Geographic Information Systems
Prof. A. K. Saraf
Department of Earth Sciences
Indian Institute of Technology – Roorkee

Lecture – 25
Demonstration through GIS software

Hello everyone! and welcome to demonstration through GIS software. So, in this demonstration, what we have discussed so far in theory classes; we will be having some you know exercises or kind of demonstration on interpolation techniques.

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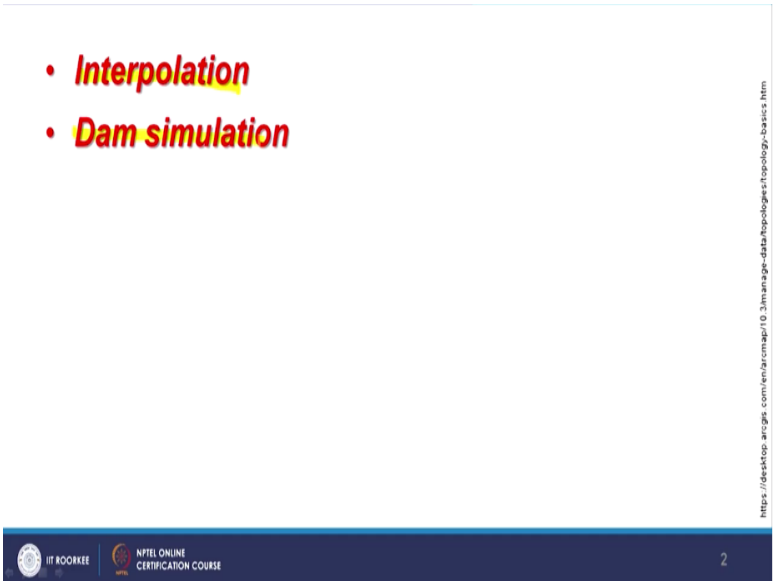

And then we will be having a demonstration on seek function especially about the reservoir planning or dam simulation. So, we are going to have one after another these 2 demonstrations. So, okay! Now we start on the software. **(Video Starts: 01:00)** So, what we are going to now use point data for creating a surface; that means from discrete to continuous.

And for this, we can take some point data files like I am taking here you know points which are here and I can make them little larger in size so that they become more visible likewise. Now using these point data, we can do interpolation. So, in this particular software, where we have to go to? In this Arc Toolbox, we have to go to another toolbox which is called a Spatial Analyst Tool.

And in Spatial Analyst Tool, you can notice that there is a further toolbox which is called Interpolation. So, what we are going to do? First, we are going to choose the first one; that is

inverse distance weightage, IDW. So, once you double click then options will start coming here. So, we have to provide first what is your theme. So, currently we are having in our display in table of content only a single theme which is our soil map.

So, that is being taken. This software is very powerful software. And sometimes it might run quite slow on you know laptop. So, one has to be little careful about this. Now, of course we have to guide that where database will reside or the output would reside. So, I am choosing the default one. Also, we can decide at this stage, what is going to be spatial resolution.

So, if you are having requirements of spatial resolution of a surface, accordingly you can choose. The only thing here one has to remember is that it is in the mapping units. So, if your mapping units are DD then accordingly you choose. So, DD has to be first converted into meters. And then accordingly, you put this value. For time being, I am just taking whatever it is coming in default.

Now it is about power. So, higher the power will put more constraint and smoother surface will be generated. However, it will take more time. So, for our simple exercise, what I am going to take is 2 as default in power. Though it is optional but I am going to take that one and then this search radius. We have as discussed in our theory classes that there are 2 options for search radius; either I can choose the fixed one.

There I have to provide the distance. Again, this distance has to be in mapping units. Or I can say that search variables and number of points are 12. I am not constraining now using distance, just number of points. So, input points; there are many in this input soil map. And these are the things. Z value, I have requested that from my attribute table, take PH as my Z value. And once you have chosen for this, recall that discussion about the barriers or you know these barriers, they can impede your surface.

