

## Integrating Image, GPS, and DEM Data

This exercise involves collecting and evaluating data we'll be using in our semester-long project. Our overall goals are to identify source areas for rainfall-runoff for the St. Paul Campus, and the extent to which expanding vegetation canopy or other actions might reduce runoff. This requires we identify each storm-sewer inlet and other storage or infiltration areas. We'll then combine these with a high-resolution DEM to develop surface flow direction data. This will help us identify inputs for each storm sewer inlet and total loadings. You will have to visit existing features and GPS them, and in a later exercise make sure the inventory is up to date. We'll be using this opportunity to practice our data collection and integration skills, and provide information on relative positional accuracy for various input layers, information that will aid us later in our analyses.

We need to develop/evaluate 3 layers: storm sewer inlets, 2) road/curb/sidewalks on two image sets, and 3) a LiDAR digital elevation model.

First the storm sewer inlets. These are the drains into which water flows from the surface. There is a point shapefile on the lab drive, L:\ESPM5295\project\Data\SWPointFeatures.shp, that contains storm sewer drains, as well as several other types of point features. The curbside drains have the attribute named "Catch Basin." We need to familiarize ourselves with what these look like, and estimate the positional accuracy of the locations. Don't worry, you don't have to digitize all the storm water inlets. We have an inventory from the UMN Physical Plant, the folks responsible for maintaining the infrastructure, so in this current work you won't have to do an exhaustive inventory. We do have to integrate these data with the landcover we'll use, and with the elevation data.

Your first task is to accurately GPS the location of at least 3 storm sewer grates, collecting three for each person in your group. Try to locate at least 2 that are not under forest canopy, in areas where the ground is clearly visible on both the stp2006 and CampusNov2015 images in the L:\ESPM5295\CampusImages directory. It is surprising how much detail you can see, and many of these grates are visible on both images. You'll need to differentially correct and export the data as before. You should calculate an NSSDA spreadsheet for the points you GPS, using your GPS as truth, and the X-Y locations from the SWPointFeatures.shp layer as the test data.

When collecting the GPS data, try to maintain carrier lock. This means you should close the feature, but not the file, between points, and carefully walk with the pole/tripod upright and above your head from one point to the next. It helps if you don't pass under any obstructions, e.g., narrow gaps between buildings, under dense canopy. The expected accuracy shown in Terrasync may spike to a larger number for a bit, but if you

maintain lock on most of the satellites, it will decline quickly and you may be able to collect for only a few minutes at each point.

When finished, turn in the NSSDA spreadsheet (as an .xls or .xlsx), the GPS files (.cors and .ssf) and the points (as a geodatabase or zipped shapefiles) for the sewer grates layer.

Your second activity will be an assessment of the spatial accuracy for images that will serve as a source of important in data layers. We'll need to develop information on impervious surface to solve our problem, including roads, curbs, and sidewalks, plazas and other paved/compacted areas. We'll want to have a ground surface feature layer that allows us to assign perviousness – whether water infiltrates or not. We need to identify these areas vs. vegetation/uncompacted soil because different amounts of runoff are generated from these different types of surfaces.

We want to evaluate the accuracy of the potential source images, the stp2006 and CampusNov2015 images in the L:\ESPM5295\CampusImages directory.

For this exercise, you want to GPS features that are very distinct on the images, e.g., sharp corners at sidewalk intersections, the base of very distinct poles where you can clearly identify the ground surface, or the corners of rectangular concrete pads in grassy fields (see the image for three examples).



These points are too close together, you would want them well-distributed throughout your area, but they are examples of the kind of points we'd like to identify.

Select three points additional features (over and above the sewer grates above, and if working in a group, then three per group member) that are visible on both the 2006 and the 2015 images, and that you can locate in the field. It would be prudent to select one or two extra points on images in the lab, because a point in the field might not suit. Visit your points in the field to ensure you can find them, or that the sidewalk hasn't been rebuilt, or the pole moved. Collect GPS data for your points, again occupying them for 10-20 minutes with the high-resolution GPS. Again, you may reduce the time at the second or third points if you can maintain carrier lock.

You may find you need to "offset" if you use power poles, e.g., stand a meter south or east of the pole so that your GPS can "see" sufficient satellites. If so, you need to measure the angle and distance to the pole, and adjust your corrected coordinates accordingly.

