



**HARAMAYA UNIVERSITY**  
*Building the Basis for Development*

**COLLAGE OF COMPUTING AND INFORMATICS**

**DEPARTMENT OF INFORMATION SYSTEMS**

**COURSE: GIS & REMOTE SENSING**

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Submission Date: March 15,2024

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## Advantages of Maps over Globes

Maps only show us a particular location on Earth, but a globe shows the entire planet at once. The map is your best option if you want to view a specific location, such as a city, nation, or continent. An additional important consideration is the variety of maps. There are numerous uses for road maps, political maps, topographic maps, physical maps, and a host of other map types. You may choose the right map based on your needs and objectives.

- ❖ **Accessible and Portable:** Compared to globes, maps are often more portable and accessible. People may take them on travels, walks, and adventures since they are simple to fold, store, and carry. Maps are useful for both fieldwork and everyday use because of their mobility.
- ❖ **Simple Visualization:** Because maps are two-dimensional and flat, it is simpler to see and evaluate the relationships, patterns, and distances between various locations. They enable the precise visualization of spatial relationships, such as the arrangement of roads, the distribution of natural resources, or the proximity of cities.
- ❖ **Different Map Projections:** A flat map can depict the surface of the Earth thanks to map projections. Various projections can be employed to highlight specific elements, like maintaining precise dimensions, forms, or separations. Because of this flexibility, cartographers can modify map projections to meet particular requirements.
- ❖ **Detailed Information:** Political boundaries, population density, transit systems, and theme data are just a few examples of the many types of information that can be included in maps. Maps are versatile because of their capacity to incorporate additional data, which enables the representation of different geographical phenomena.
- ❖ **Focus on a Specific Area:** Maps enable one to closely examine a particular region or area when performing regional data analysis, developing urban infrastructure, or researching local geography. A map of New York City, for instance, would be an essential tool for both locals and visitors to navigate the city as it would contain important details about its boroughs, neighborhoods, subway lines, and tourist attractions.
- ❖ **Updated Data:** Adding new roads, buildings, or landmarks to maps to reflect topographical changes is a straightforward process. On the other hand, because they are hard to update, globes can become outdated over time. Online mapping services like Google Maps, for example,

regularly update their data to reflect the most recent street plans, traffic patterns, and business locations.

- ❖ **Different Map Types:** Maps come in a variety of forms, such as political, climate, topographic, and themed maps. Each variety provides unique data and serves a specific purpose. A topographic map of a mountainous region, for instance, would show particular features of the terrain, such as elevation, contours, and water bodies, to aid geologists, surveyors, and hikers in their work.
- ❖ **Navigation and Route Planning:** Due to their ability to assist with route planning, distance calculations, and road condition forecasting, maps are a popular navigational tool. Online mapping tools, like GPS devices and smartphone applications, have revolutionized navigation by offering real-time turn-by-turn directions, traffic updates, and alternative routes.
- ❖ **Communication and Education:** Maps allow people to visually communicate information about features, habitats, historical events, and other topics. As such, they are useful tools for education and communication. For instance, maps are widely used to depict ideas like population density, disease transmission, and migration patterns in textbooks, museum exhibits, and presentations.

## Datum

A datum is a reference surface or model used to define the position of points on the Earth's surface. It provides a framework for mapping and geospatial measurements.

Depending on the context, some ideas can be referred to as datums. The following are two common definitions of datum:

- A. **Geodetic Datum:** To precisely depict the locations of points on the surface of the Earth or other planetary bodies, a geodetic datum is a reference framework used in geography and geodesy. It offers a standardized and uniform set of coordinates that are used for positional calculations, mapping, and surveying. The size, shape, orientation, and center of the Earth or a planet are defined by geodetic datums, as is the reference surface (such as sea level) from which heights or depths are measured.
- B. **Manufacturing and engineering:** A datum is a reference point, line, or plane that is used for measurements and to determine the dimensions, tolerances, and geometric properties of a

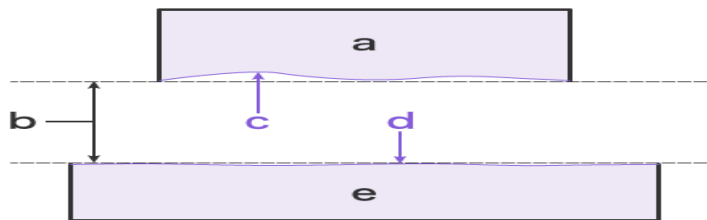
part or object. It acts as a constant point of reference for coordinating and contrasting the object's other features. In many cases, symbols found in Geometric Dimensioning and Tolerancing (GD&T) standards are used to identify datum features.