So, if I am preparing a surface for subsurface conditions, like for example of groundwater table then I need to have that information that there might be some fault lines or dikes or other things. If I am developing a real surface say using digital elevation models or any other thing like point data or elevation values then for example, in case of hydrology, I have to provide the location of my streams for more realistic generation of surface and that always has to be a polyline theme.

It cannot be line theme. It cannot be polygon theme. It has to be a polyline theme. Of course, this is optional. So, in all scenarios, it is not necessary that we have to provide a barrier for impediments. But if more realistic one is required, we must provide a barrier theme in polyline form. Now once you have done it, as you might have also observed that wherever I am clicking, I am getting the help also. So that is you know, sign of a good software.

Though I am not promoting that one but this is how, the software should be developed so that they become very easy for the users. So now, I have chosen whatever options I wanted to choose. Now, I go and say create a surface using IDW. And in few second time, it will be added in our table of content. And also, we will start seeing in display as well. Depending on the number of points, which are there.

If large number of points are there then obviously, it will take lot of time to create a surface. Otherwise, it will not take much time to create a surface. Now, that surface has been generated as you can see in the background. Sometimes it takes time as I have already mentioned that it depends on number of observations. If density and number of observations is more, it will take more time.

If density or number of observations are less, obviously it has to do less calculations. Now one important point which I want to also bring here about the extent; what is going to be the extent of my surface? So, in default, what it is giving basically wherever my points are having a spread or having extend like here at the bottom, this is the last point in the southernmost side. So, that has been taken as an extent for creation of surface.

And as you know this is raster so it has to be either in shape of rectangle or a square. So here, it is in shape of rectangle. Similarly, this input observation is creating the extent for right-hand side. Again, this one is creating for the left-hand side and this is for the top. So, individual input points observations are bringing extension by default. And therefore, you are getting the data.

Now sometimes there will be a situation for example, if I zoom in this part of the data set or display, what I see that here, since I do not have any observation in this part also. So that means between 2 points of course, I will have better results because interpolation is being

done. But beyond these 2 points till the boundary which has been decided by another you know input observation then this is all is my extrapolation.

So, there might be errors in extrapolating in that area. Nonetheless, we can utilize these whatever the results, it has created. And now what we will do? We will compare these results with our input data. For example, if I go and identify what was my input value so I will take all visible layers and again, I will click here. So, see here; the input value was 58 and IDW is bringing a very little less value.

Now here, it cannot be input as a 5.8. So, let me choose some other value. Okay! So, what we are seeing here? There was little confusion, no problem! Sometimes happens. So, we have to be very careful. Remember the rule that after each and every operation, please check for errors. This is what I was doing. Again, I will do it. So, if I remove the later one and earlier one and now, I am just bringing 2 layers here.

So, if I press here, what I am getting basically that this layer is giving my values. So here in my layers, what I am seeing that the input PH value was 8.2. And in the surface which has been generated through this IDW interpolation, it is coming up to 8.19. So, if we round off, it is giving quite good results. Only this comparison we can do, where these observations are there.

In rest of the area, we have to believe basically on the surface which this method has generated. For example, if I go in this southern part where I was discussing about the extrapolation and if I go here of course, I do not have any observation. So here, things have been extrapolated and values might be much higher or lower as compared to input. So here, this is my one of the inputs and value here is as you can see 5.8.

And if I click here or this value also, it is 6.2 which I am getting and if I get here, this is also again coming around 6.129. So, it is going now, not exactly coming 6.2. Of course, it is extrapolation and beyond this margin or extent of my surface, I do not have any observation. Because this is nonlinear interpolation so whatever the trend it develops so far near the margins that continues and based on that, the prediction has been done.

And this is how we are getting these values. So, this is 6.24 at this location. But the real input for this was 6.6 as you can see in the bottom and also 6.2 in this one whereas I am getting here 624. So, extrapolation; not too wide but still, we will call as an extrapolation. This is not truly interpolation if observations are not there. But when observations are there say in the central point, we will have more accurate estimation of the surface or the values for each cell of our raster.

