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Geography 594
Final Project
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Pre-survey

Pre-survey work involved an onsite visit, explanation of what the data was being collected for, how it was to be used, and what information was desired. The discussion included details of the area and maps for a visual reference of the area. The available maps showed approximate trail entrances and locations. The trail maps were representative in a rough sense only but may the differences may have been attributable to a few different causes.

During the initial site visit, the GPS unit was used to collect some initial data recording road and trail head locations while gathering the current Almanac information. The almanac is a file broadcast by all GPS satellites and received by the GPS unit indicating approximate location information for all GPS satellites. A current Almanac, less than thirty days old, is needed for GPS accuracy and for the Quick Plan utility in Pathfinder Office. Another file, Ephemeris, is also a file broadcast by and for each satellite but with highly accurate data of up to the minute corrections for only that particular satellite.

After the site visit, a Data Dictionary was designed and loaded into the GPS that contained the selectable information for the trail data to be collected. The Data dictionary facilitates organization and data collection by storing feature, attribute and value information. This Data Dictionary included the collector's name, trail node, hazard areas, date, trail substrate type and width.

Also prior to site collection, the Quick Plan utility was used to determine the best possible collection times. Quick Plan shows the amount of visible satellites and best DOP or Dilution of Precision. The DOP is determined by the satellites geometry to each other and to the collection site, which directly impact how viable and accurate data is for the particular place and time. Higher quantities of visible satellites and lower DOP numbers are, the better the collected data should be. Generally, the best collection times were late morning and early through mid-afternoon.

Survey Result Evaluation

The survey was performed during the first part of April using a Trimble GEO XT GPS unit running Terrasync software. The XT unit was set on the production setting with a fifteen degree elevation setting versus using the precision setting, which did not collect data very well. Usually the unit was used with a full charge and mostly clear memory during each collection time. A new file was created for each day of collection. One of the main files has 3039 points collected, about 50 minutes if the data was collected start to finish without delays or stopping. The 50 minutes does not include the in-between non-collection times for in the field orientation, labeling new points gathered, reviewing settings and maps and verifying satellite visibility using the onboard Quick Plan utility.

During the initial days of data collection, the GEO XT kept a fair lock on satellites and usually decent point collection. The most difficult data collection during this time was in the Pines. The denser the Pine tree count, the more difficulty the receiver had keeping a lock on the necessary satellites. The hardwood mix, especially in less dense areas, allowed very good data collection, at first.

Soon after the start of data collection during the first part of April, the leafing foliage was starting and increasing daily. Within a short period, the foliage increase impacted data collection negatively and the deciduous tree areas that previously had a fair to good collection status continued to degrade. After more than a week of foliage growth since the start of data collection, the more densely populated leafed tree areas were not ideal and required a fair amount of finesse in order to maintain a sufficient satellite lock.

Finesse came through experience on the trails and while paying close attention to the GPS unit and surroundings. The GPS unit has an adjustable collection rate and was set to a one second interval. A beep is heard for each coordinate point collected, which should be each second while walking and when the satellite lock is maintained. When the beeps hesitated or were missed, data was not being collected accurately.

As a result, listening to the beeps became a great indicator for slowing momentarily allowing a relock of the satellites through changing the GPS position to a few feet ahead. Walking too slowly would cause more error and wider deviations in the data point collection so it was better to keep moving. Walking too fast caused wider gaps and deviations when the

GPS would lose the satellite locks and then relock. Backing up to collect a point when one was not heard as collected made and caused more errors than would have existed with the point missing. Collecting data using a one second interval during a longer walk collects a lot of data points.

Data Editing

A connection program called Active Sync was used to establish communication between the GPS unit and a computer. Once the link was established, Pathfinder Office was opened and the data transfer utility was used to download the collected SSF files to the programs default Pfdata file locations. After downloading, the files were opened in Pathfinder Office and viewed in the program's map view. Visually reviewing the file before further post processing lets the viewer have a chance to determine if the data collection went as expected or not. While the SSF file is open in the map view, data points may be initially edited for correction and/or removal. The sooner this is done after the actual collection time, the better, as some of the real versus collected location data may not be the same and can then be modified for better accuracy. This preview also allows the post processing parameters for Differential Correction to be adjusted for additional error removal if necessary.

The next step used the Differential Correction utility of Pathfinder Office. The Differential Correction utility opens a wizard that walks through the various parameters to be set according to the correction desired for the open file. First screen sets code and carrier processing and the second sets processing and filtering parameters. The third screen selects the base provider from where the program receives a correction base file. The base file is what determines the amount of correction for the specific place and time of a collected file. The closer in proximity to the base provider, the more accurate the correction should be. The last wizard screen is a preview of a text file posting the correction process data showing how many points were corrected and the percentages of points per meters of accuracy. Here is where we learn to pay close attention to the file corrections.

The main file collected for this project was processed as other previous and future file collections using the closest station of Hillsborough as the base provider. The differential correction process appeared to go smoothly and seemed as though the points

corrected as usual. The corrected file, COR, was then opened in the map view for a closer inspection and what a surprise, it was still very rough as compared to other file corrections. The text file was reviewed and only about a thousand of the three thousand points were corrected. The main file was processed again using the same parameters and had the same poor result.