In both situations, a datum ensures consistency and precision in spatial or dimensional relationships by offering a known reference point for additional measurements and computations.

### **Datum Framework**

a set of datums that is produced by aggregating multiple individual datums for use as a tolerance feature reference.

A part's surface that is designated as a datum is not precisely formed. As a simulated datum, a surface plate, gauge, or mandrel which have a more precise surface must thus come into contact.



A=Goal segment

b= Conceptual Datum

c= Datum feature (part's plane or line)

d= Simulated datum feature, such as a surface plate or gauge plane or line.

e= Mandrel, gauge, surface plate, etc.

### **Differences between Local and Global Datum**

**A local datum:** is a horizontal datum used to represent a point's location on the surface of the Earth within a specific area. It is predicated on a reference point situated there, like a GPS benchmark or a triangulation station. Local datums are frequently employed in mapping and surveying initiatives inside a given nation or area.

On the other hand, a **global datum** is a horizontal datum that can be used to represent a point's location on the Earth's surface anywhere in the world. The Earth's center of mass serves as the reference point for it. Global datums are widely used by positioning and navigation applications such as GPS and GNSS.

Here is a table that summarizes the key differences between local and global datums:

<b>Feature</b>	<b>Local datum</b>	<b>Global datum</b>
<b>Spatial coverage</b>	Limited area	Global
<b>Reference point</b>	Located within the area of use	Located at the Earth's center of mass
<b>Applications</b>	Surveying and mapping within a particular country or region	Navigation and positioning applications

## **Difference between GCS and PCS**

The Geographic Coordinate System (GCS) and the Projected Coordinate System (PCS) are two distinct approaches used by geographic information systems (GIS) and cartography to represent locations on Earth's surface. The primary differences between the two are as follows:

### **A) Coordinate System of the World (GCS):**

GCS is an angular measurement system that represents locations on Earth's surface using latitude and longitude. Longitude is the measurement of an object's position from east to west, whereas latitude is the measurement from north to south.

It is based on a three-dimensional model of Earth that mostly shows the planet as an ellipsoid or sphere. Because GCS coordinates do not take into account the curvature of the Earth, they are not suitable for precise measurements of area and distance.

GCS is mainly utilized for site localization, navigation, and global positioning on Earth's surface. Two instances of GCS are the World Geodetic System (1984) and the North American Datum (1983).

## **B) Projected Coordinate System (PCS)**

A 2D, flat representation of a location on Earth's surface is created using the PCS system, making it appropriate for precise measurements of area and distance. It is converting the three-dimensional GCS coordinates into a two-dimensional plane, usually by means of a map projection, which may result in some distortions. Cartography, mapping, and other spatial analysis tasks are performed with PCS. Particularly useful for local and regional mapping is this.

**PCS** coordinates are commonly used for measuring areas, distances, and performing geometric calculations. They are typically expressed in linear units, such as meters or feet, and are commonly employed in geometric computations, area measurement, and distance measurement. To minimize distortion and achieve accuracy at the local level, different regions or countries may choose to utilize their own unique projected coordinate systems.

## **UTM (Universal Transverse Mercator)**

The coordinate system and map projection known as the Universal Transverse Mercator, or UTM, is used to represent locations on Earth's surface with the least amount of distortion possible, particularly in large-scale maps. The world is divided into several zones by the UTM system, each with a unique set of coordinates.

### **Important attributes and features of the UTM system consist of:**

- ❖ **Zone System:** Beginning at the international date line in the Pacific Ocean, the Earth is divided into a number of longitudinal zones, each of which normally spans six degrees of longitude. There exist the equator is the origin of all 60 UTM zones, which are numbered from -60 in the west to +60 in the east.
- ❖ **Transverse Mercator Projection:** A 2D depiction of the Earth's surface is produced within each UTM zone using the Transverse Mercator projection. Because of its minimal distortion of angles and distances within the zone, this projection is appropriate for local navigation and mapping.

- ❖ **Coordinates:** Within each zone, the easting (x) and northing (y) values of UTM coordinates are expressed in meters. Northing values are measured from the equator, and easting values are measured from a central meridian, which is a particular longitude within the zone. Usually, easting and northing have origins of 500,000 meters, which results in positive values in the east.
- ❖ **Zone Parameters:** A central meridian and a reference ellipsoid, which depict the dimensions and form of the Earth within the zone, define each UTM zone. To calculate UTM coordinates accurately, this information is essential.
- ❖ **False Northing:** To make sure that all values are positive and facilitate mathematical manipulation of the coordinate system, a false northing is appended to all UTM coordinates in the southern hemisphere.
- ❖ **Worldwide Coverage:** UTM is extensively utilized for global large-scale mapping and navigation, with regional modifications to account for local circumstances.
- ❖ **Accuracy:** UTM is suited for tasks like topographic mapping, land surveying, and GPS-based navigation because it offers comparatively high accuracy for measurements made inside a defined zone.

