# 4

# COORDINATES

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## 4.1 Introduction

The accurate location of features in space is an indispensable attribute of spatial planning. This is often enhanced by the application of geospatial tools (GIS, Decision Support system and Planning Support System). According to Environmental System Research Institute (2011), geospatial tools help in comprehending geographical location and make intelligent decisions. Despite the relevance of geospatial tools, they remain a useless facility if coordinates are not integrated. Coordinates are important components of geospatial map-making, location of features and land surveying (Ayeni, 2010). Coordinates can be defined as a set of values that show an exact position on the earth's surface. These values can be given to anyone in the world and physically existing life places will be pinpointed with precision.

Chale (2010) opines that real life places in space can be located via the use of coordinates. This implies that, coordinates provide a basis for identifying locations and features on the earth's surface with much precision. During the World War I, it was difficult for the military to arrive at a precise azimuth and range calculation of targets. This made armies to shoot arbitrarily without hitting their targets (Ayeni, 2010). To address the problem of random shot, the French army were able to construct a series of local plane, rectangular coordinates grids on their maps. The inclusion of the rectangular coordinate grids on maps helped the French army to achieve a precise shot in war front (Ayeni, 2010). To achieve precise shots, other armies had no choice other than to follow suit in incorporating coordinates on their maps.

The issue of precision is also peculiar to the field of urban and regional planning, where data are often gathered on site during reconnaissance survey. Data of features gathered by the planner should not be presented to stakeholders with error. To this effect; coordinates are often employed by planners so as to achieve spatial quality in data presentation. ESRI (2006) argues that spatial quality of features obtained on site can help planners to integrate and organize information accurately. This means that, coordinates have helped to surmount day-to-day problems encountered by planners with regard to data gathering and presentation. Against this background, the concept of coordinates relative to its definition and its relationship to urban and regional planning education and Practice will be discussed in this chapter.

## 4.2 Concept of Coordinates

Coordinates can be defined as distances or angles, represented by values, which uniquely identify points on the surfaces of two dimensions or in space of three dimensions (Rouse, 2005). The coordinate values of a particular location are entirely different from the coordinate of another. Coordinates of locations are frequently defined by a coordinate system. A coordinate system is a reference system used to represent the locations of geographic features, imagery, and observations, such as GPS locations within a common geographic framework. Coordinate systems are used to enable geographic datasets to use common locations for integration (ESRI, 2010).

Coordinate systems are often defined by unit of measurement, measurement framework which is either geographic or planimetric (in which the earth's coordinates are projected onto a two-dimensional planar surface), the map projection for projected coordinate systems and other measurement system properties, such as a spheroid of reference, a datum, and projection parameters, like one or more standard parallels, a central meridian, and possible shifts in the x- and y-directions (ESRI, 2010). Coordinate systems have different methods of splitting up the earth and also enable every location on the earth to be specified by a set of coordinates of known location on a grid (Chale, 2010).

All coordinate systems are tied to a datum which defines the starting point from which coordinates are measured (Fang et al., 2014). Datums are defined as geographic shapes of the Earth, which can be applied to maps so that coordinate systems can work perfectly. Datums can either be locally referencing or globally referencing. A locally referenced datum is a datum that has been developed for a set local area, often on a national level. For example, Minna, Niger State is set as the datum for Nigeria's coordinate system. The global referencing datum best estimates the size and shape of the Earth as a whole but is not good at calculating precise coordinates on a national scale (Chale, 2010).

### 4.2.1 Evolution of Coordinates

Distance and direction were reckoned by primitive people in terms, with respect to their own location (Ayeni, 2010). To express direction and distance, the sun's position and body part or travel time were used, respectively (Ayeni, 2010; Thorstensen, 2016). These expressions of location recognizes topology, but gave little recognition to the metric properties of measurements. To locate points precisely both topology and a strict metric form of measurement coordinate systems are needed (Ayeni, 2010).

The coordinate systems mostly used are the geographical coordinates and the rectangular coordinates or plane coordinates. The older of these two coordinates is the geographical coordinates. The geographical coordinates, which use latitude and longitude was first used by Greek philosophers/geographers before the Christian era. The geographical coordinate is primary, because it is used for all basic locational reckoning, such as, navigation and fundamental surveying (Ayeni, 2010). On the other hand, the rectangular coordinates or plane coordinates are features of the Chinese cartography after being included in the six principles of map making by Pei Hsiu in the 3rd century AD (Ayeni, 2010).

