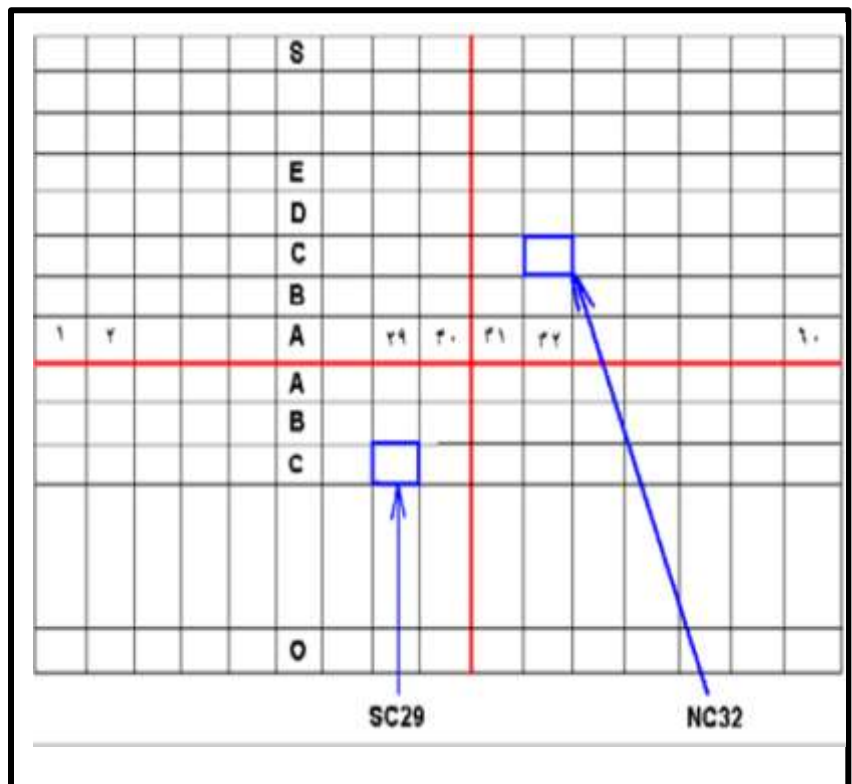




## Topic Three: A set of geographic coordinates

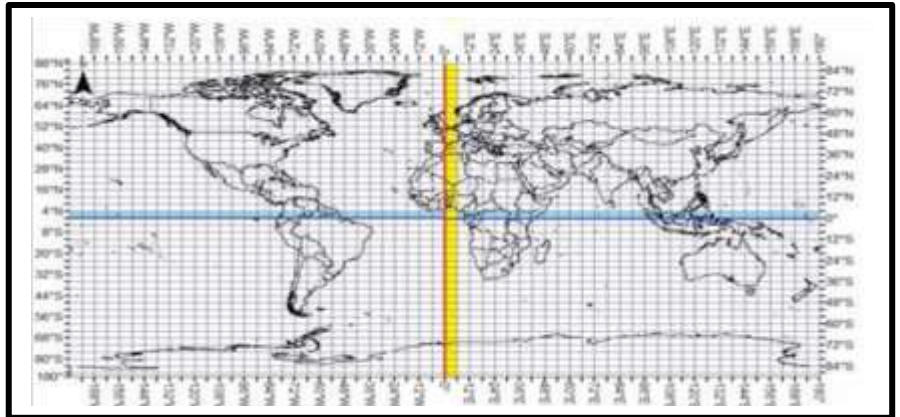
### 3.1 Cartesian geodetic coordinates

- We learned that **(Projection)** is the science of converting the Earth's spherical surface into a flat surface.
- The numbering system of these maps depends on the lines of longitude and latitude to prepare a numbering system that covers the entire Earth:
- The Earth is divided, starting from 180 degrees west longitude to 180 degrees east, into 60 slices, each slice is 6 degrees wide. The numbering of the slices starts from number 1 and the number increases as we move towards the east. Thus, the slice that ends at the Greenwich meridian (zero longitude) has a number of 30. While the first slice east of the Greenwich meridian has a number of 31.
- As for the poles, the transverse slices are 4 degrees longitude. The transverse slices are numbered with English letters starting with the letter A at the equator, then B, then C. And so on as we head towards the North Pole.
- Each rectangle has a specific name consisting of two letters and a number. For example, the rectangle or slice NC32 is located north of the equator because its name begins with the symbol N and the order of the letter C and the number of the longitudinal slice is 32. Meaning east of the Greenwich meridian.





- Each slice has a length of 6 degrees longitude and a width of 4 degrees latitude. It is drawn in Million map. At a scale of 1:1,000,000.



