Geomorphology Lab: GPS

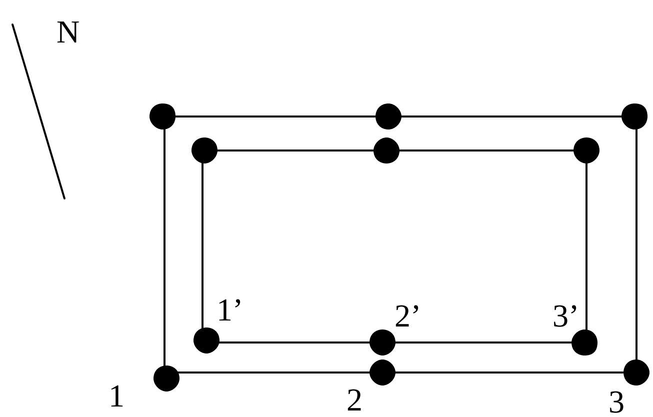
The report is due in class Friday 11 April. Reports are to be neat, typed in 12pt font. Multiple pages must be stapled together. GPS books need to be handed in at the same time or the lab will not be accepted. Late submissions will have points deducted.

The purpose of this field exercise is to acquaint you with Global Positioning System technology and how to apply it. We develop some notion of errors and how their significance changes with the scale of the problem. Finally, you are asked to examine some simple statistics of range and standard deviation.

1. Before you start to collect data, make a sketch map of the two rectangles and the landscape (buildings, sidewalks, etc) surrounding the field. This will help with question (4) below. As you move to each point to collect data, mark the location on your hand-drawn map. And estimate the distance separating each rectangle by pacing the distance. It might change from side to side.

2. Record the number of satellites used by the GPS receiver.

3. Measure the location of the points around the Peter W. Stott Athletic Field, number them 1, 2, … using the following sequence in the diagram below. The points on the inside are to be 1', 2' and so on. The midpoint doesn't have to be exactly the midpoint of the field The inside rectangle should follow the white chalk line on the field. The outside rectangle should follow the fence. Fence openings are at the corners near the library so you will have to estimate the corner as if the fence were to meet at the corner. Also, the fence on the north side takes a jog. Use the inner part of the fence and sight along it to get the north east corner correct. Team work will help greatly. The west side has no fence so use the concrete foot wall and the south side of the field is a concrete wall. Walk along the base of the wall. If for some reason you cannot follow the chalk lines, use the fence and the side walk closest to the field on all sides.



At each point take 5 measurements of the location with the GPS unit in UTM mode. That is, take a reading, wait 10 seconds, take another, wait, etc. Record Easting, Northing and elevation. The points do not have to be completed consecutive order (you can start at 6 and go in reverse, or start at 3 and go either way), but they do have to be numbered correctly. That is so every body's point 1 is the same.

4. After you finish, determine the north direction using the GPS. You can use the same screen as for the measurements.

5. Lastly, record the number of satellites.

After returning from the field,

6. Develop two tables of data.

   Table 1. Data Collected

Point	UTM N	UTM E	Elevation

   Clearly, the paces are only included after the next point is reached. (leave a blank line between different points and leave two blank lines between the data for the two rectangles)

   The second table summarizes the statistics of the first table

   Table 2. Average values and variation in the data collected. SDev is the standard deviation, E denotes east, N north, and Z is elevation. All values in meteres

Point	Average E	Range E	SDev E	Average N	Range N	SDev N	Average Z	Range Z	SDev Z

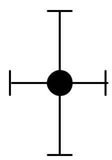
   Range is the difference between the maximum and minimum value for each point. SDev is the standard deviation.

7. Redraw the map you made in the field into a more neat and presentable form. Don't forget to include a north arrow you determined using the GPS.

8. Using computer software, such as EXCEL make a plan view map of both rectangles by plotting the average GPS position (N,E) average of the points on the same plot. Show both the points and the connecting lines between the points on the plot. Since the UTM numbers are distance in meters in each UTM zone (60 zones cover the earth), the numbers are huge. To keep the numbers small, use point 1 as your origin.

That is, subtract the average value of point 1 from all the values including that for point 1. Therefore, point 1 will have coordinates of 0 N and 0 E. Points 2, 3, 4 will also have relatively small numbers.

Provide a caption for the graph, which tells the reader what the graph is and include your correction. Something like, "The points shown are relative to the origin chosen at xxxxx N and yyyyyyy E", where xxxx and yyyy are the values you subtracted from all the points to plot them.



Point with Error bars

When plotting the GPS positions don't forget the error bars. For our purpose, the error will be calculated as the maximum value minus minimum value (for the 5 values recorded) divided by 2. Thus, the length of one arm of the error bar is the half the total range of values at each point. The errors in the north - south direction might be different than the east-west direction, and consequently, the length of the error bars will also be different. If you can't do this using plotting software, you can ink them in by hand.

In your write up of the results, in addition to including the hand drawn map of the area and the plot of the rectangles, include the following.

9. Discuss your results. How good is the result given your expectation? Can you reliably determine the size and geometry correct for either of the rectangles. Include in the discussion an examination of possible errors and their relative importance. Describe the errors (range and standard deviation) in the elevation data in comparison to the Easting and Northing data. Were the errors similar? You know the field is pretty level, and down the steps at the NE corner of the fence you were somewhat below field height (How far? Did you estimate this when you were taking the data?) Should the horizontal and vertical errors be different? Why?

10. Given the range in values for each point, would this error be significant if the size of the rectangles were much smaller, say about 10 m on a side? How good would the GPS be in providing an accurate picture of their geometry? The purpose here is to get you to compare the magnitude of the GPS error (or any instrument) to the magnitude of the absolute measurement. Or in other words, how important are the errors relative to what you want to measure?

11. In intuitive verbal terms (no equations), what is the range and what is the standard deviation? In the application here, which one tends to be larger and why?

BONUS QUESTION: How long is the fence along the north side? Show your work.