Geographic Information Systems
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Lecture - 23
GIS Analysis - 04

Hello everyone! and welcome to this new topic that the GIS analysis part 4. Here again, this is also a kind of neighbourhood operation. But we put them in a completely separate category and that called the buffer analysis. It has got lot of applications and we will see how this works? What are the advantages and limitations also?

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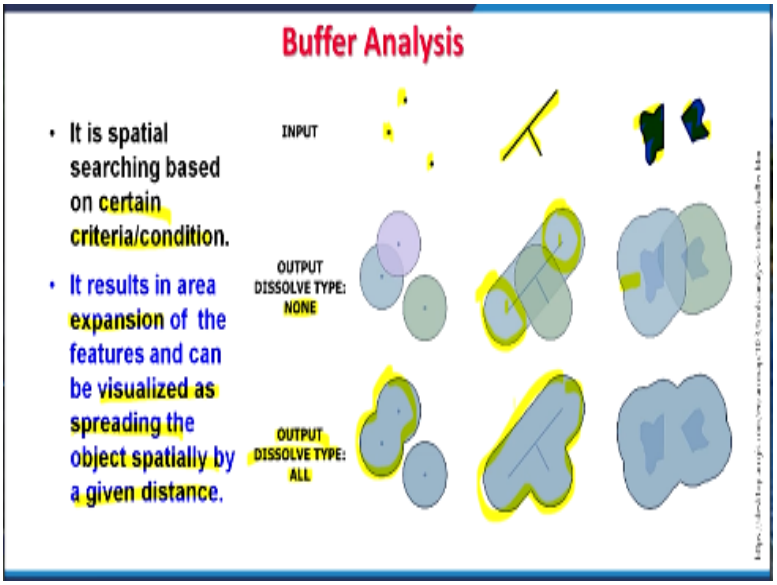

So basically, it's a combined function which is a search function in the neighbourhood. And again, you know based on certain criteria or conditions, we will put while creating a buffer. And buffers can be created around a point or polyline, polygon etcetera. So, what basically when we go for a buffer analysis, it would create an area expansion; widen the area of the feature. Feature maybe point, line or polyline or polygon.

And then we can visualise as the spreading object spatially by a given distance. And this given distance, as user we have to provide that how much expansion in a particular feature we want. For example, I can do the buffer analysis or create buffers along my 3 input points like these circles. So, in middle stage of buffer analysis, 3 circles of different radius may be created.

Now, this different radius values will come from one of the attributes. And suppose against each point, I am having certain information about say pollutants. So, how this will be there? So, the point in which the more pollutions there, it will have a larger radius and others would have less. And in the final stage, we can go for a dissolve type and here dissolved type is none, dissolved type all.

So, whichever is overlapping circles will be dissolved and then you get something like this same. Now similarly for polyline or a line feature, this is how the buffer will be generated that a buffer is generated along this line and in the surrounding. So, basically a circle is drawn like this using this point as a centre point and then again if we go for this dissolve type option then it will dissolve something like this.

Similarly for a polygon, the same way it can be done. So, this width which we are talking is basically the expansion of a feature. Now may be one example, I have given about the pollutants. It may be related with groundwater extraction. It may be related with oil exploration or oil extraction or any other feature or along a road also.

That we want to know who owns the land along a road and if we want to create a 500-metre buffer then that can be created. And once we are having say this kind of polygon then I can overlay this polygon over the revenue records and can extract information about the owners of different plots below this buffer. So, that overlay operations can be implied there also.