### - Longitude and time:

It is known that the Earth rotates on its axis in front of the sun once every 24 hours. That is, it completes 360 degrees in 24 hours at a rate of 15 degrees per hour. That is, it completes one degree in four minutes. Since the Earth rotates on its axis from west to east in front of the sun, it follows that places to the east always precede places to the west in time.

**Example:** If the time in Baghdad is 5 p.m., what is the time in London and New York, if you know that Baghdad's longitude is 45 degrees east, London's longitude is zero, and New York's longitude is 75 degrees west?

### The solution:

$45 - 0 = 45$  degrees difference in distance between Baghdad and London

$45 \times 4 = 180$  minutes

$180 / 60 = 3$  pm

$5 - 3 = 2$  pm

$75 + 45 = 120^\circ$  difference in distance between New York and Baghdad

$120 \times 4 = 480$  minutes

$180 / 60 = 8$  hours

$17 - 8 = 9$  am



**To calculate the range that covers a given area, we use the following equation:**

- If the area is located east of the Greenwich line

$$(\text{Longitude} / 6) + 31 = \text{range}$$

- If the area is located west of the Greenwich line (in this case, the longitude is represented by the negative).

$$(\text{Longitude} / 6) + 30 = \text{range}$$

### 3.2 Geographical geodetic coordinates:

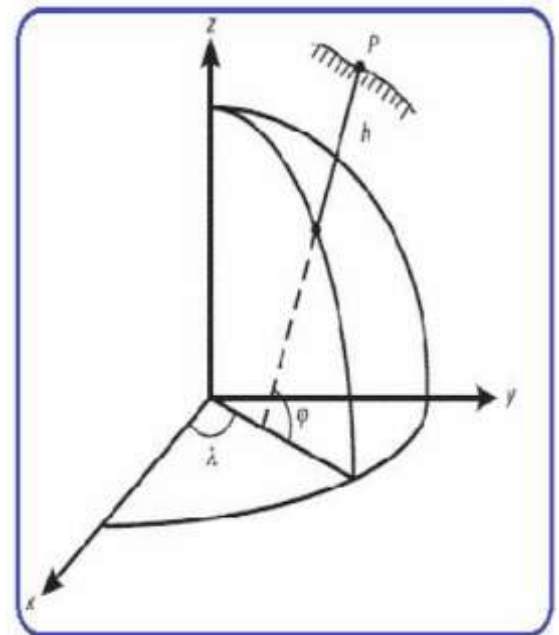
Spatial analysis in a GIS environment depends on the spatial characteristics of the locations of the phenomena under analysis. The spatial characteristics of any layer are represented in determining the type of coordinates used in the spatial signature, the type of projection used, and the earth model (reference) used in drawing the layer. Therefore, a GIS specialist needs to be familiar with the basics of coordinate systems and map projections to conduct an accurate spatial analysis.

