing and GIS

iii.) Assessment of irrigation potential created up to April 2007 using Cartosat high resolution satellite data and Identification of gap / critical areas in I.P creation

iv.) Inventory and Mapping of Irrigation Infrastructure consisting of canal network, cross drainage and other irrigation structures

v.) Assessment of Irrigation Potential (I.P) created as on April, 2007 as the data corresponds to April 2007.

Details of Methodology

Basic approach involved in the study consists of inventory and mapping of existing irrigation infrastructure viz. canal network, irrigation and other related structures from the Cartosat satellite data in a irrigation project and comparing with proposed irrigation infrastructure. Based on the completed irrigation infrastructure derived from the cartosat-1 satellite data and considering the hydraulic connectivity, the Irrigation Potential created in the project command is assessed. Brief description of methodological steps involved in the study area given below:

(a) Overview of Methodology

1. Field data collection: Collection of preliminary and detailed field data consisting of map(s) showing proposed canal network and canal wise CCA/ICA, I.P proposed, I.P created as on March 2009 or any other date as required by the project .

2.Cartosat data acquisition planning and procurement : Preparation of AIBP component polygon shape file(s) using the field maps to plan for acquisition of fresh Cartosat satellite data during April 2010 - June 2010 for all the projects (both completed / ongoing) . In case atellite data is not available, either for total project during the above period, the time window will be extended beyond Jun, 2011 till it is covered for completely ongoing projects. For completed projects, in addition to the above, the archived Cartosat data from April 2008 onwards will also be utilized.

3. Field database creation: Preparation of field database on irrigation infrastructure and Irrigation Potential information

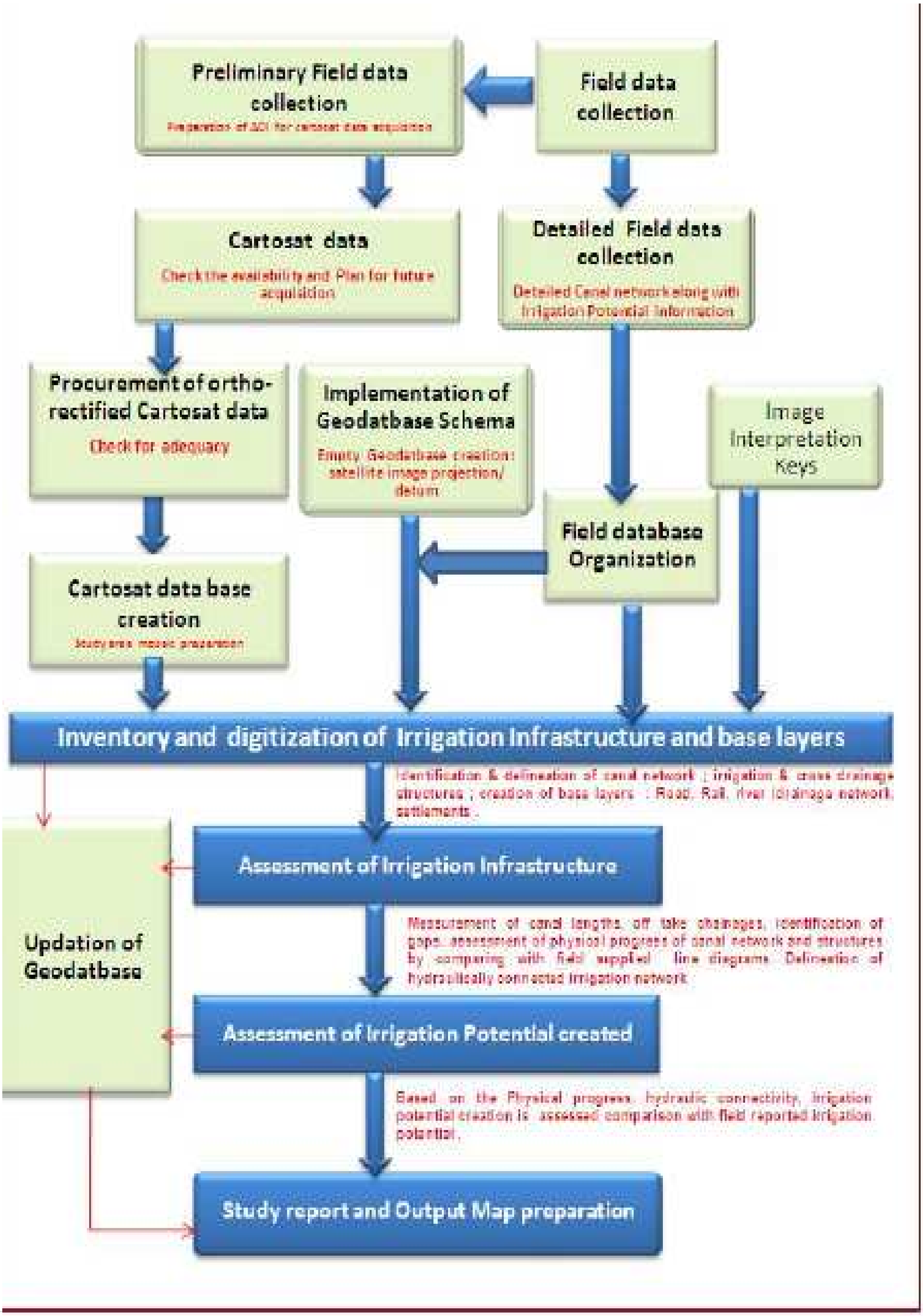
4. Cartosat database creation: Edge matching and mosaic of Cartosat satellite data tiles and preparation of satellite database.
5. Geo-database creation: All the vector layers (Irrigation Infrastructure and base layers) along with attribute information will be developed in GIS environment using geo-database schema developed for the project.

6. Inventory and mapping of Irrigation Infrastructure and base layers : Identification and mapping of existing Irrigation Infrastructure consisting of Irrigation canal network up to Minor /Sub-Minor level, Cross drainage, Irrigation and other structures as on the date of satellite overpass date. Identification and mapping of base layers consisting of study area boundary, rivers, streams, roads, railway lines, settlements, balance I.P polygons etc.

7. Assessment of Irrigation Infrastructure and Irrigation Potential created: Comparison of satellite derived information with proposed Irrigation infrastructure to create planned I.P under AIBP. Assessment of Irrigation Potential (I.P) created based on the extent of accomplishment in irrigation canal network creation with hydraulic flow continuity as on the satellite data acquisition date. Finalization of assessment of I.P created.

8. Ground truth field visit: Conduct of random field visits to check for satellite data interpretation.

9. Preparations of Outputs: Preparation of output map along with study report; Preparation of digital data backup for supply to user. Flow chart showing the over view of the methodology is provided here.



Process flow chart for the Irrigation Potential assessment

The **Inputs / Parameters** required from the **field data** and **satellite data derived irrigation infrastructure** information are:

1. **Proposed length** of canal.
2. **Satellite derived Lengths** ; Physical progress of canal construction for the corresponding canal.
3. Irrigation potential proposed under each canal .
4. **Gaps** existing in different stretches of the canal network,
- Number of gaps and gap lengths, their chainages – derived hydraulically connected length of a particular canal .
5. Number of **DPOs**, their contribution to the **irrigation potential** as per field data; their **chainages** – to assess the hydraulic connectivity .

The **steps to be followed** for the satellite based assessment of irrigation potential creation: Irrigation potential assessment is made based on physical status of canal and its hydraulic connectivity to the source of irrigation. As explained earlier, canal network hierarchy consists of Main canal – Branch canal-Distributary-Lateral-sub lateral , etc and may vary from one project to another project. In addition to this, irrigation potential is also created through the Direct Pipe Outlets (DPOs) from Main canal /Distributary, etc. Various scenarios that one would come across in different irrigation projects are briefly explained.

(Details of methodology has been described in NRSC manual).

GROUND TRUTH

The ground truth photographs have been taken from the actual site and have been compared with the corresponding images to have a clear visualization.

CONCLUSION

The endeavour of bringing together the this monitoring of Irrigation projects using online monitoring, the direction and decisions in this domain will shape our future in monitoring real time scenario of any irrigation projects with no software cost. The free plug ins can be loaded to the G-GIS to have a smart way of analyzing things.

Using Quantum GIS

Pradeep Kumar
Director, NWA

Introduction

The purpose of this write-up is to introduce one to the use of key aspects of quantum GIS (QGIS). This material is structured with the content to suit novice, intermediate and advance users. Each step is designed to instruct in one and more of these aspects, so that one can use it for extracting necessary information from the CARTOSAT satellites image for monitoring of the any irrigation projects. In the following write-up, one will have an idea how to use this open source Q-GIS, where many GIS capabilities are inbuilt. The write-up is based on the Quantum GIS training manual designed and provided by Linfiniti consulting CC for QGIS version 2.8. However, in this training course, the QGIS version 2.10 (Pisa) has been used.

Exercise Data

The sample data used throughout this write-up can be downloaded here:
http://qgis.org/downloads/data/training_manual_exercise_d

Table of Contents

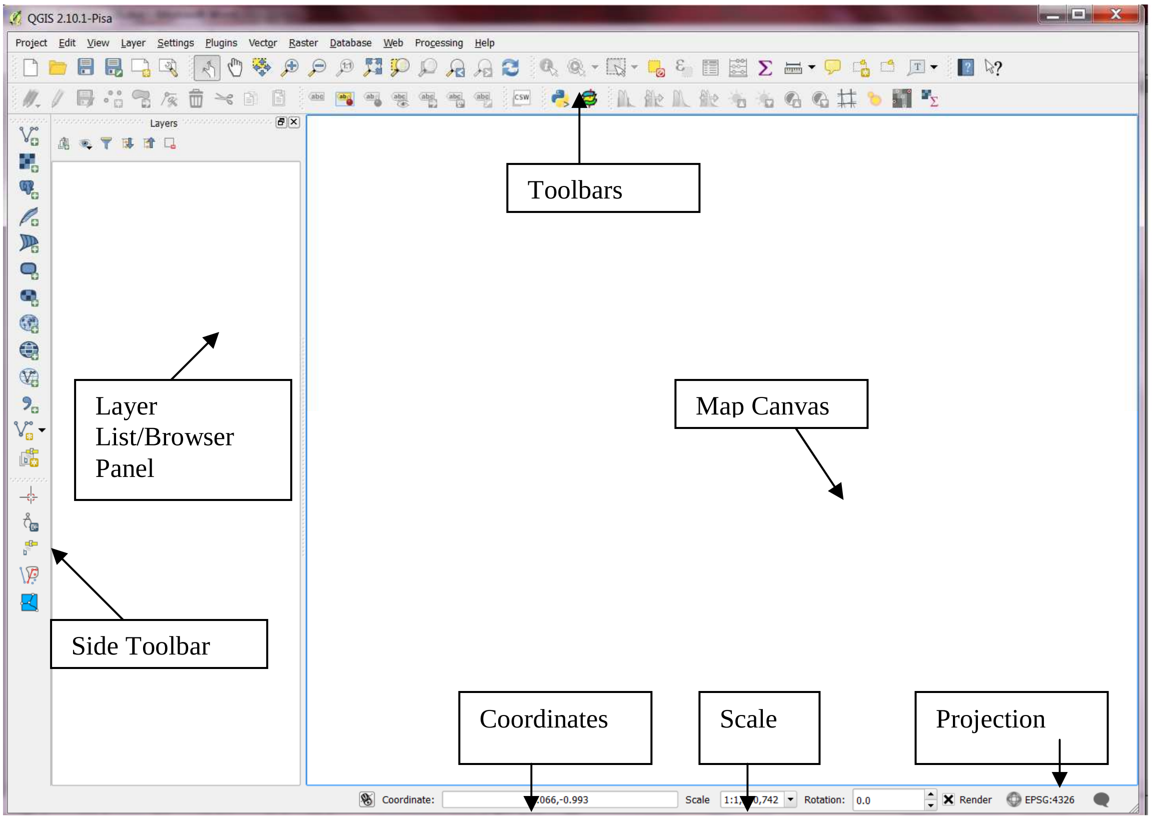
Following key aspects or functions of Q-GIS will be described in this write-up:

a) Overview of Interface of QGIS
b) Toolbar
c) Adding Layer
d) Changing names of layer, layer color
e) Working with vector data
f) Symbology
g) Attribute Data
h) The label tool
i) Classification
j) Creating New GIS Data
k) Query Builder
l) Using map composer
m) Creating a basic map and printing a map

This Training course assumes that one have some knowledge of working with Computers and knows some about theoretical GIS knowledge or the operation of a GIS program. However, a Limited theoretical background will be provided to explain the purpose of an action you will be performing in the program, but the emphasis is on learning by doing. When you complete the course, you will have a better concept of the possibilities of GIS, and how to harness their power via QGIS.

