Digital Elevation Models and Applications
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Lecture - 14
DEMs Derivatives- 4

Hello everyone and welcome to digital elevation models and applications course, and this is 14th discussion on digital elevation models. And in this say, as we have been mentioning and discussing that DEMs are storehouse of information and in continuation of that we are going to discuss how few more derivatives we can derive using digital elevation models.

Here we are going to do the, a sort of a reversal of D E M, and because a we D E M is a continuous terrain surface say representation, and whereas, for some applications sometimes we go back to rather than from a continuous surface to a discrete representation like a form of contours, because for certain applications, for some understanding or better understanding people will derive may be contour.

Sometimes we derive contours in order to display two surfaces; one may be in form of contours, one may be in form of a continuous surface. So, therefore, this reversal is also very important, they say kind of completely a new topic, but I will be going through this 7, and that how reversal can help us to derive or determine a few important parameters. So, as you know say a continuous surface, and continuous we would like to discretize back, maybe to contour lines or maybe to the points, so both we will discuss.

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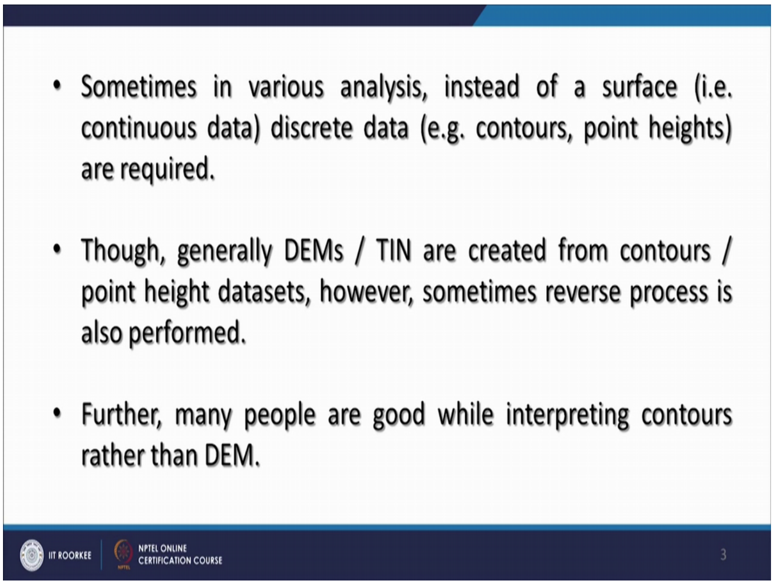

As I have mentioned that sometimes in various analysis applications instead of a completely continuous data and we may prefer a discrete data, may be in form of contours point heights, and those generally DEMs or TIN triangulated regular network are created from contours or point height datasets; however, sometimes reverse process is also performed. And further many people are good while interpreting contours rather than D E M.

Those who have been initially looking or it, and they develop the understanding while looking the topographic maps and terrain in forms of contour; they are very good on interpreting the contours rather than a continuous surface. And through my own experience I have found that they people those who have been using these topographic maps extensively, they find very convenient while going through the contour maps rather than a digital elevation models.

And they sometimes may insist that please give, say in form of contours rather than a continuous surface as a D E M or tin. So, for that purpose also and another to integrate or overlay on a continuous surface, another feature in form of contours for that too with this reversal is very important. Example is given here that we are having a digital elevation model, the same digital elevation model an example I have been taken in this course.

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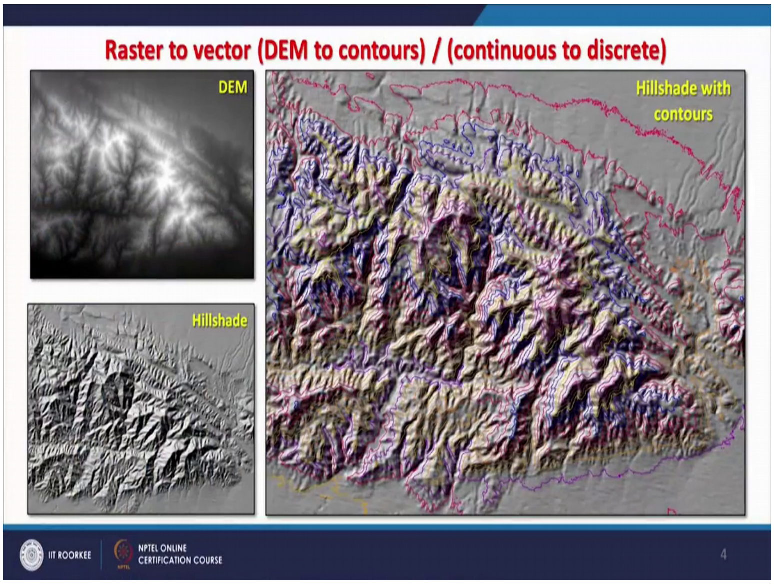

So, here also and this is the hill shade; one of the derivatives we have already discussed how these are derived, and the top of this hill shade on the right side what you are seeing the contours. And I will just show you that how contours can be derive using a continuous, its a reverse process.

