

Learning about GPS and GIS

Standards

4.4 Understand geographic information systems (G.I.S.).

B12.1 Understand common surveying techniques used in agriculture (e.g., leveling, land measurement, building layout).

E11.2 Use surveying equipment, including global positioning satellites, maps, and a compass to determine area, boundaries, and elevation differences.

Introduction

GPS and GIS technology are foundation technologies for precision agriculture (PA). Additionally they are commonly used in natural resource management. These activities offer an inexpensive and accessible method of introducing GPS and GIS to secondary students.

Tools needed:

Garmin GPS units
DNR Garmin
Cables
Computer

Resources

A wide variety of resources are available on the web. Listed below are the resources needed for these activities and a few related links.

DNR Garmin Software	http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions.html
Google Maps	http://www.google.com/maps
Google Earth	http://earth.google.com
ESRI GIS Tutorial	http://www.gis.com/whatisgis/index.html
Easy GPS Software	http://www.easygps.com/
Trimble GPS Tutorial	http://www.trimble.com/gps/index.shtml
Google Geo Education	http://www.google.com/educators/geo.html
Geocoding – Code addresses for display on a map	http://www.batchgeocode.com/
Geocaching – Sport site	http://www.geocaching.com/
The National Map	http://nationalmap.gov/
USDA Geospatial Gateway	http://datagateway.nrcs.usda.gov/

GPS Visualizer	http://www.gpsvisualizer.com/map_input?form=googleearth
ESRI K-12 (GIS Software)	http://www.esri.com/industries/k-12/index.html
Plumas NF Printable Quad Maps	http://www.fs.fed.us/r5/plumas/maps_and_brochures/order-maps/pnf_quads.php
Using UTM Coordinates	http://www.maptools.com/UsingUTM/

Activity #1 – Locating and Mapping Points

As a class choose an activity where you will collect some data in the field. Some ideas:

- Field soil samples.
- Pasture grass height
- Locations of pasture water troughs
- Location of garbage cans
- Locations of weed patches\
- Tree mapping at the school/park

Procedure

1. Demonstrate to the students how to use the GPS and store waypoints.
2. Have the students walk to the waypoint location and collect the location with the GPS by storing the waypoint. An activity sheet can be used to record the number and any attribute that is appropriate. For example tree species.
3. Upload the waypoints using DNR Garmin and save as a KML file
4. Create a map using Google Maps. Point data can be edited to make the markers different for different attributes, and descriptions can be changed. Use the class account or your own account in Google Maps.
5. Share the map with the class.

Activity #2 – GPS Navigation

Navigation back to previously collected sample points is a common use for GPS. This activity can follow the previous activity or a new set of waypoints can be chosen.

Procedure

1. Download waypoints into the GPS using DNR Garmin.
2. Using the GPS navigate to the waypoints. If the points are marked the accuracy of the GPS can be demonstrated.
3. Collect additional data.
4. Google maps can be updated with new data as part of this activity.

Activity #3 – Geocaching

Geocaching is a popular sport and a fun activity to demonstrate GPS use and navigation. Once a course is established at a school, park, or other area you can reuse the data points.

Procedure

1. Use a GPS to locate 10 or more points on the campus or farm.
2. Download the points using DNR Garmin to your computer.
3. Save the points as a KML file.

4. Create a map in Google Maps and import the points.
5. Optionally add descriptions.
6. Organize different routes to these points for each group of students. How many points each group should have is determined by the time allowed and distance between points. The idea here is to not have groups simply follow each other to the next point but rather navigate. All groups can use a common first point so you have train as a class to use the GPS.
7. Place a container at each point. They might contain a unique stamp or a uniquely colored marker/crayon. Each group should find the container and use the marker to “stamp” their activity sheet as proof of visitation.

Sample Waypoint Map



GPS waypoints created for Geocaching activities.

Sample Passport and Waypoints

GPS Points – Group 1

Waypoint	Latitude	Longitude	Altitude
011	39.69118450	-121.82394879	162
001	39.68969462	-121.82236956	199
014	39.68961859	-121.82467064	175
004	39.69328450	-121.82311672	168
009	39.69124803	-121.82301681	186

GPS Points – Group 2

Waypoint	Latitude	Longitude	Altitude
011	39.69118450	-121.82394879	162
002	39.69083707	-121.82083189	172
015	39.68997675	-121.82396840	170
007	39.68989511	-121.82617762	174
009	39.69124803	-121.82301681	186

Passport Example

Waypoint	Stamp

Activity #4 – Using GPS to Find a Map Location

Map use is a common natural resource management skill. This activity uses GPS position to plot the location on a USGS Topographic map.

Procedure

1. Explain how UTM works (zone, northing, easting). Numerous tutorials exist on the web for UTM (see resources).
2. Using a local topographic map show how UTM grid is found on the map.
3. Set the GPS to UTM coordinates.
4. Use the GPS to find UTM coordinates of your current location.
5. Find the coordinates on the map using the coordinates found on the map margins.

