USGS Hydrography Seminar Series   Session 8

Steve Aichele: [00:05] Welcome everyone to session eight in USGS hydrography webinar series. This will be the last session for this season, we'll start another season in the fall.

[00:17] Today we have all come together here to try to replicate the environment that we might have in a conference setting and really expose some new ideas, new content, new information related to the NHD, the WBD, and some related products.

[00:42] Today's session is by far our highest attended session in the series and I think it's a lot of crossover between lidar and Hydrography. Our speaker today is Karl Heidemann from the EROS data center in Sioux Falls, South Dakota. He's going to speak about lidar Topography, and Hydrographic Integration, and try to clear up a few things for us.

[01:09] After that, we will have a Q&A session. We actually would prefer if you can use the Q&A tab in the WebEx training center window, because that allows us to log the questions. After the sessions, we publish the slide deck, the transcript of the session, and the question and answers out on our website.

[01:35] If we have the questions written out, we can often get better answers for them, sometimes after the session, and put that information out on the website for folks. Without further ado here, I will move on to Karl.

Karl Heidemann: [01:53] Good afternoon, everybody. I hope this is informative. I've looked at the participant list, and I saw a lot of names that are real familiar, and that I know have seen at least some of this material before. With such a wide group of varied experiences with lidar and/or hydrography, we're going to start with a few little basic things.

[02:19] These are the high level topics we're going to discuss today. A little bit on lidar, what lidar is, some terminology. Probably as much just so you all understand what I'm talking about when I talk about things.

[02:35] Look at some things about bare earth DEMs and the variations there. Then talk about the hydrographic breaklines, what we're looking at doing between the elevation group of 3DEP and the NHD. How we see some potential benefits to trying to push the Ele Hydro integration a little bit harder than it has been done in the last couple of years. Again started at it.

[03:05] What is lidar? Light Detection and Ranging is the acronym for L-I-D-A-R. Lidar is an active airborne sensor system. I note airborne because there are many other lidar systems. There are spaceborne, there are mobile or tripod, but, for our purposes, what we generally work with, typically it's always an airborne system. It is a scanning pulse laser.

[03:37] There are new technologies, Geiger mode and single photon and photon counting lidar systems but again, for our purposes today, we're not going to focus on those technologies there. This is going to be primarily keying off the technology that has been in use for the last 15, 20 years.

[03:59] Lidar works by having very high precision clocks that can measure the time duration between an emitted laser pulse and when that reflection, the reflection of that pulse, returns to the aircraft, and in combination with a very high precision position and attitude sensors on the aircraft, you can get a 3D origin point and the direction of the beam, vector direction.

[04:31] Once we know the speed of light, we can then get the length of that vector by multiplying the speed of light by the time duration then dividing it by two, because clearly there's both directions. With that complete vector information both direction and length, we can calculate the XYZ location of the reflected point.

[04:55] We have little pictures that shows that our plane flying along. It's scanning back and forth. We can see the zig-zag patterns on the graph. Can everybody see my cursor, as a pointer?

Steve: [05:12] Yes Karl, it works.

Karl: [05:13] OK great. Thank you. These are very familiar pictures I'm sure. Probably, most everybody has seen it. So what is lidar data? Lidar data's a point cloud. It's what we are seeing here. There's no continuous surface, it's just a bunch of points. This is a surface and it is not lidar, it's a DEM. It maybe lidar derived but it's just a DEM. Particularly early in the industry, these surfaces that were lidar derived were referred to as lidar but they in fact really are not. Lidar's is the point cloud itself.

[05:59] Lidar, again omitting the Geiger mode and single photon, those new technologies, lidar almost always can collect multiple returns. A lidar beam, the laser pulse comess down and it can bounce off of multiple objects with a single pulse. If it's hitting clear and open areas, we get one return, first and only return. And if it's over a vegetated area or it catches the edges of buildings, we can get a first return, some are immediate returns, in this case a second return, and then a third return which would be the last of many. Sensors, a good while back, could collect three, four, maybe five returns. Some now can collect upwards of a dozen.

