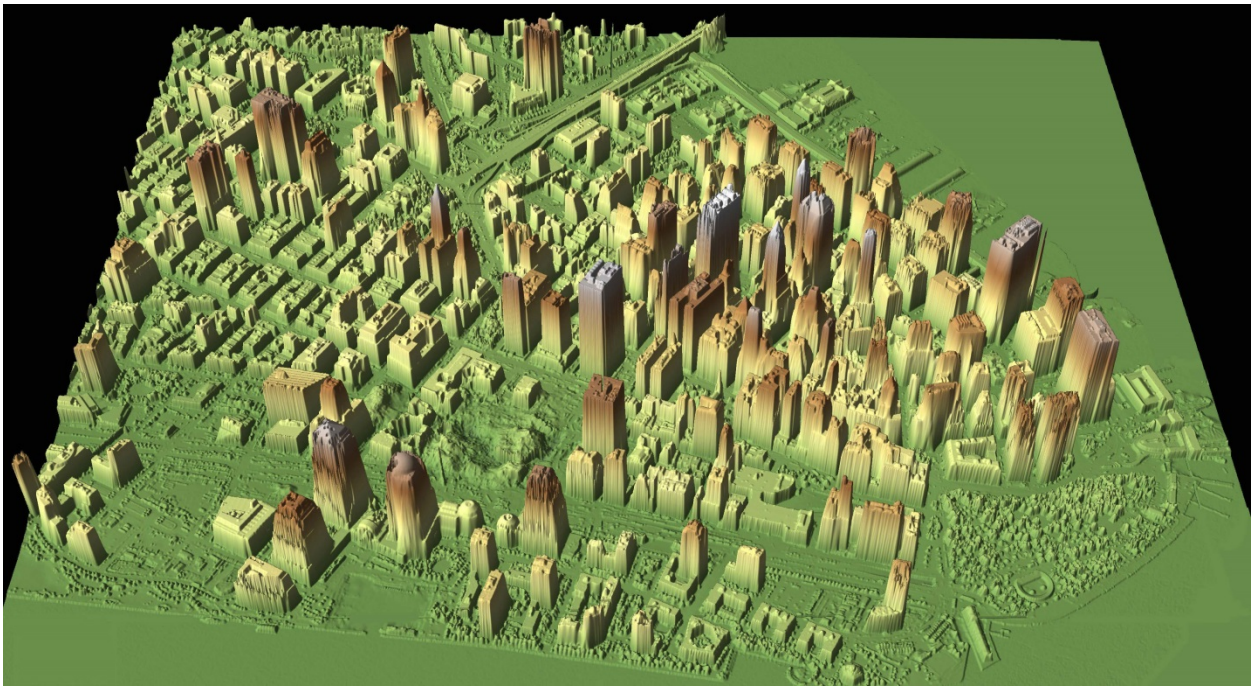
Appendix 1: AP Human Geography Topic I.D. Use of Geospatial Technologies

In the 21st century, geographers have a wide range of tools available to them to aid research. The map app on a typical smartphone would have needed a desktop computer a decade ago and a library of atlases three decades ago. Additionally, most smartphones are able to pinpoint a user's location on Earth's surface to within a few feet. For most of human history this precision was nearly impossible and even in modern times would have required a team of surveyors. This section explores some of the more important technologies available for geographic research.

Remote sensing refers to technologies that collect information about an object without touching it. For geographers, the object is generally the surface of Earth. Remote sensing technology can be divided into *passive* and *active* systems. Passive systems have a sensor that simply records radiation that is reflected or emitted from the earth's surface or an object. Typically, the radiation is reflected sunlight. A camera is an example of a passive remote sensing tool because it records light that is reflected or emitted from what is being photographed. Cameras mounted on planes or satellites are a common source of remotely sensed data. Infrared cameras that can detect heat are also examples of passive remote sensing. In recent years, the sensitivity of passive sensors has greatly improved and systems now exist that can not only see beyond the visible part of the electromagnetic spectrum (such as infrared radiation) but can also divide the spectrum into very narrow bands which allows for detailed analysis known as *hyperspectral*.

There are also numerous active remote sensing technologies that emit energy and then record the reflection of the emitted signal. In other words, active systems send out a signal and then record what comes back. The radar gun used by police is a good example of an active remote sensing device. The word *radar* is actually an acronym created in 1940 that stands for "radio detection and ranging." Radar systems can be mounted on the ground, such as Doppler radar that meteorologists use to predict the weather, or in the air or space. Some geographers even use ground-penetrating radar (GPR) to see below the surface of the earth.

Another common active remote sensing technology is *lidar*, which sends out a laser and then records the reflection. Geographers are able to make very detailed maps of the surface of the earth using lidar systems mounted on airplanes, but they can also be used on the ground to measure topographic features such as a riverbed. If you've ever seen a crime show on TV that uses a scanner to quickly map a room, that's an example of a lidar system.



LIDAR image of lower Manhattan after the 9/11 attacks, New York, Sept. 27, 2001. Credit: NOAA/U.S. Army JPSD

Your smartphone can determine your location in part through the use of the Global Positioning System, or GPS. A network of 32 satellites carrying atomic clocks orbit the earth in very predictable orbits so that a GPS receiver built into a device or vehicle can calculate its location based on its position relative to at least four of the satellites in the system. Using time and location data from each of the satellites, the receiver computes its location. Basic receivers are generally accurate to within 3.5 meters, but using advanced receivers and techniques, millimeter accuracy is possible. This can be very useful to geographers studying issues such as earthquakes because seismic faults can be precisely measured. In addition to the Global Positioning System, created and maintained by the United States, there is a Russian system called GLONASS that also provides location information as well as systems being created by the European Union (Galileo), China (Beidou Navigation Satellite System), and India.

Geographers also benefit today from a huge selection of online maps. Google Maps and Google Earth are commonly used systems, but there are also repositories of all types of specialized and historical maps. Maps that have been *georeferenced* are particularly useful to geographers because locations on the map have been linked to a commonly used coordinate system so precise measurements can be made. Typically, the georeferencing information is embedded in a digital file, most commonly a GeoTIFF file. Georeferenced images allow a scientist to know, for example, exactly where something was in the past that may no longer exist. Even a hand-drawn map can be geoferenced to some extent if several known locations with accurate coordinates can be identified in the drawing.