Ministry of
Rural Rehabilitation & Development
Islamic Republic of Afghanistan
Rural Water Supply and Irrigation Programme

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Introduction to GIS and GIS Data Management

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GIS Outline

- GIS Basics
- Three Views of GIS
- GPS Coordinates on the Globe
- GPS Coordinates
- Latitude and Longitude
- Angles and Degrees

What is a GIS?

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- GIS *stands for Geographic Information System*
- A system to organise, analyze and visualize geographic information
- GIS is a tool that
  - Apply geographical intelligence to decision making
  - Represent simplified physical objects (point, line, region) linked to a database
  - Integrate hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information

What is a GIS?

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- GIS is huge field (could not be learned by days)
  - This course can only be an introduction
- GIS allows us to view, understand, question, interpret, and visualize data in many ways
- GIS reveals relationships, patterns, and trends in the form of maps, globes, reports, and charts
- GIS helps us answer questions and solve problems by looking at our data
- GIS visualizes data in a quick-understandable and easily shared way
- GIS technology can be integrated into any enterprise information system framework

A Value Adding Tool

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- A good GIS is developed around the Information Products
- What information products are required?
- What data is required to generate the information product?
- What functions are available to perform the operations?

- GIS is a value adding tool to assist decision making

Three Views of a GIS

- A GIS is most often associated with a map
- A map is only one way for using geographic data in a GIS, and only one type of product generated by a GIS
- A GIS can provide a great deal more problem-solving and analyzing capabilities than using a simple mapping program or adding data to an online mapping tool

Three Views of a GIS

1. The Database View

- A GIS is a unique kind of database of the world—a geographic database (i.e. geodatabase)
- It is an "Information System for Geography"
- Fundamentally, a GIS is based on a structured database

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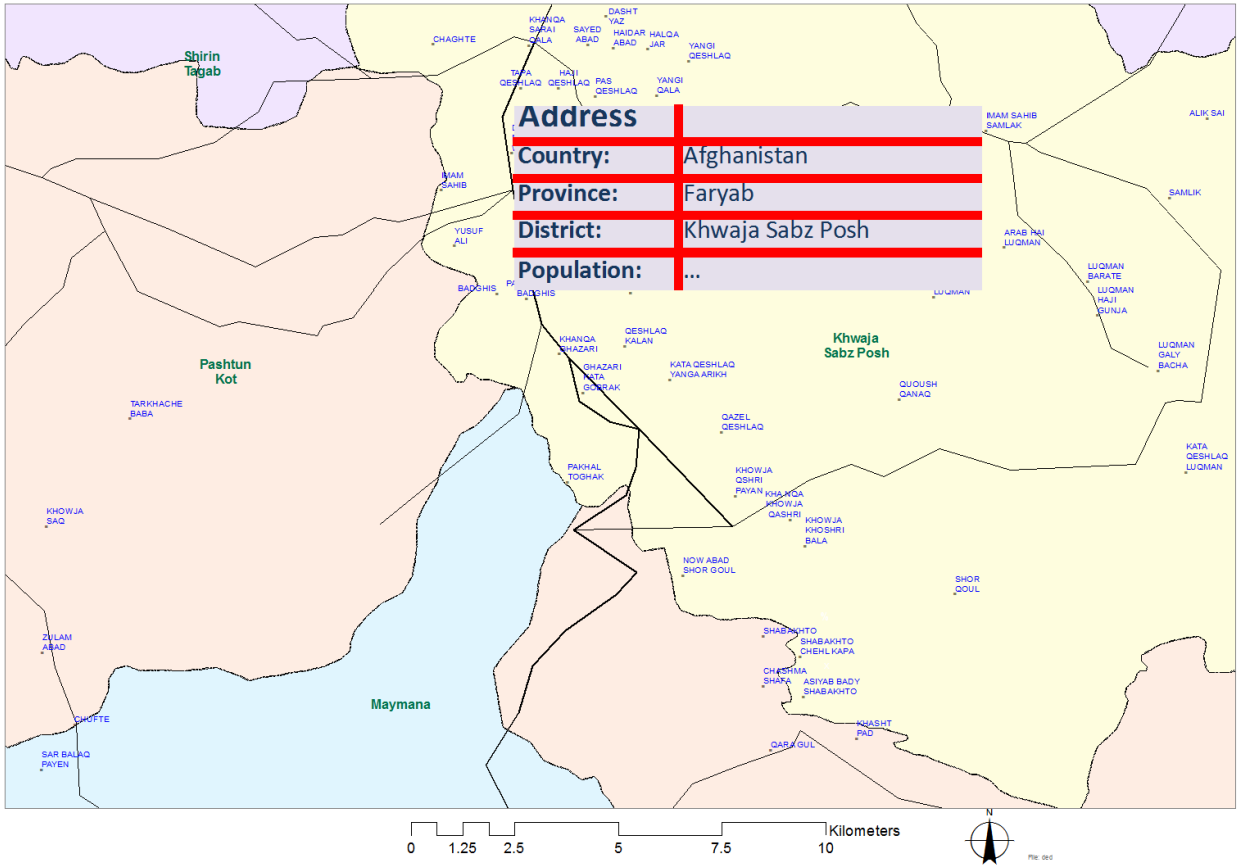
The Database View - Example