[06:58] As a schematic, this shows the more scientific sort of approach to it. One thing to notice is the laser beam shown over here by the tree diagram, it's fairly accurate in that it's wide and this is why it can hit multiple objects and get multiple reflections. We tend to think about the laser beams as a little laser pointed with this very very tiny beam. That's not the case from airborne lidars. These footprints are typically in the half meter to one meter range.

[07:29] Lidar's long been touted for its ability to penetrate vegetation and to map in forested or other vegetated and wooded areas. People have always liked to say "Yeah, lidar can see through trees." Lidar does not see through trees. Lidar can see around the trees through gaps in the canopy.

[07:57] The test is typically, if you stand in the forest and you look up and you can see the sky, then lidar could probably measure you and the ground around you. If you can't see the sky, then the lidar system cannot see you either, which makes lidar not very useful in rain forest with completely closed canopy environments. Lidar is less effective at measuring the ground in vegetative areas than it is in open areas.

[08:26] Fewer points are going to make it to the ground, you will have less accuracy. That's a typo in there. Less accuracy, less reliability because there's more interpolation going on between the points on the ground. But still as an active sensor, lidar can see and measure in places that you could not measure in traditional photogrammetry.

[08:50] As an example we have this little wooded area here and if we didn't notice off the top of our heads, right of the bat, there's a culvert draining in here. And we know it goes through here but we can't tell where and in photogrammetry since the ground is all largely in shadow. we would not be able to measure the ground points and really get much of a clear topographic idea of what lies underneath these trees.

[09:20] With lidar, finding its way through the little gaps in all the trees, we actually get a fairly good model of where that drainage channel runs through that wooded area.

[09:33] One of the problems with lidar is that it's user independent. In photogrammetry, the operator actually looks for things on the ground, picks points and measures them exactly at that location. They can therefore, follow a stream or a stream bank and actually just drop points or drop vertices on the line along the edge.

[10:04] Lidar, although it does collect in a pattern, the location of the point, it's basically random. It's just a spray of points. Lidar, by itself, cannot trace stream bank or stream centerline.

[10:21] In order to get those features, we have to develop Hydrographic Breaklines. I used the term Hydrographic Breakline because I primarily work on the elevation site. But it's been noted that these from an NHD side or from a Hydrography standpoint, really should just be called streams because that's pretty much what they are. From lidar, in order to develop those, it has to be done after the fact by a human operator. It's very often is delineated horizontally, the lateral position of the lines, and then the elevations are conflated onto the vertices.

[11:08] There have been studies, and there's ongoing research into how to do this automatically. There is to date, no production ready methodology to do that, but the search continues. We keep looking to take the human out of that process.

[11:32] Some slippery terms in the industry and lidar is an industry that is just rife with bad vocabulary or vague vocabulary. I'm going to give you these definitions. This depends on who and where you are. If you are in Australia or Europe or maybe even just a different part of the US, people may use these terms differently.

[11:55] A DTM is a Digital Terrain Model. Traditionally, that's what you would call the masspoints and breaklines that come from stereo compilation. DTMs are used to create DEMs. Those are then in turn used to create contours.

[12:16] If we put ourselves back 20 years, contours were really one of the primary elevation products that people wanted to use. The DTM onto itself is not really that user friendly.

[12:35] A DEM is a Digital Elevation Model. It is a continuous raster surface of the bare earth. Now bare earth can mean a lot of different things. We're going to get to that in a little bit, but we need to be clear on the fact that DEM basically means the ground surface.

[12:59] I say that it's continuous raster surface. Technically, it really doesn't have to be. It could be a TIN, but they're used so infrequently as far as exchange and storage that we really just regard these primarily as always being raster.

[13:18] The same is true for DSM, Digital Surface Model, which would be a continuous surface of something other than the bare earth, for example, the top of canopy, first reflective surface. You may have building models with the trees or without the trees. There's a lot of different flavors of digital surface models as well.

[13:43] Looking at the DTMs, this is just a classic stereo DTM. This is a little sample area that I worked with up in West Virginia. This is the actual DTM that was collected back I think about 15 years ago or so, when they re-did their statewide mapping.