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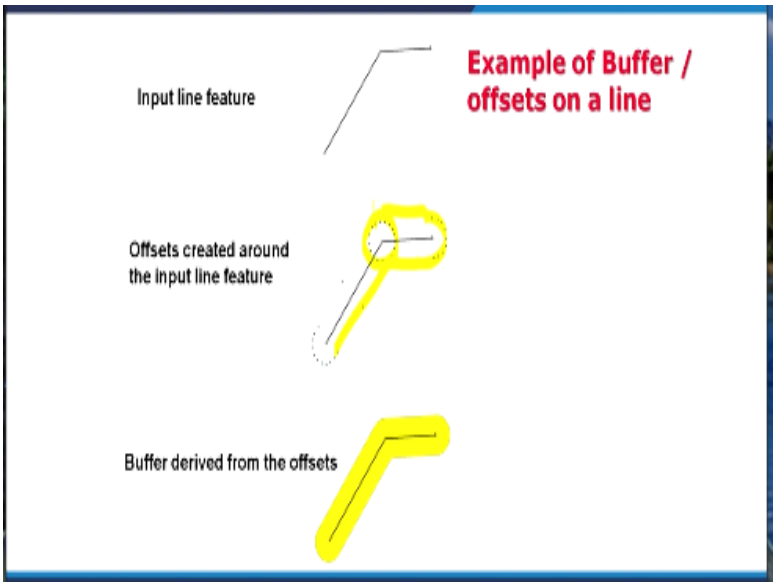

So, buffer has got lot of applications. This is basically expansion, also sometimes it is called offset of a line. Example here along the line. How along a line or polyline, buffer is created? As I was mentioning in the previous slide that a circled are drawn. Here, because this is the end so half circle is drawn.

Here, this is within the polyline so the full circle is drawn. And then finally these circles are connected like this as we can see here. So here, input is a line feature then offset or expansion is decided by the user depending on the understanding about a particular requirement or phenomena and then buffer can be generated like this.

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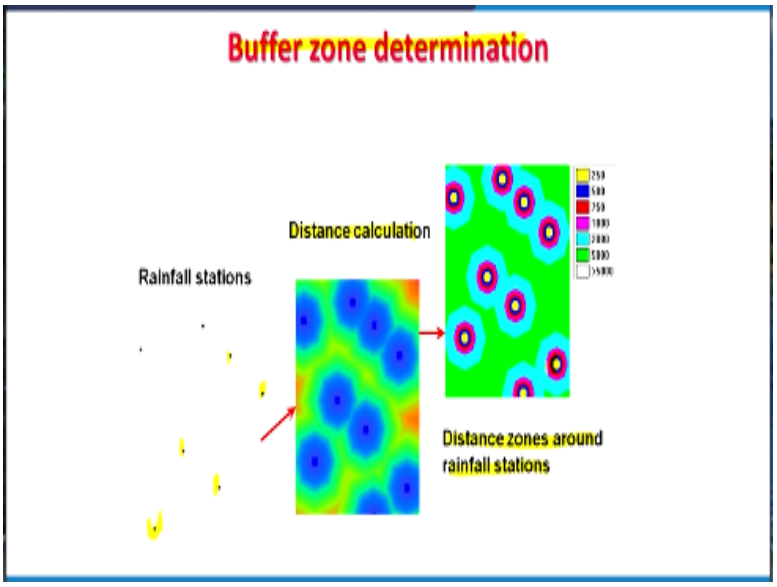

Similarly, for a buffer zone determination for using point data that can be done. If we are having the rainfall information about certain points, I can do the distance calculation. And finally, I get the distance around rainfall stations that it is expected that the value of rainfall would be more as per input. But as I go away from the station, that uncertainty is not there.

But still, I can generate buffers like this. So, for different kinds of analysis, buffers can be generated quite easily on a GIS platform.

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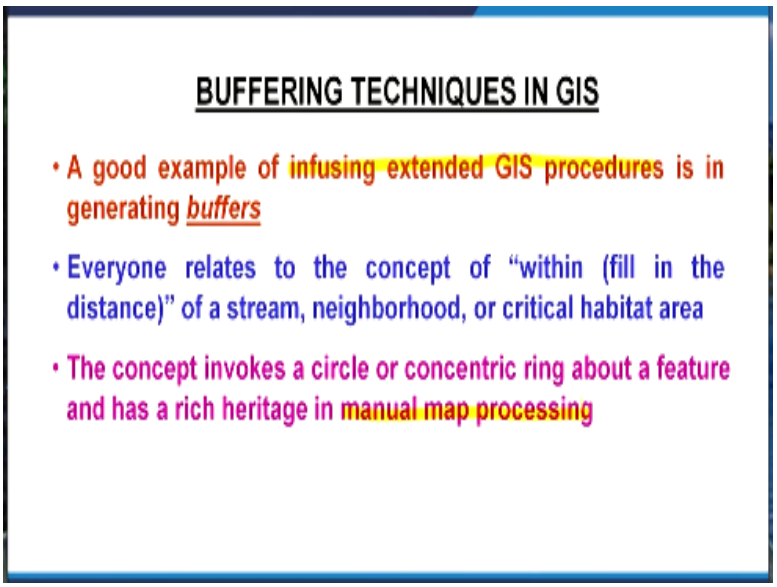