Three Views of a GIS

2. The Map View

- A GIS is a set of intelligent maps and other views that show features and their relationships on the earth's surface
- Maps of the underlying geographic information can be constructed and used as "windows into the database"
- Maps do support queries, analysis, and editing of information

Faryab Growndwater Sources - Construction Details

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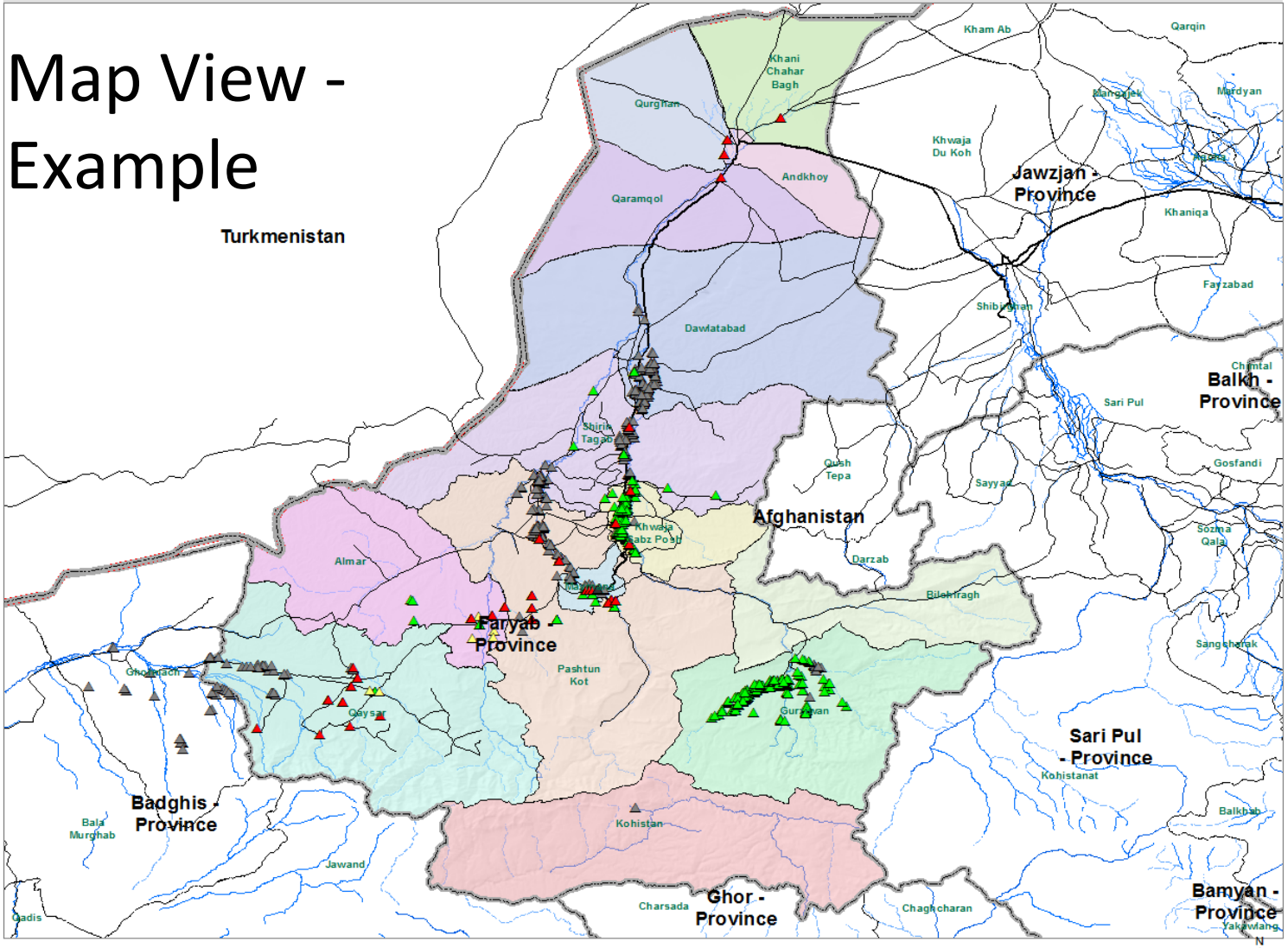
Map View - Example



