Digital Cartography

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Introduction

Cartography is the art of making maps. So, **Digital Cartography** is a method of making maps on a digital platform.

A **map** is a graphic representation of the cultural and physical environment.

Reduced: The first term, reduced, refers to the fact that almost all maps are more useful when they are reproduced at a smaller scale than the actual phenomenon being mapped. For example, a road map depicts all the roads irrespective of their width.

Selective: The second term, selective, means that maps should only include items that are directly related to the message of the map. For instance, a map designated to show where all the hospitals are located within a city should not include the location of every manhole cover in the city on the map. The reason is, the location that the manhole covers have nothing to do with the locations of the hospitals, and therefore it would be a meaningless feature on the map.

Symbolized: The third term, symbolized, refers to the idea of extracting the item being mapped by using a representative symbol. Examples of representative symbols would be a star with a circle around it that represents a state capital, or a symbol of the front of a bus that represents a bus stop.

The basic goals of conventional cartography

- Set the agenda for the map and pick the characteristics of the object that is to be mapped. This is the main focus of map processing. The traits might be physical, like roads or masses of land, or might be abstract, like political borders or toponyms.

- Reflect the mapped object's terrain on flat media. This is the problem with map projections.

- Decrease the sophistication of the features that are to be mapped. There is also the dilemma of generalization.

- To better transmit its vision to its viewer, organize the components of the map. This is the major area of focus with map design.

Importance of Cartography

- Cartography is useful because it encourages spatial visualization of data. This can display population spatial trends, economic growth, urbanization, as well as more.
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- Cartography often aids in the preparation and rehabilitation of disasters and allows emergency responders to consider what is going on in the region where they operate.
- Also, people use maps every day as they drive, locate restaurants, shops, and track their online transactions as they reach, with GPS and maps readily available on mobiles and other devices. The value of cartography is rising and becoming profoundly ingrained in our lives.

General Mapping Concepts

- All maps are representations since features can not be shown in their actual size or even in full detail.
- A Map is a model of the earth (or a portion of it) at a reduced scale.
- Because it is not possible to show features at their actual size, they must be generalized.
- In addition, 3-dimentional (3D) objects have been flattened for a 2-dimentional (2D) display.
- Transferring features from 3D to 2D involves the use of map projection.
- Looking at a map, real features like trees or buildings are not seen, rather, the symbols that represent these real features are seen.
- In order for the map to communicate its message effectively, these symbols should be easily understood by the map reader.
- Things in the real world are quite different from their map seen on the screen or a page. Is this view of reality still accurate?
- Assessing map accuracy is quite difficult. A selective view of reality is shown by all maps, so instead of asking “Is the map accurate?” it is better to ask “Is the map appropriate for my purpose?”

Cartographic Representation

- Cartographic representation is the topmost level of geographical visualization.
- Cartographic representation is a comprehensive capture and display of the distribution, combination and connection of spatial entities (features)
- Cartographic representation displays not only the respective quantity and quality characteristics of one geographic feature but the macro (overall) structure of the whole cartographic region.