The plane coordinate system (rectangular coordinates) evolved from the Cartesian coordinate system which gained its name from a French mathematician and philosopher René Descartes (1596-1650). René Descartes was most famously known for his work on merging algebra and geometry into algebraic geometry (Lawrence, 2007). The Cartesian Idea was developed by René Descartes in 1637 in his book *Discourse on Method* to which an appendix *the Geometry* (*La Géometrié*) was added, trying to mathematically show the application of his philosophy (Lawrence, 2007). The Cartesian coordinates is used to uniquely determine a point in two-or three-dimensional space by its distance from the origin of the coordinate system. The Cartesian coordinates are often applied to maps for military needs (Ayeni, 2010).

### 4.2.2 Types of Coordinates

There are two major global coordinate systems, known as the "Geographic Coordinate System" (a global or spherical coordinate system, such as latitude-longitude) and a projected coordinate system, such as Universal Transverse Mercator (UTM). These two coordinate systems provide a framework for defining real-world locations (Chale, 2010).

The *Geographical Coordinates* divide the earth into grids of circular segments which are perpendicular to one another, called latitude and longitude. *Latitude* lines run horizontally, and are parallel to the equator. Degrees of latitude are numbered from 0° to 90° north and south. Zero degrees (0°) is the equator, 90° north and 90° south are the North Pole and South Poles, respectively (Figure 4.1). Latitude is commonly the first number expressed in a lat/long coordinates and is often expressed in the form of degrees, minutes, and seconds (N9°16' 11.62" E7°13' 01.69"). The lines of longitude (also called meridians) run perpendicular to the line of latitude lines. Their spacing is widest at the equator, and converges at the Poles (Figure 4.1). The Geographical Coordinates are useful for locating positions uniformly on the curved surface of the earth (Ayeni, 2010).

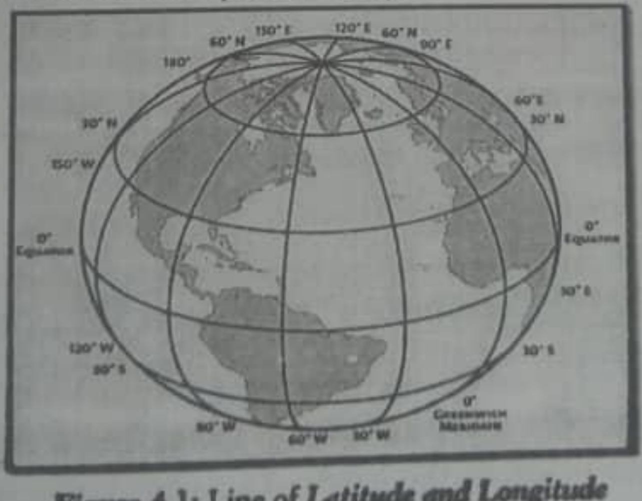


**Figure 4.1:** Line of ***Latitude and Longitude***
**Source:** ***National Geographic*** **(2002)**

The Universal Transverse Mercator System provides the mechanism to project maps of the earth's spherical surface onto a two-dimensional Cartesian coordinate plane (Chale, 2007). The Universal Transverse Mercator grid is commonly referred to as UTM and it is based on the Transverse Mercator projection. The UTM is a coordinate system that largely covers the globe. The UTM coordinate system reaches from 84 degrees north to 84 degrees south latitude, and it divides the Earth into 60 north-south oriented zones that are 6 degrees of longitude wide (Figure 4.2). The UTM is reported numerically as "eastings" and "northings" for example, 304155.65m east, 1025182.17m north.