Now, there are some little different techniques variations within buffer techniques. For example, buffer infusion; infusing extended GIS procedures in a generating buffer. We may create buffers using some impedance. For example, if I am studying a pollution which is point source pollution coming out of a chimney. Now, I want to create a very realistic buffer by employing not only the dispersal distance but also, I would like to involve the wind speed and direction.

So, for that, I can infuse some other GIS procedures to create more realistic buffers by using such impedance. So, everyone which relates to the concept of within or fill in the distance of a stream, neighbourhood or critical habitat area, all there we can do this buffering. Basically, as you have seen that this concept involves a circle or concentric ring about a feature and that has a rich heritage in the manual map processing.

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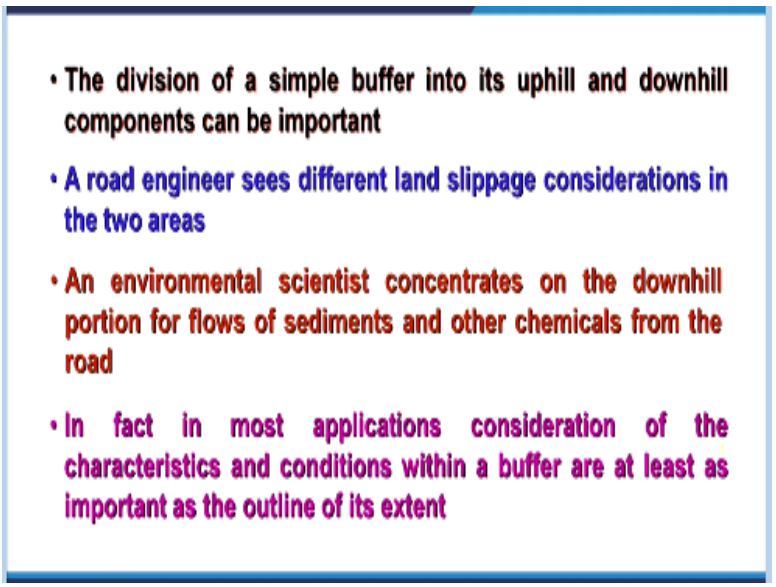

So, in that way, we can create buffers. For example, we can have division of a simple buffer into its uphill and downhill components can be used or generated and such applications are useful for the road journey or train journey.

And these are like civil engineer those who are related with transportation engineering would like to understand all this before any such a thing is planned or during the planning operation or before the construction, that road engineer sees different land slippage considerations in 2 areas that is up and down slope in a hilly terrain. Environmental scientists whereas would be concentrating on downhill portion for flow of sediments. Same with those who do the soil erosion studies and the same maybe the hydrologist who are looking how the water is flowing and how much sediment it is carrying?

So, this is down flow slope analysis. And other chemicals or elements in the water might be there. So, in most applications, the consideration of characteristics and conditions within a buffer are at least as important as outline of its extent. That means that not only the extent is important but other impedance which will allow us to create more realistic buffers; that is to generate such outputs, one has to have a good understanding about that particular phenomenon.

And then we need to have that input also and then we generate more realistic buffer. If I take back again the same example of your pollution studies coming out of your point sources then in case of air then it is a 3-dimensional space. So, I have to consider not only the wind direction and speed but within the depth of near surface atmosphere, how things will vary?

And that means the temperature might also come. Whether the wind speed I am taking throughout the column is same or different. So, as we go for more realistic; higher and higher real scenarios, we might be requiring more inputs and better understanding about that particular phenomenon. But it is possible. It is being done. And lot of such modelling work is being done using buffers combined with some other GIS operations, specially like an overlaying operations etcetera.

