Geographic Information Systems
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Lecture-40
Demonstration through GIS Software

Hello everyone! and welcome to this demonstration in which we are going to discuss two main things. How to generate a TIN and we will also discuss the boundary issue and other things. And I can show you on two different softwares. But the results are going to be the same so we will be having this demonstration on ARCGIS. You can try on like QGIS or other softwares and I am sure that it will generate the same results.

And the second thing which we will be discussing about DEM resolution so I would be showing different digital elevation models and I will see that how these resolutions will affect the representation of terrain in our real GIS operations. So, let us start a demonstration on this.
(Video Start Time: 01:28)

Here I am having points which earlier also we have been taking this point. So, first we will go through the attribute file or this what are the non-special data associated with these points. And what we are going to do? We will use this Z value associated with each point in our database and then we will use this one you know, to create a TIN here. And you know there are two extensions within this software which will allow to create TIN.

And the best thing which I find is that this is the best way rather than searching your you know tool. You can do this directly here in the search, for example you type here create TIN. And once I go for search, I should get that these are the tools which are available here and there in my toolbox to create TIN. For example, there is a create TIN in 3d analyst also and elsewhere also.

So, I do not bother about that. I would go only the best option which generally is the first one. So, let us go because this is TIN to raster, TIN to edge. I am looking how to create TIN using given points and points are already being displayed here. And once that option comes and we

will provide some information to that one and then can do that kind of operation. Sometimes say you know the software is very huge so it may take some time here. Okay!

So, now options are available to us and this is where it will keep the output. So, I am choosing wherever let it keep. And I can also choose the coordinate system or other things, though currently it is optional. So, I am just leaving it. Now input feature class that I want. So, of course here I am having this input feature class and there this one. And the field is more important here which we have to provide the height field.

Height field information has discussed the Z value we will keep here. This is very important to provide here otherwise there might be because it does not know where to do or not or where to search the Z value. If it is in very first field, by default it will search. In our case, it is in the last field. So, it will not be able to search automatically. So, you must provide the field or column where the Z values have been kept.

I am not going to change any other options or going for optional. So, let us first create with whatever the default things are there except providing the height field or the field which is having my elevations. And then once you have provided, you can create these things very easily. Now see, it has created a TIN model for given points which we have given. As I was mentioning that in the TIN, the only problem which you are having about the border areas or at the boundary because the unit here has to be triangle.

And therefore, like here, it didn't have any other observations. So, let me change the color of this point. Instead of this color if I choose red then hopefully it would be more clearly. So, here I am having three points, a triangle has been formed. I do not have any other point so that my area of interest. What I mean here is that my area of interest may be a rectangular one. But TIN will not be created for rectangular area, however a digital elevation model can definitely be created for that area.

So, this is one limitation which you are having with the TIN here. Now I can also demonstrate to you some other you know, things here. Like for example which we have been discussing in this

theory classes and that if I would like to go for this random selection or random creation then I can do it. For example, I am adding a digital elevation model here and this is the issue which I was mentioning here.

What I have done in the background? I have added a digital elevation model which was created earlier using the same input points and the same field that is height field; Z value. And when you create, you can instruct the software for the extent of your digital elevation model. I mean here is that whether you want within your data file or input data extent or you want some extrapolation also.

So, I could have generated the same points with a DEM covering a large area. But if I would have created then that means I have created an extrapolated surface, not interpolated surface. But if I am keeping my digital elevation model within my extent then it is in really under control and not much extrapolation has been done here. Now when we compare with this surface, see the TIN and your interpolated surface. Though the source of both of these models or surfaces are points which we have taken and the same field and everything same.

But the products are or outputs are completely different. So, TIN which you are seeing top of this, do not have coverage beyond these input points. Whereas your digital elevation model because it can be saying a two-dimensional matrix and therefore it can be either stored in a rectangular form or in a you know, square shape. Here in this particular example, it is in rectangular form.

So, that brings that thing very clearly here. Further the boundary issues which are related with this are always there with the TIN which are not a big problem in your simple raster or a digital elevation model. Now what we can do? We can you know generate some random points and then try to do how we can you know create such things. So, random points can be generated if you are having some details about the extent.