The Interface

Open QGIS by Double Clicking **[QGIS desktop]** icon on desktop or by going to **Start > All Programs > Quantum GIS > Quantum GIS Desktop.** Following window will open:



This is how QGIS 2.10 looks when you open it. How many tools/icons you see might be different from this screen capture. Using QGIS we are able to use data layers in the form of **Shapefiles** and **Images**

Shapefiles (.shp) are geospatial data files that hold vector-based data. Vector data layers are **points**, **lines** (arcs, polylines), and **polygons** (closed shapes with defined area).

Images(.img, .tiff etc) are raster-based datasets that are made up of cells, organized in columns and rows, which contain data. Raster imagery includes digital USGS topographic maps, aerial photography (Ortho-photography), and satellite imagery.

Layer List

In the Layers list, you can see a list, at any time, of all the layers available to you.

Toolbars
Your most oft-used sets of tools can be turned into toolbars for basic access. For example, the File toolbar allows you to save, load, print, and start a new project. You can easily **customize** the interface to see only the tools youuse most often, adding or removing toolbars as necessary via the **View→Toolbars** menu. Even if they are not visible in a toolbar, all of your tools will remain accessible via the menus. For example, if you remove the File toolbar (which contains the Save button), you can still save your map by clicking on the File menu and then clicking on Save.

The Map Canvas
This is where the map itself is displayed.

The Status Bar
Shows you information about the current map. Also allows you to adjust the map scale and see the mouse cursor's coordinates on the map.

Adding a Layer

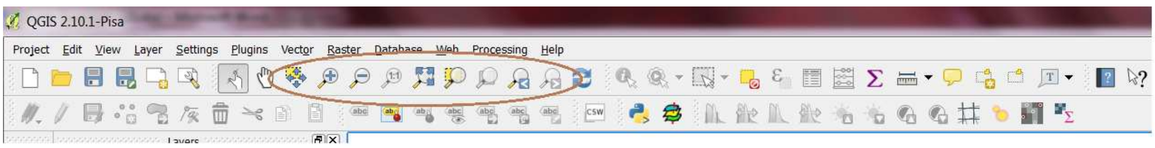
A common function of GIS Applications is to display **map layers** or simply layer. Map layers are stored as files(**.shp** files) on a disk or as records in a database. Normally each map layer will represent something in the real world- a roads layer for example will have data about the street network.

- *Look for the Add Vector Layer button:* 
- *Select "**File**" as the "Source type". The encoding is "**System**".*
- *Click **Browse** and Navigate to your PM_GIS\shapefiles folder. Load a shape file. (say **Canal network.shp** file)*

Congratulations! You now have a basic map. Now would be a good time to save your work.

- Click on the Save As button:
- Save the map under \exercise_data and call it basic_map.qgs.

Now please experiment with the map navigation toolbar and use the zoom and pan functions



Working with Vector Data

Vector data is arguably the most common kind of data you will find in the daily use of GIS. It describes geographic data in terms of points, that may be connected into lines and polygons. Every object in a vector dataset is called a feature, and is associated with data that describes that feature.

It’s important to know that the data you will be working with does not only represent where objects are in space, but also tells you what those objects are.

From the previous exercise, you should have the canals layer loaded in your map. What you can see right now is merely the position of the canals.

To see all the data available to you, with the roads layer selected in the Layers panel:

• *Click on this button:* 

It will show you a table with more data about the canal layer. This extra data is called **attribute data**. The lines that you can see on your map represent where the canal go; this is the **spatial data**.

The **attributes** of a feature describe its properties or characteristics. For example a road polyline may have attributes that describe whether it is surfaced with gravel or tar, how many lanes it has, whether it is a one way street, and so on. Attribute data can make a map more interesting and informative. Attribute data can be very useful in carrying out **spatial analysis**. Spatial analysis combines the spatial information stored in the geometry of features with their attribute information. This allows us to study features and how they relate to each other. It is therefore very important that you should ensure that you know what attributes are need for carrying out a specific spatial analysis.

Reordering the layers

- *Click the Add Vector Layer button:* 
- *Select “**File**” as the “Source type”. The encoding is “**System**”.*
- *Click **Browse** and Navigate to your PM_GIS\shapefiles folder. Load a shape files **(studyarea.shp)** by using **Ctrl + A** and deselect the canal network layer.*
- *Now again click add layer button and Click **Browse** and Navigate to your PM_GIS\shapefiles folder. Load all the shape files by using **Ctrl + A** and deselect the canal network layer and study area layer.*
- *Click the Zoom Full button:* 

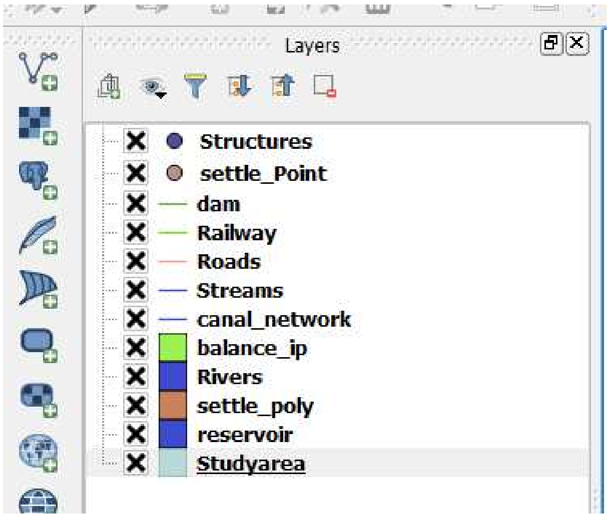
What you see?
You see only Study area layer, reservoirs layers, some portion of settlement polygon layer.

The layers in your Layers list are drawn on the map in a certain order. The layer at the bottom of the list is drawn first, and the layer at the top is drawn last. By changing the order that they are shown on the list, you can change the order they are drawn in.

The order in which the layers have been loaded into the map is probably not logical at this stage. To resolve this problem:

• *Click and drag on a layer in the Layers list.*

• *Reorder them to look like this:*



You'll see that the map now makes more sense visually, with roads and buildings appearing above the land use regions.

Symbology

The symbology of a layer is its visual appearance on the map. The basic strength of GIS over other ways of representing data with spatial aspects is that with GIS, you have a dynamic visual representation of the data you're working with.
Therefore, the visual appearance of the map (which depends on the symbology of the individual layers) is very important. The end user of the maps you produce will need to be able to easily see what the map represents. Equally as important, you need to be able to explore the data as you're working with it, and good symbology helps a lot.

Changing color

To change a layer's symbology, open its **Layer Properties**. Let's begin by changing the color of the landuse layer.

- *Right-click on the landuse layer in the Layers list.*
- *Select the menu item Properties in the menu that appears.*

In the Properties window:

- *Select the Style tab at the extreme left:*
- *Click the color select button next to the Color label.*

A standard color dialog will appear.

- *Choose a any color and click OK.*
- *Click OK again in the Layer Properties window, and you will see the color change being applied to the layer.*

Scale Base Visibility

Sometimes you will find that a layer is not suitable for a given scale. For example, a dataset of all the structures may have low detail, and not be very accurately displayed they are overlapped. When that happens, you want to be able to hide the dataset at inappropriate scales. In our case, we may decide to hide the structures from view at small scales.

To enable scale-based rendering:

• *Open the Layer Properties dialog for the structures layer.*
• *Activate the General tab.*
• *Enable scale-based rendering by clicking on the checkbox labeled Scale dependent visibility:*
• *Change the Maximum value to 1:50,000.*
• *Click OK.*

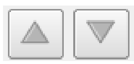
Test the effects of this by zooming in and out in your map, noting when the structure layer disappears and reappears.

Adding Symbol Layers

Now that you know how to change simple symbology for layers, the next step is to create more complex symbology. QGIS allows you to do this using symbol layers.

- *Go to the **reservoir** layer's symbol properties panel (by clicking Simple fill in the Symbol layers panel).*
- *Select the Fill in the Symbol layers panel.*
- *Then click the Add symbol layer button:* 
- *Click on it and there's a second symbol layer.*

Being a solid color, it will of course completely hide the previous kind of symbol. Plus, it has a Solid Line border style, which we don't want. Clearly this symbol has to be changed.
With the new Simple Fill layer selected:

- *Set the border style to No Pen, as before.*
- *Change the fill style to **Dense 7 and color white**.*
- *Click OK.*
- *Reorder the symbol fill styles by clicking button :* 
- *Now you can see your results and tweak them as needed.*

You can even add multiple extra symbol layers and create a kind of texture for your layer that way. When you're done, remember to save the symbol itself so as not to lose your work if you change the symbol again in the future.

You can save your current symbol style by clicking the ***Save Style*** ... button under the ***Style*** tab of the ***Layer Properties dialog***. Generally, you should save as ***QGIS Layer Style File***.

Save your style under ***PM_GIS/styles***. You can load a previously saved style at any time by clicking the ***Load Style*** ... button. Before you change a style, keep in mind that any unsaved style you are replacing will be lost.

Similarly we can add deferent symbology to point and line layer also.

In addition to setting fill colors and using predefined patterns, you can use different symbol layer types entirely. The only type we've been using up to now was the **Simple Fill** type. The more advanced symbol layer types allow you to ***customize*** your symbols even further. Each type of vector (point, line and polygon) has its own set of symbol layer types.