So similarly, we can also develop you know surfaces using some other methods. So, quickly I will also go through this Kriging method where again I am going to take the same input feature file. I am going to take the same PH is my Z value. And I am keeping everything same except different interpolation technique. And I am keeping output in the same folder.

I can choose these 2 options of Kriging; either ordinary or universal. So, for time being, I am choosing say in ordinary. Now semi variogram model; which model you want to choose, you can choose. By default, it is spherical. So, you know that is spherical semi variogram model; this is what is default. The circular semi variogram model is different and all those details should be available to you.

Now of course, here I can again control the spatial resolution and also the search radius and other things. And if barriers are required, the barriers can be used. So, in theory, I have demonstrated that how barriers will affect your surface. So, there were 2 scenarios; one without barrier and with barrier. So of course, with barriers if that prior information is available in polyline form, you can provide and can create more realistic surface.

So, let us do it. Now, it will create 2 things; one is variogram also, not only the surface but the variogram also. And variogram basically give you the estimations about the error. How much you know errors are? This is the only interpolation methods in which this much of information, you can also have. So, this Kriging surface has been created. Here compare again like we did in the previous case.

If I do it like this that I go and I choose this tool and say, I want to identify here. So, in input map, the value was 6.2 and in Kriging surface, it is coming 6.253. So, very-2 close but of course, if I go little away, now I do not have any observation so whatever is coming as a

prediction. Prediction based on the surrounding values of 12 values which we have given while going for this interpolation.

So likewise, you can really go for different options. Even if I go for again that one and choose little different options, let us see what happens. If I go over PH and same output, I am keeping. Instead of now ordinary, I am going for universal and in variogram, I am choosing a linear with quadratic drift and remaining things are same. Let me go and create a surface, that would be a Kriging surface.

In the bottom, you can see that the progress is being made here and very soon, this will be added. So, the latest one is this one. If we compare these 2 and with the data, let us see what happens whether values are same or different because now, options or we have used the variant within the Kriging for generation of surface. So, if I go like this, what I am seeing for this point which I have chosen here that the input value or observation for PH value was 6.2.

Whereas in the earlier stage, when we went for ordinary Kriging, it was 6.253. Whereas in case of this universal Kriging and different semi variogram, it is now coming 6.367. So, that these options later on which I have chosen, are bringing higher values as compared to my previous one. Now likewise there is no direct, we can assess that which interpolation is best for my set of data. That is a separate discussion which we will have some time later that how to assess which interpolation is best.

If we do not have say any observation, we can still compare that for the same point, the ordinary Kriging is giving this 6.2 whereas this one is giving 6.35. So, there is some difference between these 2 surfaces. Visually also, if I zoom to the layer and bring one by one. See visually, the top one; the universal Kriging method brings some more finer details and therefore, less smooth surface as compared to ordinary Kriging.

Ordinary Kriging is bringing more smoother surface whereas this one is bringing less smooth surface. Because the constraints were little different; the conditions were different. So, all kinds of interpolations are there. More popular one like Spline, IDW and another trend surface. And as you have seen like within Kriging, there are various variants too are available. Most of these things we have already discussed in theory that how to exploit, how to understand.

Even then if there are doubts, the best thing you can do whenever you choose, you can always see the help on the right side in this particular software. Most of the good software will provide detailed help to you. So, if you do not understand fully what it means universal and linear and linear drift, you must read first and then go for these options.

And there are other advanced parameters also which if that much of realistic surface is required for certain applications, one should also explore those possibilities. **(Video Ends: 21:22)** Alright! Now, I go for another demonstration. That is about dam simulation. Now dam simulation demonstration, there is no readymade tool is available in this ArcGIS, ArcMap software.

So, I will go back to my most favorite GIS tool or software that is ArcView. Here, what I am going to do is I will you know get that dam simulation project so that things would be is quicker, faster. What I am doing here? In the background, I am having a digital elevation model which you can see. I am also having a stream network which I derived using surface hydrology modelling which in theory, we will be discussing little later. And may come back again here to demonstrate that part.