You can ask the system to generate random points within that extent or maybe collect some points also. For example, if I say create random points. Now create a random raster or create

random points. So, I would go for this one and then we can say that which are the things which we have to follow. So, let it store in the default place. This field says what is the basically the output point feature class.

So, we have to the name of the random points featured classes to be created. So, we just give h ere name which is a random one or maybe if I am creating say 100 points, I would say random 100. And then whether I would go for some constraining these features. So, for time being, let us keep it simple and I am not going for constraining my features. Or what we can do? we can provide the extent that create a random within that extent also.

So, inside that area only, the random points will be created or will be generated. And then what we can control here is the number of points. So, number of points that is the how many points. So, in default, it is giving 100. Let us keep 100, no issue is there. And then the units which we have to be providing here. What are the units? So, I can say in meters or whatever. So, let us keep in meters here; units are in meters. And minimum allow distance or value I am saying, whatever the default that is zero and I can also have this option that multipoint option that is.

So, if I check that output will be geometrically type, multipoint's, all points are single feature. So, I want that one and the maximum number of points per multiple option, an let us do that without this check and go for more simplest generation of these points. Let us see what happens. They are being generated random points. Now see these points have been added here and these points; fortunately, they are at the same locations, they have been generated and in fact these should have been generated at different location.

Probably we constrained because we kept at this. So, let me remove this one, also remove this one and sometimes say these things keep happening. So, what I will do? I will go again. This time, I am not basically going to take anyone. Let us keep things very simple here except here, I can say meters and let us go ahead. See when I gave little freedom to the software, it has now selected or generated 100 random points within that constraint which I have or within that extent which I have provided which was already there because of the display of those and DEM and other data sets.

So, why I wanted to show this that you can select randomly 10 points or you know random points, you can play with that. You can create random points; you can select random points and you can use these random points to assess the quality of a digital elevation model or even in that case a TIN. So, in that way, you can assess that how good it is on the border areas or margins there.

But generally, you would find that in TIN, the margin issue might be there. And of course, the resolution of a digital elevation model which you can always control. I am not just will go up to the options, interpolation. But I will not do it because it takes a lot of time. So, you try by yourself. So, if I go for this interpolation then we will see like which interpolation. So, I go for you know, a simple interpolation may be a moving window kriging.

Here you have to provide the points whichever are available to the source and input data set, output location and other constraints are there and that will allow. Or another way of reaching to menus if you can remember where those are in the toolbox then you can again employ in that way also. I am more interested to show you about this interpolation options through this IDW or Spline method.

So, just waiting. So, here when I go for this special analyst, here I get options and there I go for the surface and interpolation. Sorry! And now I am having options IDW, Kriging, Natural neighbours, Spline and other. So, if I go for IDW, this is what it will do. The input feature points so, I say random points. Z value, we have to provide. Whether Z value is there, in this case there is not yet we have collected Z values.

But if it would have been then you can use those Z values and then where it will be stored. And here this is the point which I wanted to discuss about the resolution. When we ourselves are creating a surface, we are having full control over the resolution. But that does not mean that I am having just few points and I am creating a digital elevation model at 1-meter resolution, it will not be a very good result.

So, if I want a very high spatial resolution digital elevation model and resolution, I can control through software, I need high density of my observation points. If that is not there then there is no use of increasing spatial resolution here. So, this one has to be very careful. Generally, the default values which will come based on already displayed themes or data sets because it is assuming that you are going to use these data sets along with the newly created digital elevation model.

So, it assumes and it brings you know already filled value. But definitely you can change that value. Also, you are having options of power and other things. How you want to constrain and how tight you want and how loose, you want interpolation against the input points that you can also decide. And there are some other options are also available so by which if you choose. Now here before this stage, you can have 90 percent points.

Generate digital elevation models using different options of different interpolation techniques and at the end you may have 10-12 surfaces. Now using those 10% points, you can check how close a particular digital elevation model among whatever you have generated. So, whichever one is close to you, you can definitely do that. Once you have decided or once you have found that this is the digital elevation model which is most suitable for that particular data set then you can employ all hundred percent points and generate.