Legend

- Material: Steel
- Material: Unknown
- Material: Galvanised Steel
- Material: PVC
- Material: Concrete
- Primary Roads
- Secondary Roads
- Tersuary Roads
- Unspecified Roads
- International Boundary
- Province Boundary
- District Boundary

Rivers

- Primary
- Secondary
- Seasonal

Disclaimer and Source:

Date Printed: 20 May 2013 4:09:29 PM

Administrative Boundaries: AIMS
General Content: NORPLAN, RuWatSIP, MRRD

Datum/Projection: WGS-84/ Geographic

File: Faryab Growndwater Sources - Construction Details

Three Views of a GIS

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3. The Model View

- A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets
  - These geo-processing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets

The Model View - Example

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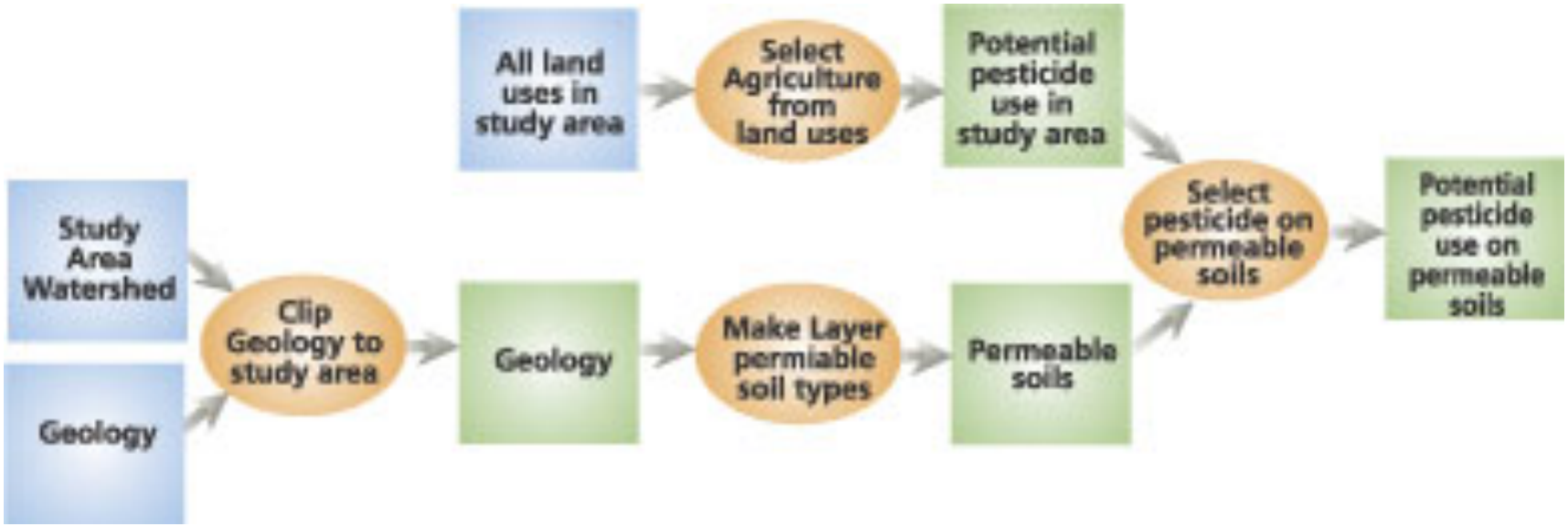

GIS Applications

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- GIS is using across natural resource management
- Besides, GIS is using in applications such as disease surveillance, crime analysis, market analysis, transportation
- Integration of GIS with GPS and the Internet continues to introduce new applications such as interactive mapping, location-based services and other mobile technology

GIS Activities

- Spatial data input
  - Data entry and use of existing data and data projection
- Attribute management
  - Data entry, verification and data management
- Data display
  - Maps, charts, tables both static and interactive display

GIS Activities

- Data exploration
  - Querying and geographic visualization
- Data analysis
  - Vector and raster data
- GIS modeling
  - Different modeling methods