[14:03] What we should note is that we have masspoints, which are all the little stars, and we have the breaklines, but this is not a surface. If you drop something on this, it would fall all the way to the ground. It's not going to bounce off of any of these lines because it's not continuous. They're just discrete lines.

[14:26] Typically, these are the contours or the products that are generally derived from that. These are not particularly pretty. They're angular and sharp because this was just done quickly off of the DTM or the TIN made from the DTM without any editing or smoothing applied to the contours.

[14:50] Digital surface model, shown here floating up above the ground, shows the tree heights and the treetops. This is a continuous surface. The DEM is the bare earth ground surface shown down here below. These are, by the way, artificially separated from each other in the software. Just to make sure everybody understands what those terms mean.

[15:18] Different flavors of digital elevation models. There's two primary kinds that we deal with. One is a topographic DEM, which is fundamentally used for mapping. They come from different sources. There's different types.

[15:35] One is a stereo derived that comes straight from masspoints and breaklines. We can certainly create a DEM only from the lidar points. We can hydro flatten, which is a treatment for the water bodies. You can do that simply, or you can also make that a little bit more involved. We're going to look at some pictures of those.

[15:59] The other major type of DEM would be a hydrologic DEM, which is fundamentally used for modeling. The two big flavors of those are hydro enforced and hydro conditioned. Again, in both cases, within the modeling community, depending on exactly what type of solutions are being looked for, there are various flavors of those two different subtypes.

[16:32] This is a stereo DTM. This is actually the same area you probably recognize from the previous slide or a couple of slides back, this little area in West Virginia. This is actually made from the very DTM that I showed, the masspoints and breaklines.

[16:49] It's a very coarse resolution compared to what we're used to seeing the lidar data, but it depicts the expected character of the DEM. The water surfaces are flat. Bridges, here for the highway and there's a little bridge here, have been removed.

[17:10] The road edges are nicely defined. I think you can probably see that. Road fills over the culvert, which there is a culvert riding right along under here, but the road is still continuous above the culvert, which is great for mapping and drawing contours, not also great for hydrologic modeling because water will flow here. It will stop on that surface and it will back up and pool here. Then at some point, it will start running over the road, going under where this bridge was, which is not the way the water actually flows.

[17:51] If we do the same DEM with nothing but lidar points, a pure lidar, or some folks might call this a raw lidar topographic surface, we see massively more detail. We don't see the triangulation and the artifacts over the ground surface, not to the same degree that we saw on the previous, but we will notice that we have some real serious tinning artifacts over all of the water surfaces.

[18:19] This occurs because there typically are no points in the water surface. The ones that do appear are geometrically unreliable. You don't really know if it's measured correctly or not. There's a lot of reasons in physics as to why that is that I don't think we're going to need to go into today.

[18:41] What happens in this process is that the triangulation goes across from one bank to the other, whatever happens to be nearby. These elevations are not typically the same, again because the points are in a fairly random pattern. They may be right on the bank, they maybe a foot back from the water's edge and therefore little bit higher. We get this very aesthetically unpleasing appearance to the water bodies.

[19:18] If we were to run contours on this, because of the way the water bodies behave and with no breaklines, the contours will require an immense just enormous amount of editing to make them acceptable.

[19:35] Being faced with that in the NED [National Elevation Dataset] several years ago, we elected to start flattening the water bodies by...in most cases developing breaklines around the water bodies in the wider rivers, and using those to ensure that the water bodies were...if they're pond or lake that they stay flat, one continuous elevation. If they are stream...a wide stream that it continues flat bank to bank but with the gradient that follows the terrain going down.

[20:13] It's important to stress that this is done as a cartographic aesthetic enhancement. There's absolutely no relativity to true water surface elevation at a given time, or a given water stage, or flood stage. This is purely done just to make the elevation surface, the topographic surface work properly.

[20:41] We can also take that and extend it a little more by adding more breaklines to it. In this one we've added breaklines to define the road edge, and breaklines to define the buildings.

[20:55] If I go back real quick you'll notice this building has triangulation because there are no points on the ground where this building sits. Here we've gone ahead and added them, so that we get nice pretty building footprints as well.