Please experiment with different ***symbol layer type*** of each type of layer (point, line and polygon)

USING THE QUERY BUILDER

The query builder tool enables you to find all map features that meet a certain criterion or criteria. For example, suppose you were working with a map of the area and wanted to find all reservoirs with area greater than some threshold value. The following is an outline of how to use the Query Builder tool:

- *Right click the layer for which you want to find map features, and select Open Attribute Table.*
- *In the toolbar click the* *. The Build Query dialogue box will appear.*
- *From the Fields Menu, choose the desired field by double clicking it.*
- *Choose the appropriate mathematical operation for your query.*
- *Click **Select** and then click show only selected features results box will appear and show how many matching features that meet the criterion will be displayed.*
- *Click OK*

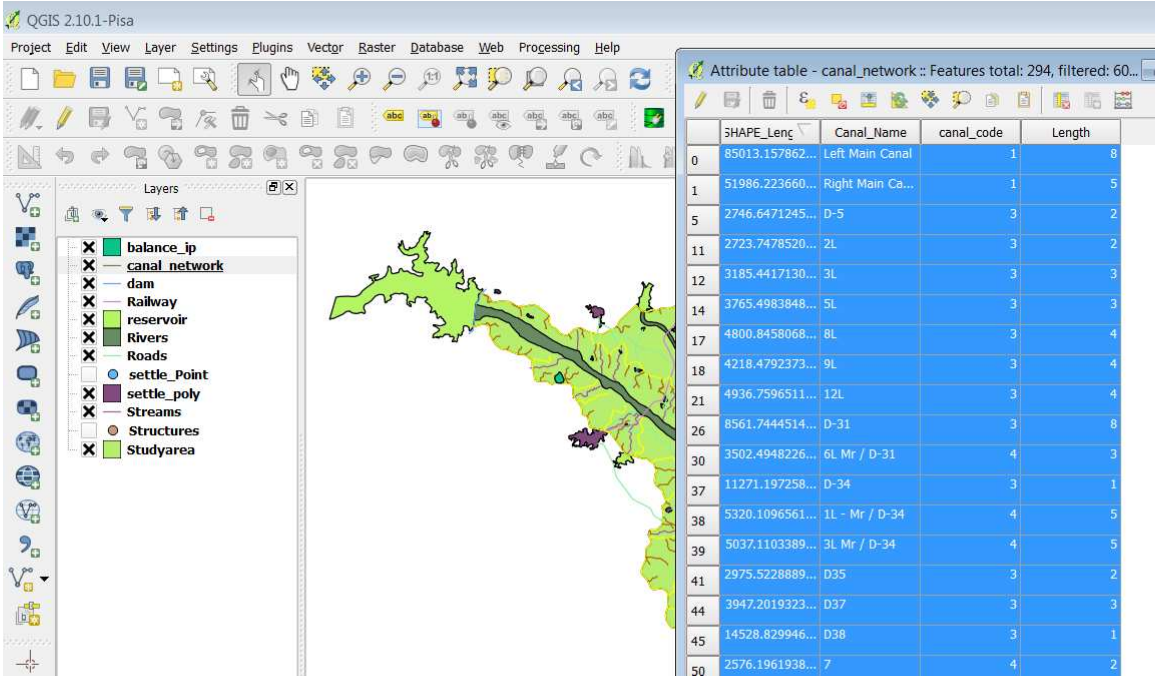
Build the following query using the Right Main Canal layer:

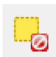
Length > 2500

Click Test and note there are 20 matching features (i.e. canals with a length more than 2.5 km). Similarly you can expand the query to:

Length < 5000 AND length >2500

Click Test and note there are some matching features (i.e. canals with a length more than 2.5 and less than 5 km). Click OK.



Click Show selected only (at the bottom of the attribute table) to easily distinguish which canal have been of that length. Look at the map to see the selected features and visualize the canals Make sure Labels are turned off at the full extent. After you've completed this step, you can clear the selected features  (this button is to the right of the Select single feature button).

In Qgis 2.10, query builder tool is also be used by ***selecting layer->open properties dialog->general Tab*** in there lower-right corner click **Query builder**. The **Fields list** contains all attribute columns of the attribute table to be searched. To add an attribute column to the SQL where clause field, double click its name in the Fields list. Generally you can use the various fields, values and operators to construct the query or you can just type it into the SQL box.

The **Values list** lists the values of an attribute table. To list all possible values of an attribute, select the attribute in the Fields list and click the **[all]** button. To list the first 25 unique values of an attribute column, select the attribute column in the Fields list and click the **[Sample]** button. To add a value to the SQL where clause field, double click its name in the Values list.

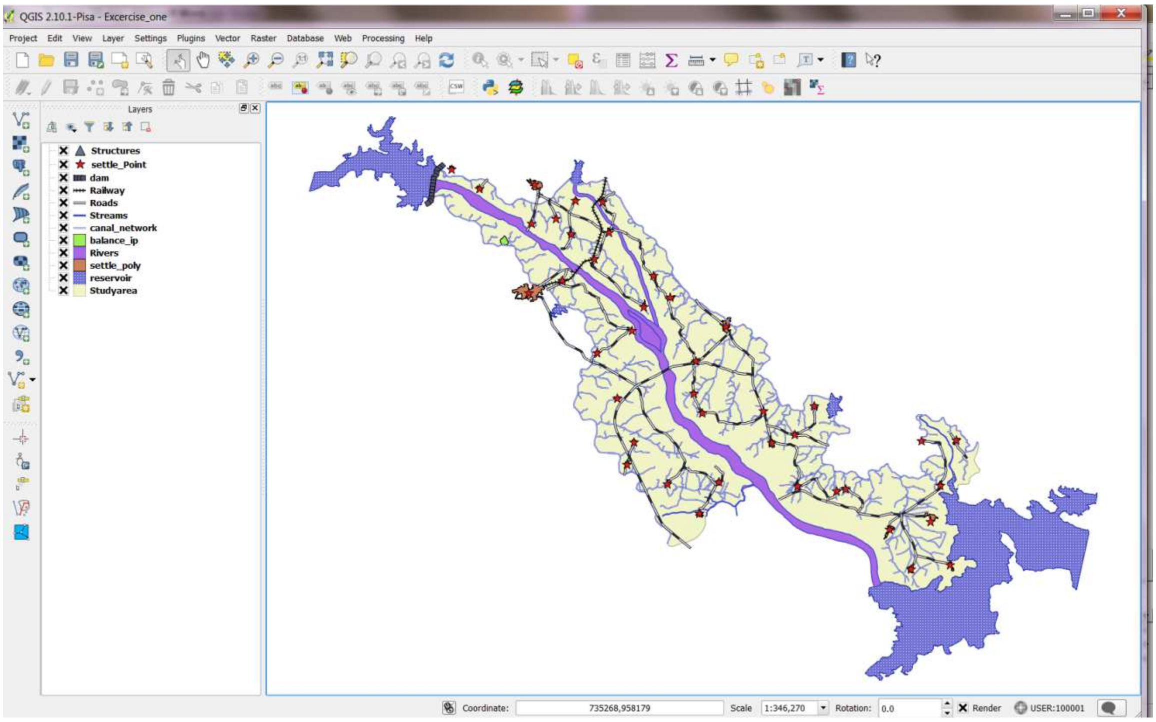
The **Operators section** contains all usable operators. To add an operator to the SQL where clause field, click the appropriate button. Relational operators (= , > , ...), string comparison operator (LIKE), logical operators (AND, OR, ...) are available.

The **[Test]** button shows a message box with the number of features satisfying the current query, which is usable in the process of query construction. The **[Clear]** button clears the text in the SQL where clause text field. The **[OK]** button closes the window and selects the features satisfying the query. The **[Cancel]** button closes the window without changing the current selection.

You can also save the selected/filtered feature in the new save file by just clicking right mouse button on layer and click ***Save Selection as*** button.

Exercise -1

Now look this map



All of you are requested, please make a group of two and try yourself to create a map similar to this map. Please ensure that.

1. Create new project and rename it **excersice-1**.
2. set the scale base visibility for structure for 1:50000 minimum
3. set the scale base visibility for stream for 1:100000 minimum
4. Once you have created the map please save it.
5. Also Save all the new style types used in the map

Please feel free to ask if you have any problem while creating this map.

Classifying vector data

Classifying vector data allows you to assign different symbols to features (different objects in the same layer), depending on their attributes. This allows someone who uses the map to easily see the attributes of various features.

Up to now, none of the changes we have made to the map have been influenced by the objects that are being shown. In other words, all the land use areas look alike, and all the roads, canals look alike. When looking at the map, the viewers don't know anything about the roads they are seeing; only that there is a road of a certain shape in a certain area.

But the whole strength of GIS is that all the objects that are visible on the map also have attributes. Maps in a GIS aren't just pictures. They represent not only objects in locations, but also information about those objects.

The label Tool

Labels can be added to a map to show any information about an object. Any vector layer can have labels associated with it. These labels rely on the attribute data of a layer for their content.

Before being able to access the Label tool, you will need to ensure that it has been activated.

- *Go to the menu item View→ Toolbars.*
- *Ensure that the Label item has a check mark next to it. If it doesn't, click on the Label item, and it will be activated.*
- *Click on the canals layer in the Layers list, so that it is highlighted.*
- *Click on the following toolbar button:* 

This gives you the Layer labeling settings dialog.

- *Check the box next to* ***Label this layer with****....*

You'll need to choose which field in the attributes will be used for the labels. In the previous lesson, you decided that the NAME field was the most suitable one for this purpose.

• Select canal_ name from the list:

• Click OK.

The map should now have canals with labels.

You can change the format like font style, size, case etc. by selecting ***text Tab.***
Now let's look at the problem of the labels overlapping the points, but before we do that, let's take a look at the Buffer option.

- *Open the Label tool dialog.*
- *Select Buffer from the left-hand options list.*
- *Select the checkbox next to Draw text buffer*
- *Then click apply*

You'll see that this adds a colored buffer or border to the place labels, making them easier to pick out on the map

Now we can address the positioning of the labels in relation to their point markers.

- *In the Label tool dialog, go to the Placement tab.*
- *Change the value of Distance to 2mm and make sure that Around point is selected****(in case of point layer):***

You can also set the scale dependent visibility by clicking ***Rendering Tab*** and set the minimum value to the desire scale.

Classification

Graduated Symbols:

Sometimes vector features represent things with a changing numerical value. Contour lines area good example of this. Each contour usually has an attribute value called 'height' that contains information about what height that contour represents. Adding colour to the contours can help us to interpret the meanings of contours. For example we can draw low lying areas with one colour, mid-altitude areas Setting colours based on discrete groups of attribute values is called Graduated Symbology in QGIS. **Graduated symbols are most useful when you want to show clear differences between features with attribute values in different value ranges**.

This allows you to symbolize features based on a number of classes. Each class is composed of a range of values. The field used to render the features must be numeric

Continuous Colour Symbols

Graduated Colour symbols can draw features in discrete groups or classes. Sometimes it is useful to draw features in a **colour range** from one colour to another. The GIS Application will use a numerical attribute value from a feature (e.g. contour heights or pollution levels in a stream) to decide which colour to use.

This allows you to render the features based on the value of a field, starting with a color for the minimum value and ending with a color for the maximum value. The field used to classify the data must be numeric.