- The shape of the natural surface of the Earth, including continents, oceans, mountains, valleys, and seas, is not an easy shape or regular enough to be easily expressed.
- The geoid is the true shape of the Earth, and it is an irregular shape that is difficult to represent with mathematical equations. Scientists have turned to searching for the closest known geometric shapes and have found that the ellipse or ellipsoid is the closest. If this ellipsoid rotates around its axis, it will produce the ellipse or ellipsoid.
- It is a coordinate system whose center is the Earth and whose axes are fixed with the Earth during its rotation, and therefore it is called a fixed geocentric system. The center of the system is located at the center of gravity of the Earth and its vertical axis Z coincides with the axis of rotation of the Earth its first axis X is directed with the Greenwich line while its second axis Y is perpendicular to the X axis.
- The location of any point in this system is represented by three coordinates, i.e. the 3D system is:



1. **Longitude** is symbolized by the Latin symbol ( $\lambda$ ) pronounced **lambda**, which is the angle measured in the equator between the Greenwich line (the longitude internationally agreed to be zero degrees) and the longitude of the desired point.
2. **Latitude** is symbolized by the Latin symbol ( $\phi$  or  $\varphi$ ) pronounced **phi**, which is the angle in the vertical plane made by the vertical direction passing through the desired point with the equator.
3. Height above the surface of the ellipsoid symbolized by the symbol  $h$  and called the geodetic height.

- Latitude and longitude represent **the geographic coordinates** ( $\phi, \lambda$ ) of a point **P** with respect to the selected reference surface. They are also called **geodetic**.
- **Coordinates** or ellipsoidal coordinates when an ellipsoid is used to approximate the shape of the Earth. Geographic coordinates are always given in angular units.
- There are several formats for the angular units of geographic coordinates. The (DMS) Degrees: Minutes: Seconds ( $49^{\circ}30'00''\text{N}$ ,  $123^{\circ}30'00''\text{W}$ ) is the most common format, another the Decimal Degrees ( $49.5000^{\circ}$ ,  $-123.5000^{\circ}$ ), generally with 4-6 decimal numbers.



### 3.3 Plane coordinate system:

Planar coordinate systems locate data on the flat surface of a map in a 2D space. This includes 2D Cartesian Coordinates and 2D Polar Coordinates.

#### Explanation

A flat map has only two dimensions: width (left to right) and length (bottom to top). Transforming the three-dimensional Earth onto a two-dimensional map is the subject matter of map projections and coordinate transformations. Here, as for several other cartographic applications, two-dimensional Cartesian coordinates ( $x$ ,  $y$ ), also known as planar rectangular coordinates, describe the location of any point unambiguously.



- 1. 2D Cartesian Coordinate System (X,Y):** The 2D Cartesian coordinate system is one of intersecting perpendicular lines with the X-axis and the Y-axis as principal axes. The X-axis (the Easting) is the horizontal axis and the Y-axis (the Northing) is the vertical axis with an intersection at the origin. The plane is marked at intervals by equally-spaced coordinate lines that together form the map grid . Given two numerical coordinates  $x$  and  $y$  for point  $P$ , one can unambiguously specify any location  $P$  on the map.
- 2. The 3-D coordinate system :** The 3-D coordinate system is known as latitude, longitude, and radius to specify the location. 3-D coordinate systems that represent a sphere such as the Earth. The important thing to note about the 3-D coordinate systems is that they will not ignore the curvature of the earth, which makes it ideal for displaying locations and measuring distances across long distances.

**Reference Data:** According to the National Geodetic Survey, reference data is a set of constants that define the coordinate system used to calculate the coordinates of points on the Earth. Reference data serves as a starting point of reference for surveying and mapping because it links the physical Earth to mathematical coordinates. Reference data is a reference surface for measuring locations on the Earth. Reference data has two main components specifying the origin and direction of lines of latitude and longitude. We cannot assign any coordinates to a location without first specifying reference data and relating that reference data to the shape of the Earth through field measurements. WGS 84: A common reference point is the World Geodetic System 1984, commonly referred to as WGS 84. It is based on satellite measurements. Its data has global coverage and is used by Global Positioning Systems (GPS) to report latitude and longitude.