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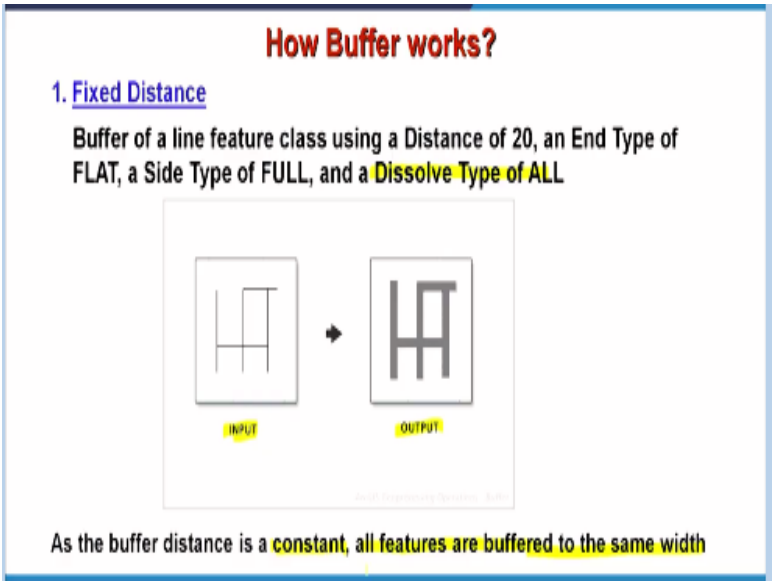

How buffer works? You can have a fixed distance. Like buffer of line features so far, the examples which we have seen. All where the fixed distance using a distance of 20 and then End Type, maybe FLAT. We can put all these options during the buffer calculations and finally, we can say that I want dissolved type. So, when we do, all we put these conditions. For example, this is my input which is a polyline and this is how the buffer has been created.

Finally, these have been dissolved all and this is how I see the output. So, for road network or a street network within a city, such kind of buffers can also be created. Now as buffer distance in this example is constant; all features are buffered to the same width. But if this is not constant. It is varying depending on say this is the road traffic. So, where more traffic is there, I want wider road.

So, if widening has to be done; which part has to be done say within this example? That means from where, that value will come? Instead of constant value, I want a varying value.

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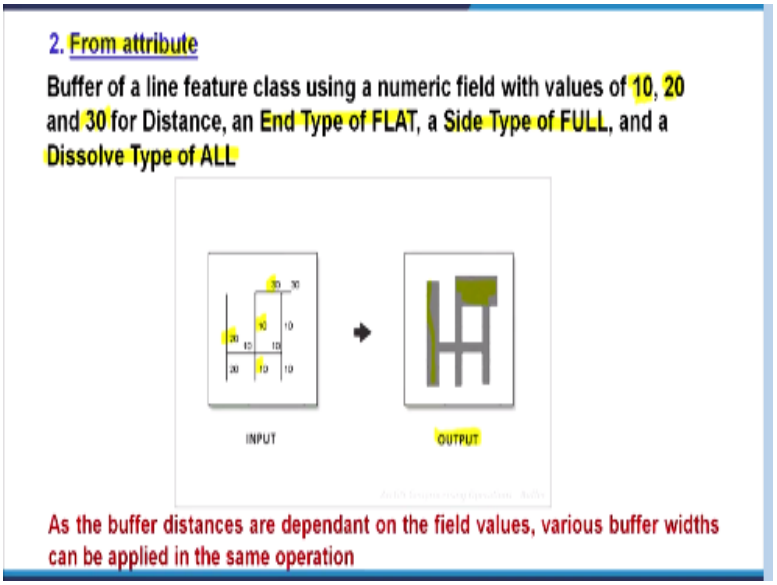

So, definitely that varying value is going to come from one of the attributes. So here, the conditions are that in the previous example, there were fixed width. Now here. values are varying; 10, 20 and 30 from the centre of the road. End Type is FLAT that means it is in the flat terrain. And for all sides, I want the full means all sides, there will be expansion or buffer generation and it is dissolved type.