[21:11] OK, that was it for that. That, of course makes for a lot of additional collection which does have a cost associated with it.

[21:27] If we look at our contours in this area, right over where the big overpass is on the interstate, we can see that this bridge deck has been removed and the contours run around it kind of nicely.

[21:40] We will also see over here where this culvert was we pointed out, we'll see this again in more detail, but this road surface is intact. Again this is what is needed for topographic mapping of a topographic DEM.

[21:57] If we start looking at the hydro enforced surfaces, what has been done is breaklines have been added to follow the culverts and the single line drainages, and we get a cut through the road…. actually several of them….one here, one here, and another one up here underneath this ramp, and this ramp, so that the surface can then actually allow water flow to continue on its natural course to whatever its downstream outfall is.

[22:34] A further addition or enhancement to this is hydro conditioned, which is very similar to hydro enforced but also takes areas of internal drainage and raises the elevations until the water or fluids would flow naturally out of these areas. These are basically sinks, for those who use the ArcInfo software, and they are just being filled.

[23:03] Now we can see several examples through here, where in the normal DEM or the unenhanced DEM, it simply is a depression that does not have a drainage.

[23:16] The problem that we have the difference between topographic mapping and hydrologic mapping is that while we still have the bridge removed in both cases this is where the cut would go where that culvert is, if we were to try to do contour mapping on a hydrologic surface.

[23:37] Clearly this would not be acceptable for a contour map. There would be hundreds upon hundreds of these ... they would appear everywhere. Next time you drive down a highway just notice how many culverts there actually are that you cross over.

[23:59] Quickly just to go through and have some quick comparisons. This slide, by the way, can be made available...I have found a lot of people really like playing with this one. We can see this is the reference DTM surface traditional mapping has been done for years...The raw lidar, the hydro flattened. This is just simple breakline the buildings are not flat.

[24:26] The enhanced that then goes and flattens the buildings or the building footprints. Hydro enforced introduces these two cuts in the road. We'll go back real quick and look here, and there, and then full hydro conditioning that fills in, for example, this little drainage here, or this little sink right here.

[24:50] OK, so breaklines and how would we actually work with these. This is from the same set of breaklines and DTM that we looked at earlier. It is only those breaklines that represent hydrographic features, that we took the roads out, and buildings, and some natural ridges, and depressions.

[25:19] If we look at the breaklines that were derived for hydro flattening. Only for the hydro flattening - we have a breakline around this pond, which is actually a sedimentation pond...I think this a water treatment plant, and then this little pond over here. We have also added the bank lines of the river, and the cyan, the greenish color here is the center line of the river.

[25:49] In many of the production processes to do hydro flattening, the center line is needed in order to get consistent elevations on the opposing bank lines. Some processes, some data producers may or may not use this but many will also put in that center line. That's going to become important in a later comparison.

[26:15] Now if we were to do an expanded collection of the hydrographic breaklines we would also add these single line streams, culverts which are one of our favorite things to argue about, and these little connectors that connect the single line stream to the center line, from here to there. This one here. There's another one there. One actually over here too.

[26:44] You can see that there is just tremendous similarity between what was pulled from the lidar and what was compiled in stereo. Of course there's a time difference between those two projects. There are some variations that may be natural changes in the streams.

[27:07] If we go and look at the NHD, and this is the actual NHD for this area, we have the flow lines which are the single line streams and the center lines, and then an area polygon which we're not showing except...We're only showing the edges of here, but this area polygon that is effectively the bank lines.

[27:31] If we overlay on that the expanded hydrographic breaklines that were drawn from lidar, we can see that there's just a tremendous similarity between them. Clearly we've got a little more definition in detail along the lateral location. We have culverts that are not shown, or not differentiated in the actual center or the flow line.

[28:00] We don't have a couple of the ponds delineated or shown, exactly, in this picture, because we're trying to make the point here on the single lines.

[28:13] When we go and do the collection of breaklines for hydro flattening, we're collecting features very accurately that basically reflect what the NHD would have or should have, we like to think, with a much higher degree of detail.