Because from continuous data we are going for discrete data, and it contours can be derived at our desire interval and we can also decide that from which elevation level, it should start driving the contours and to what intervals it can derive, or if somebody's would like to derive only contour of a particular elevation; that is also possible, because the input here which we are having in our system is a digital elevation model, is a continuous surface. So, if I take an example of a G I S software which is arcGIS.

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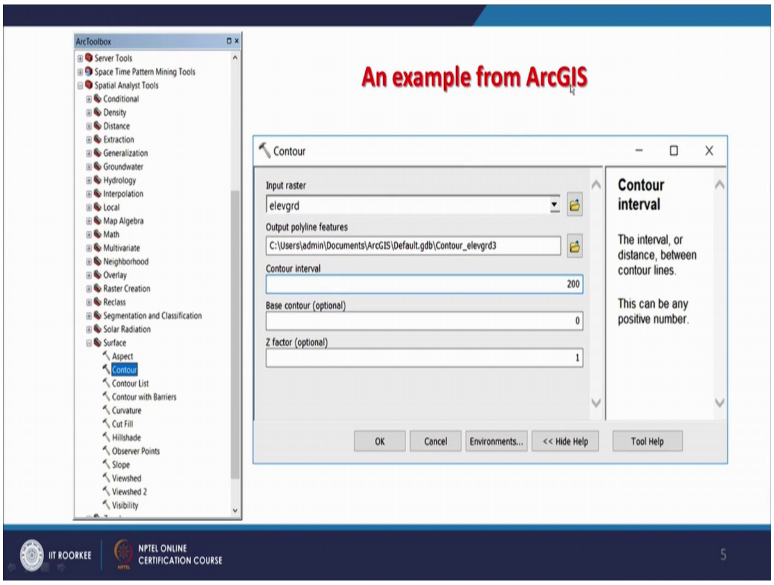

Then this is how these are the inputs say will require to derive contours, that input is digital elevation model, the raster grid which the example we have taken, where it will be kept you know, on your hard disk what is the contour intervals. So, in this example we are taking contour interval is 200 meter. We can also, if we want we can restrict that from where the contours, should a start driving and z factor also will play in this particular example z factor was one, but one has to take care, we have been discussing this issue earlier.

So, z factor should be taken care, rest just (Refer Time: 05:43) thing and one can derive a contour like this. So, we can derive the contour at desire scale or wherever we click, we can also get the contour at that point also. So, it is both ways that like continuously for entire terrain, we can derive contours while giving the contour intervals, base interval or just contour at desired location.

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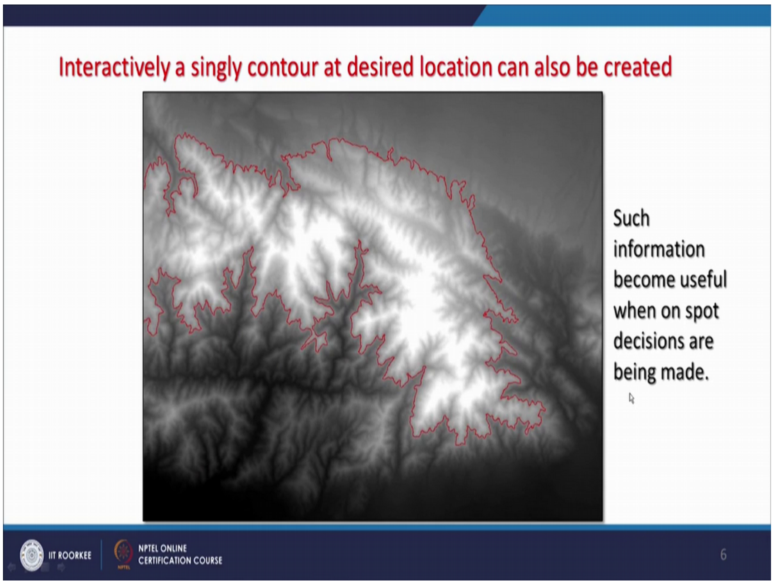

So, wherever if I click here I get a contour here, if I click here I get a contour here very quickly. So, this way this digital elevation model becomes very useful. Though its a reversal process, but many times it is desired, it is required to do these kind of reversals.