Vectors

Point
Line
Polygon

Rasters

Pixels
Grods

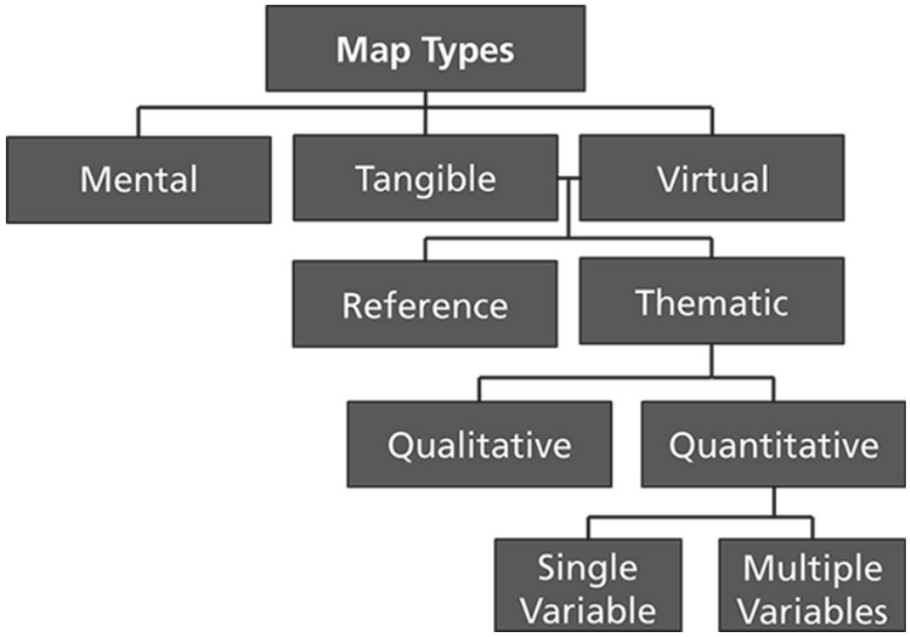
Types of Maps

General reference maps are usually small scale maps that depict very large areas. A good example is an atlas.

Thematic maps are used for special purposes such as showing the distribution of certain selected types of demographic or scientific data on a map that follows a theme. This is the main type of map that is made using GIS applications and is the result of performing some type of analysis.

Charts are maps that represent the world in a way that are useful for navigational purposes.

Plans are used by governments and buiders to layout construction projects (blueprints).



There are three mediums of maps: mental, tangible, and virtual and of those three mediums, we can create tangible and virtual maps using geospatial information systems (GIS). There are two types of maps that can be produced on tangible and virtual media: general reference, and thematic. Thematic maps are broken down further into two categories: qualitative thematic maps and quantitative thematic maps. A quantitative thematic map can simultaneously represent single or multiple variables.

Cartographic Scale

The size of a map determines the area that is depicted by the map. A fraction such as 1:250,000 or 1/150,000,000 typically denotes it. Such fractions mean that in the real world, standard measure on the map is equivalent to 250,000 or 50,000,000 of those same units.

It is beneficial to use ratios to label the scale since they could be used in every measurement device without converting from one system to the other (such as from feet to meters). A map covering a large area is classified in cartography as a small-scale map, whereas a map covering a small area is defined as a large-scale map. This relates to the map's representative fraction.

The 1:250,000 fraction is greater than the 1:50,000,000 fraction, much like 1/2 is greater than 1/4 and 1/3 is greater than 1/6. A simpler way of describing the difference, though, is that the characteristics of a large-scale map (buildings, highways, rivers, etc.) are greater than the characteristics of a small-scale map.

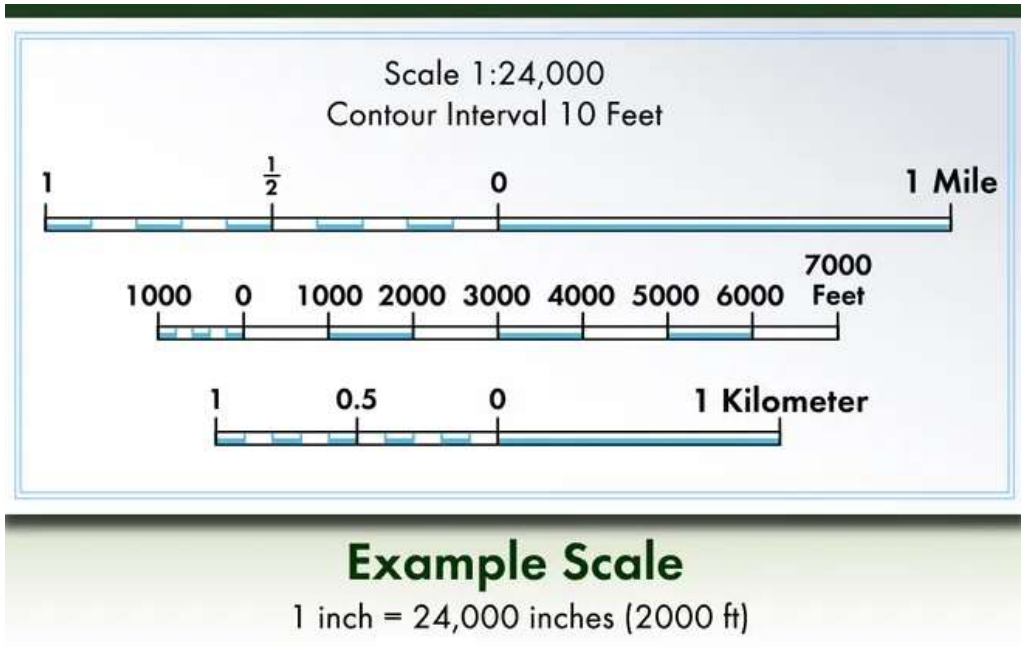
It must be remembered that although there is no standard unit of measurement for the absolute level of a map, like meters, feet, or miles, the scale bar is used as a reference bar for map readers.