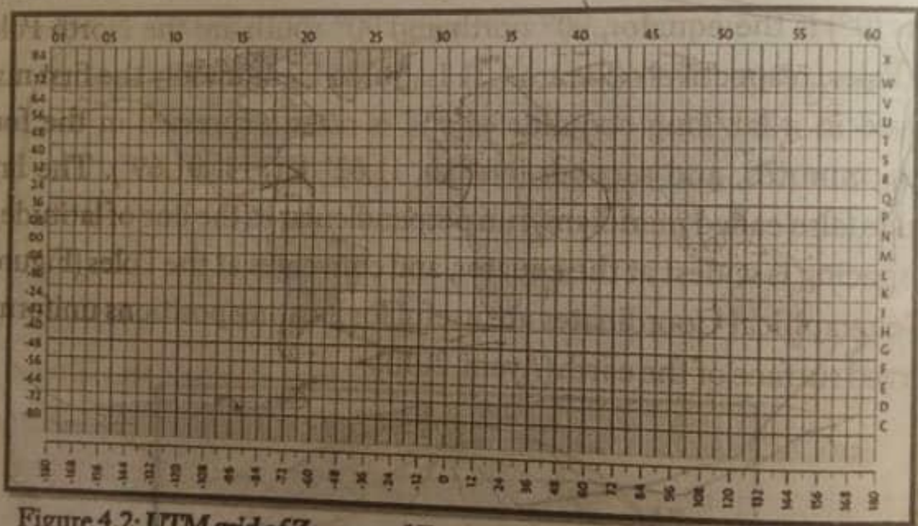


Figure 4.2: *UTM grid of Zones and Zone Characters, C – X*
Source: *National Geographic* (2002)

## 4.3 Relationship of Coordinate with Urban and Regional Planning Practice

Planning, has a discipline and profession, is focused on making choices from various alternatives to satisfy the needs of a particular location, people and settlement at any given time. It can be said that planning practice is time-and location-based. The aptness of coordinates cannot be ignored in the field of urban and regional planning. Coordinates help the planner to accurately locate spatial features on the earth's surface. They also allow for statistical analysis of these points (features). With this, the planners can ascertain if spatial distributions of features (water mains, transformers, skip bins, street lights, security post, etc.) identified on the site are random, cluster or sparsely distributed.

Facility mapping and provision, part of the basic duty of planners will be difficult to accomplish and also impossible without coordinates. To avoid falsification of data, planners now use applications synchronized with coordinates (Open Data Kits) so as to ensure that data gathered in fields by research assistant are genuine. Also, Geo-database of spatial features (skip bins, street lights, bore holes, etc.) can be created by the urban planners using coordinate systems. To verify the authentication of any property (land) in a region, coordinates are often used by the urban planners for "charting" to check if any property (land) exist/registered with the Ministry of Lands before any development is approved by the planner. Coordinates have now made it possible for urban planners to track and know directions of features in space.

House coordinates are used to determine the number of addresses per building object by planners; and, in storing official documents on buildings, coordinates of buildings can be used as auxiliary data (Hecht et al., 2015). Coordinate points can be used in representing all addresses of buildings in a region. This information is used by the planner to identify buildings that are not compatible in an area from the compatible ones (zoning). Coordinates can be used by planners to describe the types and function of buildings (land use classification) in an area.

Coordinates provide a planner with a vital reference when calculating contextual features, such as the building density or the mean distance between buildings (Hecht et al., 2015). Urban planners use coordinates in preserving building planning information instead of adopting the outdated means of keeping data on filling cabinets.

Urban design experts depend on coordinate systems provided by geospatial tools to be able to use planning applications such as Google Earth, ILWIS, ArcGis, and QGIS for analysis on positions on the earth surface. Global Positioning System a tool of great relevance to planning activity works on the guiding principle of coordinates.

Coordinates will help the planner achieve effective "ground truthing" and reconnaissance survey. The "ground truthing" and reconnaissance survey are often done, when planners try to verify features on earth's surface that seem unclear on satellite images and establishment of site boundaries, respectively.

The planner can use coordinates to map out prevalent crime spots in an area/region. The planner can invariably use these coordinates to distinguish areas of hot spots from areas of light crime. When this knowledge (coordinate) is shared with security operative, security forces can be mobilized to appropriate locations with precision. For example, if crime is committed in the Beere Neigbourhood of Ibadan, and the security forces were asked to dispatch men to the neighbourhood. Much time will be spent by security operative looking for the crime scene and sometimes security operative may rush to a wrong place. But when coordinates are given, the security forces will just drive to the scene without confusion (230396.63m east, 1060602.60m north: crime scene Beere) without missing their way. The knowledge of coordinates does not only help planners advise security operatives in discharging their duties, but it also helps the planner give an articulated crime report for a region.

