Universiti Malaysia PAHANG

Network of Women Scientists of the Islamic World

Workshop on :
GIS&RS Application in Simulation of Hydrological Process

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GIS definitions

GIS: A simplified view of the real world by point, line and polygon layers.

GIS: “A system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the Earth. This is normally considered to involve a spatially referenced computer database and appropriate applications software”

GIS components

GIS software

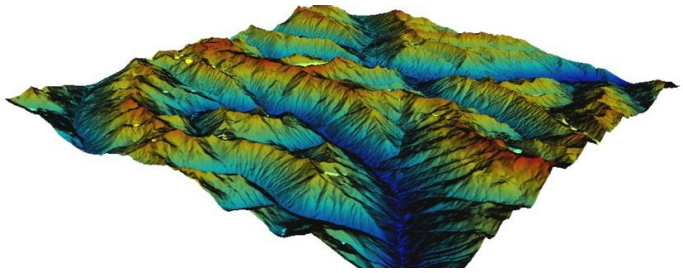
GIS

- ArcGIS
- MapInfo
- GRASS
- Geomedia
- Geoconcept
- WIN GIS
- Microstation

Digital Image Processing

- ERDAS Imagine
- ER Mapper
- ILWIS
- ENVI
- PCI Geomatica
- TNTMIPS
- Ecognition

Related technologies



GIS ⟷ RS

Data

- Dynamic nature (not static)
  - Forest grow
  - River channel change
  - City expand or decline
- Identification of discrete and continuous features
  - Road to be a line or a area?
- Scale
- Some may not fit to any type of features: fuzzy boundaries
  - Transition area between woodland and grassland

Data format

Vector data
- Shapefiles
- Coverages
- TIN (e.g. elevation can be stored as TIN)
  - Triangulated Irregular Network

Raster data
- Grid (e.g. elevation can be stored as Grid)
- Image (e.g. elevation can be stored as image, all remote sensing images)

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Data format

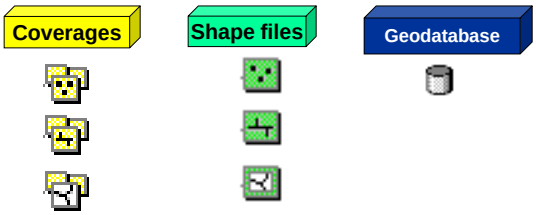
Vector data
- **Shape file**
- **Coverage**
- **E00**
- **TIN**

Raster data
- **Geotiff**
- **GRID**
- **ASCII**
- **IMG**

- **Geodatabase**

- **Metadata: In GIS, Metadata is data about the data**

Common data formats



A shapefile consists of multiple files, and the common ones are *.dbf, *. shp, *.shx

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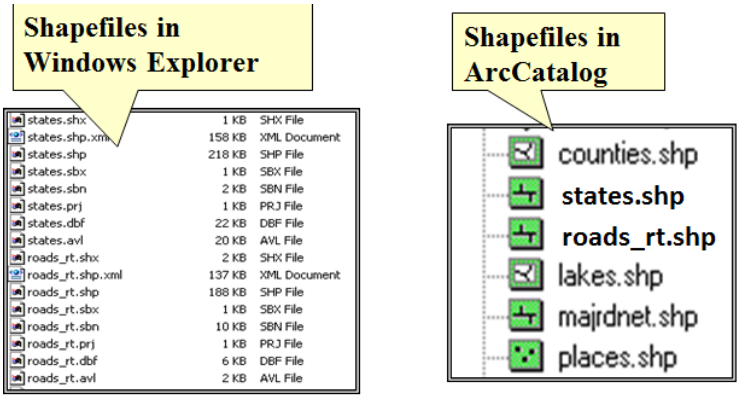
Common data formats



Meta data

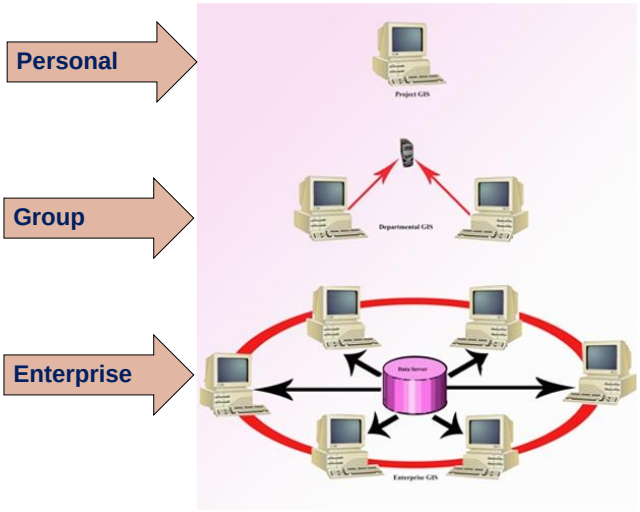
According to the FGDC, metadata includes:

- Date of data collected.
- Date of coverage generated.
- Bounding coordinates.
- Processing steps.
  - Software used
  - RMSE, etc.
- From where original data came.
- Who did processing.
- Projection
- coordinate System
- Datum
- Units
- Spatial scale
- Attribute definitions
- Who to contact for more information

Exercise

- View files in your folder d:data
- Create a new point file
- Create a new line file
- Create a new polygon file
- open attribute table
- Add new column
- Delete new generated column

GIS organization structure



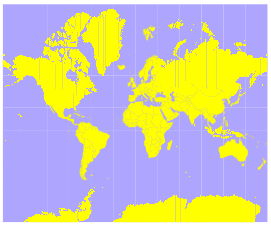
Coordinate Systems, Datums and Map Projections

- Creating spatial data (collecting GPS data)
- Import into GIS and overlay with other layers
- Acquiring spatial data from other sources

Coordinate Systems

2 types of coordinate systems:

- Geographic Coordinate Systems
- Projected Coordinate Systems



Geographic Coordinate System

Cartography

Cartography is the science that deals with the construction, use, and principles behind maps Understanding the way maps are encoded to be used in GIS requires knowledge of cartography

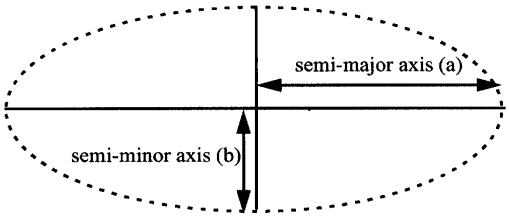
map

A map is a representation of all or part of the earth or other geographic phenomenon on the Earth's surface as a set of symbols and at a scale whose representative fraction is less than one to one

- Map Scale
- Spatial Entity
- Earth Models and Datum
- Geographic Coordinate System
- Map Projection
- Geo-referencing/Spatial Referencing

Geographic Coordinate System

Measuring the Ellipsoid



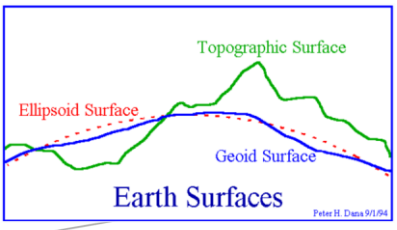
$$f = 1 - \frac{b}{a}$$

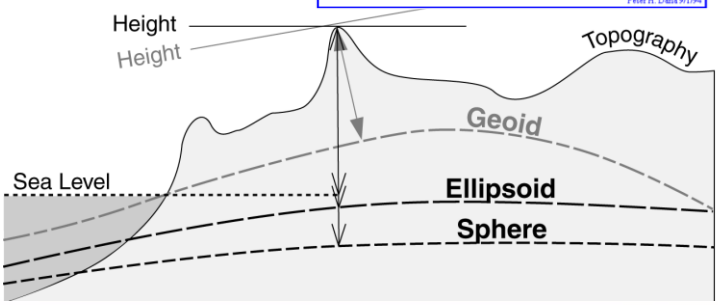
For the WGS84
a = 6,378,137
b = 6,356,752.3 so f = 1/298.257

Figure 2.3 The ellipsoid. The long axis is the Major axis, the short the Minor axis. Half of each of these lengths is used to calculate the flattening of the ellipsoid.

Geographic Coordinate System

Earth Models and Datum





Geographic Coordinate System

Datum

A datum defines the position of the spheroid relative to the center of the earth Origin and orientation of latitude and longitude lines are determined by the datum. Different nations and international agencies use different datums as the basis for coordinate systems in GIS, precise positioning systems, and navigation systems.

Linking geodetic coordinates to the wrong datum can result in position errors of hundreds of meters.