So, if we take the same example as previous one but having different attribute values; 10, 20 and 30. And therefore, using those attribute values as the width of my buffer, I can generate something like this. So instead of that first example, here I am getting more realistic example. Here because of every phenomenon may not have same kind of you know requirements for the width or expansion.

So, if I talk here about say traffic point of view then here, more traffic is there or maybe more pollution is there. So, depending on that, I may have that information as one of the attributes. While creating a buffer, I can use the varying expansion width or distance and can calculate the more realistic buffer than the previous example.

Now here in this one, as the buffer distances are dependent on the field values that means one of the attributes, the various buffer width as you can see here 3 types of buffer width have been created using the same operation as we applied in the previous but there, we kept only the fixed width or fixed distance. Here, we are having other parameters are same; no changes are there.

But still, we are getting different outputs because instead of fixed width, we are getting now varying width as per given attributes. So, we have already discussed some applications of buffers but for completeness, we will go one by one.

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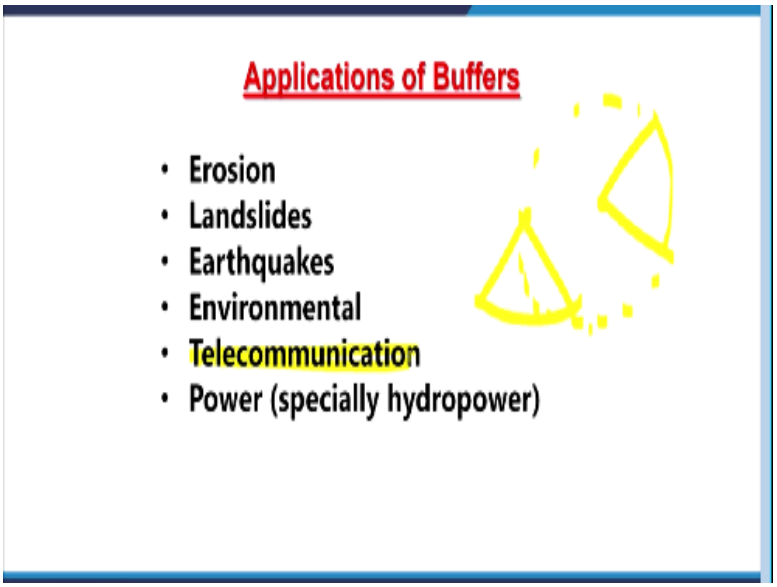

For soil erosion studies, buffers are very-2 useful or any other type of erosional studies, buffers can be generated and situations can be assessed. In landslide studies also, buffers are very-2 important to know that which are the areas which are initially going to be affected then later on and so on? How a landslide will expand in future depending on of course, the terrain characteristics?

And other like vegetation cover, land use, soil lithologic but along with that terrain characteristics. So, all that information is there. We can create buffer along an existing landslide. And these buffers will let us know how it would expand in future if things continue in the same way. Similarly in case of earthquakes, buffers can also be created about the damage that how the damage has occurred.

Of course, there is a completely different concept about assessment of damage which is based on the Mercalli scale which is called the intensity map. But there also, the buffers are created. You can employ GIS to create those buffers. Of course, the input has to come first from the field if we want to create that intensity map of an earthquake. In many environmental studies including in pollution studies, buffers are very-2 important to analyse.

In telecommunication also, especially in mobile communication that a tower as you know that the transmission or the connectivity is not in a circular form, it is having an angle. So, suppose there is a tower located then it might cover only this much area, not like this. Now while putting, if there is a gap then probably one more tower is required here to cover this much area and so on and so forth, of course depending on about the users and other thing.

So nowadays, these mobile agencies or mobile operators, they are using GIS extensively and these buffers technologies along with these overlaying operations to know where the gaps in the mobile signals within a city or town. And those gaps initially can be analysed and then installing a new tower, these gaps can be filled. So, there is a large application of buffering techniques of GIS into telecommunication also.