The base provider was then changed from Hillsborough to Durham and then to Pittsboro. Using Durham and Pittsboro the post processing corrected all but one point in the raw data file, 3038 of 3039. Not sure why the Hillsborough base file wouldn't correct the data but both of the last base files corrected the data similarly and what appeared as correct in the map view. The text file showed post processing corrected 89.4% of the data points to 1-2 meter accuracy.

The post processing does not take out or correct bad data; it just corrects points by the amount of spatial error for the specific time period and outputs a COR file. Post processed data was opened again in Pathfinder Offices map view, reviewed and printed. The trail used for data collection was walked again and compared to the print out of the corrected data or COR file and edited. The edited files were then exported using the Export utility of Pathfinder Office in the ESRI shapefile format. The shapefiles are directly importable into ArcMap for further review and editing.

Before loading the shape files into ArcGIS they were first assigned a coordinate system using Arc Catalog, the coordinate system is US State Plane 1983, North Carolina 3200, US survey feet, Datum WGS 1984. Without assigning the coordinate system, ArcMap usually does not have the necessary data to load and view the shape files, or if it does, they may not be in a relevant scale. Arc Catalog was also used to assign the same coordinate system to the IKONOS and OrthoPhotoQuad SID files used for background files during ArcMap editing.

ArcMap editor and smoothing was used to smooth file lengths using an MAO of 3. The smoothing made the lines appear more natural looking and flow as the trails do. There are points where the trails cut back sharply but most of them are difficult to see in the heavily covered wooded areas. The background OrthoPhotoQuad SID air photo files make excellent background files because of their high resolution. The high resolution files and great for seeing where some of the GPS trail data collection errors might be located. Key

thing to remember here is that there aren't any background files more current than these from 2003, which are already four years old. The trails may move some or a lot from year to year and the latest background files should always be used for accurate results. Final preparation in ArcGIS included adding standard map elements for a clear understanding of the document.

ArcMap version 9.2 has a KML, Key Markup Language, tool that allows a Google Earth compatible KMZ file to be produced. First a shape file is saved as a layer file. Second, the KML tool is loaded with the layer file, reassigns the coordinate system for Google Earth-WGS84, and then converts the layer file into a KMZ file. The KML overlay makes it possible to further review data collections being shown in a real time variable environment. Further post corrections were not made at this point. The most beneficial aspect of these KML files is that they are directly loadable by anyone to any computer running Google Earth. They can be loaded one at a time or all at once showing any or all the trail files and be saved to the users computer for immediate reference at any time in the future.

Conclusion

The equipment seemed sufficient for data collection in this terrain. There may be a make or model with more gain or sensitivity for data collection but probably would not be necessary for this application. The GEO XT units are excellent for data collection and offer many onboard features to help with relevant decisions. Quick Plan can be used to verify the best collection times, File Manager can be used to open existing files and update or modify them and onboard mapping to see what the data is looking like real time.

This year, the beginning of April was the latest time of the year for data collection at this site. Foliage was causing increasing problems with each passing day. The site has a lot of Pine trees, and some areas are fairly dense, that seem to have inhibited good data collection. Increasing the elevation mask may help with this issue. Further data collections for the site would probably be best in the late fall or early spring when there is less leave cover. Another possible issue that didn't come up this time is higher moisture content. This spring was dry during the collection times but if there had been normal or higher than normal precipitation amounts, the 1.5 GHz used by GPS would be inhibited to an unknown degree.

Another possibility for future data collections would be comparing the various DOP settings in Quick Plan and a few trials of data collection and review the results prior to performing a full collection for the desired feature. While the best times somewhat coincided with the lowest PDOP and most amount of visible satellites, at times the data collection results didn't coincide with what was indicated by Quick Plan. One reason might be that the PDOP's are based on the best satellite geometry for data collection, probably for an area with a clear view of the sky, but this site is mostly wooded so the best may not be when the PDOP is the lowest or with the highest number of visible satellites.

The Data Dictionary could be redefined for the next site collection. The features defined in the current data dictionary were good starting points but could be improved on in a number of areas. Improvements would come from parties using the data, like trail users. Mountain bikers would be able to explain and outline in more detail what they could and would use in these trail maps. Another and related example would be hazardous areas. Hazardous means something different to each person looking at a feature. Things a non-biker might consider dangerous, a mountain biker might consider mildly challenging and fun but not dangerous.

The data dictionary might also include a place for a longer text string or an area for more extensive notes. The available generic features already have a limited space for text but it isn't sufficient for some explanations. Paper notes and pictures would also be beneficial for post processing and explaining parts of files and so would a method of notation in the data dictionary making reference to the notes or picture.

The software package used for processing the raw files does a good job of working the data into manageable and accurate results. Quick Plan parameters are easy to set, and then adjust, the collected file datum. ArcGIS does an excellent job Post processing and could be used to further improve the data. This would require more time to review the latest maps and high resolution overlays and carefully match them to the actual walked terrain for verification if a higher degree of preciseness is desired or needed. Precision could also be improved using a new set of OrthoPhotoQuad SID air photos for the area.

Some of the collected and processed files are at http://aa9nv.r2i.net/Trails.htm. The files include KMZ, SSF, COR, SHP file groups and PDF's.