Unique Value

This renderer displays all features of the same type in the same color. You can use any field in the attribute table as the classification field. For each unique value, you must set the color and fill style, or accept the random defaults assigned by QGIS.
Now we will classify the canals network layer according to its type

- *Open the Layer Properties dialog for the canals layer.*
- *Go to the Style tab.*
- *Click on the dropdown that says **Single Symbol** and change it to **Categorized**:*
- *In the new panel, change the Column to **canal_type** and the Color ramp to **Blues**.*
- *Click the button labeled **Classify**:*
- *Click OK.*

You will see the color changed according to their type. The empty category is used to color any objects which have a NULL value. It is important to keep this empty category so that canal type with a NULL value is still represented on the map. You may like to change the color to more obviously represent a blank or NULL value.

Now we will use ratio classification to classify the **Reservoir** by area.

- *Save your reservoir symbology (if you want to keep it) by clicking on the Save Style ... button in the Style dialog.*
- *Close the Style dialog.*
- *Open the Attributes Table for the reservoir layer by clicking:*

We want to classify the reservoir areas by size, but there's a problem: they don't have a size field, so we'll have to make one.

- *Enter edit mode by clicking this button:*
- *Add a new column with this button:*
- *Create new field **AREA** with data type **double Real** and set **length 10** and **precision 4.***
- *Click OK.*

The new field will be added (at the far right of the table; you may need to scroll horizontally to see it). However, at the moment it is not populated, it just has a lot of NULL values.

To solve this problem, we'll need to calculate the areas.

- *Open the field calculator by clicking:*
- *Change the values at the top of the dialog to look like this:*
- *In the Function List, select **Geometry→ $area**:*
- *Double-click on it so that it appears in the Expression field.*
- *Click OK.*

Now your AREA field is populated with values (you may need to click the column header to refresh the data). Save the edits and click Ok.

- *Open the **Layer properties dialog's Style tab**.*
- *Change the classification style from Categorized to **Graduated**.*
- *Change the Column to **AREA**:*
- *Under Color ramp, choose the option **New color ramp...** to get a dialog*
- *Choose Gradient (if it's not selected already) and click OK.*

You'll be using this to denote area, with small areas as Color 1 and large areas as Color 2.

- *Choose appropriate colors.*
- *Click OK.*
- *Choose a suitable name for the new color ramp.*
- *Click OK after filling in the name.*

Check the map how its look.

It's often useful to combine multiple criteria for a classification, but unfortunately normal classification only takes one attribute into account. That's where rule-based classification comes in handy. In following activity, we will only make the color of main canal (RMC and LMC) different and dominant (**dark Blue**) with other type of canals in the canals network layer

- *First of all convert the layer simbology to Single Symbol then*
- *Open the Layer Properties dialog for the canals network layer.*
- *Switch to the Style tab.*
- *Switch the classification style to Rule-based.*
- *Click the Add rule button:* 
- *A new dialog then appears.*
- *Click the ellipsis ... button next to the Filter text area.*
- *Using the query builder that appears, enter the criterion "canal_type" = 'main'*
- *click Ok and choose a Bark blue-grey for it*
- *No filter layer to red color.*
- *Apply this symbology.*

Now you have a map with main canal (RMC and LMC) the most prominent with other type of canal.

Symbology allows us to represent the attributes of a layer in an easy-to-read way. It allows us as well as the map reader to understand the significance of features, using any relevant attributes that we choose. Depending on the problems you face, you'll apply different classification techniques to solve them.

<u>Using Map Composer (printing)</u>

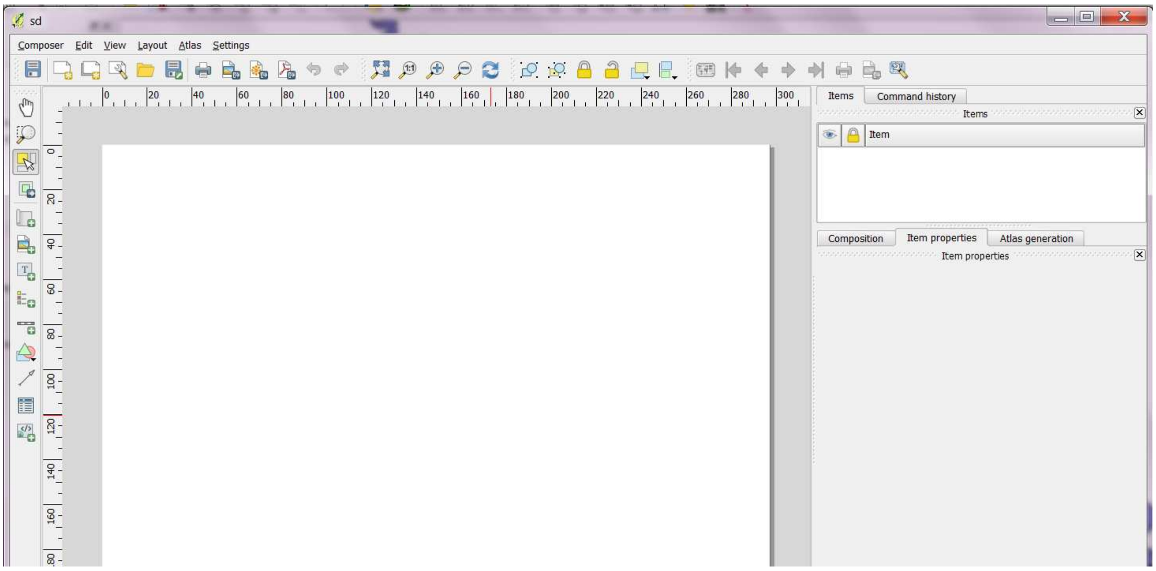
Now that you've got a map, you need to be able to print it or to export it to a document. The reason is, a GIS map file is not an image. The purpose of this topic is to demonstrate how to use QGIS to print basic maps in landscape format containing a theme list (legend), the map scale, a title, and a north arrow, as well as save a map as a .jpg, .qpt or a .pdf file.

QGIS allows you to create multiple maps using the same map file. For this reason, it has a tool called the Composer Manager.

- *Click on the **Project → Composer Manager** menu entry to open this tool. You shall see a blank Composer manager dialog appear.*
- *Click the Add button and give the new composer the name of **Jurala**.*
- *Click OK.*

- *Click the Show button.*

You could also close the dialog and navigate to a composer via the ***File → Print Composers*** menus. Now you will now see the Print Composer window:



In this example, the composition was already the way we wanted it. Ensure that yours is as well.

- *In the Print Composer window, check that the values under Composition → Paper and Quality are set to the following:*
- *Size: A4 (210x297mm)*
- *Orientation: Landscape*
- *Quality: 300dpi*

Now you've got the page layout the way you wanted it, but this page is still blank. It clearly lacks a map. Let's fix that!

- *Click on the Add New Map button:* 

With this tool activated, you'll be able to place a map on the page.

- *Click and drag a box on the blank page*

The map will appear on the page.

- *Move the map by clicking and dragging it around:*

Resize it by clicking and dragging the boxes in the corners
Be sure to leave margins along the edges, and a space along the top for the title.

Zoom in and out on the page (but not the map!) by using these buttons:
Zoom and pan the map in the main QGIS window. You can also pan the map using the ***Move item content***: 

When zooming in, the map view will not refresh by itself. This is so that it doesn't waste your time redrawing the map while you're zooming the page to where you want it, but it also means that if you zoom in or out, the map will be at the wrong resolution and will look ugly or unreadable.

- *Force the map to refresh by clicking this button:* 

Remember that the size and position you've given the map doesn't need to be final. You can always come back and change it later if you're not satisfied. For now, you need to ensure that you've saved your work on this map.

Because a Composer in QGIS is part of the main map file, you'll need to save your main project. Go to the main QGIS window (the one with the Layers list and all the other familiar elements you were working with before), and save your project from there as usual.

Now your map is looking good on the page, but your readers/users are not being told what's going on yet. They need some context, which is what you'll provide for them by adding map elements. First, let's add a title.

- *Click on this button:* 
- *Click on the page, above the map, and a label will appear at the top of the map.*
- *Resize it and place it in the top center of the page. It can be resized and moved in the same way that you resized and moved the map.*

As you move the title, you'll notice that guidelines appear to help you position the title in the center of the page. However, there is also a tool to help position the title relative to the map (not the page):  (align button)

- *Click the map to select it.*
- *Hold in shift on your keyboard and click on the label so that both the map and the label are selected.*
- *Look for the Align button and click on the dropdown arrow next to it to reveal the positioning options and click Align center*

To make sure that you don't accidentally move these elements around now that you've aligned them

- *Right-click on both the map and the label.*

A small lock icon will appear in the corner to tell you that an element can't be dragged right now. You can always right-click on an element again to unlock it, though. Now the label is centered to the map, but not the contents. To center the contents of the label

- *Select the label by clicking on it.*
- *Click on the Item Properties tab in the side panel of the Composer window.*
- *Change the text of the label to "**JURALA COMMAND AREA**":*

- *Use this interface to set the font and alignment options*
- *Choose a large but sensible font (the example will use the default font with a size of 36) and set the Horizontal Alignment to Center.*

You can also change the font color, but it's probably best to keep it black as per the default.
The default setting is not to add a frame to the title's text box. However, if you wish to add a frame, you can do so:

- *In the Item Properties tab, scroll down until you see the Frame option.*
- *Click the Frame checkbox to enable the frame. You can also change the frame's color and width.*

The map reader also needs to be able to see what various things on the map actually mean. In some cases, like the place names, this is quite obvious. In other cases, it's more difficult to guess, like the colors of the farms. Let's add a new ***legend.***

- *Click on this button:* 
- *Click on the page to place the legend, and move it to where you want it:*

Not everything on the legend is necessary, so let's remove some unwanted items.

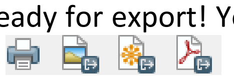
- *In the Item Properties tab, you'll find the Legend items panel.*
- *Select the **studyarea** entry.*
- *Delete it from the legend by clicking the minus button*

You can also rename items.

- *Select a layer from the same list.*
- *Click the Edit button:* 
- *Rename the layers to settle_pint, Roads and Streets, Structures, and Rivers.*
- *Set **Structures** to Hidden, then click the down arrow and edit each category to name them on the legend.*

You can also reorder the items. As the legend will likely be widened by the new layer names, you may wish to move and resize the legend and or map.

Scale of map may also be add by clicking buton: 

Finally the map is ready for export! You'll see the export buttons near the top left corner of the Composer window: 
The button on the left is the Print button, which interfaces with a printer. Since the printer options will differ depending on the model of printer that you're working with, it's probably better to see the printer manual

The other three buttons allow you to export the map page to a file. There are three export formats to choose from:

- *Export as Image*
- *Export as SVG*
- *Export as PDF*

Exporting as an image will give you a selection of various common image formats to choose from. This is probably the simplest option, but the image it creates is “dead” and difficult to edit. The other two options are more common. If you’re sending the map to a cartographer (who may want to edit the map for publication), it’s best to export as an SVG. SVG stands for “Scalable Vector Graphic”, and can be imported to programs like Inkscape or other vector image editing software. If you need to send the map to a client, it’s most common to use a PDF, because it’s easier to set up printing options for a PDF. Some cartographers may prefer PDF as well, if they have a program that allows them to import and edit this format.

For our purposes, we’re going to use PDF.

- Click the Export as PDF button: 
- Choose a save location and a file name as usual.
- Click Save.

EXERCISE – 2

Now it is time of your second exercise for creating a map consists of various features with suitable symbology, labels, classifications etc and using Map composer, export your map into PDF format.