So, this these informations are good for decision makings while decisions are being made at that spot, and maybe, one may be having in the field, would like a you have determined the position by G P S. Now you want to know exactly when you are in the field that from where this contour will go and immediately it will show you on the system. So, they that is the advantage of deriving contours at desired locations and automatically for the entire region, input the digital elevation model that contour will be determine.

And another reversal way is a going from raster to vector that is D E M two points, because basically when interpolation techniques which we have discuss, in which the input is always point. Whereas, through of course, if you are having only contours and you want to create a surface, that to first the system will convert the contours into point, and then point to interpolations, through interpolation say surface is created.

So, that basically means that we are going from continuous to discrete that is the reversal of a digital elevation model, and there various ways are there. I am going to take example which is, in which I am going to involve random points and in that way our you know the output would remain very reliable, because we do not know where to collect the elevation value at what location. So, the best technique in this may be to create random points, and it is very easy on a G I S platform to create random points at desired number, whatever the number we decide for a particular area. And once these random points are there we can extract the z value or elevation value against those points over a digital elevation model, or also we can analyze these random points, these points along comparing with some other distributions of points.

May be locations of epicenter, may be locations of some earlier observations, whether they use observations were done systematically randomly or there is a clustering phenomena or something. So, point data analysis can also be performed. So, let us see first what is first how digital elevation models and through digital elevation models how would points will be enriched with the z value or elevation value.

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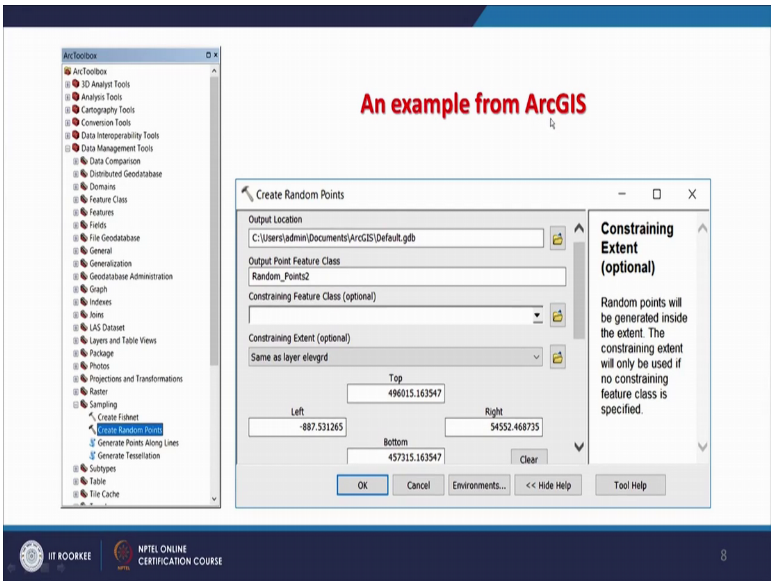

And this is how it can be done, again on a G I S platform that I will go for, first for the create random points, that through the data management tools sampling create random points. Here where things will be located, because the input here is just extend we are providing.

So, and the extent is decided by that elevation grid or that example digital elevation model which we have been taken in this course. So, if we take that example then these becomes the extent of my digital elevation model, extent of my random points and where these random points will be stored and this is how these can be declared here and once that is done, then these random points as generated here. We have to also provide how many random points say.

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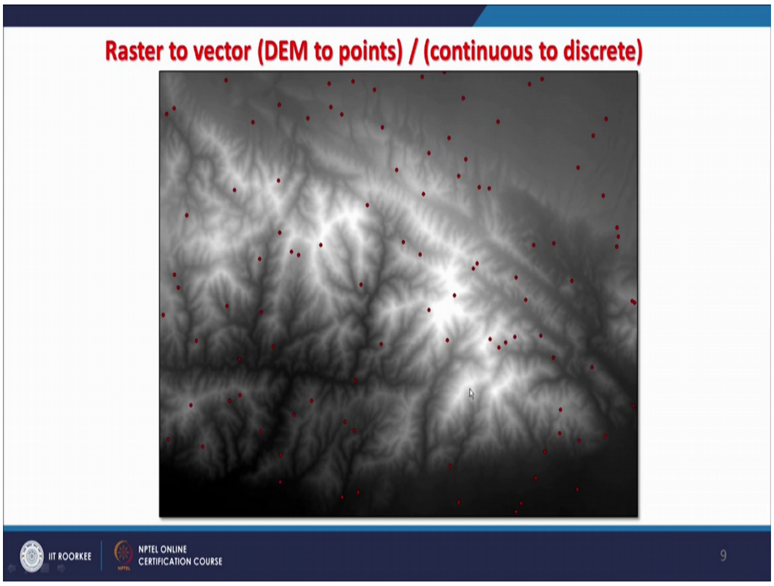

So, suppose a there are 50 random points are generated, as one can see that they are truly randomly located and the system has generated. This is very interesting and this I have also checked, one you can also check before you are relying for the random point generated by a particular G I S platform or G I S software, that again for the same extent, if you generate the same number of points, compared with the first one, this would be on a different locations.