Also extract the X-Y coordinates for the points from the images, one set for the USGS 2006 images, and another for the 2015 images. At the same time you should extract the image coordinates for the image-visible sewer grates you GPSed above, increasing the number of test points.

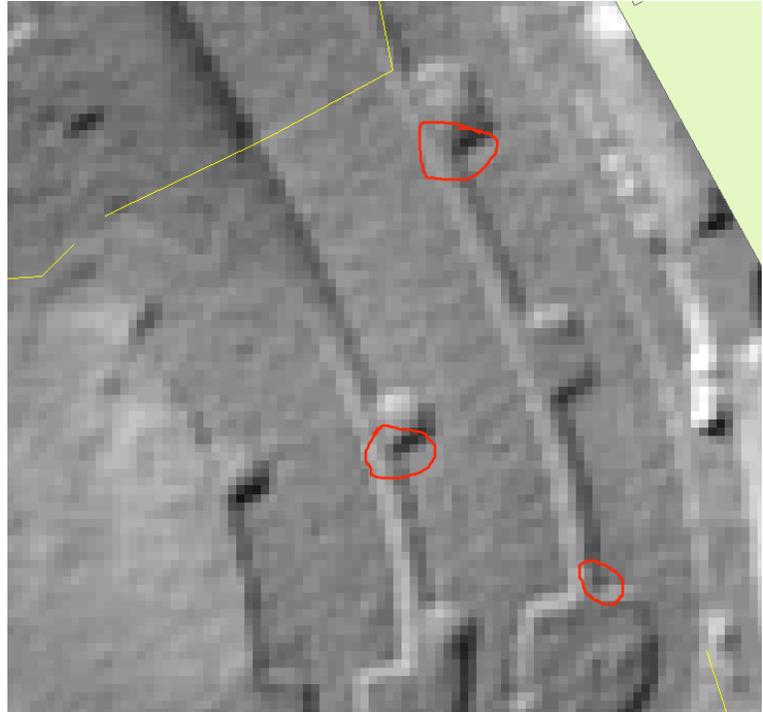
Again, complete NSSDA sheets, one for each image. Consider the GPS data your "truth," and the coordinates from the images as your test data. Turn in an NSSDA spreadsheet, as an .xls or .xlsx (not as a pdf or text file, I'd like to compile the data from all students into one file). Also turn in the .ssf and .cors files for your GPS points, and the geodatabase or shapefile for these points.

The LiDAR-derived DEM is the final layer we have to assess, and accuracy assessment is a bit more difficult. We will be calculating flow out of each of the cells to adjacent cells, and create a flow direction surface. We then calculate a flow accumulation surface, and identify flow paths. This in turn will be used with the storm sewer grates to define watersheds, identifying all the areas that drain to each storm sewer. We'll try to evaluate the horizontal accuracy of the DEM layer, because this will give us some idea of how we might approach watershed and flowpath delineation.

Unfortunately, there are no "well-defined" features in the DEM. It is a real-valued raster surface, and the changes are somewhat continuous. However, derived surfaces can help us identify some features unambiguously. Here we'll use the hillshade surface dem\_1m\_hs1.tif surface provided in the L:\ESPM5295\project\Data\ directory.

You can identify locations by abrupt changes in elevation, which in turn cast distinct changes in tone and illumination, as shown in the figure at right. These are curbs in the parking lots east of Green and Skok Halls.

Again, select three points (per person that are clearly identifiable on the image and in the field, and GPS them. As above, try to maintain carrier lock when moving between features to reduce your occupation times to 5 to 10 minutes; observe the predicted accuracy in Terrasync to determine your collection times.



A main point in this exercise is that some data will be logically inconsistent, and this almost always occurs when combining data from distinct sources. Because of unavoidable spatial errors, some of your sewer grates may end up on sidewalks or streets, or off the water flowpaths. Hence, water may bypass a drain in your GIS “model” of the world, and so give erroneous answers. Data mismatch is a general hazard for many spatial analyses, and this should raise your awareness and give you one example of how to evaluate it. In our work we will have to integrate landcover, drain feature, and DEM-based flowpath data to make them consistent. We have to do this while degrading the spatial accuracy as little as possible.

Create maps of your project areas with one of the image as a background, show your test point layers, and an appropriate legend, title, and other map elements. Turn this in on Moodle on the specified due date.