[28:36] The question is if we are already collecting those lines what can we do to make them useful not only for what is needed for a hydro flattening on the elevation side but also allows those lines to be useful to the NHD in updating, and enhancing their data, and keeping it up to date, and improving the accuracy?

[29:01] These extra lines here would also...All of these additional lidar baselines would allow the elevation side of the house to make improved DEMs, and different types of DEMs. If we have these culverts and these single lines we can start making hydrologic DEMs that are hydro enforced or even a hydro flattened in addition to the topographic DEMs.

[29:32] In looking at trying to integrate these, we look at the two primary stakeholders. On the elevation side we've been steeped in a tradition of topographic mapping for decades, but we're getting more and more requests from people who would like to see hydrologic surfaces already made and deliverable.

[29:57] We're already collecting limited breaklines just for the hydro flattening. If we were to start collecting additional breaklines, as I said, we can improve the surfaces we have, and we can start making these other sorts of surfaces.

[30:11] The NHD, of course, is always looking to update their data, and to improve it improve the accuracy. NHD has a very clear and just really magnificent GIS data dictionary that defines attribution; what the codes are, what the domains are, what's the capture requirements and specifications are.

[30:36] Lately they've been getting more requests, and developing interest, and actually incorporating elevation information into the NHD. What this really comes down to is we have an ideal setting for further cooperation between the two groups, and integrating the data sets much more closely than they have been.

[31:02] Initially what's needed to be done is we have to examine the NHD data dictionary as it exists, and look for what is compatible with what elevation requirements are, and what's different, and then resolve those differences, and try to produce the single data dictionary that will support both programs.

[31:26] Things have to be looked at not only just an attribution but also in topology, because there are some differences. We'll look at some examples of that in just a few minutes.

[31:38] Having done that we need to test that data dictionary in house to just make sure that it's really doing what we want and producing the kind of data, and the functionality, and product generation that we're hoping for.

[31:56] These steps have all been completed. We've gotten past all of this.

[32:00] We think we have the Data Dictionary. I don't want to say finalized but set well enough to actually start looking at some pilot projects and we'll get to that.

[32:16] We have our Data Dictionary. This is just an excerpt and these are still regarded as draft because until we get through pilot projects we feel there's probably still some changes. What we have is how Elevation describes a given element, how the NHD describes it, what classifications.

[32:40] And these are fields in the actual shapefile or geodatabase attribute table, the EClass, Elevation class type, surface feature type which relates to TIN construction in Arc. Feature group and feature code are the familiar codes straight from the NHD.

[33:00] The slightly grayed out areas indicate that there are features that we need in elevation that are not needed by the NHD and visa versa. We have a table for points. We have a table for lines, different types of lines, and a different table for polygons as well.

[33:28] There's a tremendous, just huge amount of similarity but there are a few little differences that are important. Again, the NHD has features that Elevation doesn't need, wells, pipelines, flumes. Elevation has some things that are utterly irrelevant to the NHD. I'm going to show an example of what we call a flattener.

[33:51] Then there's some topological differences between how the NHD uses a water body and how Elevation needs to use it. Features that pass under bridges and culverts as a particular problem child. As close as the two data sets are the requirements are, they are and they are very, very similar.

[34:19] We decided that it would be best if we just simply added attributes and codes so that Elevation could ignore all the feature codes and just look at the codes for Elevation.

The NHD didn't have to worry about the Elevation codes. Trying to keep them all the same was going to cause more confusion than it was going to solve.

[34:49] The handful of differences certainly while the NHD might want to pipeline indicated. This is an oil pipeline but let's just pretend there's water in it. This is not part of the landscape that would be modeled in a topographic DEM because it's not the ground. It's not even on the ground.

[35:11] The flatteners that I mentioned are...we have a flow coming in here and it winds its way around …. and I should have done these in different colors but I failed …. these lines here for example do not indicate any water flow. They're not flow lines. They're not part of the network of the system.

[35:38] These three segments here, here and this little piece here are there to ensure that when we go to flatten this water body that we can do it consistently. We have to have lines to carry elevations and put them on the bank lines.

[35:58] Culverts have to be differentiable. In the NHD this is a stream and it would be represented as a single line. There would be no break here. There would be no separate lines or attributed but just be a stream flowing all the way across.