If they are coming on the same locations then it is not a correct software. So, you can also check, because every time it should generate randomly at different locations. So, every time the location of each point has to be different and this is what the purpose of random point generation. So, once the random points are generated. Now we want to enrich these random points with the z value, and from where the z value will come. Of course, from that a particular elevation over which these random points are being shown now here. So, z value can be picked, and these are example was the four hundred random points here; digital elevation model in the background. So, there are some other applications where we can exploit these random points.

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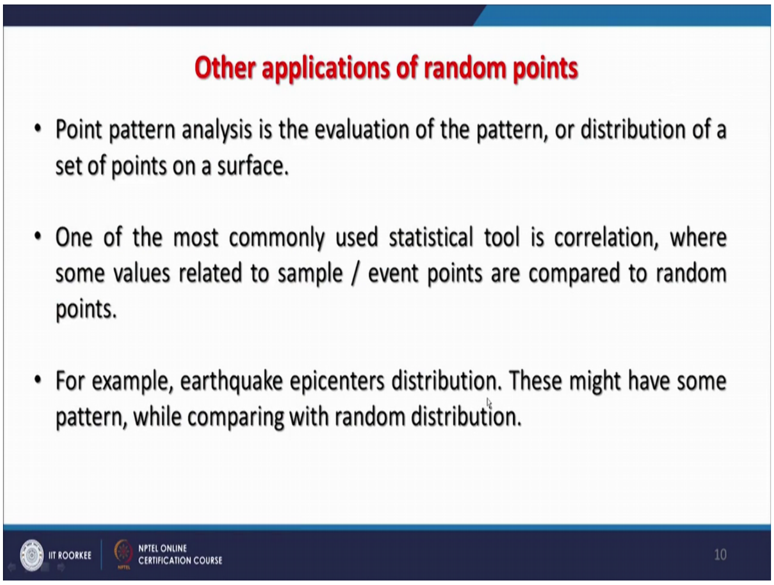

And that like point pattern analysis can be evaluated, how these point are distributed, for comparing with other distribution of points, and one of the most commonly used statistical tool, is correlation, where some values related to sample or even points are compared to random points, because if you are seeing a my distribution of a point data.

Now, you want to assess that how they are distributed, whether there is some clustering phenomena, whether they are distribute in a linear fashion or they are distributed in a systematic fashion or they are at a regular interval or they are distributed randomly. So, for randomly you can take always the random data or random point data for comparison and accordingly one can do this analysis, the distance from each point analysis kind of thing and then you can perform, you would know exactly whether the distribution of your input points, what is the pattern, whether they are randomly distributed or there is a some alignment or systematic distribution or there is a some clustering phenomena.

So, that is the best use of random points on a G I S platform and also in a digital elevation model. So, the example I have already given; like earthquake epicenters distribution, these might have some pattern while comparing with the random distribution, because generally earthquake epicenters may follow a pattern, a linear pattern along a fault line. So, if you are having of say 100 years locations of epicenters if you plot, you may find some pattern. So, how you compare for that comparison you can use these random points.

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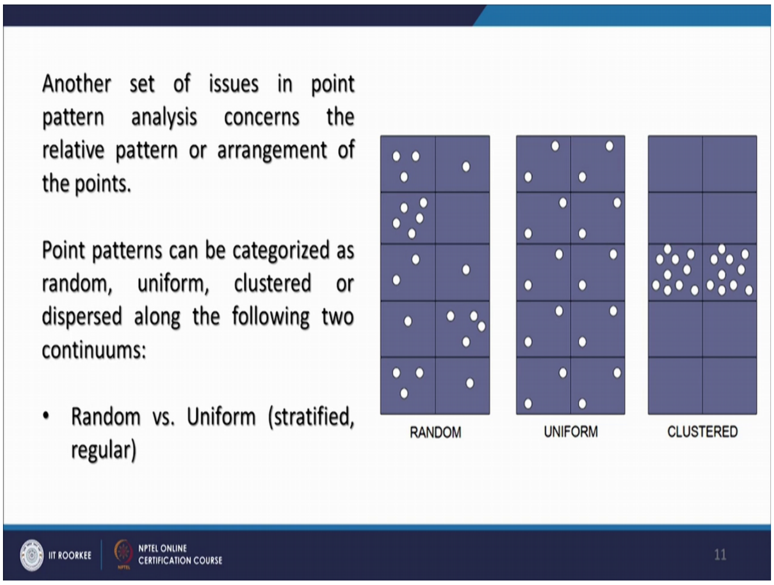

The example here is, like here the random points are uniformly distributed; that means, the distance between each these points is almost same and whereas, here it is completely random, whereas, in this example in his this schematic it is clustered.