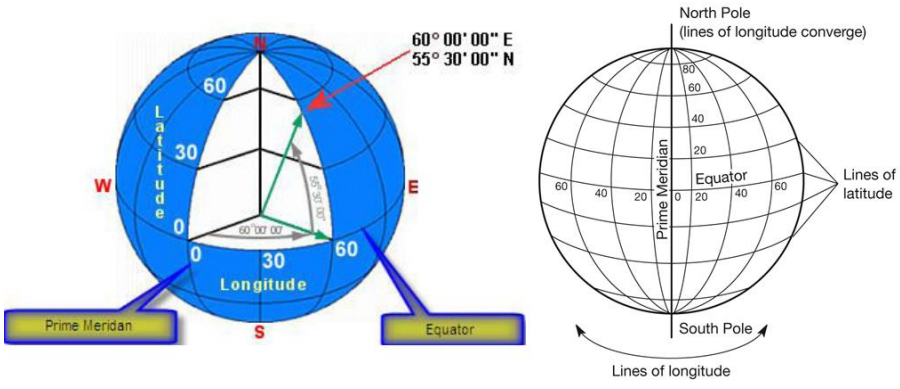
WGS 1984

Most recently developed datum/ framework for measurements worldwide
Earth centered, or geocentric, perspective
This is the datum used by all GPS satellites
Nearly identical to NAD83…therefore NAD83 is compatible with data collected in GPS using WGS84!

Geographic Coordinate System

- Latitude: 90 degrees south to 90 degrees north
- Longitude: 180 degrees west to 180 degrees east
- Parallel: A line with a constant latitude running east to west
- Meridian: A line with constant longitude running from the north pole to the south pole
- Prime Meridian: The zero-longitude meridian, passing through Greenwich, England
- Graticule: A grid of parallels and meridians shown as lines on a map

Geographic Coordinate System



Heywood *et al.*, An Introduction to Geographical Information Systems, 2/e
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Geographic Coordinate System

- A reference system using latitude and longitude to define the location of points on the surface of a sphere or spheroid

- decimal degrees (DD) 101.5
- degrees/minutes/seconds (DMS) 101° 30’ 00” W

Spheroid approximates the shape of the earth

Also called an “ellipsoid”

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Geographic Coordinate System

Universal Coordinate System (lat/lon)
Lat/lon good for locating positions on surface of a globe
Lat/lon is not efficient for measuring distances and areas!

Latitude and longitude are not uniform units of measure
One degree of longitude at equator = 111.321 km (Clarke 1866 spheroid)
One degree of longitude at 60° latitude = 55.802 km (Clarke 1866 spheroid)

Map projection

- A projection is a representation of a spherical or ellipsoidal surface on a flat surface.
- A projection mathematically transforms a position on the Earth's surface identified by latitude and longitude into a position in Cartesian coordinates, (x,y).
- To compare or edge-match maps in a GIS, both maps MUST be in the same projection.

Projected Coordinate Systems

A map projection is the systematic transformation of locations on the earth (latitude/longitude) to planar coordinates

The basis for this transformation is the geographic coordinate system (which references a datum)

Map projections are designed for specific purposes

Projected Coordinate Systems

This process of flattening the earth will cause distortions in one or more of the following spatial properties:

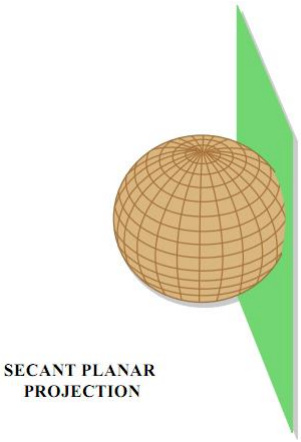
Shape
Conformal map projections preserve shape
Area
Equal area map projections preserve area
Distance/Scale
Equidistant map projections preserve distance
Direction/Angle
Azimuthal map projections preserve true direction

Projected Coordinate Systems

Three Basic Projection Surfaces

Plane (Azimuthal Projection)
----the globe grid is projected onto a flat plane
Cylinder (Cylindrical Projection)
----wrapping a cylinder of paper around the Earth
Cone (Conical Projection)
----wrapping a cone of paper around the Earth

Projected Coordinate Systems



SECANT PLANAR PROJECTION

Planar surface

Earth intersects the plane on a small circle. All points on circle have no scale distortion.

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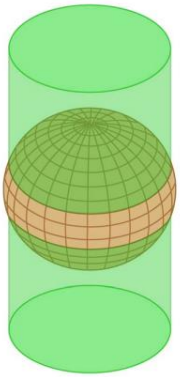
Projected Coordinate Systems

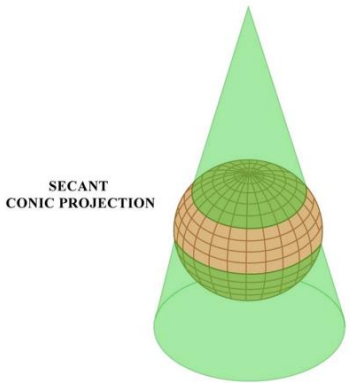


SECANT CYLINDRICAL PROJECTION

Cylindrical surface

Earth intersects the cylinder on two small circles. All points long both circles have no scale distortion.

