

20. UTM Coordinate System



Shown below in Figure 2.21.1 is the southwest corner of a 1:24,000-scale topographic map published by the United States Geological Survey (USGS). Note that the geographic coordinates (40° 45' N latitude, 77° 52' 30" W longitude) of the corner are specified. Also shown, however, are ticks and labels representing two plane coordinate systems, the Universal Transverse Mercator (UTM) system and the State Plane Coordinates (SPC) system. The tick labeled "4515" represents a UTM grid line (called a "northing") that runs parallel to and 4,515,000 meters north of the equator. Ticks labeled "258" and "259" represent grid lines that run perpendicular to the equator and 258,000 meters and 259,000 meters east, respectively, of the origin of the UTM Zone 18 North grid. Unlike longitude lines, UTM "eastings" are straight and do not converge upon the Earth's poles. All of this begs the question, **Why are multiple coordinate system grids shown on the map? Why aren't geographic coordinates sufficient?**

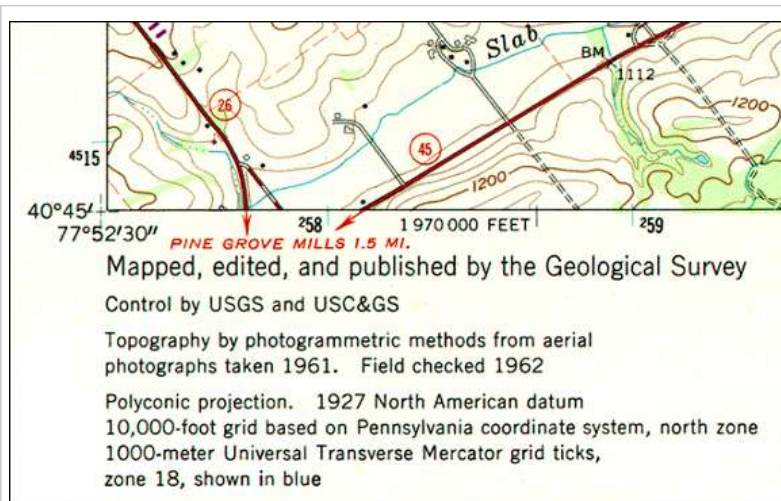


Figure 2.21.1 Southwest corner of a USGS topographic map showing grid ticks and labels for three different coordinate systems, including the UTM coordinate system.

Credit: USGS. "State College quadrangle, Pennsylvania"

You can think of a plane coordinate system as the juxtaposition of two measurement scales. In other words, if you were to place two rulers at right angles, such that the "0" marks of the rulers aligned, you'd define a plane coordinate system. The rulers are called "axes." The absolute location of any point in the space in the plane coordinate system is defined in terms of distance measurements along the x (east-west) and y (north-south) axes. A position defined by the coordinates (1,1) is located one unit to the right, and one unit up from the origin (0,0). The UTM grid is a widely-used type of geospatial plane coordinate system in which positions are specified as eastings (distances, in meters, east of an origin) and northings (distances north of the origin).

By contrast, the geographic coordinate system grid of latitudes and longitudes consists of two *curved* measurement scales to fit the nearly-spherical shape of

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the Earth. As you know, geographic coordinates are specified in degrees, minutes, and seconds of arc. **Curved grids are inconvenient to use for plotting positions on flat maps. Furthermore, calculating distances, directions and areas with spherical coordinates are cumbersome in comparison with plane coordinates.** For these reasons, cartographers and military officials in Europe and the U.S. developed the UTM coordinate system. UTM grids are now standard not only on printed topographic maps but also for the geospatial referencing of the digital data that comprise the emerging U.S. "[National Map](#)."

In this section of Chapter 2, you will learn to:

- 1. describe the characteristics of the UTM coordinate system, including its basis in the Transverse Mercator map projection; and
- 2. plot UTM coordinates on a map.

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