[36:13] In order for elevation to create both topographic and hydrologic DEMs we have to have that culvert identifiable and separable from the rest of the stream. As I mentioned water bodys going under bridges, this orange segment here is actually a water …. it's part of, it's a separate polygon but it represents this river here, here and these two orange areas are also the polygons but they are the under the bridge segment.

[36:49] The bridge is the actual segment that is the hashed green polygon across it. Likewise the center line of the river is broken here under the bridge and broken here under the bridge as well. These are just some of the differences topologically between what the NHD's water modeling needs are and what elevation surface needs are.

[37:15] Currently, we are incorporating the Data Dictionary into the Lidar Base Spec, the newer version 1.3. It is being put in only to get the data structure published. At this point, there are no capture requirements at version 1.3 of the Lidar Base Specification.

[37:39] We are conducting pilot projects with GPSC contractors to do some of these collections so we can gauge the cost and the quality of breakline collection done by data producers, lidar data producers and to determine the most effective and appropriate extent of the collection for the integrated breaklines.

[38:02] That is including the scale or the level of detail as well as the feature types. Do we need rivers, do we need streams, do we need dams, do we need weirs. What things do we actually need to collect or not collect?

[38:18] Scale is a really huge and important thing to be concerned with. We can certainly add a lot of value to the elevation products and improve the NHD. The hydrographic breaklines are really the crux of that and trying to get from talking about integration to actually accomplishing it.

[38:42] We can see the nice sharp lines and definition of the water bodies here that clearly is not present without the breaklines.

[38:55] Oops, I went too fast.

[38:57] But at the same time we've got to temper our expectations with reality. This is a detail of the previous slide.

[39:10] Again we can see how horrible the water surfaces are and the rivers and the lack of definition and we can see how nice and pretty this is but you also get an idea of how much detail has to be drawn. I'm sure anybody who has done any digitizing can well imagine how difficult and time consuming this is.

[39:38] On top of this there are folks who would say, "Well, we need a breakline on this river over here," or "We need to have this go further inland." This gets just unthinkably expensive to undertake doing this even this little area was just incredibly tedious.

[40:01] The future task, what do we continue to need to look at as we move forward is develop internal processes for how we're going to use the breakline data. What products are we going to produce and deliver? How are those going to be produced and delivered? We need to develop, finalize and then introduce capture requirements into the Base Spec and into GPSC task orders, and then produce and distribute the new improved Elevation and Hydrographic products.

[40:36] All of those are...they're fairly large chunks of work and effort to get into. But that's the direction that we're looking at to try to get these breaklines to where they're useful for two different groups and share the wealth of all of that new information.

[40:58] That's what I have for you today. I got in just in my allotted time.

Steve: [41:05] Thanks Karl. We have 13 minutes or so for questions. Again, I encouraged you to use the Q&A button on the WebEx tab and mine is at the top of my monitor, it moves around a little bit depending on your software.

[41:22] Then Al Rea, our NHD co lead and Sue Buto our acting WBD lead will read off questions and Karl will try to answer them. If we need to go back and answer one in writing later we can do that.

[41:39] Any questions for Karl?

Al Rea: [41:41] Yeah, This is Al and I'm going to start off with the question while people are finding where the Q&A tab is on the interface to get their questions in. Karl could you go to the slide where you summarize the differences between hydro flattening and hydro enforcement and hydro conditioning just as a review because those terms are hard to remember.

Karl: [42:07] OK. Is this the slide you meant Al?

Al: [42:10] Yes, this is the one.

Karl: [42:12] I'm clicking my way back. This is not behaving properly. We'll go back to these.

[42:45] This is pure lidar. Again there's no breaklines so we get this rather unpleasant appearance across all of the water surfaces. This is hydro flattened and all we have done is added breaklines around the water bodies with appropriate elevations to make the water surfaces look natural. At least natural in the context of what does a DEM, a traditional topographic DEM look like.

[43:21] I keep going the wrong way, sorry guys.

