Report on Developing a Method Using GPS Measurements to Monitor Creek Edge Erosion.

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Abstract: The preliminary phase for developing a method for using global positioning measurements (GPS) to map the position of creek edges as a database for determining erosion changes was completed. The student project did show that once landmarks were chosen and recorded, it was possible to reproduce the GPS measurements of the edges several weeks apart. In addition, the sensitivity of the GPS method in determining small changes in the creek edges was also shown. However, several factors critical to the eventual construction of a permanent reference database were also identified.

The original purpose of this portion of the grant was to investigate the feasibility of developing an early warning system to begin to address the erosion issue at West Valley, New York (where high level and low-level nuclear waste is buried) that would be comparatively inexpensive to set-up and continue, with volunteer help if necessary. The main goal of this research is to determine if soil erosion can be monitored quickly and efficiently by using Global Positioning Systems (GPS) and Geographic Information Systems. By coordinating the satellite positions with GIS with a map of a stream, the relative position of its banks to permanent landmarks can be monitored more efficiently. A base map can be corrected with the GPS points to show the true boundaries of a water channel and landmarks with a program such as ArcView™. Once the corrected map is in place data can be taken over time to show a recession of the banks of the channel if erosion is occurring. By testing these theories on a small stream or creek with variation in stream edges, it can then be applied to areas where erosion is more common, needs to be more closely monitored. In this project, we wanted to combine the GPS measurements with ArcView™ software to construct these maps and a database of GPS measurements of the creek edges. The West Valley burial site, the original focus of the project, is surrounded by creeks and is particularly prone to erosion. The region had comparatively "dry", as the Great Lakes are at a historical low level since precipitation in the region had been below normal for several years prior to 2003. Therefore, it was an opportune time to collect data for a "dry period". This database could furnish a basis for easily determining if erosion was occurring at positions of the creek edges. As of this writing no such database exists, We had hoped to be able to select landmarks and begin the marking of the current position of at least a section of the creek edges surrounding the West Valley site and any detectable alterations during the seasonal changes that appeared within the period of the grant. However, after much deliberation, the agencies that control the site Department of Energy (DOE) and the

New York State Energy Development Agency (NYSERDA) decided that we could not have access to any part of the creeks, even those well away from the actual burial site. The concerns of the agency, as given by the NYSERDA representative (Mr. Paul Bembia), were based on security issues. Currently, there are several train cars filled with spent nuclear fuel, containing uranium and plutonium, stored above ground onsite awaiting transport to Utah. Consequently, with the current fears of terrorist attacks, no one but official employees of the state or federal governments can be allowed on the site. Although the sections of the creek we were interested in would be several acres away from the fuel, it was felt that no exceptions could be made to the policy at this time.

Instead, the project focused on developing the method, which could then be transferred to other streams in the future, and a section of a nearby creek (Ellicott Creek) that had free public access was chosen. This particular section of the creek was chosen because of the ready availability of landmarks, such as trees and bridges, and a creek edge that showed several twists or turns within a distance of 1000 feet. Walking along this section, major landmarks were determined, at least 15 feet apart along the edge and each given a label. Then the GPS longitude and latitude (and elevation)was recorded as a "waypoint" by the GPS unit (Garmin 76S). The landmarks chosen were independent of the creek edge and could therefore acts as permanent markings. Checking the reading from the GPS unit at these landmarks would then indicate if a person was in the right landmark point. The position of the landmarks were not stored in the unit, but instead recorded in the notebook on a schematic map. This would allow the landmarks to be indicated separately from the creek edge data on the final map. Table 1 shows two sequences of GPS measurements (without landmark data) made at this section of the Ellicott Creek. (The low number of measurements was small because of the lateness of the funding, needed to purchase the unit, and the delay from discussions with West Valley officials.) Figure 1 is a schematic showing the relationship of the first set of measurements with respect to a nearby bridges. It is apparent from a comparison of the location of the waypoints as shown in the graphs in Figure 2, that the student was able to reproduce the measurements of the section to the north side of the bridge. (Apparently the weather or snow cover did not allow access to the other side, nearer Main Street in the second set.) When the data for the two measurements is overlapped, as in Figure 3, the closeness of the measurements is more apparent. It is also apparent from Figure 3, that small differences in positions of the observer or the creek edges will be discernable by the unit. In the future, the distance from the landmark will have to also be recorded to ensure that the observor is indeed standing at the same relative position on the creek edge. Then differences in the GPS measurements can be attributed to changes in the creek edges alone.