scale representation

representative fraction

Scale bar

Verbal



Scale Examples

Common Scales

1:200 (1”=16.8ft)

1:2,000 (1”=56 yards; 1cm=20m)

1:20,000 (5cm=1km)

1:24,000 (1”=2,000ft)

1:25,000 (1cm=.5km)

1:50,000 (2cm=1km)

1:62,500 (1.6cm=1km; 1”=.986mi)

1:63,360 (1”=1mile; 1cm=.634km)

1:100,000 (1”=1.58mi; 1cm=1km)

1:500,000 (1”=7.9mi; 1cm=5km)

1:1,000,000(1”=15.8mi; 1cm=10km)

1:7,500,000(1”=118mi); 1cm=750km)

Large versus Small

large: above 1:12,500

medium: 1:13,000 - 1:126,720

small: 1:130,000 - 1:1,000,000

very small: below 1:1,000,000

(really, relative to what’s available for a given area; Maling 1989)

Map sheet examples:

1:25,000: 7.5 minute SOI Toposheets

1:50,000 15 minutes

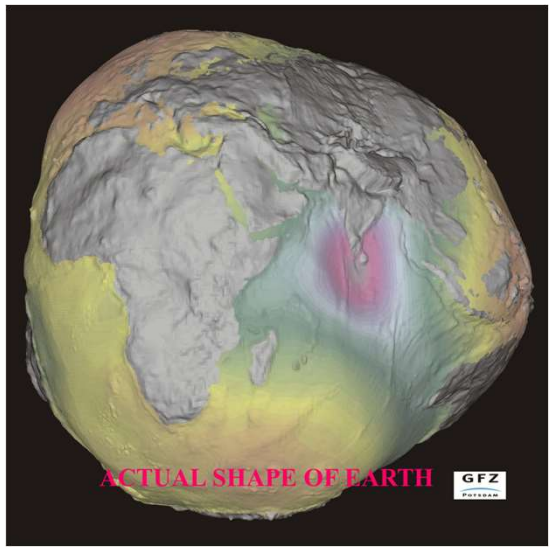
Example of Resolution, Scale, Accuracy relation

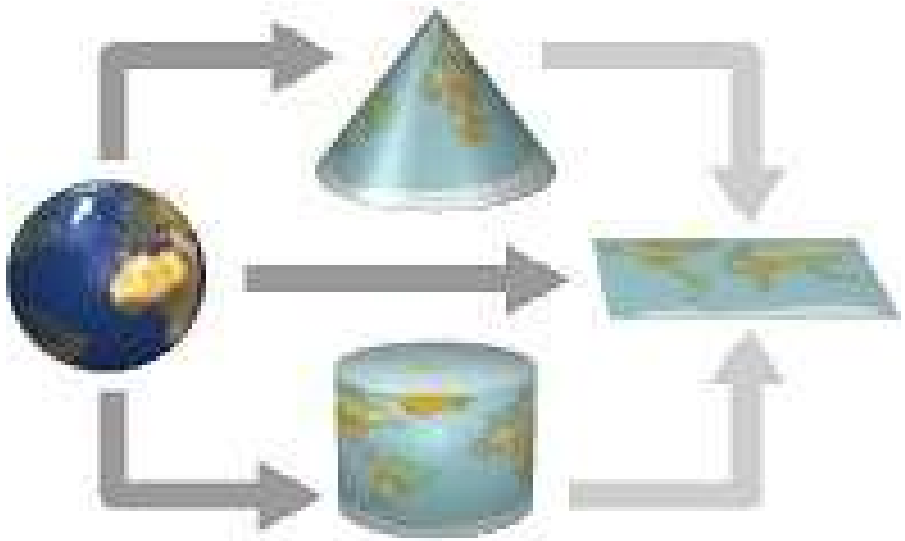
Pixel (actual meters)	Map Scale (max.)	Accuracy (max. meters)	Accuray (NMAS meters (ft))
5	1:24,000	5	12.2 (40.0)
2	1:9,600	2	8.1 (26.7)
1	1:4,800	1	4.06 (13.33)
0.5	1:2,400	0.5	2.03 (6.67)
0.25	1:1,200	0.25	1.0 (3.33)
0.125	1:600	0.125	

Map Projection and Coordinate System

What is Map Projection?