Please look this Exported PDF on the screen. You how close you all can reach this output: Further, it is not binding that u create you map according to the symbologies used in this map. Use your thought process.

Means I am to say that While customizing your map, keep asking yourself questions. Is this map easy to read and understand for someone who’s unfamiliar with the data? If I saw this map on the Internet, or on a poster, or in a magazine, would it capture my attention? Would I want to read this map if it wasn’t mine?

Remember that the appearance of maps will always be ease of use. The nicer the map is to look at and the easier it is to understand at a glance, the better.

Please note that please try to include following aspect of Qgis.

1. **Enable the labels for settlement, river, canal_network, reservoir layer with suitable font, size, placement etc.**
2. **Classify and symbolize the canal_network layers according to the type of canal.**
3. **Classify and symbolize the Structure layers according to the type of structure.**
4. **Using MAP composer, create a map of 1:70000 scale and A0 size paper size with suitable titles and details, border, scale bar, and Legend.**
5. **Export the map into PDF file jurala_map.pdf**

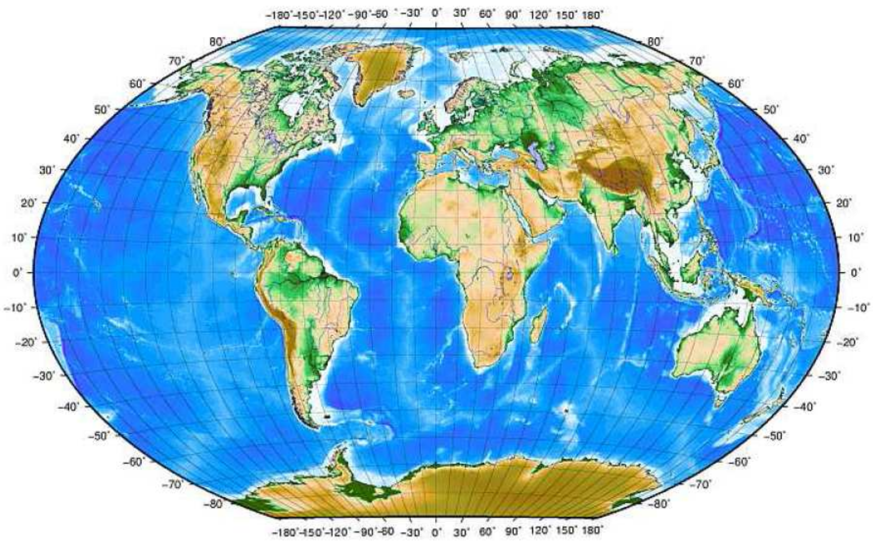
Map Projections

Coordinate reference system (CRS)

You have learnt about shape files which contain vector data in form of spatial data as well as attribute date of specific geographical feature of earth. The data that you use has to come from somewhere. For most common applications, the data exists already; but the more particular and specialized the project, the less likely it is that the data will already be available. In such cases, you'll need to create your own new data. But before going on creating new data set (shape file) let's discuss about the Map projections and world Coordinate reference system

Geographic Coordinate Systems

The use of Geographic Coordinate Reference Systems is very common. They use degrees of latitude and longitude and sometimes also a height value to describe a location on the earth's surface.



Lines of latitude run parallel to the equator and divide the earth into 180 equally spaced sections from North to South (or South to North). The reference line for latitude is the equator and each **hemisphere** is divided into ninety sections, each representing one degree of latitude. In the northern hemisphere, degrees of latitude are measured from zero at the equator to ninety at the North Pole. In the southern hemisphere, degrees of latitude are measured from zero at the equator to ninety degrees at the South Pole. To simplify the digitization of maps, degrees of latitude in the southern hemisphere are often assigned negative values (0 to -90◦). Wherever you are on the earth's surface, the distance between the lines of latitude is the same (60 nautical miles).
Lines of longitude, on the other hand, do not stand up so well to the standard of uniformity. Lines of longitude run perpendicular to the equator and converge at the poles. The reference line for longitude (the prime meridian) runs from the North pole to the South pole through Greenwich, England. Subsequent lines of longitude are measured from zero to 180 degrees East or West of the prime meridian. Note that values West of the prime meridian are assigned negative values for use in digital mapping applications.

Rectangular coordinate system
Most of the spatial data available by means of remote sensing system or any other sources of data for the use in GIS are in two-dimensional form. This coordinate reference system to locate any object point is called rectangular coordinate system.

In order to determine the true earth locations of these (remote sensing data or any other sources data) digitized entities, it is necessary to devise a mathematical transformation formula to covert these rectangular coordinates/map units into the positions (latitude and longitude) on the curved surface of earth as represented on map.

Map projections

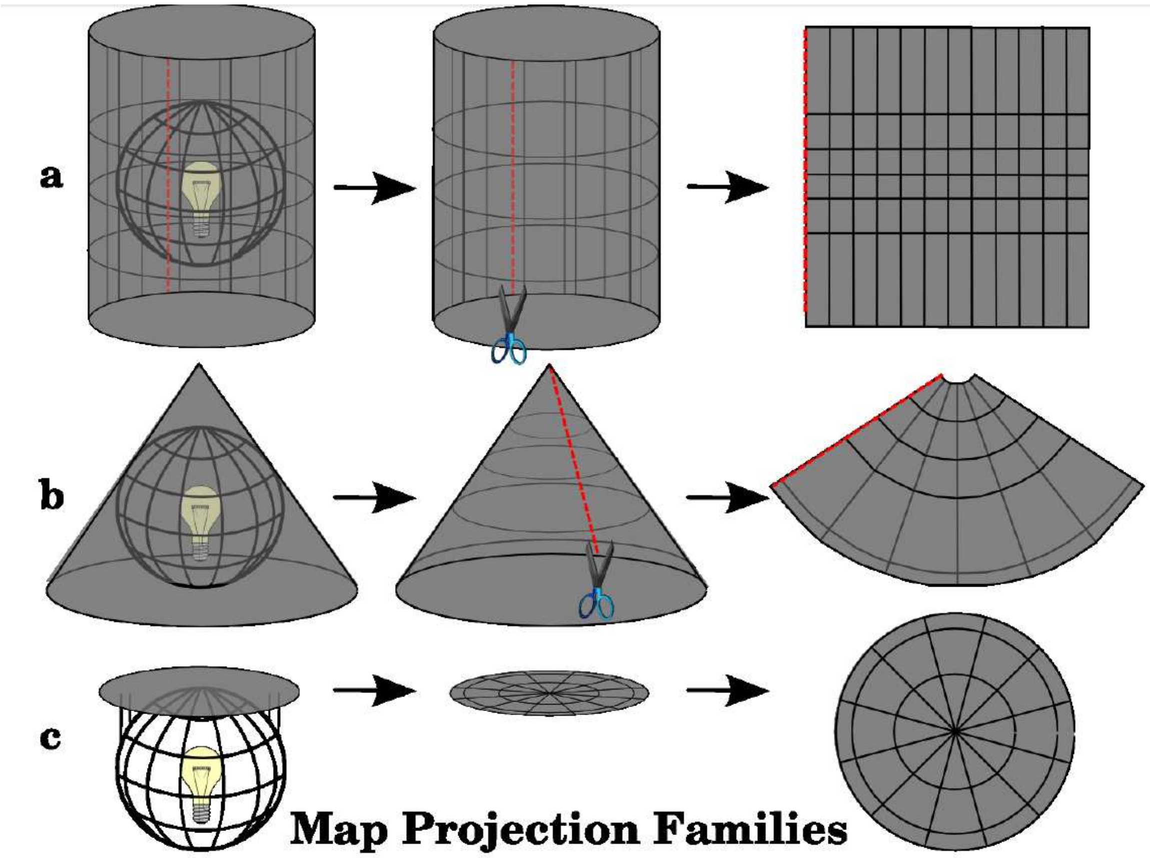
It is to portray the surface of the earth or a portion of the earth on a flat piece of paper or computer screen. To transfer the image of the earth and its irregularities on the plane surface of a map or computer screen, three factors are involved, namely, a geoid, an ellipsoid or a datum with ellipsoid and a projection.

Geoid is a irregular spheroidal shape which representation of the surface of the **earth** that it would assume if the sea covered the **earth**, also known as surface of equal gravitational potential.

ellipsoid the observations made on the geoid are then transferred to a hypothetical regular geometric reference surface for the mathematical computations of geodetic data reduction, also called 'Geodetic Datum' or 'Map datum'. The accuracy of such computations and mapping is directly affected by the suitability of the datum used. Several hundred local geodetic datums are in use in different parts of the world, and many of these have been / are being redefined to meet the ever-increasing accuracy requirements. The GPS yields positions of survey points on a global reference surface called ***World Geodetic Sysetm 84 (WGS 84).*** It is most popular geometric reference surface system. This geodetic datum is geocentric, and defined to high accuracy by the Defense Mapping Agency, USA (DMA). In order to correlate the coordinates obtained by using GPS, on this datum, to the coordinates of the point on Survey of India topographical maps, the relationship between the WGS 84 and Indian map datum must be defined.

Map Projection

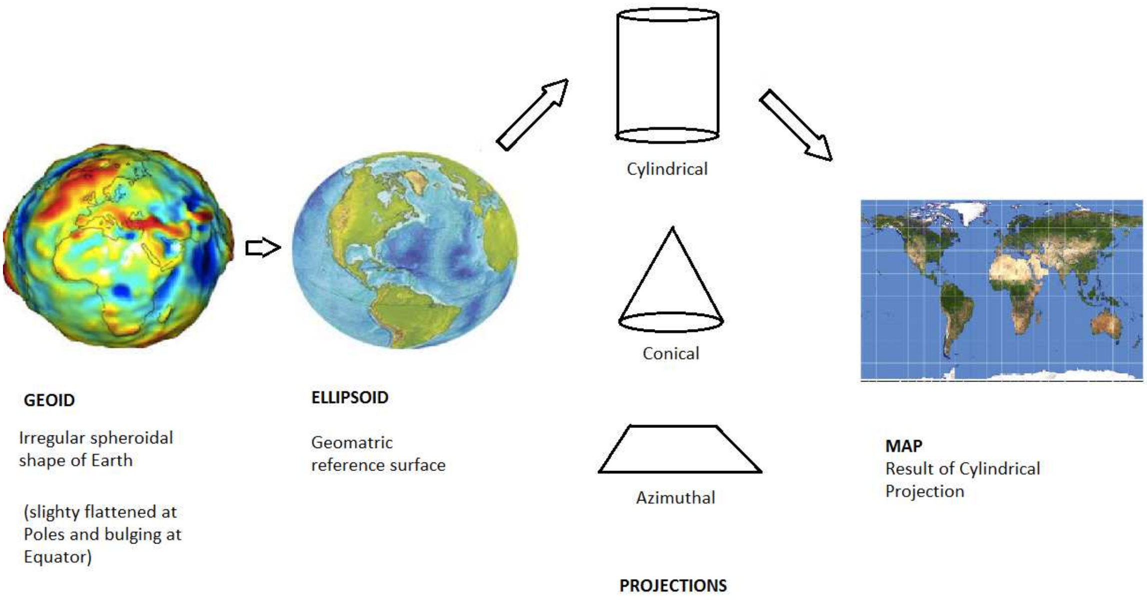
The process of creating map projections can be visualized by positioning a light source inside a transparent globe on which opaque earth features are placed. Then project the feature outlines onto a two-dimensional flat piece of paper. Different ways of projecting can be produced by surrounding the globe in a ***cylindrical*** fashion, as a **cone**, or even as a **flat surface**. Each of these methods produces what is called a map ***projection family***. Therefore, there is a family of **planar projections**, a family of ***cylindrical projections***, and another called **conical projections**



a) Cylindrical projection b) conical projection c) planer projection

Each map projection has **advantages** and **disadvantages**. The best projection for a map depends on the scale of the map, and on the purposes for which it will be used. For example, a projection may have unacceptable distortions if used to map the entire African continent, but may be an excellent choice for a **large-scale (detailed) map** of your country. The properties of a map projection may also influence some of the design features of the map. Some projections are good for small areas, some are good for mapping areas with a large East-West extent, and some are better for mapping areas with a large North-South extent. Map projections are never absolutely accurate representations of the spherical earth. As a result of the map projection process, every map shows **distortions of angular conformity, distance and area**. A map

projection may combine several of these characteristics, or may be a compromise that distorts all the properties of area, distance and angular conformity, within some acceptable limit.
It is usually impossible to preserve all characteristics at the same time in a map projection. This means that when you want to carry out accurate analytical operations, you need to use a map projection that provides the best characteristics for your analyses. For example, if you need to measure distances on your map, you should try to use a map projection for your data that provides high accuracy for distances.