Anyway, now we have to focus on dam simulation. And there is a tool in ArcView which is very easy to use and very-2 useful tool is there. So, I am going to open that tool. It says only that where the grid file data is there. So, now it says you have to provide of course, there has to be one grid file or raster file, not image and then where you know this database will be stored that thing you have to also provide.

So, if I say okay! Store there wherever replace the older file. Now this extension is called profile extractor. And because this software is no more supported by Esri, it is available free of cost. Anyone can install, including this extension and play with this one. I tell you one would really enjoy and see the efficacies of GIS in a very good manner.

So, what I am going to do here that first I am going to create the dam axis. So, using this tool across this stream which is shown here in the blue color, I am going to draw my potential or future dam axis. As soon as I have finished, at the same time, it has also drawn topographic

profile along this line; the line which I am calling as dam axis. Now here, I have to fill with water.

Because after all we are have to calculate what is the inundated area in upstream? What would be the volume and so on and various other parameters? So, currently there is no water. Now, I see this profile. If I fill water up to 1400 meters then in profile, water should be here and also, I would see how that is inundating. So, for time being, what I will do? I will just choose 1200 instead of 1400.

And say now, take this surface, use this grid here and see that the water has come at 1200 meter. Now I say that I want to calculate volume. When we go and say that calculate volume, same time it will also so as the inundated area in this upper view number 1. So, let me press that one. Now here, I am saying fill up to the grid extent; this is the extent I am declaring, nothing else and say calculate. Very quickly it will do it. Very fast tool is available.

And see now this green polygon which you are seeing here. Let me zoom it. And the green polygon which you are seeing here is showing the inundated area. If a dam is constructed having 1200-meter height then this much of area will get inundated. What would be the volume of water? That too is calculated. What would be the inundated area? That too is calculated.

And there can be 2 types of area; one is planar area and another one is called the surface area. And surface area is going to be always larger than the planar area. So, what I can also get more information about my profile characteristics by pressing this one. And here, I can then differentiate that what is the terrain length along my dam axis and what is exactly straight-line length along my dam axis?

Of course, straight-line length is always less than what is terrain length. Now, using simple topographic maps without involving GIS, such calculations are really impossible and if at all possible but not accurate. Here, I am calculating distance up to 2 places of decimal. So very high accuracy, I can achieve depending of course, on my spatial resolution of digital elevation model.

If I myself is generating, there also I can control. And what is the minimum elevation in my area? What is the maximum elevation? And what are the maximum slope. Other hydraulic properties which are required while constructing our planning a dam or a reservoir? How much area will be inundated? That is also shown. Wetted perimeter. How much will be touching the ground; horizontal length, vertical length and hydraulic radius?

Every data is here and of course, this all results are coming in mapping units. Now, the next thing which I am going to do, if you recall that profile. Here I kept water only up to 1200 level. Now, I have shown this scenario to my higher ups for decision making. And they say no! The volume of water which this reservoir is going to store is not sufficient for my requirements.

I might be developing irrigation or maybe groundwater recharge or any other thing or maybe hydropower in a large project. So, in order to increase the volume of water, that means I have to raise the height of my dam axis. Now on toposheets, these things cannot be done quickly. But here, these things can definitely be done quickly. So now, we decide that instead of 1200 meter, now I want to raise the height at 1400 meter and just notice that what happens here in the profile section.

As soon as I press enter for 1400 meters, the water will raise here. Now, those steps which I have done earlier have to be done again. Let me close all this. And I will say now, calculate the volume because it is a recalculation. So, calculate the volume and of course, say calculate now. And now, it will create another inundated area in the upstream of my reservoir. Now both are in same color.

So, what I will do? I will change the color here. Let me change the color here and let me make this one as red one. And let me also send this one in to back. Now both areas. So, green area or green polygon is showing when water level I am keeping in my modeling or simulation at 1200 meter. And if I go for 1400 meter then in a plan view, it will extend where this red polygon is showing to us.