Now here I would like to mention after all whatever you are going to do is interpolation and only it is telling that among the surfaces which you have generated, this is the best. But again, that main would be the best. So, it is impossible to know which is the real best you know. So, what we are choosing? Whatever are available, different surfaces generated through different options variants of interpolation techniques, that is the best.

And of course, if you imply this like last option here is the barrier, you may get more realistic surface generation using this barrier polyline. So likewise, you can find the best possible interpolation techniques employing random selection, taking out those selected points and later on using them in your analysis. Now I will go for another demonstration which I told earlier that we will go for different spatial resolution DEM which are available currently.

And how you know, the quality you have to assess because remember quality is especially or errors are especially varying. So, for particular plain area, I may find SRTM is good. But for another area, I may find ASTER is good or in third area, I may find CARTOSAT is good. All may be on the same resolution. So, errors are especially varying and therefore we cannot always rely on a single digital elevation model.

Here what I am going to do? I am going to display one after another digital elevation models having different spatial resolutions and then we will compare different spatial resolutions all together of different layers or different DEM's. The one which is being displayed currently is the TOPO; G-TOPO or USGS TOPO. That TOPO stands here from the Sources Topographic maps at 1-kilometer resolution.

And this entire tile is for India. So, whenever you download, the entire tile will come. But if I start zooming it, for example if I zoom like this, I have started noticing that jiggered thing you know, that the individual cells have started appearing very quickly. So, let us go back to that zoom level where we started. Okay! And what we will do? We will zoom to the layer. Now add another digital elevation model which is at 90-meter resolution and this is based on the SRTM DEM; shuttle radar topographic mission.

So, this DEM is covering a very small area relative to what 1-kilometer resolution DEM is. So, if I bring in the background and give a different palette or color here. So, both things will be much easier to see. Sorry! See so, this is what we can assess immediately the difference in different spatial resolution of two digital elevation models. In the background that the colored one which you are seeing is USGS TOPO 1-kilometer resolution DEM and on top of that. you are seeing a 90-meter resolution DEM or part of G TOPO area.

And as you can compare, see here because each cell is representing 1 square kilometer and whereas it is representing 810 square meter area, your SRTM and the huge difference in spatial resolution can be clearly seen. Even if I give the same color palette or assign same color palette

to this one, still there should not be any problem. See the difference; you can see where you know one is overlapping here.

So, in the background, you are seeing a digital elevation model at 1-kilometer resolution on top of that, you are seeing a 90-meter resolution. Now immediately you would realize that what is the huge difference which you are seeing here. Now let me also add one more digital elevation model of a different resolution and this is SRTM DEM of 30-meter resolution. The extent is same, that means if you if you see carefully the naming of the files.

The tile size is same. But if you very carefully read the file that it is telling that north 30. So, that you can see that north 30 and 78. So, the bottom left corner coordinates are written plus also, it is mentioning 3-arcs second and this is version 2. 3-arc seconds roughly stands for 90-meter resolution or 90-meter cell size whereas this one, the 30-meter resolution SRTM, though the origin is the same as that one as you can see, the origin is same.

So, let me make this one as black and white to make things better. And when I add this one, this is what I get here. So, the tile size is same that means the extent is same. But the resolution has improved again very significantly from 90-meter or 3-arc second. Now we have reached to 30-meter or 1-arc second. So, if I compare these two digital elevation models, let me bring the same color to these two. And the USGS for time being, I can switch off.

And when I zoom a particular part or section of this digital elevation model say here and currently, what you are seeing is 30-meter SRTM DEM and below here, it is a 90-meter. And you can see a difference, not as that big one. But definitely, you would see difference very clearly. So currently, you can see these pixelized or you know jiggered kind of cells. But when I bring 30-meter then I see much smoother area.

So, this is another way of. You know always try to zoom a part of input data and see what is happening there because many times you know that level; one to one scale level or one to one display level, you may not observe the problems or you know quality of a digital elevation model

for visual inspection. But when you zoom it, you can definitely see like here which I am showing currently again 90-meter SRTM and this is 30-meter.