- Transformation of Three-Dimensional Space onto a two-dimensional map
- A systematic arrangement of intersecting lines on a plane that represent and have a one-to-one correspondence to the meridians and parallels on the datum surface





Classification

- A) Based on Extrinsic property
- Nature:
  - Plane, Cone, Cylinder
- Coincidence:
  - Tangent, Secant
- Position:
  - Normal, Transverse, Oblique

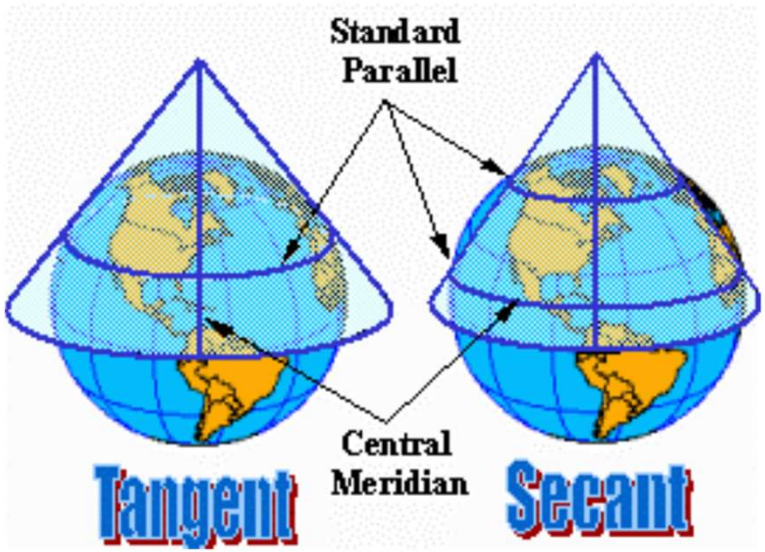
- B) Based on Intrinsic Property
- Property of Projection:
  - Equidistant
  - Conformal or Orthomorphic
  - Equivalent or Equal area

Generation Methods:

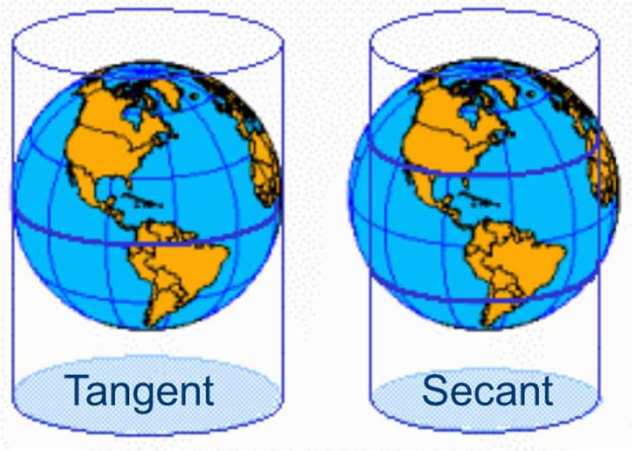
- Geometric, Semi Geometric, Mathematical

