NSGIC 3DHP Monthly Forum:

Question and Answers

High Resolution Hydrography Using Geomorphons New Approaches & Perspectives for Automated Mapping

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Participant Questions:

Have you been able to automatically detect karst areas using your process?

We haven't run our algorithm with the intention of identifying karst areas. However, when we are operating in karst terrain, we see blue lines that are associated with a channel feature change, fairly dramatically, and the algorithm produces connectors that have no channel associated with them for long extents. That may be a signal that can be used to detect karst but we haven't actually done it with that purpose in mind.

How important is temporal resolution to the model? Can you run it with just one set of flight data?

Temporal data sets are not required. The method that I described is based on multiple DEMs from a single lidar flight, each processed at one (not necessarily the same) specific point in time.

What do you consider as 'high resolution' land cover?

In the Chesapeake Bay watershed we worked with a one meter dataset. We found it useful to be able to see open bodies of water, large rivers, and roads. When we started developing the algorithm, we focused on finding headwater channels thinking their detection was the problem of greatest need. But, as we started looking at applications like mapping streams across the entire Chesapeake Bay Watershed, we realized needed to capture large streams and in-line open water features like lakes and reservoirs as well. Hydro-flattening of lidar data can confuse terrain interpretation of where water flows, so using the high resolution landcover to map open water features was helpful.

I do, however, think we could probably get by with a slightly coarser data set - like five meters. I would want the land cover to include canopy, pavement, and canopy over pavement as discrete classes. I'm not sure how accurate the results would be mapping smaller roads with a 10 meter dataset.

Did you map culverts?

We track whether connectors between channel features go over a ridge or over a road, then use that information to detect likely culverts or bridges. This is another reason that the impervious cover data, i.e. roads, is useful.

Is this packaged in a tool, or is the method or code available to the audience?
Not yet, we are still developing it and making sure that it's generalizable across different terrains with different hydrography features. We do intend to develop a publicly available resource that is open source and easy to use (funding permitting). We will also need to make the parameters customizable so that they can be applied in different landscapes.

The current application is encoded in Python and runs in GRASS GIS and R, all open source software.

Have you experimented with different, lighter, point densities?
No, not yet. We have used available lidar DEMs to demonstrate what was possible with existing elevation products. It would be an interesting to explore how modifying lidar quality or the point density influences the output.

Do you see value in building a community of practice and the vocabulary needed to effectively communicate with decision-makers about the value of the data beyond their perception of a 'map'?
Yes. We produce a lot of maps, but those maps don't always relay the research information that informed our thinking and went into producing the map. There is far more information generated during our processing than is displayed on a map produced for a specific purpose (e.g., blue lines). Much of this depends on what role the data in the map plays in the larger system – hydrological, chemical, geographical. We are finding that our processes help mapping ditches, gullies, wetlands, valleys and floodplains, floodplain drainage channels, possibly different geologic formations (e.g., karst), buried streams, ghost channels, and water control structures.

Are you incorporating any of this work into the USGS National Hydrography Dataset (NHD)?
No, but we hope to and would like to see the next generation of NHD make use of lidar derived products. One conceptual/methodological challenge is how to link existing NHD attributes to any new hydrography data you create. The method we used produces a lot of information that can be used to inform the conflation exercise.

How do geomorphons perform in areas of no lidar returns, where DEM interpolation estimates, and not actual returns, dominate the elevation surface?
Well, first it is important to say our approach (which is not the only way geomorphons might be applied) was designed to make use of elevation information. It was not designed to circumvent the absence of elevation. When our algorithm loses a channel signal, it typically has an advantage of knowing where upstream and downstream features are and, in the absence of terrain information, our approach would use a straight line (least cost path) to traverse the area.

How do you deal with areas where we have high vegetation cover and there is not good ground penetration?
We constrain our channel networks to remain within the valley, which is usually detectable in the broader terrain, and use a least cost path approach to try and get to the next downstream feature. We try to constrain the mapping exercise with topography and distance. We also compare discrepancies between the terrain-based line, or connection, and a least cost path line and try to understand the information embedded in those differences.

Have you tried this algorithm using photogrammetrically derived mass points and breaklines?
No. I don't know exactly what that would do, though I'd be curious if there is an example of a real need for such an application going forward. I think it would be a lot like results we might get from a rather coarse-resolution DEM, which is not a data set for which our algorithm was designed.

How are you evaluating the reliability/accuracy of the mapping algorithms?
It's a challenge over such broad extent, which such a variable array of features. We did not know what we would produce when we started so it was hard to anticipate what "accuracy" would mean at the outset. I knew conventional methods of assessing validity (e.g. how many reaches are correct) would bias the results as most are easier to detect. We've done some formal assessment of headwater streams in different physiographic and land use settings, but mostly our assessment thus far has been if blue line maps pass the laugh test when compared to imagery and existing maps (i.e., do they generally run downhill and correspond to the channel features visible in lidar hillshades). We do want local input and hope that any errors we find will lead us to better understand systemic errors in the processing. Because our process is automated and rapid, we can remake our products with alacrity, so our current plan is to collect data about certain situations or embedded assumptions that create problems or unrealistic outputs and correct them algorithmically.

Have you tried integrating urban storm sewer networks into your processing?
No, but we would like to. The existing effort covers such a large area that it hasn't yet been feasible. But, it is important to do so, and the results would benefit by incorporating information such as existing storm sewer networks.

When you mentioned the attributes of 'width' and 'depth' do these refer to the water feature or the top of the bank?
We measure top of bank to top of bank for the width of a feature. When we were doing a bank height we get estimates from individual pixels so that we capture the bottom of the channel in the DEM (not always the true channel bottom) to the top of the bank. This is dependent on the lidar data and whether there is a bottom of the channel as well as the sidewall heights and all of those are integrated into our averages.

Interview Questions:

What would you now do differently?

The budget and timeline. We used our time differently than we initially expected. We originally thought that we would be spending time making maps early in the process. The ability to automate was not clear. Based on the success of the automation, we adjusted our timeline to spend more time on developing the automated approach. We also budgeted a lot of time for validation of the line work at the end of the project and would now do the validation earlier in the process. We never budget for the resources that would have allowed us to make the code widely accessible and easy to use. That's a different animal than just building something that works.

What surprised you during this process?

How many things in lidar terrain look like channels but aren't, or at least should be included in a blue line map that folks would accept. Things that aren't intentionally created to route water can still look like channels and they often just repeat multiple times in the landscape.

What resources, other than the data (e.g. tool, document, online resource, etc.) did you find of most value to the process?

Our Chesapeake Conservancy partnership. We've benefited from their high resolution land cover mapping effort but more importantly it's been valuable to a have a braoder community of interest (to whom the Conservancy connects us) with which to share challenges and different perspectives. Also, Google Earth imagery, especially the temporal image feature. It was useful in trying to validate hard to detect features. Having the imagery as a resource facilitated us in communicating with students and practitioners what the algorithm was 'seeing' and doing.

What resource(s) would you recommend be developed to support the derivation of hydrography using elevation data?

I think it is important that resources such as this be available and easy to use. We've focused on using publicly available, open-source, tools such as QGIS and GRASS, but there is more work to be done here.