Activity #5 – Navigation to a Map Point

GPS is used with maps to find map locations on the ground. In this activity you determine coordinates from a paper map or from an image (Google Map or Google Earth). Once the waypoints are determined they are programmed into the GPS for navigation to the points.

Procedure

1. Using Google Maps or a USGS Topo Map find the coordinates you wish to navigate to. It is useful to pick a point that can be identified on the ground and is not visible from your starting point. Obvious points would be a building, crossroads, a large tree (visible on a satellite image). In Google Maps you will want to load a gadget like “position finder” to get the coordinates of a spot on a Google Map. Google Earth displays the position of the cursor.
2. Program the waypoints into the GPS. You may wish to enter waypoints in EasyGPS or DNR Garmin if you have many points. If the coordinates are found on in Google Maps or Google Earth they may be saved as a KML file and downloaded to the GPS using DNR Garmin.
3. Navigate to the waypoints using the GPS.

Activity #6 – Marking and Navigating to Waypoints

The activity below is fun and provides practice in navigating to waypoints. Minimal preparation is required. Activity is well suited for a campus or farm activity. Markers can be landscape flags, milk jugs, or any easily found object.

Procedure

1. Reset (clear) waypoints on the GPS
2. Review how to mark a waypoint on the GPS.
3. Divide into groups.
4. Give each group a “marker” for each waypoint they will create.
5. Have each group travel in a different direction. They should mark their waypoint location(s) and collect the waypoint with the GPS then return to the starting point.
6. Exchange GPS units between groups and have each group retrieve the markers as proof finding the waypoint.

If the GPS has a map that displays the waypoints student can use this to develop an efficient route to multiple waypoints.

GPS Reference Materials

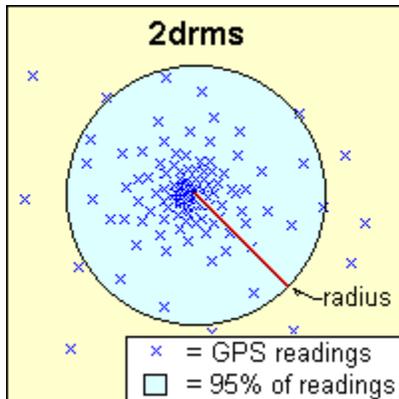
Global Positioning Systems (GPS) are the means used to accurately associate data with a spatial position. GPS is a satellite based positioning system created and maintained by the U.S. Military. The user uses a receiver that receives data from at least four satellites to triangulate a very accurate position. Typical uncorrected accuracies for civilian GPS receivers are 13m. While this is accurate enough to locate a favorite fishing spot we need better accuracy for Precision Agriculture (PA). Increased accuracy is achieved by use of a differential correction (DC) and this is known as Differential GPS or DGPS. For most PA applications the Coast Guard or private satellite service is used for the DC and the error is improved to "sub meter". With local DC the error can be further reduced to less than 2 cm.

GPS Terms

Coordinates	Two values (x,y) that describe a location such as Latitude/Longitude or UTM Northing/Easting. GPS units commonly support many different coordinate systems.
differential correction	Correction of the GPS signal to make it more accurate. An uncorrected signal will be accurate to about 13 m. A corrected signal can be accurate to within 1 m. Correction of a signal is done from a second GPS receiver at a known fixed location. The signal is then transmitted to the portable receiver that corrects the proper location through differential processing.
GPS	Global Positioning System. A system composed of satellites, ground control, and user receivers to locate positions in three dimensions.
GPS Receiver	An electronic instrument that receives GPS signals from the GPS satellites.
Great Circle Distance	The computed distance between two coordinate that takes into account the curvature of the earth.
Latitude	Latitude is the north to south position. Zero degrees latitude is located at the equator. Precise locations are described in degrees, minutes and seconds or Degrees, and minutes and fractions of minutes. Positions in North America are North or positive values
Longitude	Longitude is the east to west position. Precise locations are described in degrees, minutes and seconds or Degrees, and minutes and fractions of minutes. Zero degrees longitude is located in England. Positions in North America are West or negative values.
Route	A stored set of coordinate points that make up a path. Routes can be stored on most GPS units allowing
UTM	(Universal Transverse Mercator.) A commonly used map projection that uses a set of transverse mercator projections for the globe which are divided into 60 zones, each covering 6 degrees longitude. Each zone has an origin of the central meridian and latitude of 0 degrees. California is located in zones 10 and 11. Coordinate values are given in meters North (Northing) and East (Easting) from the zone origin (south west corner of the zone).
WAAS	Wide Area Augmentation System. A GPS differential correction method common to sport GPS units. Accuracy is generally 3-5m with WAAS correction.
Waypoint	A stored GPS location.

How GPS Works

GPS receivers use a “constellation” of 24 satellites to determine horizontal and vertical position. Four satellites must be in “view” to compute an accurate position. Satellites are always moving and may be blocked by terrain or trees. The accuracy of a given position is affected by the number of satellites in view, the geometry of the satellites, atmospheric conditions, and the quality of the GPS receiver. Satellite geometry is calculated as the Dilution of Precision (DOP). DOP values < 4 are usually considered good. Typical uncorrected GPS accuracies (2drms) are 13 meters.