So, in that way, this is what the first scenario and this is going to be my later scenario. Now, still if requirements are not being fulfilled; your higher ups are not still happy that the volume of water even if the dam height is 1400 meter is raised is not sufficient, still you can change,

no problem. You can simulate further or instead of 1400 because what we are seeing in the profile that at this location, I can raise even up to 1500 meter.

So, I said to higher ups no problem sir! I can raise up to 1500 meters. So, as soon as I will press this one, you would see the changes which will occur here in my simulation in the profile. Now, again calculate the volume here. Now, it would be a large inundated area. So, again I will change the color of this one to some different color so that things are clearly visible here. And let me change the color. Okay and send me to the back.

So, there are now basically 3 layers. The only thing I want now it is taking and sent to back. And the color I have chosen for the last one is similar to the previous one and that is why, there is some issue here. So, the green one is showing if water level is kept up to 1200 meter. The light blue one is showing when water is kept up to 1400 meter and the yellow one is showing when water is kept at 1500 meter.

And all those further details, you can definitely get about each such thing after each calculation that what is going to be the inundated area, wetted perimeter, terrain length, horizontal length? Everything can be measured or estimated very easily using GIS software, particularly about this tool. Now, this tool exactly in this form is not available in ArcMap or ArcGIS.

But if you understand the concept then it can be implemented there also very easily. What it is being basically done is an analysis which is called cut and fill analysis or volume calculation and exactly this is what it is being done. That a level is being decided and how much fill will be there, this is what it is being simulated. But in this particular tool, everything is very user friendly and many scenarios can be done.

Now last one which I want to do it here that there might be some question in somebody's mind that what happens if I fill beyond say 1600 or less than 1800? See if 1800 goes, what would happen? So, let us put 1800 and keep focusing that what would happen on the first profile and then later on in the calculation. So, see now what you are seeing here that water is going out of my topographic profile.

That means this is not correct means topography is not allowing me to keep that height of my dam. This is not but still if we insist because these are the dumb machines basically. Still, we insist that no I want to have. You are not allowed to go further beyond this point so that this option will not come because it has already recognized that you are going beyond topographic profile.

So, you know while designing such software's, these things have been kept in mind that you know one should not get confused that at any height, you can create a dam. No, the height of the dam will depend of course, what is the topographic profile is available to you. So, the topographic profile does not allow but if I keep say at 1700, now still it is going beyond that one but interesting part here, I was discussing in the lecture also is the connectivity.

Now, this might not be connected here but because it is just filling the water. Let us see this scenario because now this option is open. So, I want to see this scenario also. So, let me do it and let us see what happens to the results. What it is saying unable to calculate; change water level or select new cross section line because at this height, you cannot hold the water behind the dam axis. That is why it is not allowing. So, this level has to be reduced.

Otherwise, flooding will occur something like this which is shown in the red color. So, that means we have reached to the limit for the height of the dam axis. It has to be less than anyway 1700 or maybe somewhere 1650 then only a dam can be created. Otherwise, it cannot be. So, one has to be very-2 careful about all these things. Now, I have deleted that one which is the flooding part.

Now only one more thing which I want to discuss here about that once I have drawn a line for dam axis, I can create a dam elsewhere like here, here or anywhere or I can shift that dam axis to some other location. But I can navigate you know. So, previous one, I can change this and say I reorient. As soon as I start doing, it will keep me showing here in the profile as well as in my here.

So, I can change the orientation of my dam axis as per requirements. And then you can again simulate. So, you can relocate your dam axis, you can change the orientation of dam axis, you can rotate the dam axis because everything is being done on the computer. Nothing on the

ground and therefore, no problem about having several simulations or several scenarios' presentations.

So likewise, please try if you are having this software or ArcGIS; ArcMap. Please try this thing on your machine. And I hope you will enjoy it. Thank you very much. **(Video Ends: 38:21)**