Projected Coordinate Systems



Conic surface

Earth intersects the cone at two circles. all points along both circles have no scale distortion.

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Projected Coordinate Systems

Four Positions of Projection Surface Relative to Globe:

Polar: the projection surface is placed over the north or south pole and the point or line of angency is at or near that pole.

Equatorial: the projection surface is placed over the equator.

Transverse: the projection surface is placed 90 degrees from the normal position.

Oblique: a projection surface is placed above or on any position between, except the equator and the poles.

Projected Coordinate Systems

Scale distortion

- Scale near intersections with surface are accurate
- Scale between intersections is too small
- Scale outside of intersections is too large and gets excessively large the further one goes beyond the intersections

Why project data?

- Data often comes in geographic, or spherical coordinates (latitude and longitude) and can't be used for area calculations in most GIS software applications
- Some projections work better for different parts of the globe giving more accurate calculations

Universal Transverse Mercator (UTM)

Grid system
Great for small areas
    minimal map distortion
    distortion greater at edge of zones

A type of cylindrical projection, conformal.

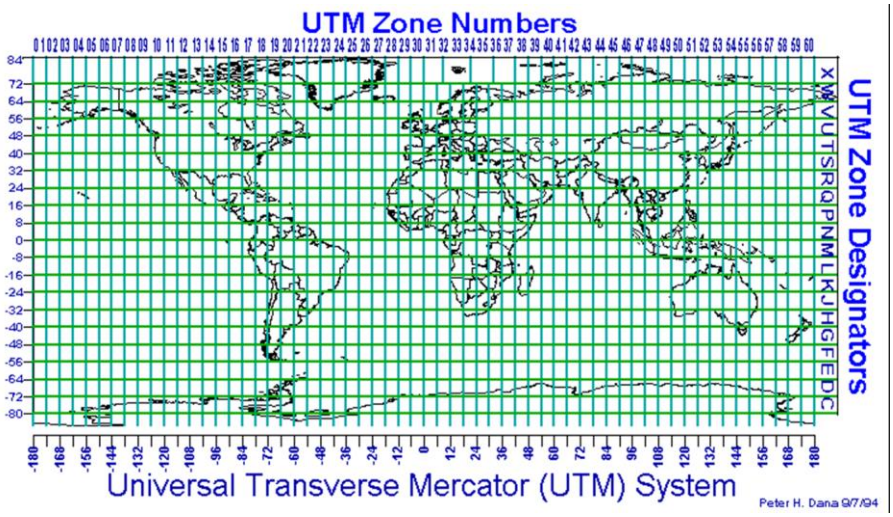
Implemented as an internationally standard coordinate system

Divide the Earth into 60 zones
- Each zone is a north-south column 6° of longitude
- wide, ranging between 84°N and 80°S latitude
- Maximum distortion is 0.04%

•Each zone corresponds to a half cylinder wrapped along a particular line of longitude.

•UTM is secant, with standard lines located on both sides of the central meridian.

Projected Coordinate Systems



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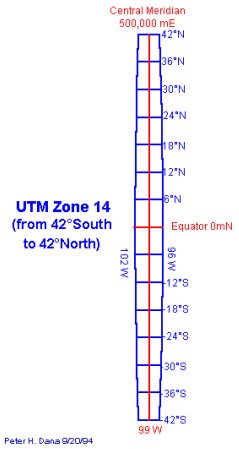
Projected Coordinate Systems

(UTM coordinates)



- It is a metric system.
- In the N Hemisphere define the Equator as 0 mN. In the S Hemisphere define the Equator as 10,000,000mS.
- The central meridian of the zone is given a false Easting of 500,000 mE
- Eastings and northings are both in meters allowing easy estimation of distance *on the projection*
- A UTM georeference consists of a zone number, a six-digit easting and a seven-digit northing

  E.g., UTM14, 468324E, 5362789N

Projected Coordinate Systems

How to choose projections

- Generally, follow the lead of people who make maps of the area you are interested in. Look at maps!
- State plane is a common projection for all states in the USA
- Conic and UTM variants
- UTM is commonly used and is a good choice when the east-west width of area does not exceed 6 degrees

Projected Coordinate Systems

In Malaysia

Projected CRS used in Malaysia - West Malaysia
Kertau (Rectified Skew Orthomorphic (RSO)) / RSO Malaya (m) is a projected CRS last revised on 08/14/2006 and is suitable for use in Malaysia - West Malaysia.

Projected Coordinate Systems

Exercise 2

- Arctoolbox contains the projection tools
  - Define a projection
  - Project a shapefile or grid to a new projection
- Arcmap
  - Change the projection for display and calculation

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Thank you

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