The image displays a set of GPS points (shown as "x"s) with 95% of these readings contained within a large circle. "2drms" would represent the length of the resulting radius.

If accuracy is reported as CEP then only 50% of "x"s would be in the circle, and if accuracy is reported as rms then 68% of the "x"s would be in the circle.

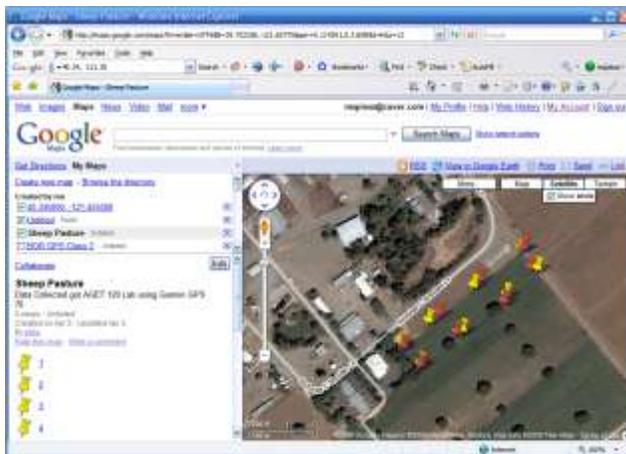
WAAS GPS Correction: Wide Area Augmentation System is based on a network of approximately 25 ground reference stations that covers a very large service area. Signals from GPS satellites are received by wide area ground reference stations. Each of these precisely surveyed reference stations receive GPS signals and determine if any errors exist. Correction information is computed and a correction message is prepared and uplinked to a geosynchronous satellite. The message is then broadcast from the satellite to GPS receivers that are within the broadcast coverage area of the WAAS. The WAAS will improve basic GPS accuracy to approximately 3-7 meters horizontally.

Using Google Maps

1. Open the Google Map Site at: <http://www.google.com/maps>
2. Login using your gmail account or use the class account.
3. Select the My Maps Link. Then choose Create a New Map, add a title, and click on the SAVE button.
4. Enter the latitude and longitude of each point in the search box. For example: 40.245, -121.234
5. When Google finds the point, click on the Save to My Maps link and select your map by name.
6. Repeat this process until all points are entered.
7. When you have entered all the points, click on Save to save the map.

You may wish to edit the description and/or the icon. See Help for more information. You may use Alt-PrtScn to capture the screen and paste into a Word Document or use the View in Google Earth link to view your points in Google Earth (available in the campus labs or download for free at:

<http://Earth.Google.com/>)



Screen Capture



Google Earth Image

Sample Quick Guide to GPS Map 76

Simple guides can be made for the activities using the screen capture option in DNR Garmin. These guides can be used by students in the field as a "cheat sheet" to GPS operation.

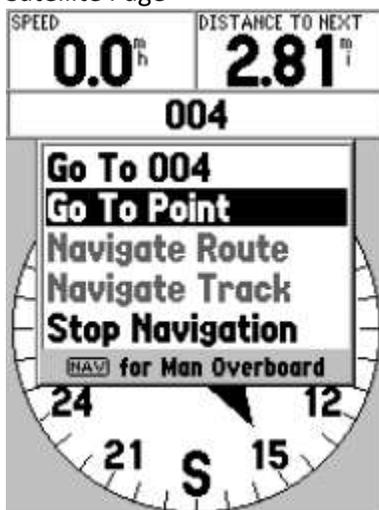
- Press the Light Bulb button to turn on the GPS. (Press and hold to turn off)
- Use the Page button to change the display between the various pages.
- The Satellite page displays the current status of the GPS. 3D should be displayed (see screen below)
- The Navigation page displays the distance and bearing to the next waypoint (see screen below). Always point the GPS in the direction of travel to get an accurate indication of the direction to the waypoint. NOTE: You need to be moving for the GPS to determine your direction of travel.
- Press Nav button to load a waypoint. Use the cursor (big round button) to select GoTo Point then press Enter, Press Enter to select Waypoints, use the cursor to select the desired waypoint, then press Enter. Press Enter again to "goto" the waypoint.



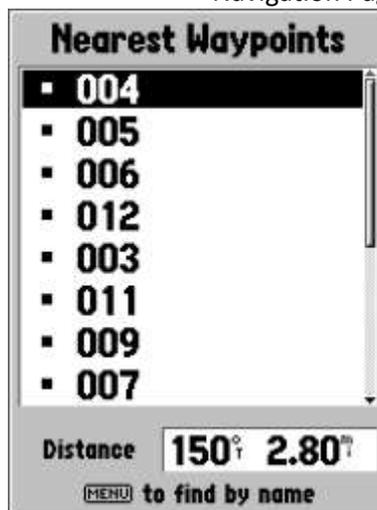
Satellite Page



Navigation Page



Pressing the "Nav" button



Selecting a Waypoint



Waypoint Screen