GIS Data Types

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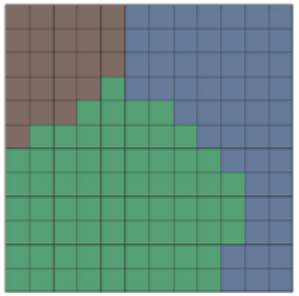
- Vector data
  - Constructed by points (x & y coordinates)
  - Points, lines and areas (polygons)
  - Spatial component and attribute set
  - Single or multiple attributes

- Raster data
  - Grid of cells (matrix)
  - Cell value (z-value or attribute)
  - Spatially defined by an origin and cell size
  - Photos, satellite imagery, digital elevation model (DEM)



GIS Architecture

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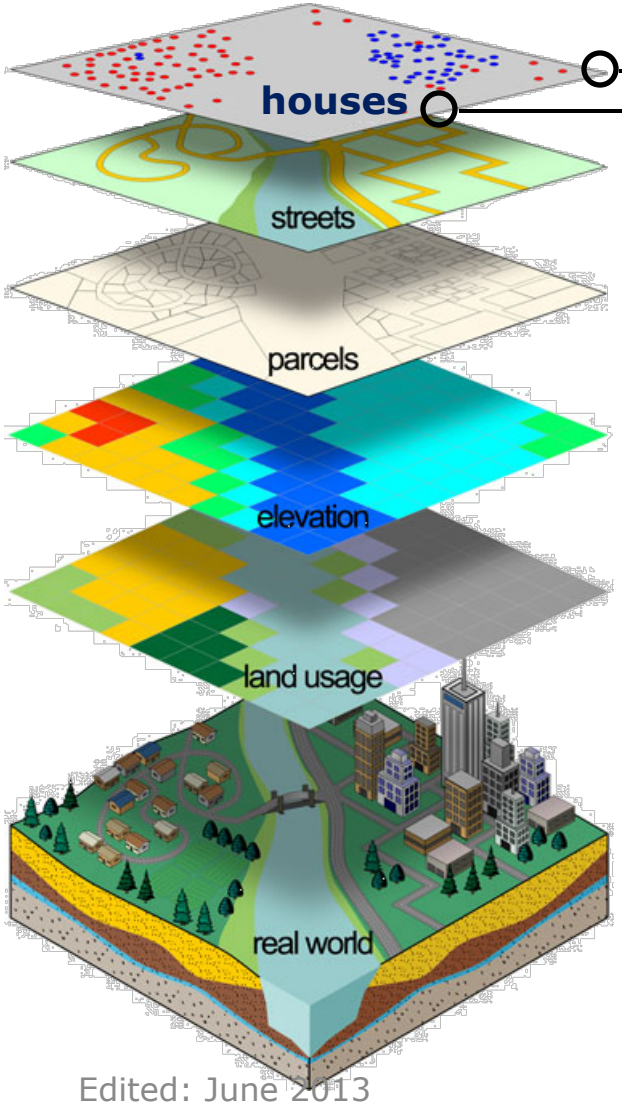
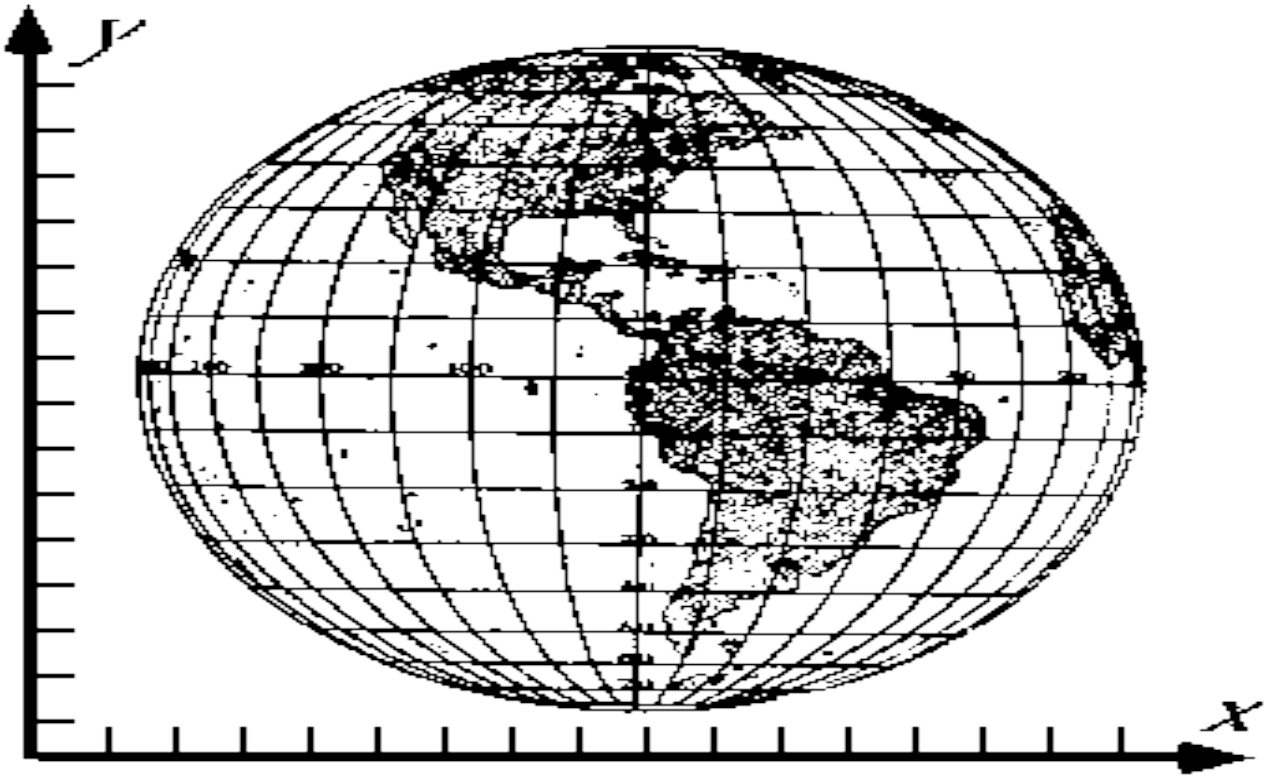