Angular conformal or orthomorphic projection: The projections that retains the property of maintaining correct angular correspondence (i.e East will always occur at a 90 degree angle to North). These projections are used when the **preservation of angular relationships** is important. They are commonly used for navigational or meteorological tasks. It is important to remember that maintaining true angles on a map is difficult for large areas and should be attempted only for small portions of the earth. The conformal type of projection results in distortions of areas, meaning that if area measurements are made on the map, they will be incorrect. The larger the area the less accurate the area measurements will be. Examples are ***UTM*** and ***lalmbert comformal conic projection.***

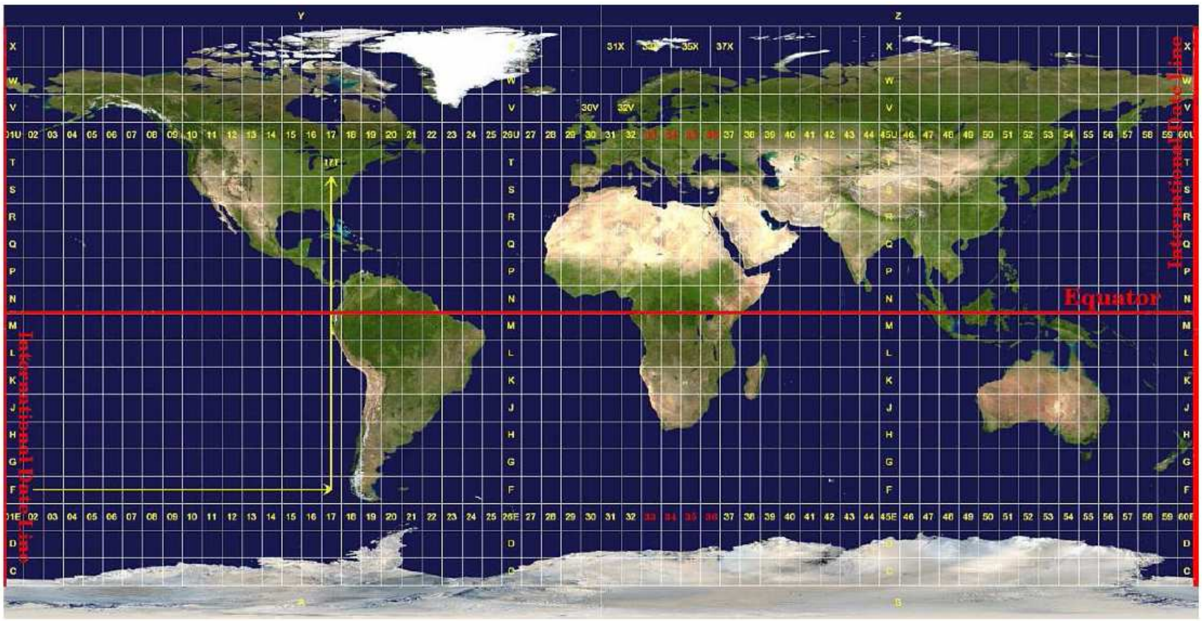
Equidistant projections: The projections by which the distances are preserved are known as equidistance projection. It maintains accurate distances from the centre of the projection or along given lines. These projections are used for radio and seismic mapping, and for navigation.

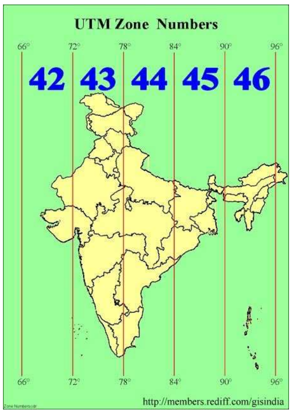
Equal area projections: When a map portrays areas over the entire map, so that all mapped areas have the same proportional relationship to the areas on the Earth that they represent, the map is an **equal area map**. These maps are best used when calculations of area are the dominant calculations you will perform. If, for example, you are trying to analyse a particular area in your town to find out whether it is large enough for a new shopping mall, equal area projections are the best choice. an equal area projection results in **distortions of angular conformity** when dealing with large areas.

Keep in mind that map projection is a very complex topic. There are hundreds of different projections available worldwide each trying to portray a certain portion of the earth's surface as faithfully as possible on a flat piece of paper. In reality, the choice of which projection to use, will often be made for you. Most countries have commonly used projections and when data is exchanged people will follow the national trend. The National Spatial Framework for India uses Datum WGS84 with a LCC projection and is a recommended NNRMS standard. Each state has its own set of reference parameters given in the standard.

Universal Transverse Mercator (UTM) CRS in detail

The Mercator projection is a typical cylindrical projection with the equator tangent to the cylinder. The Universal Transverse Mercator (UTM) is also an internationally popular map projection. The Universal Transverse Mercator (UTM) coordinate reference system has its origin on the **equator** at a specific **Longitude**. Now the Y-values increase Southwards and the X-values increase to the West. The UTM CRS is a global map projection. This means, it is generally used all over the world. But as already described in the section 'accuracy of map projections' above, the larger the area (for example South Africa) the more distortion of angular conformity, distance and area occur. To avoid too much distortion, the world is divided into **60 equal zones** that are all **6 degrees** wide in longitude from East to West. The **UTM zones** are numbered **1 to 60**, starting at the **International Date Line** (**zone 1** at 180 degrees West longitude) and progressing East back to the **International Date Line** (**zone 60** at 180 degrees East longitude)





As you can see in above two Figures, INDIA is covered by six **UTM zones** to minimize distortion. The **zones** are called **UTM 42N, UTM 43N, UTM 44N,UTM 45N,UTM 46N and small area in UTM47N**. The **N** after the zone means that the UTM zones are located **North of the equator** and **S** for UTM zones are located **south of the equator.**

The position of a coordinate in UTM south of the equator must be indicated with the **zone number** (44) and with its ***northing (y) value*** and ***easting (x) value*** in meters. The **northing value** is the distance of the position from the **equator** in meters toward north. The **easting value** is the distance from the **central meridian** (longitude) of the used UTM zone toward east. The ***northing*** (y) value and easting (x) value is taken negative for south of equators and west of **central meridian.** However, in the UTM coordinate reference system, negative values are not allowed therefore, we have to add a so called **false northing value** of 10,000,000m to the northing (y) value and a false easting value of 500,000m to the easting (x) value.

This sounds difficult, so, we will do an example that shows you how to find the correct **UTM 35S** coordinate for the **Area of Interest in South Africa**.

The northing (y) value
The place we are looking for is 3,550,000 meters south of the equator, so the northing (y) value gets a **negative sign** and is -3,550,000m. According to the UTM definitions we have to add a **false northing value** of 10,000,000m. This means the northing (y) value of our coordinate is 6,450,000m (-3,550,000m + 10,000,000m).

The easting (x) value
The place we are looking for is **85,000 meters West** from the central meridian. Just like the northing value, the easting (x) value gets a negative sign, giving a result of **-85,000m**. According to the UTM definitions we have to add a **false easting value** of 500,000m. This means the easting (x) value of our coordinate is 415,000m (-85,000m + 500,000m). Finally, we have to add the **zone number** to the easting value to get the correct value. As a result, the coordinate for our **Point of Interest**, projected in **UTM zone 35S** would be written as: **35 415,000mE / 6,450,000mN**. In some GIS, when the correct UTM zone 35S is defined and the units are set to meters within the system, the coordinate could also simply appear as **415,000 6,450,000**.

Reprojecting and Transforming Data
Let us understand How to reproject and transforming data into Quantum GIS:

The CRS that all the data as well as the map itself are in right now is called WGS84. This is a very common Geographic Coordinate System (GCS) for representing data. But there's a problem, as we will see.

- *Save your current map.*
- *Then open the map of the world which you'll find under exercise_data/world/world.qgs.*
- *Zoom in to INDIA by using the Zoom in tool.*
- *Try setting a scale in the Scale field, which is in the Status Bar along the bottom of the screen. While over South Africa, set this value to 1:25000000 (one to twenty five million).*
- *Pan around the map while keeping an eye on the Scale field.*

Notice the scale changing? That's because you're moving away from the one point that you zoomed into at 1:25000000, which was at the center of your screen. All around that point, the scale is different. To understand why, think about a globe of the Earth. It has lines running along it from North to South. These longitude lines are far apart at the equator, but they meet at the poles In a GCS, you're working on this sphere, but your screen is flat. When you try to represent the sphere on a flat surface, distortion occurs. What this means on a map is that the longitude lines stay equally far apart from each other, even at the poles (where they are supposed to meet). This means that, as you travel away from the equator on your map, the scale of the objects that you see gets larger and larger. What this means for us, practically, is that there is no constant scale on our map!

To solve this, let's use a Projected Coordinate System (PCS) instead. A PCS "projects" or converts the data in away that makes allowance for the scale change and corrects it. Therefore, to keep the scale constant, we should reproject our data to use a PCS.

"On the FLY" Re-projection

As you can probably imagine, there might be a situation where the data you want to use in a GIS are projected in different coordinate reference systems. For example, you might get a vector layer showing the boundaries of South Africa projected in UTM 35S and another vector layer with point information about rainfall provided in the geographic coordinate system WGS 84. In GIS these two vector layers are placed in totally different areas of the map window, because they have different projections.

To solve this problem, many GIS include a functionality called **On-the-fly** projection. It means, that you can **define** a certain projection when you start the GIS and all layers that you then load, no matter what coordinate reference system they have, will be automatically displayed in the projection you defined. This functionality allows you to overlay layers within the map window of your GIS, even though they may be in **different** reference systems.