So, based on that, though the number of points are same, but based on their distributions we can tell the pattern of distribution. So, this a set of issues to point pattern analysis, concerns, relative pattern or arrangement of points. Point patterns can be categorized as we have seen random, uniform, clustered or dispersed along following two continuum; that is random versus uniform; that is stratified or regular in that case or clustered versus dispersed sometimes you may have clustered, sometimes you may not have.

So, that you know you can bring some quantities, some values to this distribution; otherwise it becomes completely visual interpretation. The example where we have distributed 100 you know selected, first generated 100 points against which we the elevation values were picked from a background digital elevation model, and these elevation values are shown here, along with your these 100 randomly generated points, so that shows.

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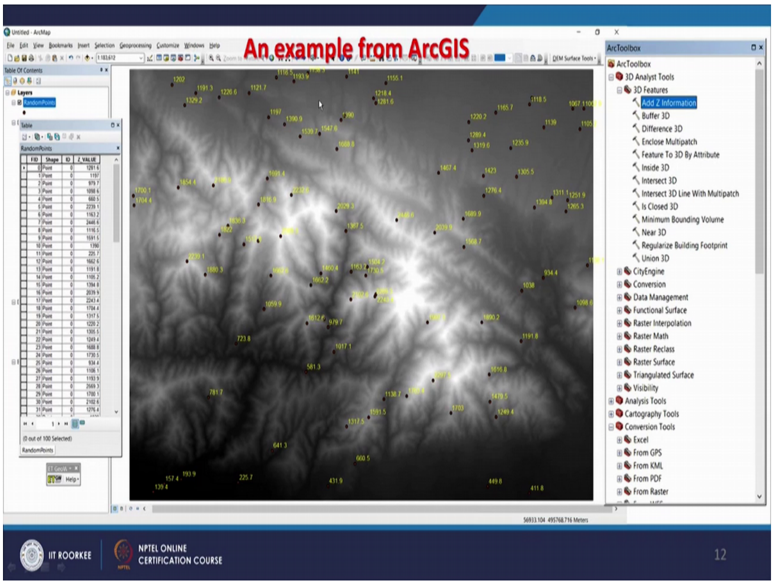

Now if we generate a digital elevation model based on these hundred points, I am sure we are not going to have exactly the same digital elevation model as we are seeing in the background, because we do not know exactly how many points and data were used to generate such digital elevation model. So, because nowadays we are; the digital elevation models which are becoming popular, which we are using are based on a completely continuous data; that is means based on the satellite data and therefore, in a reverse way; that means, from point like this, we cannot go back or generate the same original digital elevation model.

But in case of a digital elevation models which have been generated using survey points, contours another things. Probably we can generate a closed digital elevation model, but not to that detailed. So, there are some other derivatives or other processing which is required with digital elevation model, and that is the mosaicking of D E Ms. Why mosaicking, because many digital elevation models which are available on net, are available in form of tiles, because when we discussed the global digital elevation model; that means, not in a single file, the entire data of entire globe will come; not even based on the country.

So, what the developers of these digital elevation models have done, they have produced these elevation models in form of tiles. So, you may get tile of 1 degree by 1 degree of 5 degree by 5 degree, depending on the spatial resolution of these digital elevation models.

So, suppose a your study area or the country requires to, if you want to cover an area or a country you may require say 10 tiles. Now 10 tiles you may download, but they are separate files. You want to make them as if one single file, and if one has to do it, because in several analysis for which we need a continuous one single file and therefore, mosaicking of names would be required.

So, that is why its a kind of one more derivative of digital elevation model or even can call as a processing on digital elevation model. So, basically what mosaicking will do, is merging of multiple existing digital elevation models. In this case maybe in many times, it may be the downloaded digital elevation models of inform of a raster. And it is required, because many global, as I have already mentioned are available in form of tile form. So, this S R T M D E M G D M, all these are available in tile forms.