A power supply especially in hydro power, there also buffer because we can analyse that how much loss in the power will be there if the energy or this power has to be transported to a larger distance. So, from that point of view, buffers can also be generated and these things can be estimated even before a power line is put in the field. So, this analysis can be done. This is non-exhaustive list and this will continue.

More and more applications of buffers are coming. People are trying to explore the possibilities, how to use these buffer technologies of GIS for their own purposes. Now, one more analysis which we can do which is not at all directly linked with buffers but it is linked with the terrain. In some literature, you may find earlier we used to say viewshed analysis. Also, now it is a visible area for a rugged terrain or hilly terrain.

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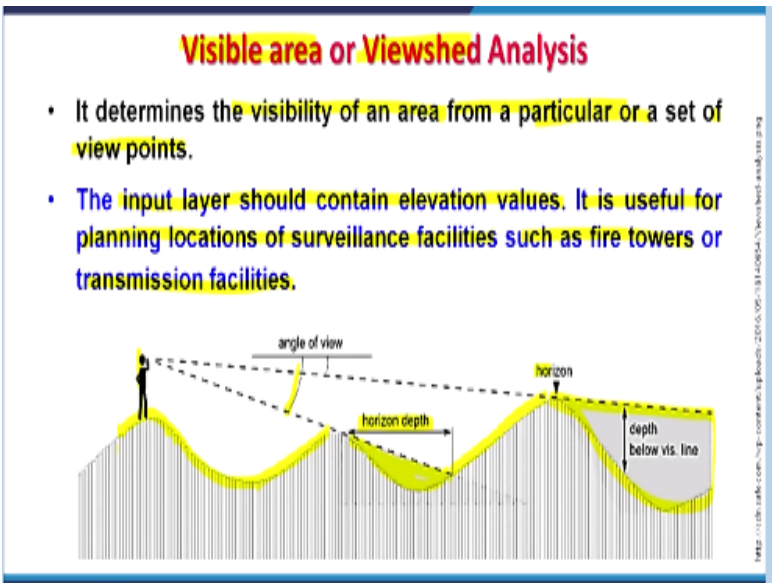

So, basically in this analysis what we do? We determine the visibility of an area from a particular point or a set of viewpoints. For example, if I say that somebody is about to construct a hotel in Missouri and he would like to assess that how much Dehradun Valley would be visible from top floor of his hotel, though the hotel not yet has come. But all these things can be modelled, can be analysed using this viewshed analysis.

Viewshed analyses are having applications for various purposes from security point of view, from mining operations and for many other operations also, including in your mobile tower, including laying of power cables etcetera. So, viewshed analysis can also be implied. What is the input layer? Here, the input layer generally is the elevation values which is there.

And which is used for the planning locations of surveillance facilities such as fire towers or transmission facilities, power lines etcetera. Or just for in the forest also, they use where they put some tower to see even the wildlife and others and overall, the forest conditions as well. So here, what you can see that a terrain schematic is shown.

A person; his height will become offset so that has to be added in the height. Whatever the height and where he is standing above mean sea level? How much distance he can see and what is the angle which he is having? All these will allow us to know that like this area will come in the shadow. So, a person is standing here, will not be able to see this much of area.

Similarly, the same person after this peak may not be able to see this area either. But for him, this area is visible. For him, this area is completely visible. So, I have just discussed in terms

of 2D or in a profile section but the same analysis can also be done in terms of 3D means for all around, not only in one direction. Here, it is shown only in one direction but in all directions, it can be done.

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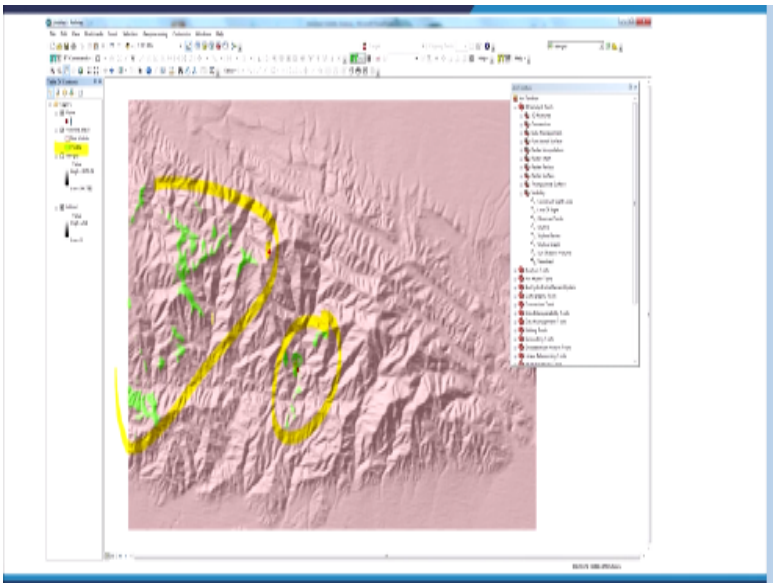