Family	Yard Number	Number Houses	Number Men	Number Women	Filter Number
Sparrow	345	2	1	9	333
Burton	456	3	1	5	444
Allan	456	4	1	9	555
Olson	678				

- Layers of information
- Spatial objects
- Attribute tables
- etc

GPS Coordinates on the Globe

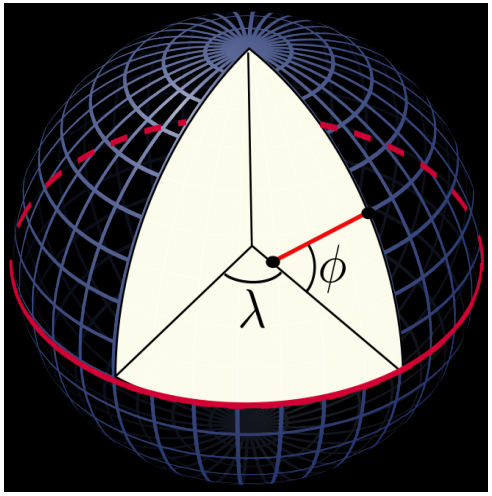


Latitude and Longitude

- GPS coordinates are commonly displayed as latitude and longitude
- Degrees of latitude and longitude measure the angle between a location and the reference lines, namely the Equator and Greenwich Line
- The equator bisects the globe to North and South

Latitude and Longitude

- Latitude is the angle formed by a line from the center of the earth to the equator and a line from the center of the earth to your location
- Latitude is
  - Zero at the equator
  - +90 degrees at the North Pole
  - - 90 degrees at the South Pole



Latitude and Longitude

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- Longitude is more complicated as it is more difficult to determine without GPS unit
- Longitude is the angle formed by a line from the center of the earth to the prime meridian at Greenwich England and a line from the center of the earth to your location
  - A meridian is a line of longitude running from pole to pole (also called the time-line)

Latitude and Longitude

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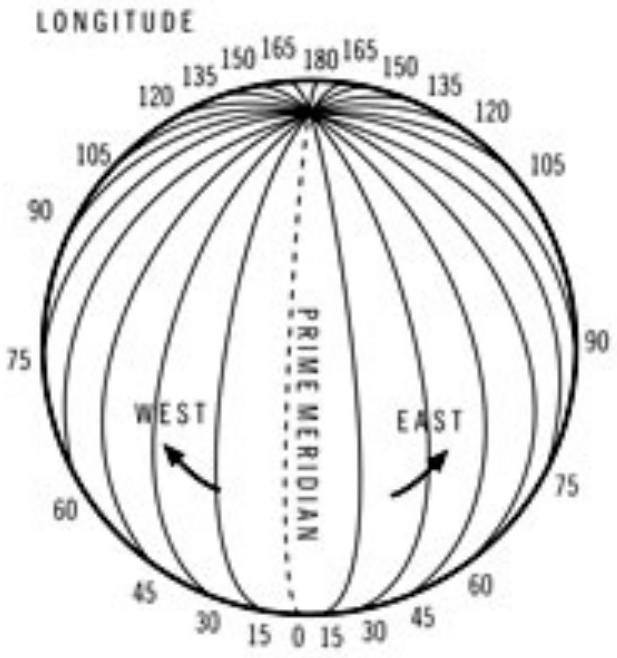