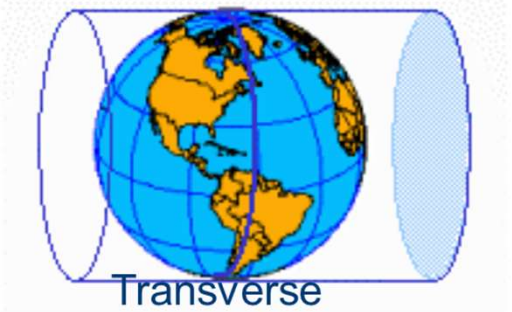
The projection surfaces is used

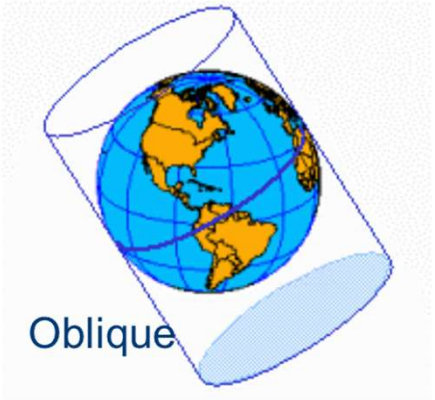
Conical



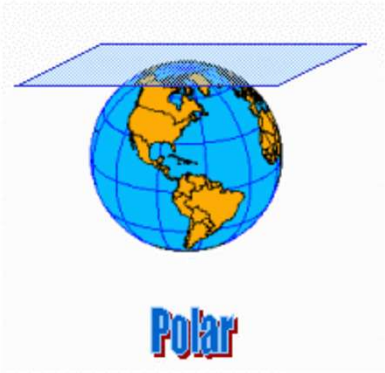
Cylindrical

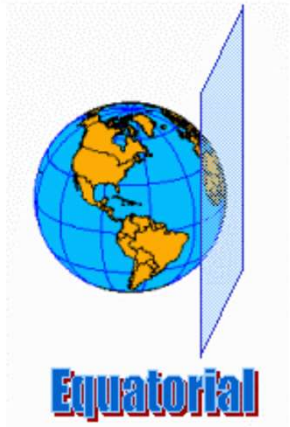


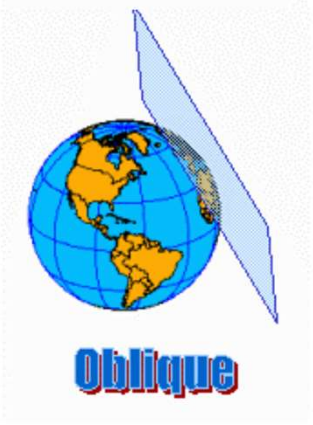




Azimuthal







Cylindrical Map Projections

- Cylindrical map projections are made by projecting from the globe onto the surface of an enclosing cylinder, and then unwrapping the cylinder to make a flat surface
  - Mercator
    - Conformal
    - Meridians are equally spaced straight lines
    - Parallels are unequally spaced straight lines
    - Scale is true along the equator
    - Great distortion of area in polar region
    - Used for navigation
  - Transverse Mercator
    - Conformal
    - Central meridian and equator are straight lines
    - Other meridians and parallels are complex curves
    - Used extensively for quadrangle maps at scales from 1:24,000 to 1:250,000
    - For areas with larger north-south extent than east-west extent
  - Cassini-Soldner
    - Equidistant
    - Cylinder is tangent along the meridian centrally located
    - Scale deteriorates away from central meridian
    - Normally used in 70 km belt from the central meridian, as linear distortion factor at 70 km is 1.00006
    - Used for old cadastral surveys in India

Conic Projections

- For a conic projection, the projection surface is cone shaped
- Locations are projected onto the surface of the cone which is then unwrapped and laid flat

Lambert Conformal Conic Projection

- Conical, Conformal
- Parallels are concentric arcs
- Meridians are straight lines cutting parallels at right angles.
- Scale is true along two standard parallels, normally, or along just one.
- It projects a great circle as a straight line – much better than Mercator
- Used for maps of countries and regions with predominant east west expanse
- Used for plane coordinate system (SPCS) in USA

Polyconic Projection

- In this projection all parallels are projected without any distortion
- Scale is exact along each parallel and central meridian.
- Parallels are arcs of circles but are not concentric.
- It is neither conformal nor equal area.
- Central meridian and equator are straight lines; all other meridians are curves.
- Central Meridian cuts all parallels at 90 degrees
- Free of distortion only along the central meridian.
- It has rolling fit with adjacent sheets in EW direction.
- Was used in India for all topographical mapping on 1:250,000 and larger scales.