[43:29] This is again a hydro flattened surface. It's got a few more breaklines in it to dress up some of the non hydro features, but it's still hydro flattened because the water surfaces have been treated to make them look decent.

[43:44] This is a hydro enforced surface. It is also hydro flattened and drainages and flow has been forced through roads. There could be other types of obstructions but culverts under roads is 95 percent of the problems if not 98 percent.

[44:17] All we've done is taken the surface and just carved out the road where the culverts are so that if you imagine pouring a bucket of water up here...Somebody had mentioned that we...I can't see the pointer. I hope you all can see the cursor.

[44:36] But if you pour a bucket of water up here in the northern part and it flows down these channels when it gets to the highway it will continue to flow all the way down into the river.

[44:52] Hydro conditioned is basically the same thing as the hydro enforced but other areas that are just depressions in the landform that do not have a natural pour point, a natural or obvious flow of where that water would go, basically the surface fills those up so there are no internal unconnected internal drainage.

[45:26] There are some variations in a different engineers working on different models and different types of projects. There are variations to these definitions but these are fairly typical across the industry.

[45:42] Did that answer the question?

Sue Buto: [45:46] I believe it did. Thanks Karl. We have a question from the audience, will hydro enforced DEMs become a standard requirement and a standard product for 3DEP products in the near future?

Karl: [46:01] I don't know that I would say near future, but maybe the mid future they may be. That's really more of a programmatic question than a technical question. I'm a technical person, but I think given the demand that we have seen and the interest in having those surfaces I'm going to stick my neck out a little bit and say yeah, we will see those, but I don't know that I would say they're going to be real soon.

[46:40] There's a lot of question about what will it take to produce those, what will it take to distribute those, what resolution can we make them at, should we make them on the fly as on demand products, how would that he handled, how would that be funded. There's a lot of questions about how to get new products actually implemented as standard products.

[47:07] [crosstalk]

Al: [47:14] One question was from the audience, could you explain what you mean by point spacing?

Karl: [47:19] Yeah. We try to use the term pulse spacing more than point spacing. I've got a good... OK, we'll go back and look at this real quick.

[47:38] First of all, and I had a slide for his but I took it out for time reasons but you get a pulse as the emission of the laser from the aircraft and you may get several reflections back which would all be ultimately converted into points.

[47:58] We have a fundamental difference between what a pulse is and what a point is. The pulse spacing is almost always calculated against first or last. But let's just say first returns because for every pulse you're going to have a first reflection. It may be the only reflection but you're going to have one. I realized that there are sometimes you don't get anything off of water but what the pulse spacing is... the nominal or average pulse spacing is... if we look at these points what is the typical distance between one point and another in all directions.

[48:47] If we take an area and say, "Well, I've got a meter and I've got four points that landed in it. I've got one square meter and I have four points that landed in it," what is the spacing of those points, the nominal or average spacing?

[49:03] As you can see in this is zigzagy pattern, there are places where you would have higher density than others. Right at the turn around at the edge of the scan, the points are going to be denser than they are in between the scan lines.

[49:22] This is why we call it nominal pulse spaces. A lot folks want to think that means what the posting is of the ground points on the ground and this is why we tend to stay with the pulses not the points. Once you move into vegetation you don't know and you cannot predict how many of those points are going to reach the ground.

[49:50] We might actually...yeah, you can kind of see in this. This is a little bit tricky but in these areas over here, I'm over way on the left hand side of the screen. There's some green points that are vegetation and they're sticking up and then underneath it you can see gaps where it's just black and the ground points would be depicted in blue but there aren't really very many.

[50:16] These are points and this is why we try not to talk too much in terms of point spacing because so many folks will very rightly expect that to mean ground points. Ground points can't really be predicted as far as the quantity or density.

Steve: [50:39] OK Karl.

Karl: [50:39] Yes.

Steve: [50:40] We have a boatload of questions for you.

Karl: [50:44] I can see them.

[50:44] [laughter]

Steve: [50:45] There you go. I'd like to field as many as we can online here.

Sue: [50:51] I'm going to merge two of these together and see what your thoughts are on this. Are there any plans for using lidar for karst hydrology modeling surface to ground water or other and do you have any insights into particular issues in karst terrain?