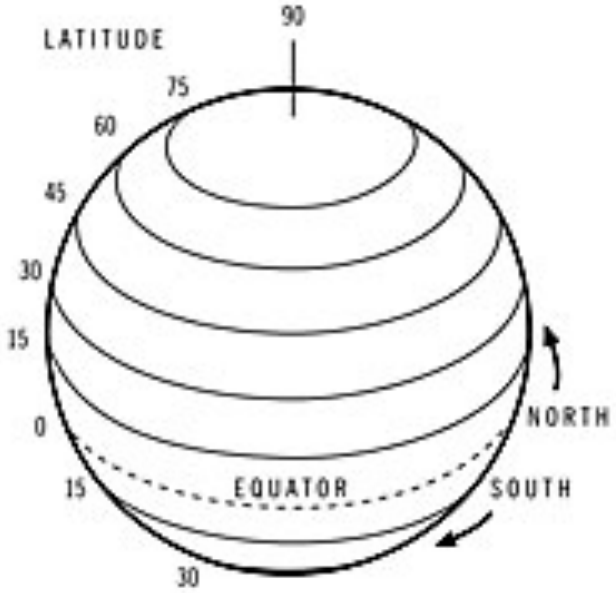

Latitude and Longitude

- The earth rotates 360 degrees each day
- Longitude ranges from West (negative) 180 degrees to East (positive) 180 degrees

For more information visit:

http://millennium-dome.com/info/conference.htm

Latitude and Longitude

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Angles and Degrees

- Latitude and Longitude are frequently recorded as degrees, minutes and seconds
- A degree is divided into 60 parts (minutes) and those parts into 60 parts (seconds)
- GIS systems need to use a simpler format called Decimal Degrees

Angles and Degrees

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	Latitude	Longitude
1 degree	111.04 Km	67.59 Km
1 minute	1850.75 m	1126.54 m
1 second	30.845 m	18.775 m

Angles and Degrees

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Decimal Degrees	Latitude	Longitude
0.1	11104.47 m	6759.24 m
0.01	1110.447 m	675.924 m
0.001	111.0447 m	67.5924 m
0.0001	11.10447 m	6.75924 m
0.00001	1.110447 m	0.67592 m
0.000001	0.111045 m	0.06759 m
0.0000001	0.011104 m	0.00676 m

Angles and Degrees

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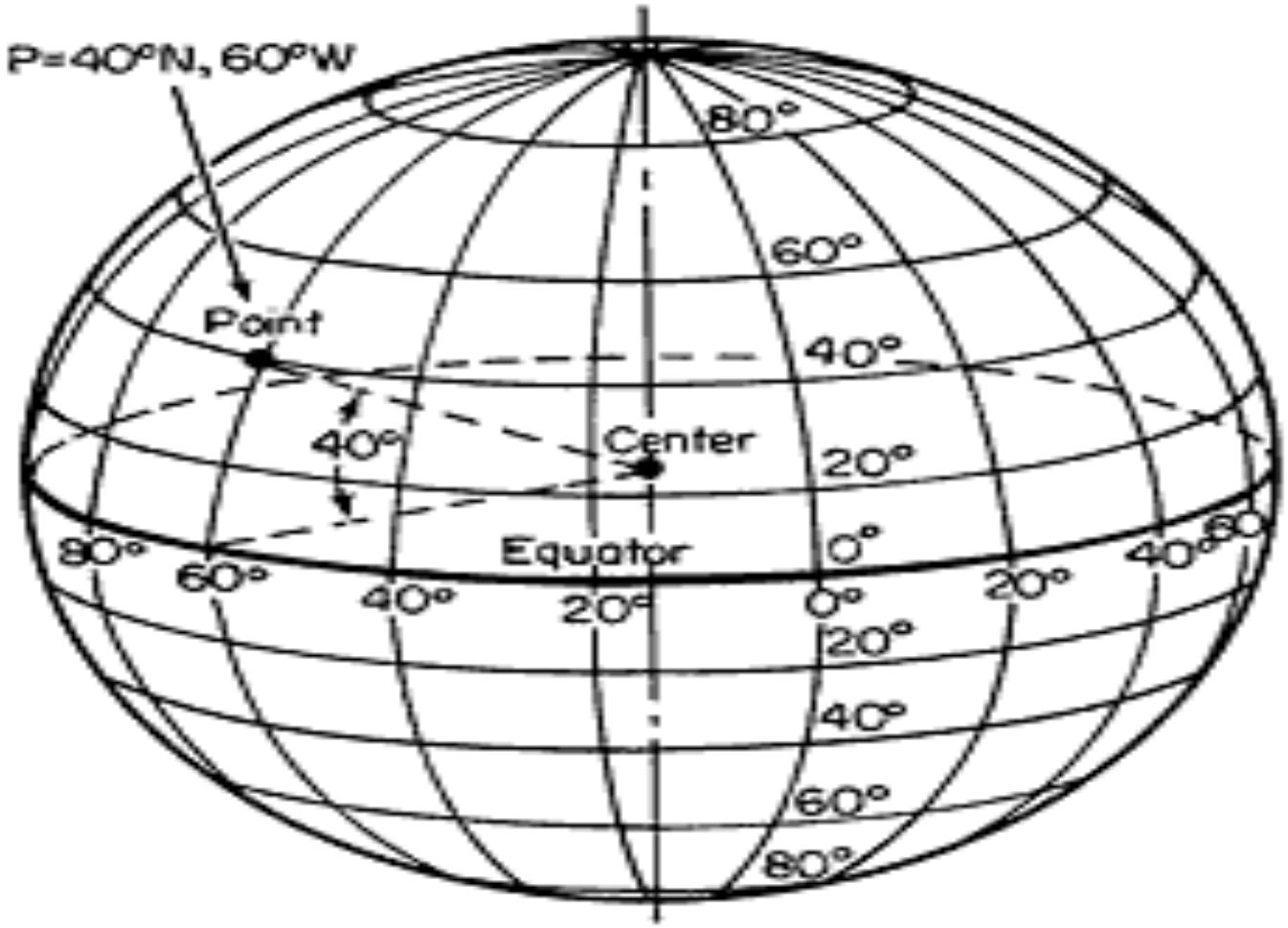