To enable "on the fly" projection, click on the CRS Status button in the Status Bar along the bottom of the QGIS window: 

- *In the dialog that appears, check the box next to Enable 'on the fly' CRS transformation.*
- *Type the word global into the Filter field. One CRS (NSIDC EASE-Grid Global) should appear in the list below.*
- *Click on the NSIDC EASE-Grid Global to select it, then click OK.*
- *Notice how the shape of South Africa changes. All projections work by changing the apparent shapes of objects on Earth.*
- *Zoom in to a scale of 1:25000000 again, as before.*
- *Pan around the map.*

Notice the scale stays the same this time

"On the fly" reprojection is also used for combining datasets that are in different CRSs.
Deactivate "on the fly" re-projection again:

- *Click on the CRS Status button again.*
- *Un-check the Enable 'on the fly' CRS transformation box.*
- *Clicking OK.*

In QGIS 2.0 onward, the 'on the fly' reprojection is automatically activated when layers with different CRSs are loaded in the map. To understand what 'on the fly' reprojection does, deactivate this automatic setting:

- *Go to Settings→Options...*
- *On the left panel of the dialog, select CRS.*
- *Un-check Automatically enable 'on the fly' reprojection if layers have different CRS.*
- *Click OK.*
- *Add another vector layer to your map which has the data for South Africa only. You'll find it as exercise_data/world/RSA.shp.*

What do you notice?
The layer isn't visible! But that's easy to fix, right?

- *Right-click on the RSA layer in the Layers list.*
- *Select Zoom to Layer Extent.*

OK, so now we see South Africa... but where is the rest of the world?
It turns out that we can zoom between these two layers, but we can't ever see them at the same time. That's because their Coordinate Reference Systems are so different. The continents dataset is in degrees, but the RSA dataset is in meters. So, let's say that a given point in Cape

Town in the RSA dataset is about 4100 000 meters away from the equator. But in the continents dataset, that same point is about 33.9 degrees away from the equator.
This is the same distance - but QGIS doesn't know that. You haven't told it to reproject the data.

To correct this:

- *Click on the CRS Status button again and switch Enable 'on the fly' CRS transformation on again as before.*
- *Zoom to the extents of the RSA dataset.*

Now, because they're made to project in the same CRS, the two datasets fit perfectly:
When combining data from different sources, it's important to remember that they might not be in the same CRS. "On the fly" reprojection helps you to display them together.

Before you go on , you probably want to have the 'on the fly' reprojection to be automatically activated whenever you open datasets having different CRS:

- *Open again **Settings→Options**... and select CRS.*
- *Activate Automatically enable **'on the fly'** reprojection if layers have different CRS*.

Digitization (Creating New Data Set)

In the previous two topics we looked at vector data, but how these vector data are created. The process for creating a new data set is called digitization. Digitizing is one of the most common task that a GIS specialist has t o perform. Often a large amour if GIS time is spent in digitization to create vector layers.

We saw that there are two key concepts to vector data, namely: **geometry** and **attributes**. The geometry of a vector feature describes its **shape** and **position**, while the **attributes** of a vector feature describe its **properties** (colour, size, age etc.). In this section we will look more closely at the process of creating and editing vector data - both the geometry and attributes of vector features.

GIS Applications can store their data in files on the computer hard disk. There are a number of different file formats for GIS data, but the most common one is probably
the 'shape file'. it actually consists of at least three different files that work together to store your digital vector data,

Extension	Description
.shp	The geometry of vector features are stored in this file.
.dbf	The attributes of vector features are stored in this file.
.shx	This file is an index that helps the GIS Application to find featu morequickly.

Many GIS Applications are also able to store digital data inside a **database**. In general storing GIS data in a database is a good solution because the database can store **large amounts** of data **efficiently** and can provide data to the GIS Application quickly. Using a database also allows many people to work with the same vector data layers at the same time. Setting up a database to store GIS data is more complicated than using shapefiles, so for this topic we will focus on creating and editing shapefiles.

Before you can add new vector data, you need a vector dataset to add it to. In our case, you'll begin by creating new data entirely, rather than editing an existing dataset. Therefore, you'll need to define your own new dataset first.

- *You'll need to open the New Vector Layer dialog that will allow you to define a new layer.*
- *Navigate to and click on the New Shapefile Layer button:*  *.*

Before you can create a new vector layer (which will be stored in a shapefile), you need know what the geometry of that layer will be (point, polyline or polygon),

Points layer is generally used if we wanted to mark specific location, like school, hospital, bus stands, mall, drainage structure, bridge etc. however, it is also depend of the scale of map. For example, for small scale map best way to mark a city is point but for very large scale map polygon layer is used to mark the area of city.
Polylines layer is used to mark the road, track, route, canal, river, stream, air way etc
Polygon layer is used to mark the area like forest area, reservoirs, landuse etc.

It's important to decide which kind of dataset you want at this stage. so once you've created the layer, you can't change its type.

- *Click on the Polygon radio button*

The next field allows you to specify the Coordinate Reference System, or CRS. A CRS specifies how to describe a point on Earth in terms of coordinates, and because there are many different ways to do this, there are many different CRSs. The CRS of this project is WGS84:

Next there is a collection of fields grouped under New attribute. As you know attributes defines the properties of a geographical feature like name, length, area, color, type etc. Deciding which attributes and symbology to use requires some planning. Before you start collecting any **GeoSpatial** data, you should ensure you know what attributes are needed and how it will be symbolised. It is very difficult to go back and re-collect data if you plan poorly the first time around. Remember also that the goal of collecting attribute data is to allow you to analyse and interpret spatial information.

By default, a new layer has only one attribute, the id field (which you should see in the Attributes list) below. However, in order for the data you create to be useful, you actually need to say something about the features you'll be creating in this new layer. For our current purposes, it will be enough to add one field called name.

- *click the **Add to attributes list** button*
- *Click OK. A save dialog will appear.*
- *Navigate to the **New_vector_data**(if not there, please create) directory.*
- *Save your new layer as **New_reservoir.shp**.*
- *The new layer should appear in your Layers list.*

When you create new data, it obviously has to be about objects that really exist on the ground. Therefore, you'll need to get your information from somewhere. There are many different ways to obtain data about objects. For example, you could use a GPS to capture points in the real world, then import the data into QGIS afterwards. Or you could survey points using a theodolite, and enter the coordinates manually to create new features. Or you could use the digitizing process to trace objects from remote sensing data, such as satellite imagery or aerial photography.

If you are digitising using a backdrop raster layer such as an aerial photograph or satellite image, it is very important that the raster layer is properly georeferenced. A layer that is georeferenced properly displays in the correct position in the map view based on the GIS Application's internal model of the earth. How to georeference a satellite image, will be discuss later.

A sample georeferenced raster datasets are provided, so you'll need to import them as necessary.

Please make sure **'on the fly'** option is checked (project properties)

- *Click on the Add Raster Layer button:* 
- *Navigate to **Rater_data_geo_referenced** Folder.*
- *Select the file **PM_Jurala_3875.tif**.*
- *Click Open. An image will load into your map.*
- *Find the new image in the Layers list.*
- *Click and drag it to the bottom of the list so that you can still see your other layers.*
- *Find and zoom to this area*

In order to begin digitizing, you'll need to enter edit mode. Edit mode is switched on or off individually for each layer.

- *To enter edit mode for the **New_reservoir** layer:*
- *Click on the layer in the Layer list to select it. (Make very sure that the correct layer is selected, otherwise you'll edit the wrong layer!)*
- *Click on the Toggle Editing button:* 

If you can't find this button, check that the Digitizing toolbar is enabled. There should be a check mark next to the **View→Toolbars →Digitizing** menu entry.

As soon as you are in edit mode, you'll see the digitizing tools are now active:

These are:

Toggle Edit Button

Save Edits*: saves changes made to the layer.*

Add Feature*: start digitizing a new feature.*

Move Feature(s): *move an entire feature around.*

Node Tool: *move only one part of a feature.*

Delete Selected*: delete the selected feature.*

Cut Features: *cut the selected feature.*

Copy Features*: copy the selected feature.*

Paste Features*: paste a cut or copied feature back into the map.*

You want to add a new feature.

- *Click on the Add Feature button now to begin digitizing our school fields.*

You'll notice that your mouse cursor has become a crosshair. This allows you to more accurately place the points you'll be digitizing. Remember that even as you're using the digitizing tool, you can zoom in and out on your map by rolling the mouse wheel, and you can pan around by holding down the mouse wheel and dragging around in the map.

- *The first feature you'll be digitizing is the reservoir at top left corner*
- *Start digitizing by clicking on a point somewhere along the edge of the field.*
- *Place more points by clicking further along the edge, until the shape you're drawing completely covers the reservoir.*
- *After placing your last point, right-click to finish drawing the polygon. This will finalize the feature and show you the Attributes dialog.*
- *Fill in the values*
- *Click OK and you've created a new feature!*

Remember, if you've made a mistake while digitizing a feature, you can always edit it after you're done creating it. If you've made a mistake, continue digitizing until you're done creating the feature as above. Then:

- *Select the feature with the Select Single Feature tool:* 

- *the Move Feature(s) tool to move the entire feature,*
- *the Node Tool to move only one point where you may have miss-clicked,*
- *Delete Selected to get rid of the feature entirely so you can try again,*
- *the Edit →Undo menu item or the ctrl + z keyboard shortcut to undo mistakes.*

Feature Topology

Topology is a useful aspect of vector data layers, because it minimizes errors such as overlap or gaps. For example: if two features share a border, and you edit the border using topology, then you won't need to edit first one feature, then another, and carefully line up the borders so that they match. Instead, you can edit their shared border and both features will change at the same time.

Snapping

To make topological editing easier, it's best if you enable snapping. This will allow your mouse cursor to snap to other objects while you digitize. To set snapping options:

- Navigate to the menu entry Settings→ Snapping Options....
- Set up your Snapping options Snappind mode →**current layer, snap to->to vertex and segment and tolerance->20(pixels)**
- Click OK to save your changes and leave the dialog
- Enter edit mode with the new_reservoir layer selected.
- Check under View→Toolbars to make sure that your Advanced Digitizing toolbar is enabled.
- Zoom to this area (enable layers and labels if necessary):
- Digitize this new (fictional) area of reservoir
- When prompted, give it a ID of 2, but feel free to leave the other values unchanged.

If you're careful while digitizing and allow the cursor to snap to the vertices of adjoining farms, you'll notice that there won't be any gaps between your new farm and the existing farms adjacent to it.

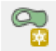
Correct or update topological features using node tool

Simplify Feature tool: 

- Click on it to activate it.
- Click on one of the areas which you joined using either the Node Tool or Add Feature tool. You'll see a dialog set the different value of tolerance and see what happens.
- This allows you to reduce the amount of nodes in complex features.

- Click Ok

Notice what the tool does to the topology. The simplified polygon is now no longer touching the adjacent polygonsas it should. This shows that this tool is better suited to generalizing stand-alone features. The advantage is that it provides you with a simple, intuitive interface for generalization. Before you go on, set the polygon back to its original state by undoing the last change.

Add ring tool: 

It allows you to take a hole out of a feature, as long as the hole is bounded on all side by the feature. For example, if you've digitized the **KRISHANA river** you need to add a hole for small island in the river using this tool.

If you experiment with this tool, you'll notice that the current snapping options prevent you from creating a ring in the middle of the polygon. This would be fine if the area you wished to exclude linked to the polygon's boundaries.