Karl: [51:11] Karst is tricky because karst goes underground and lidar doesn't. Without having a hydrologist and typically people who are familiar with the area it would be very difficult for lidar to really give you a lot of insight into that except where you've got a sink where water might just roll into the ground.

[51:37] And where again it might appear from the ground but as far as the connection there's just no real good way to do that with lidar.

Al: [51:47] Karl, another question has to do with the anticipated scale or targeted scale for NHD collection or breakline collection and would we be extending doing additional flow lines beyond what's currently in the NHD? Could you maybe address how we're approaching that in the pilots?

Karl: [52:13] Yeah. That's what our pilot projects are really aiming to answer. We've established a number of different levels of detail so to speak, different scales whether it's 1:24K or the 1:5,000 or even a much larger scale local resolution.

[52:35] But we're looking at having vendors do small sample areas at different scales and get us an idea of what cost could be expected to do these different levels. As with everything else money is important. We have to look at what the real value is. I personally think reproducing the 1 to 24K is a real good place to start, but the data can certainly support much more than that, if the budget can as well.

Sue: [53:13] Can you delimit the coastline with lidar, considering it's always dynamic?

Karl: [53:25] The big problem is defining what is the coastline. NOAA has one, USGS has another. There is mean low, low water and mean high, high water. If you fly at low water, you can find the zero contour. Really, how do you define what coastline you actually want? That's just an age old problem and lidar is not a silver bullet on it.

Al: [54:01] OK. If we have more time, question about automated tools or methods for identifying culverts and creating the breaks through the process or is it all manual?

Karl: [54:16] I think it's largely manual though there are some techniques that even been researched and published from other researchers here at EROS on how you can find many of them and it's doing fills and sinks and analyzing those results.

[54:38] That can be fairly automated but it's never going to capture all of them. Probably they are going to need a little spatial adjustment as well.

[54:49] I would love it if every jurisdiction had a nice dataset of all of their culverts that we could drop in but that's not usually available.

Sue: [55:07] In a similar vein, in these surfaces why are there breaks in the highways?

Karl: [55:16] Those would be for...come on I got to find the slide.... if we go hydro enforced, these breaks in the highway here are to allow the drainage from here to continue to where it goes.

[55:41] This is a surface that is designed and built for hydrologic modeling. In order to see where the water goes on a two dimensional surface or two and a half dimensional surface, the water has to have a place to go through it.

[56:00] In nature it goes through the culvert but we can't model a culvert on a single surface. We just have to cut the road away to allow it to function the way it does in nature. That makes sense?

[56:16] This can be tricky in trying to get back and forth between topographic and hydrologic.

Al: [56:23] I guess a related question is whether a culvert database would be useful?

Karl: [56:31] Yes, it would be very much, a graphic. Yes, it would be. Not everybody has one and not all of the ones that people have, have the accuracy or the detail that is needed to make them really work.

Steve: [56:53] We hit the top of the hour here .We've put up a poll on the WebEx site. We'd like some feedback from the audience on what you thought of today's session and what was valuable to you and so forth.

[57:10] If you take a few minutes and fill out that poll before exiting the WebEx, that would be great. Thank you, Karl. I think everybody found this informative. I've seen some of this before and thought it was very good.

[57:23] We did capture the written questions so we will be forwarding those to Karl for homework. We will get those answers posted along with the answers to the questions he answered online here.

[57:37] Those questions we posted to the NHD website, nhd.usgs.gov, under the Hydro Seminars tab. If you go to there, if you are interested in previous seminars, all of the seminar slide decks, Q&A and transcripts for most of the seminars are posted there along with video recordings.

[57:59] We'll have a recording of this seminar up. It will be several weeks, maybe a month, but we will have a seminar up as soon as we can. Then we are going to go on hiatus for the summer.

[58:14] We plan to resume these in the fall, but we don't have a fixed date or agenda yet. We have your email addresses from the registration. We will send a notification. Along with the notifications that we send out along the same lines as the notifications we send out for this seminar.

[58:32] I guess without further ado we can thank Karl one more time and answer the poll and thanks everyone.