## Places Where GPS Does Not Function

Despite being a strong and popular navigation and positioning tool, the Global Positioning System (GPS) has limitations and may not work properly in some circumstances or places. Among these locations and situations are:

- ❖ **Indoor Environments:** Accurate GPS positioning indoors can be difficult due to buildings' resistance to GPS signals. Indoor GPS is not as common as outdoor GPS, but it is present in some modern buildings.
- ❖ **Urban Canyons:** In crowded urban areas, tall buildings have the potential to reflect or block GPS signals, resulting in reduced signal strength and positional inaccuracies.
- ❖ **Heavy Tree Cover:** GPS signals can be attenuated by dense tree cover in forests or other wooded areas, making it difficult to get a dependable fix beneath the canopy.



- ❖ **Tunnels:** GPS signals are completely blocked when passing through tunnels, and the device is unable to determine your location until you emerge.
- ❖ **Caves:** In a similar vein, caves are not serviced by GPS signals, necessitating the use of inertial navigation or specialized cave mapping technologies.
- ❖ **Underwater:** GPS signals are useless for underwater navigation because they cannot pass through water. Submarines and underwater vehicles usually use other types of navigation, like acoustic or inertial.
- ❖ **Remote Wilderness Areas:** Due to a lack of nearby ground-based GPS infrastructure (monitoring stations), GPS coverage may be minimal or nonexistent in extremely remote and uninhabited wilderness areas.
- ❖ **Radio Interference:** GPS signals can be interfered with or jammed by radio frequency interference, which can make precise GPS positioning difficult or impossible. This can be intentional or unintentional interference.
- ❖ **Space weather:** GPS signals can be interfered with by solar flares and geomagnetic storms, which can alter the Earth's ionosphere and lead to temporary outages or inaccurate readings.
- ❖ **Military Restricted Zones:** To stop unauthorized users from using GPS signals, certain military or sensitive areas may purposefully block or degrade GPS signals.
- ❖ **Aircraft at Altitude:** Although GPS is extensively utilized in aviation, there may be restrictions when flying at extremely high altitudes, so aircraft may need to rely on alternative navigation techniques like inertial navigation or ground-based systems.
- ❖ **Electronic Devices Close by:** Occasionally, GPS receivers may experience difficulties acquiring and tracking signals due to strong radiofrequency interference (RFI) or electromagnetic interference (EMI) from nearby electronic devices.

## Ethiopia's UTM Zone

Because of its vast east-west extent, Ethiopia is situated in several UTM (Universal Transverse Mercator) zones. Ethiopia is primarily covered by the following UTM zones:

- ❖ **UTM Zone 35 (East):** This zone encompasses the majority of the Somali Region as well as the eastern portion of Ethiopia. This zone extends from longitude 36°E to 42°E.

- ❖ **UTM Zone 36 (East):** Addis Ababa, Ethiopia's capital, and the rest of the country's center are located in UTM Zone 36. This zone extends from longitude 30°E to 36°E.
- ❖ **UTM Zone 37 (East):** This zone encompasses the western portion of Ethiopia, which includes parts of the Oromia and Southern Nations, Nationalities, and People's (SNNP) regions. This zone extends from longitude 24°E to 30°E.

These UTM zones span the whole breadth of Ethiopia and are oriented from east to west. The following are the cardinal directions for each of these zones:

- UTM Zone 35 (East): This zone's central meridian is north to south. Thus, South, North, East, and West are this zone's cardinal directions.
- UTM Zone 36 (East): A central meridian extending from south to north is also present in this zone. The cardinal directions of this zone are north, south, west, and east.
- UTM Zone 37 (East): Similar to the zones before it, the central meridian of this zone runs from south to north. The cardinal directions of this zone are north, south, west, and east.

## Importance of Coordinate Systems in GIS

In a GIS, a coordinate system is comparable to the Earth's global address system. It provides a distinct set of numbers to each point on the earth, which are commonly expressed as latitude and longitude or easting and northing. This system makes it simpler to locate specific locations for features, objects, and places by using digital databases or maps. It is the foundation for all geographic information and allows us to map, navigate, and analyze spatial data with devices like GPS.

Consider coordinate systems as data and map equivalents of the GPS. They give computers a common language to comprehend location in the world. Coordinate systems are essential for accurately representing and working with geographic data, whether it is for managing city infrastructure, tracking the spread of diseases, or finding your way on a road trip.