Like here, this is the screenshot of ArcGIS analysis. The person or offset is given here; the person is standing here or a tower. Now from here, we would like to know and also one more here for this area, the analysis has been done and for this area, the analysis has been done. It is not necessary that entire circular areas should be covered but if we can restrict that only a particular angle, I want to see or arc, I want to analyse.

So, all green areas are here the visible and all other areas are not visible. Now, if there is a choice of increasing the offset. If we can do that like raising the height of a building during planning process then if we raise that, obviously the visible area will become much larger. So, such analysis before anything really happens on the ground can be done very easily employing this technique of GIS which is viewshed analysis.

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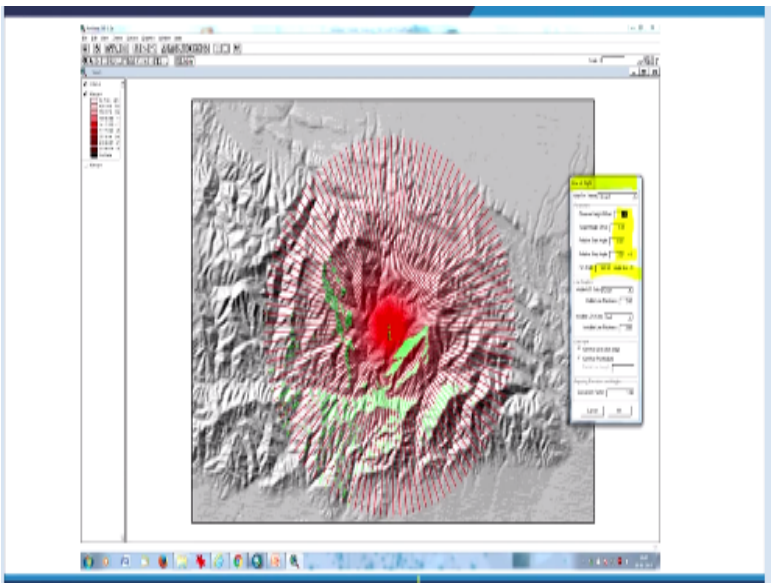

Another example in a circular fashion that if a person is standing here. If he rotates, how much area would be visible and how much area will not be visible? So, these green areas again are visible, red areas are not visible so remaining areas are not visible. This red is because of these lines which are concentrating all around the points.

And see in this line of sight or a viewshed analysis, lot of parameters, a user himself can control. So, the impedance and other things can also be provided here. Impedance; this area might be forest cover. So, if we know the average height of the tree, that impedance we can put and of course, the terrain is already there.

So, that information plus adding the height of the tree, also adding the offset value or height of a person or a building or tower, we can create a more realistic picture or viewshed like this before really anything happens on the ground. If you recall the definition of GIS, in the last it says that it allows to do the modelling. Modelling means prediction. And prediction that means nothing is happening on the ground; we are trying to model it, predicting it, how it will happen, how it will look?

And that way GIS and especially this technique for viewshed analysis is really very powerful technique. By which we can exactly know, once this building comes or this tower comes, how much area would be visible from top of that building or middle or wherever you want to analyse that can be done. Of course, as detailed input information is available. Not only the digital elevation model but other parameters says impedance which are available, more realistic scenarios can be generated.

So, this brings to the end of this discussion about the GIS analysis part 4. We will continue on this GIS analysis in next lecture. Thank you very much.