So, 90-meter and 30-meter, you can see how the difference in the spatial resolution. Now what I am going to do is I am not showing now 90-meter. I will show 3 DEM's of 30-meter each, generated through three different techniques or three different sources are there. Though all are having 30-meter special resolution and also, they are having the same geographic extent.

So, each tile is 1-degree tile you are having; 1 degree or let me check 78, 1 degree tile. So, each tile is one degree tile of DEM of different sources. So, the one which you are seeing currently; this colored one, is a SRTM 30-meter. And this ASTER DEM; this is again 30-meter. So, both have been generated using completely different remote sensing technique. SRTM based on SAR interferometry, ASTER DEM based on stereo pairs and CARTOSAT is also based on stereo pairs.

And now at this stage, what I will do? I will keep every elevation model having the same color here or same pellet and then let me zoom it. Is there any difference or much difference because all three are of same spatial resolution? So, see even they are varying spatially. This is currently SRTM DEM which you are seeing here. Now I add the ASTER DEM of 30-meter and I attach here the CARTOSAT.

So, all are showing a completely different way the terrain is. Now what is the true form of the terrain? It is very-2 difficult to represent. So, how you can assess? As we have discussed while discussing in theory about the how to assess the quality of a digital elevation model. Now what you can do here? Again, you can employ those random points. You can generate random points for the same extent like here maybe 100 points or 200 points.

And then enrich the database or attribute table of that random point with through all three digital elevation models. So, in your random point attribute table, you would have a height field from SRTM. You would have a height field or elevation field of ASTER DGEM and you would have

another third field for CARTOSAT DEM. And once you have collected all these points against those random points.

Now you can perform a simple statistical analysis like example standard deviation and the things and you can find that which one is giving minimum standard deviation. And probably which one is closer to the points which I might be having for test points and then you can assess again which one is the best. Another way which we have also discussed while doing either surface hydrologic modeling and creating a drainage network or morphometric analysis and then that will also give you insight about the quality of a digital elevation model.

Currently, these softwares have not implemented to assess the quality of a digital elevation model. But I am sure that since lot of options are available like for example at 30-meter spatial resolution. We are having now at least 3 freely available digital elevation models for India and therefore, we should have some mechanism or some tool by which we can assess that which one is the best for this my area of interest.

As we have been discussing that a particular digital elevation model says for example ASTER GDEM or CARTOSAT may be very good for my hilly area of study whereas SRTM is not so good and SRTM may be good for plane areas. But there, CARTOSAT and ASTER GDEM is not good. Now when we assess within CARTOSAT and ASTER; both are based on photogrammetric techniques then again, I would like to know which one is more accurate.

So, there are no basically standard you know tools available. But you know the theoretical understanding or statistical tools are available. Random generator, random selectors in a standard GIS software, by employing those things, you can definitely assess in a good way about the quality of an input digital elevation model of your area. But this exercise has to be done every time if you are changing the area.

Suppose, today I am working in a flat area or Indo Gangetic plane area then I after assessment, I find that SRTM is good. But I cannot assume the same assessment would be true in case of hilly terrain. So, for a hilly terrain area, again I have to do the assessment. I may find that ASTER

GDEM or CARTOSAT DEM is going well then, your SRTM DEM. So, every time if I shift my area of interest or research then definitely, I should do the assessment of quality of DEM.

If you are using your own generated digital elevation model then the scenario is different. You can check it with the 10% randomly selected points kept in a separate file and later on, once you have found that which one is the best interpolation then you can employ 100% point. But here you need some control points to check. If they are not available then relative checking can also be done using random points.

So, there are various ways. You know once in theory things can be summarized or a sequence can be given much easier way. But when we come for real practical things, many times you have to you know do some kind of innovations in terms of sequence or you have to find out the most appropriate tool to do that work. So, the manuals or books or literature will never tell you that how these things can be done.

But if you are having a such a very used tool box, only thing you have to find the most appropriate tool and then do the part. So, ways are there always. You are having a rich tool box. And find the most appropriate tool and perform the analysis which you are intending. So, with this say, I end this demonstration. Thank you very much.

(Video End Time: 38:40)