The elevations recorded for the two sets in Table 1 are very different, and indeed are impossibly different. The second set of measurements are typically 100 feet higher than that of the first set. It therefore appears that the elevation measurement must be calibrated before

each measurement set is taken. The next step would be to view this data projected on maps of the site from ArcView™. Unfortunately, this transfer of data is not available at the time because of difficulties with the software that were not resolved before this report was due. It will be an immediate future goal of the project to overcome the software difficulties and show the overlap of the landmarks and data points to published GPS/map data. Once this has been accomplished, another essential part of the database for the chosen site, to track erosion, would have been constructed.

In conclusion, we have been able to show that a GPS survey, constructed over a long period of time at the same site will provide waypoints measurements to estimate the changes of a stream bank. The student project showed that once landmarks were chosen and recorded, it was possible to reproduce the GPS measurements of the edges several weeks apart. In addition, the sensitivity of the GPS method for determining small changes in the creek edges was also shown. Several factors critical to the eventual construction of a permanent reference database were also identified. In the future, visual measurements may also be taken to help to predict potential erosion of the banks such as soil types and current strength and support the GPS data.

Experimental Method:

Data was taken at the research site of Glen Falls Park in Williamsville, NY on three occasions. The first day of data collection was a cold day of around 5°C on January 2, 2003. Data points 01 – 15 were collected using a Garmin model 76s GPS unit. Each data point was labeled 001 – 015 and for each corresponding data point a land mark was labeled in a lab notebook to insure that the position could be reproduced. The data points were then input into Microsoft Excel with three columns being Latitude, Longitude, and Elevation (Table 1). The X,Y coordinates were converted from the format of deg°,hh.mm to deg°.mmmm by dividing the hh.mm by 60. The second day of collection was a wintry day of -4°C on February 4, 2003. Data points 20-33 were collected using the same GPS unit. The same method of collection was used and points were recorded in notebook. By the same method as above the points were then transferred to MS Excel (Measurement 2). The waypoints were then entered into Garmin's Mapsource™ to give a basic map with the corresponding waypoints and their relationship to a stored amp was developed. Unfortunately, the figure demonstrating that effect is not available for the report at this time.

Table 1: Summary of Data collected using GPS unit for creek edges opposite specified landmark positions.

	Latitude	Measurement		Longitude	Measurement		Elevation (ft)	
	1	2			1	2	1	2
N	42.96500			W	78.74513		585	
N	42.96500			W	78.74517		580	
N	42.96513			W	78.74538		579	
N	42.96523			W	78.74517		591	
N	42.96558	42.96550		W	78.74597	78.74515	590	682
N	42.96580	42.96502		W	78.74607	78.74548	585	683
N	42.96600	42.96508		W	78.74592	78.74558	588	686
N	42.96645	42.96545		W	78.74608	78.74585	587	688
N	42.96700	42.96557		W	78.74615	78.74617	594	690
N	42.96685	42.96600		W	78.74612	78.74620	619	694
N	42.96500	42.96582		W	78.74883	78.74600	617	694
N	42.96478	42.96605		W	78.74983	78.74613	617	700
N	42.96485	42.96618		W	78.74468	78.74638	621	701
N	42.96457	42.96652		W	78.74330	78.74605	626	704
N	42.96420	42.96672		W	78.74422	78.74632		712
		42.96688				78.74615		