Transportation planning can be enhanced when coordinates are employed by the planner. Effective transportation planning is often achieved when a "comprehensive card catalogue" is built. The planner can store 10,000 or more coordinates of geographical names on the card catalogue. Coordinates of Landmarks or milestones, stations (bus, train), bridges and tunnels can also be catalogued. Ruxton (1945) explains that the card catalogue system is adopted by rail stations in the United States to transmit the location of any serious derailment or crime to the emergency department and police department.

Transportation planners also use GSP tracker system which is enhanced by coordinates to monitor mass transit. For example, the Abuja Urban Mass Transportation Company (AUMTC) embraced this technology (GSP Tracker) to monitor driver's speed limit and the present location of the drivers on transit (Obike, 2014). In case of theft or road crash, vehicles can be easily spotted. Coordinates on GPS tracks are used by transportation planners to trigger automated stop announcements (Brown, 2011). About 50% of the buses of the American Public Transportation Association (APTA) utilizes the GPS technology to trigger automated stop announcements (Brown, 2011). This is made possible because of the coordinates generated by the GPS.

In disaster management, coordinates are used as a tool by the planner as a means of communication between the emergency response officer (NEMA) and the security forces. This is achieved when similar coordinated maps are prepared for the two institutions by the planner. The security forces can quickly alert the emergency response team that on location 256474.76m east 1114715.88m north, for instance, there is a fire outbreak. This approach will help the emergency response team to carry out strategic planning in cordoning off the area in question. Also with this strategy, prompt action towards disaster management will be taken.

## 4.4 Implications of Coordinate to Urban and Regional Planning Education

Over the years, a wide set of computer-based tools have been providing tactical support to urban planners to enhance their analytical, problem-solving, and decision-making capability. These sets of computer-based tools developed (Planning Support Systems) cannot be effectively used by the urban planner without the adequate knowledge of coordinate systems. The knowledge of coordinate systems will not only enhance data collection, storage of data, data analysis and data presentation for urban planners, but it will also ultimately develop a comprehensive urban planning, zoning, land use inventories, site suitability assessments and map making. That is, coordinates give insights from data by identifying, displaying, analysing, and interpreting real-world problems. The availability of this information help planners to make more enlightened decisions (ESRI, 2011).

It is believed that a considerable proportion of planners' resources are often taken up by data collection (Nedovic, 1999). This is because planning databases are usually derived by compiling data from multiple sources of varying quality and scales which call for interoperability and integration (Devogele et al., 1998). In achieving this enormous task, the acquaintance of coordinates will enable the urban planner to integrate datasets within maps as well as to perform various integrated analytical operations, such as overlaying data layers from different sources (ESRI, 2010).

In interacting with multiple communities, digital technology, which hinges on coordinate systems, is frequently used by planners to visualize models so as to enhance public participatory planning. The knowledge of coordinates will help planners achieve the goal of effective spatial organization of urban activities through technological means.

Courses like Urban Management, Development Control and

Environmental Impact Assessment taught in Urban and Regional Planning require detailed information about the functions, forms and socioeconomic structure of the built environment (Maantay and Maroko, 2009). These requirements can be fulfilled when the planner keeps abreast of the knowledge of coordinates. This implies that knowledge of coordinates will improve planning education, especially practical courses (urban design, master plan and regional planning).

## 4.5 Conclusion

As space characteristics vary in space, it becomes unarguable to locate and classify locations according to their characteristics. This classification can only be done with the location of such areas with the use of the coordinate system. It is important to note that the use of coordinates cannot be undermined in the planning profession and, for any planning support system to be functional, coordinates and coordinate system will be instrumental. Coordinate systems, both geographic and projected (UTM) provide a framework for defining real-world locations and a common basis for communication about a particular place or an area on the earth's surface. This chapter has effectively discussed the concept of coordinates and their basis in relation to urban and regional planning education and practice.

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## References

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