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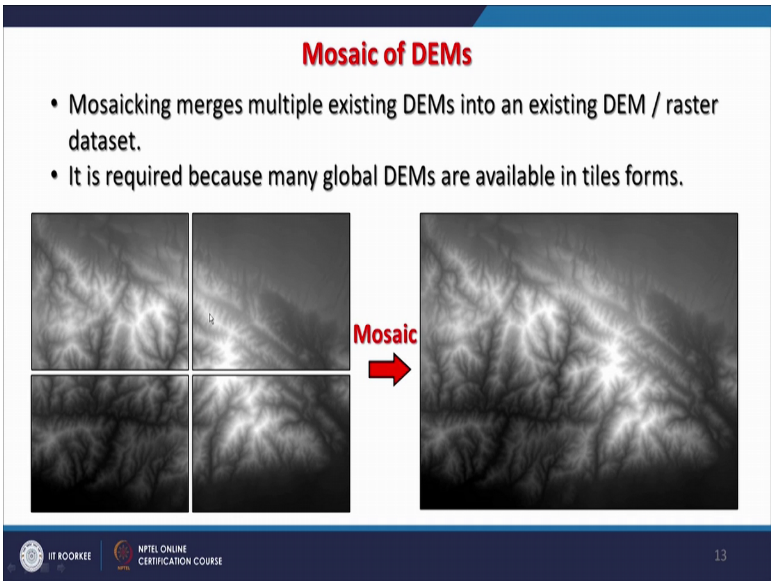

Example given here that the four edges and tiles, if you have downloaded then you want the continuous data without any seams. So, the best thing in the first step in this case would be to create a mosaic and that will create a completely seamless mosaic of your area, study area which will fall within this digital elevation model.

So, sometimes we have to tile maybe twenty tiles, thirty tiles, depending on how big area is and also depending on what is the spatial resolution. If a spatial resolution is relatively very high then we make a tile of one degree by one degree; that means, roughly if I talk; that means, hundred ten kilometer by one hundred ten kilometer one degree by one degree for Indian, where India is located on the globe, for Indian conditions I am talking. And if I go for relatively low spatial resolution data; for example, maybe a ninety meter data then I may get a tile of five degree by five degree.

So, depending as I have been mentioning, depending on the spatial resolution of the data, the size of the tile or the coverage of the area would change. So, higher spatial resolution, digital elevation model will come in a small tile. Whereas, a relatively low spatial resolution, digital elevation models will come in a large tiles, but whether its a large tile or a small tile does not matter, five degree tile or one degree tile through same process, we can we can make a single seamless file and that process is called mosaicking.

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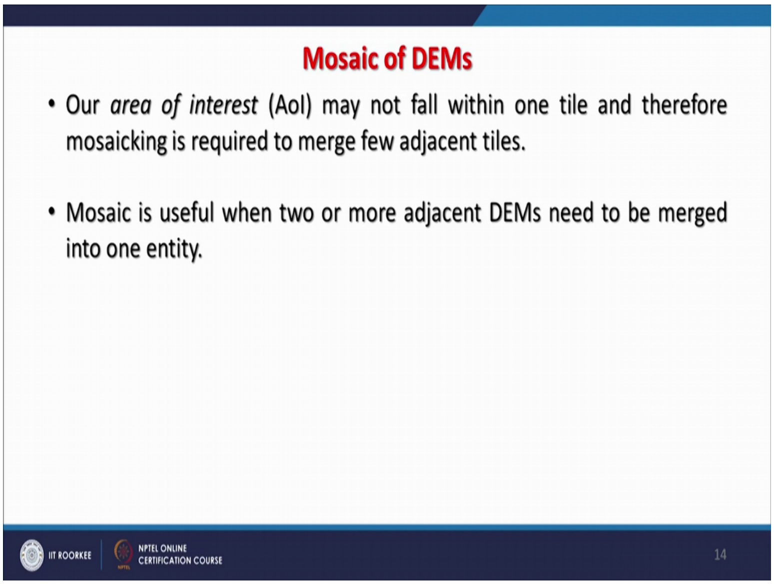

So, because as I have mentioned that area of interest may not fall within one tile and therefore, mosaicking is required to merge many adjacent tiles. Mosaicking is also useful when two or more adjacent DEMs need to be merged into one entity.

Another why mosaicking is required, because one may argue that I will keep in different tiles fine, but what happens, but if you keep in different tiles, then each tile will have the range of elevation values, and when you perform the analysis, then perform the analysis using statistical tools, then the minimum and maximum value in each tile will change and therefore, there will be lot of complications. So, this cannot be done, this is not good or right approach. The right approach is first make a seamless mosaic that mosaic should cover your area of interest entirely, and then do the processing or derive whatever the derivatives one requires for his application.

So, some mosaicking techniques can help to minimize the error of changes along the boundaries of overlapping DEMs. The DEMs which I have been talking, global elevation models which are available, there is no overlapping and tiles are there. So, that issue will also not come, and the one area, one tile ends another starts. The area in one tile ends, the area, next area will is start one another tile. So, there is no overlapping. So, the issue of overlapping will not come. This a complication comes when we try to mosaic satellite images. Sometimes there are overlapping, and then one has to decide that which one will come on top or bottom.