Figure1: Schematic the relationship of first set of measurements to creek site;

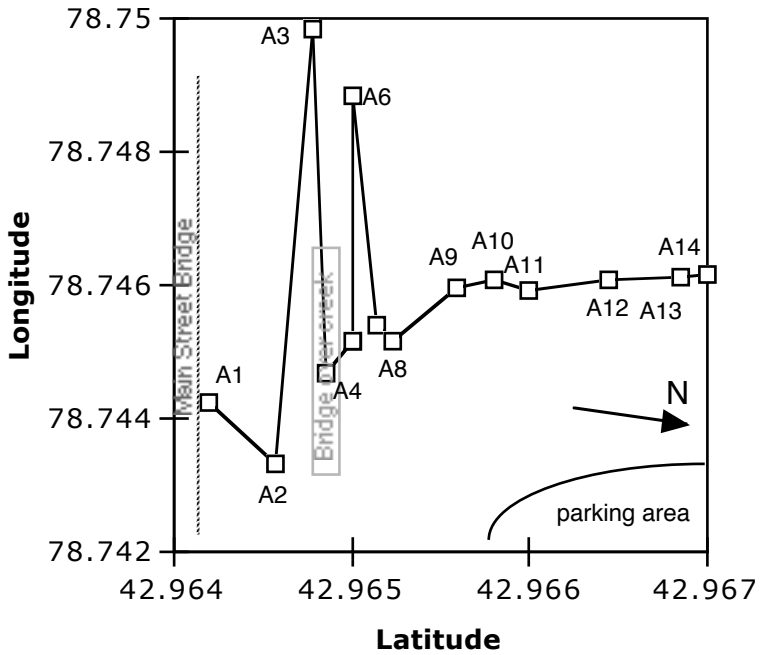

Figure 2: Comparison of longitude and latitude measurements made at the site taken several weeks apart, indicating the position of the creek edge relative to a landmark.

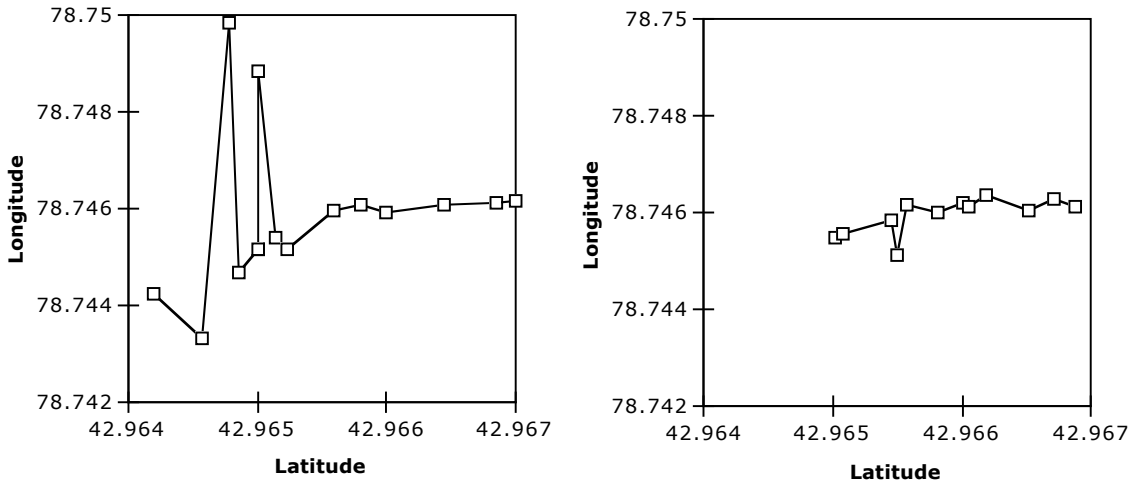

Figure 3: Overlap of the two sets of measurements of latitude and longitude shown separately in Figure 2.