Datum (WGS84)

- Geographic coordinates are defined by a datum called “World Geodetic System 1984”
  - Comprises a standard coordinate frame for the Earth and a standard spheroidal reference surface for raw altitude data
  - Origin is at the earth’s centre of mass
  - It is referred to a geocentric datum

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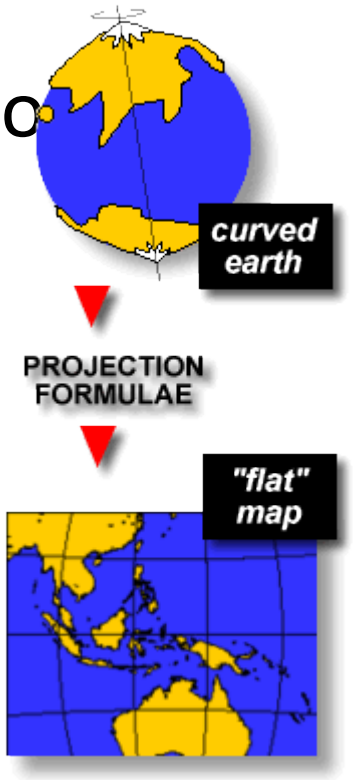
Projection

- Converting the spherical earth (latitude & longitude) to a flat map is called projection
  - Also called Cartesian coordinates
- Cartesian coordinates (x&y) are easier to with
- Example can be UTM/UPS



UTM / UPS

- UTM stands for "Universal Transverse Mercator“

- UPS stands for "Universal Polar Stereographic"

UTM / UPS

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- This System assigns world-wide locations a decimal numeric position on rectangular two-dimensional grids
- UTM/UPS is actually two systems:

1. UTM is the main one in practice
2. UPS is used for the polar areas only
   - 84°-90° around the North Pole and 80°-90° around the South Pole

UTM - Example

- 42 511753.481 3836783.346 is a point in Shakardara District, Kabul
- 42 511953.481 3836883.346 is a point 200m further east and 100m further north from the first point
  - In the above coordinate: 42 is the zone number, the two digits shows north and east coordinates of the point

UTM

- The surface of the Earth, for the purposes of UTM, is mapped as 60 zones running North/ South
- These are numbered 01-60 running Eastwards from the International Date Line
  - *These strips do not run from Pole to Pole: they terminate at 84° North and 80° South*