- *Disable snapping for the layer via the dialog you used earlier.*
- *Now try using the Add Ring tool to create a gap in the middle of the reservoir.*
- *Delete your new feature by using the Delete Ring tool:* 
- *You need to select a corner of the ring in order to delete it.*

Add Part tool: 

It allows you to create an extra part of the feature, not directly connected to the main feature or you want further to update the feature. For example, if you've digitized the boundaries of reservoir but you haven't yet added the some area which is not connected but it is a part of the same reservoir. Another example like if you want to add some stretch of canal or road or stream into the already digitized feature of same then you'd use this tool to create them.

- *To use this tool, you must first select the polygon to which you wish to add the part by using the Select Single Feature tool:* 
- *Now try using the Add Part tool to add an outlying area to the reservoir.*
- *Delete your new feature by using the Delete Part tool:* 

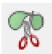
Reshape Features tool: 

It can add a bump to an existing feature. With this tool selected:

- Left-click inside reservoir to start drawing a polygon.
- Draw a polygon with three corners, the last of which should be back inside the original polygon, formingan open-sided rectangle.
- Right-click to finish marking points and see what happens

You can do the opposite, too:

- *Click outside the polygon.*
- *Draw a rectangle into the polygon.*
- *Right-click outside the polygon again:*

Split Feature: 

The Split Features tool is similar to how you took part of the farm away, except that it doesn't delete either of the two parts. Instead, it keeps them both.

- *First, re-enable snapping for the reservoir layer.*
- *We will use the tool to split a corner from reservoir.*
- *Select the Split Features tool and click on a vertex to begin drawing a line. Click the vertex on the opposite side of the corner you wish to split and right-click to complete the line:*
- *At this point, it may seem as if nothing has happened. But remember that your symbology for the reservoir layer does not have any border, so the new division line will not be shown.*
- *Use the Select Single Feature tool to select the corner you just split; the new feature will now be highlighted:*

Merge Feature: 

- *Use the Merge Selected Features tool, making sure to first select both of the polygons you wish to merge.*
- *Use the feature with the ID of 1 as the source of your attributes (click on its entry in the dialog, then click the Take attributes from selected feature button):*

Using the Merge Attributes of Selected Features tool will keep the geometries distinct, but give them the same attributes.

Attributes Form & Identify Tool

When you add new data via digitizing, you're presented with a dialog that lets you fill in the attributes for that feature. It is called form.

Identify Tool: 

The Identify tool is used to quickly retrieve attribute information for a feature on a map. In order to use this tool for a specific map layer, the layer that contains the information must be made active, then the features of the layer on the map can be clicked to obtain information about each feature. One of the benefits of GIS is that, in addition to being able to display a map of a layer, one can also display attributes about a layer that are stored in a database.

How to edit attribute using form:

- *Add the **canal_network** layer in the Layers list.*
- *Select the layer*
- *Activate edit mode (if it isn't already activated).*
- *Using the Identify tool, click on the Right main canal*
- *Edit its one of the field.*
- *Save your edits.*
- *Exit edit mode.*
- *Open the Attribute Table and note that the value has been updated in the attributes table and therefore in the source data.*

Above dialog is not, by default, very nice to look at. This can cause a usability problem, especially
If you have large datasets to create, or if you want other people to help you digitize and they find the default forms to be confusing.

Fortunately, QGIS lets you create your own custom dialogs for a layer.

Setting Form Filled Types

It's nice to edit things using a form, but you still have to enter everything by hand. Fortunately, forms have different kinds of so-called widgets that allow you to edit data in various different ways.

- *Open the **Canal network layer's Properties**.*
- *Switch to the Fields tab.*
- *Add a field "**canal_type**" with data type set to **integer**.*
- *Click on the Text edit button in the same row as **Canal_type** and you'll be given a new dialog.*
- *Select Checkbox in the list of options*
- *Click OK.*

- *Enter edit mode (if the layer is not already in edit mode).*
- *Click on the **Identify tool**.*
- *Click on the same RMC.*
- *You'll now see that the **Canal_Type** attribute has a checkbox next to it denoting True (checked means Lined) or False (unchecked means unlined).*

By above methods you can customize you field form for more understandable and easy to fill. Now we want to create our own custom form for the attribute data capture phase. You need to have Qt4 Designer installed (only needed for the person who creates the forms).

Actions
An action is something that happens when you click on a feature. It can add a lot of extra functionality to your map, allowing you to retrieve additional information about an object, for example. Assigning actions can add a whole new dimension to your map! Now we'll create an action that will open the image for a property when clicking on the property.

The Dam layer has no way to associate an image with a property yet. First we'll create a field for this purpose.

- *Open the **Layer Properties dialog**.*
- *Click on the **Fields tab**.*
- *Toggle editing mode*
- *Add a new column*
- *Create a new field with name **Image** of type **String** with **text size 240***
- *After the field has been created, click on the **Text edit** button next to the new field.*
- *Set it up for a File name*
- *Click OK on the Layer Properties dialog.*
- *Use the Identify tool to click on one of the three features in the Dam layer.*
- *Since you're still in edit mode, the dialog should be active*
- *Click on the browse button (the ... next to the image field).*
- *Select the path for your image. The images are in **Project_photos** folder*
- *Click OK.*
- *Save your edits and exit edit mode.*

Now Creating an Action

- *Open the Actions form for the **dam layer properties dialog**.*
- *In the Action properties panel, enter the words **Show Image** into the **Name field***
- *Click on the **Type** dropdown and choose **Open**.*

You want to open the image, and QGIS knows where the image is. All it needs to do is to tell the Action where the image is.

- *Select image field from the list*
- *Click the Insert field button. QGIS will add the phrase [% "image" %] in the Action field.*
- *Click the Add to action list button.*
- *Click OK on the Layer Properties dialog.*

Now we will test the new Action:

- *Click on the dam layer in the Layers list so that it is highlighted.*
- *Find the Run feature action button:* 
- *Click on the down arrow to the right of this button. There's only one action defined for this layer so far, which is the one you just created.*
- *Click the button itself to activate the tool.*
- *Using this tool, click on dam.*
- *The image for that property will now open.*

Vector Analysis

Now that you have created and edited a few geographical features, you must want to know what else one can do with them. Having features with attributes is nice, but when all is said and done, this doesn't really tell you anything that a normal, non-GIS map can't.

The key advantage of a GIS is this: a GIS can answer questions.

Vector data can be analyzed to reveal how different features interact with each other in space. There are many different analysis-related functions in GIS, we won't go through them all. Rather, we'll pose a question and try to solve it using the tools that QGIS provides.

In the next section we will used digital dataset of roads, river, lanuse, buildings, school, water bodies of a place called Swellendam in the south Africa. Data is available on internet.

Before we start, it would be useful to give a brief overview of a process that can be used to solve any GIS problem.
The way to go about it is:

1. State the Problem
2. Get the Data
3. Analyze the Problem
4. Present the Results

The problem is: you are an estate agent and you are looking for a residential property in Swellendam for clients who have the following criteria:

1. It needs to be in Swellendam.
2. It must be within reasonable driving distance of a school (say 1km).
3. It must be more than 100m squared in size.
4. Closer than 50m to a main road.
5. Closer than 500m to a restaurant.

To answer these questions, we're going to need the following data:

1. The residential properties (buildings) in the area.
2. The roads in and around the town.
3. The location of schools and restaurants.
4. The size of buildings.

Here we are using internet downloaded data. However, you can also use OpenstreetMap(OSM) data for you local area through Qgis plugin Openlayers. We will discuss about the plugin and hou to use them in respect of Qgis latter.

Now first of all please remember when you calculated areas, length or any measurable parameter of a feature, it is required to re-project all dataset into a Projected Coordinate System.

So, we'll need to reproject it. But it won't help to just use 'on the fly' reprojection. 'On the fly' does what it says - it doesn't change the data,it just reprojects the layers as they appear on the map. To truly reproject the data itself, you need to export it to a new file using a new projection.

In this example, we are using the WGS 84 / UTM zone 34S CRS because this region is situated around 34S zone of UTM projection. Now if you are using data set of your region, you may use a UTM CRS which is more appropriate for your region.

Now, follow as:

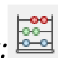
- *Select **road layer**.*
- *Go **vector->geoprocessing tools->buffers...***
- *Set buffer to **50m** and save new shapfile as **road_buffer_50m**. make sure **that dissolve buffer results** check box is **checked**.*
- *Select **schools layer***
- *Go **vector->geoprocessing tools->buffers…***
- *Set buffer to **1000m** and save new shapfile as **schools_buffer_1000m**. make sure that **dissolve buffer results** check box is **checked.***
- *Now go **vector->geoprocessing tools->intersect…***
- *Set input vector layer as school_buffer_1000m and intersect layer as road_buffer_50m.*
- *Save the output shapfile as **road_school_intersect**.*

- *Remove the road_buffer_50m and school_buffer_1000m layer*
- *Go **vector->Research tools->Select by Location…***
- *Set select feature in house layer and intersect feature **is road_school_intersect***
- *Click ok and then close*

The buildings highlighted in yellow are those which match our criteria and are selected, while the buildings in green are those which do not. We can now save the selected buildings as a new layer.

- *Now save the selected buildings as new layer file **well_located_houses***
- *Click ok and remove the road_school_intersect layer*
- *Select the **restraurant layer***
- *Go **vector->geoprocessing tools->buffers...***
- *Set buffer to **500m** and save new shapfile as **restra_buffer_500m**. make sure that dissolve buffer results check box is checked.*
- *Go **vector->Research tools->Select by Location…***
- *Set select feature in well_located_houses layer and intersect feature is restra_buffer_500m*
- *Click ok and then close*

The buildings highlighted in yellow are those which match our criteria and are selected

- *Now save the selected buildings as new layer file **well_located_houses2***
- *Now select the well_located_houses2 layer*
- *And add new field in **the attribute table as AREA** and calculate the same using **field calculator**:* 
- *Now by using **query builder** filter those houses whose **area are >= 100sqm**.*
- *Save the result in now shapfile **solution.shp.***
- *Check your result with house layer and solution layer.*

Your map should now only show you those buildings which match our starting criteria and which are more than 100m squared in size.

राष्ट्रीय जल अकादमी

पुणे स्थित राष्ट्रीय जल अकादमी, केन्द्रीय जल आयोग की एक विशिष्ट संस्था है। जल संसाधन क्षेत्र से जुडे राज्य तथा केन्द्र सरकार में विविध स्तर पर कार्यरत अभियंताओं के प्रशिक्षण के क्षेत्र में राष्ट्रीय जल अकादमी एक “उत्कृष्ट केन्द्र” के रूप में कार्य कर रही है। राष्ट्रीय जल अकादमी जल संसाधन के विकास एवं प्रबन्धन के क्षेत्र में अल्प एवं मध्यम अवधि के पाठ्यक्रमों के नियमित आयोजन के साथ-साथ केन्द्रीय जल अभियंत्रण (वर्ग ‘क’) सेवा के अंतर्गत चयनित अधिकारियों के लिए लम्बी अवधि का प्रवेशन कार्यक्रम भी आयोजित करता है।

राष्ट्रीय जल अकादमी की वेबसाइट http://nwa.mah.nic.in से इस संबंध में जानकारी प्राप्त की जा सकती है ।