Azimuthal Projections

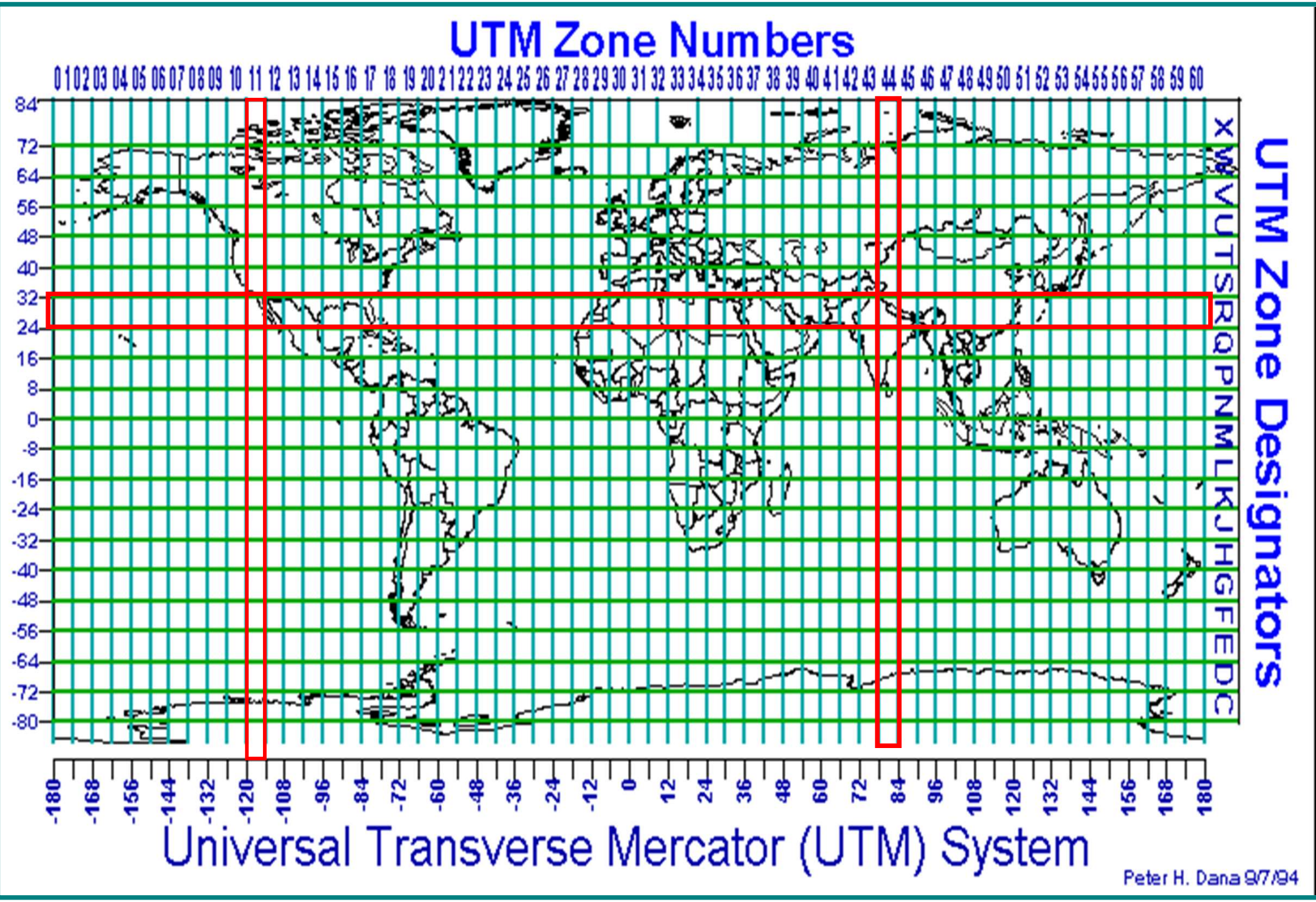
- For an azimuthal, or planar projection, locations are projected forward onto a flat plane.
- The normal aspect for these projections is the North or South Pole.

Universal Transverse Mercator

There are four elements in a UTM Grid reference and these are:

1. UTM Grid Zone number.
2. A pair of letters identifying a 100000 metre grid square.
3. An Eastings and northings value in metres.
4. A northings value in metres.

To keep distortion within acceptable limits narrow longitudinal portions of Earth's surface are mapped on to the projection surface.


UTM Zone Numbers
0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 1 0 1 1 1 2 1 3 1 4 1 5 1 6 1 7 1 8 1 9 2 0 2 1 2 2 2 3 2 4 2 5 2 6 2 7 2 8 2 9 3 0 3 1 3 2 3 3 3 4 3 5 3 6 3 7 3 8 3 9 4 0 4 1 4 2 4 3 4 4 4 5 4 6 4 7 4 8 4 9 5 0 5 1 5 2 5 3 5 4 5 5 5 6 5 7 5 8 5 9 6 0
84
72
64
56
48
40
32
24
16
8
0
-8
-16
-24
-32
-40
-48
-56
-64
-72
-80
X W V U T S R Q P N M L K J H G F E D C
UTM Zone Designators
-180 -168 -156 -144 -132 -120 -108 -96 -84 -72 -60 -48 -36 -24 -12 0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

Choosing a map Projection

- The choice of map projection is made to give the most accurate possible representation of the geographic information, given that some distortion is inevitable. The choice depends on:
- The location
- Shape
- Size of the region to be mapped
- The theme or purpose of the map

THANK YOU!