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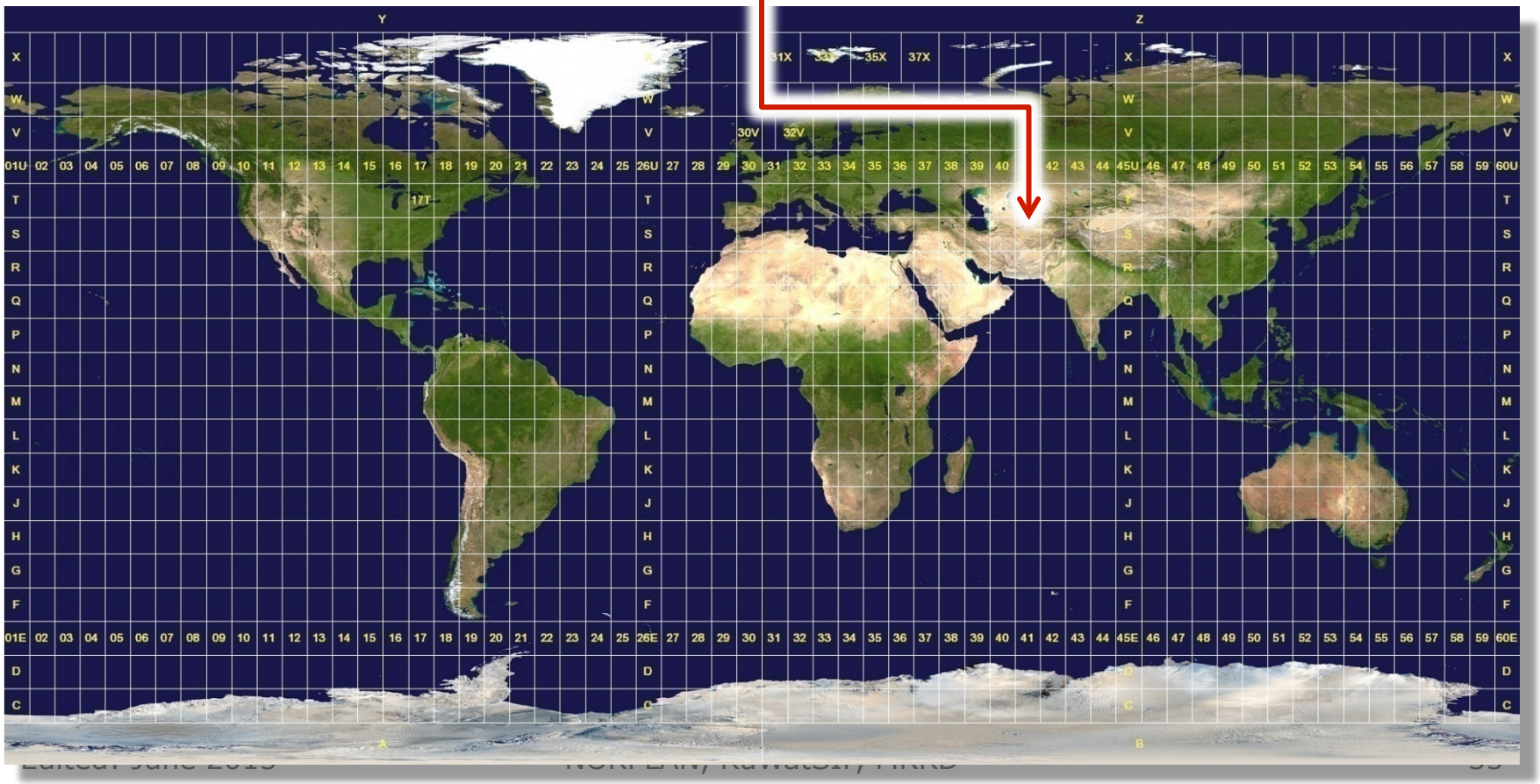
UTM Zones

Afghanistan:
UTM Zone 41,42,43 Nth



UTM Coordinates

- To create a set of UTM coordinates for a location, we need three components:
  1) a sector identity (Zone 1 to 60)
  2) an "East-West" measurement in meters
  3) a "North-South" measurement in meters

UTM Converter

- UTM coordinate converter to other standard coordinate systems are available free and by purchasing
- The following web address has a free converter for UTM coordinates
  - http://home.hiwaay.net/~taylorc/toolbox/geography/geoutm.html

UPS

- The polar regions are handled by the UPS system, where the area is mapped to a flat circle and then divided into squares
- Each square is given a two-letter designation
- For more information you can check:
  - http://www.colorado.edu/geography/gcraft/notes/coordsys/coordsys.html#ups

Some Notes

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- The UTM system starts at the International Date Line, while longitude starts at the Greenwich Meridian
- The long narrow shape of the UTM sectors (zones) means that 6 digits are needed for the "Easting" and 7 digits for the "Northing“
- The Earth has a circumference of 40,075km, measured at the Equator.
  Hence a UTM zone is roughly 700 km wide and 20,000 km long

Thank you