But here in case of this tile digital elevation model this will not come. Overlapping, if it is there then overlapping areas of the mosaic can be handled in several ways.

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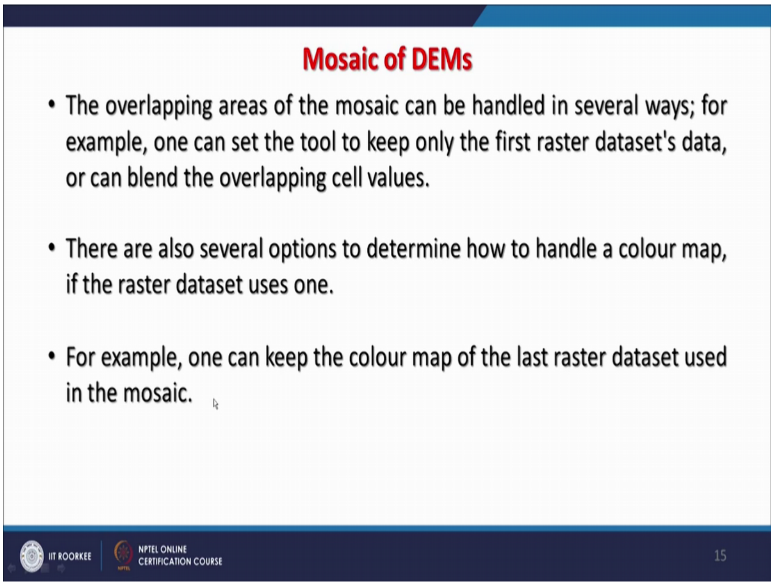

For example, one can set the tool which is using for mosaicking that keep only the first raster data sets or can blend the overlapping cell values. So, various options may be chosen for making tiles using overlapping data sets. And there are several options to determine how to handle a color map, if the raster dataset uses one. Generally digital elevation models which we are using, we may give color later on, but generally these are the values we assign the color.

So, that issue will also not come in a large way, but if it is there, then one has to take care, because most of the time now we are going to use the digital elevation models, which have been generated by others and they are available on through net.

So, one about this one example of this color, is that one keep the color map of the last raster dataset used in the mosaic. Color also meaning here the grayscale so, that can be decided that which tile will influence the grayscale for all tiles. So, that can also be decided, but its not a big problem, this can be solved very easily. Another, you can call as derivative or a process.

In previous example we have we have combined various tiles, but in this one, it is a subset of a tile or subset of a already mosaic D E M; that means, suppose like in the previous example what we have seen, is that there were a digital elevation model, and now in this one, my area of interest is having an arbitrary shape maybe a watershed or basin, I want to extract the values for that one or a digital elevation model for my area of interest, and that is also called and, in some different softwares different terms are used, both terms I have used here, the clip or extract a extracting idiom.

So, its a basically sub setting of a D E M based on a polygon, this polygon can have arbitrary boundaries.

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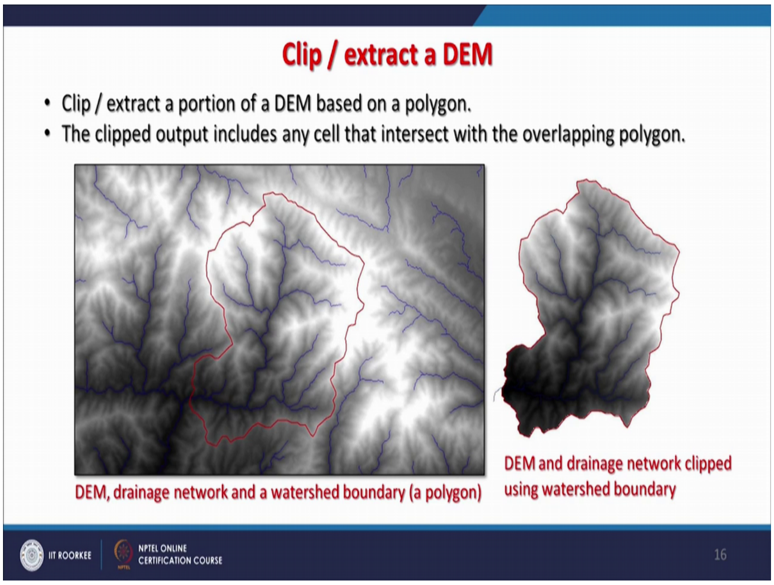

So, that is the advantage, the cleaved output will include any cell that intersect with the overlapping polygon. Especially it is taking care at the boundary, at the border where this polygon will fall over a digital elevation model example given here, that this is a watershed boundary and it is a shown over a digital elevation model. Now I want to extract the digital elevation model only for this red polygon or watershed boundary and this is what exactly is clip or extract and this can be done again like this.

So, the output would look like this. So, its a subset of a digital elevation model for a study area. That study area might be a political boundary; for example, my way boundary of a state, boundary of a district or a city, large city, small city or boundary of a basin, catchment, watershed or whatever.

So, based on these a polygon boundaries one can extract a digital elevation model or can have a subset of a large tailed digital elevation model. So, the important thing here is, that when you create a subset, you are not changing anything in the original or input digital elevation model. So, your elevation model, from which a subset will be calculated will remains intact, only a new file will be generated, but a subset or a digital elevation model only for your area.

Now, I am going to repeat one more concept which we have already discussed, there is the no data, because by definition I have mentioned the digital, the overall shape of a digital elevation model or a raster can be either rectangular or a square, but here what you are seeing the shape of a digital elevation model of a watershed is neither rectangular or nor a square, but only for our eyes.

But in the system, it is definitely in a rectangular form, because if you draw a line which is going from extreme north of this, extreme south, extreme east and extreme west that will make the rectangle, and the rest areas are being filled by no data value and in this case that no data value has been assigned the same color or same tone as the background of the screen, and therefore, you are not seeing those no data values. And at the end or end what the result is, that you are seeing a digital elevation model for a polygon or a watershed boundary.

But in fact, inside the system it is stored as a rectangular 2 dimensional matrix. So, overall shape; fundamentally will remain either rectangular or a square in case of a digital elevation model or in case of a overall raster. So, the no data basically help us to create a digital elevation models which look that we are not having this thing. At the boundary of these a polygons, any cell even a part of the cell is coming, that will come as a part of a digital elevation model of subset. So, this if we zoom on any at the boundary part we will see a see zigzag kind of boundary stair steps case and this that is the major difference, when we talk about a digital elevation model or raster and a vector data.

Because vector data generally may have a smooth boundaries depending on the scale, but in case of a raster and the boundaries, in case of such arbitrary lines or polylines or polygons we may have zigzag or a stair steps case boundary. So, the boundary issue will definitely be there in this case also. Now we have seen, we have discussed in 4 topics a DEMs derivative one two three and this one is 4. And sometimes in literature you will find that people have a classified and these derivatives as first order derivative second order derivative and third order.

So, this is what I am going to discuss in next few minutes that what are the first order derivatives. Basically the derivatives which quickly derived generally they are used and for example, is first order derivative is a digital elevation model, where you do not go for next step processing, just first stage processing will produce these derivatives. So, that is why they are called first order derivative and the slope map may be one of the first order derivatives.

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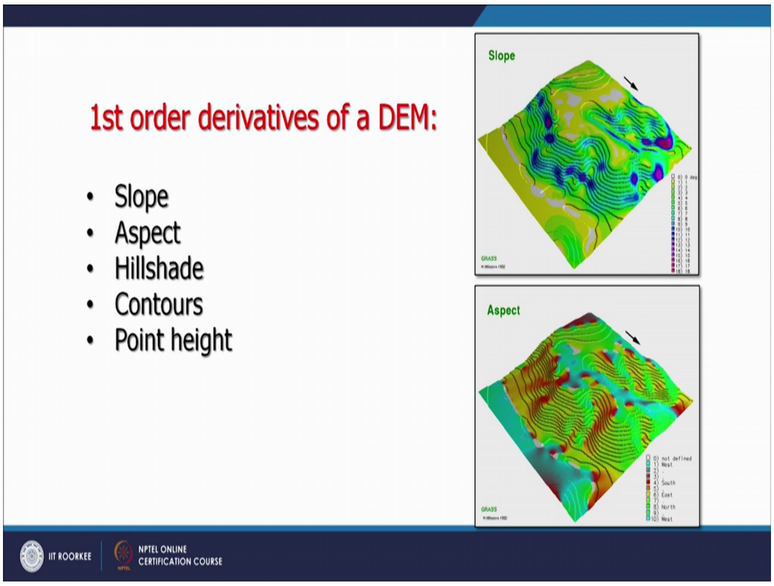

Then aspect and examples are also coming on right side, and then hillshade that is a shaded relief model, which is a again first order derivatives based. These are all based on the neighborhood analysis as we have seen. Contours as also are first order derivatives and point heights, and so these are, though these last two contours and point heights are part of DEMs reversal.

But they are people consider them as a first order derivative, among the second order derivatives of a digital elevation model, we put as a curvature or slope, because the slope has been considered at first order.

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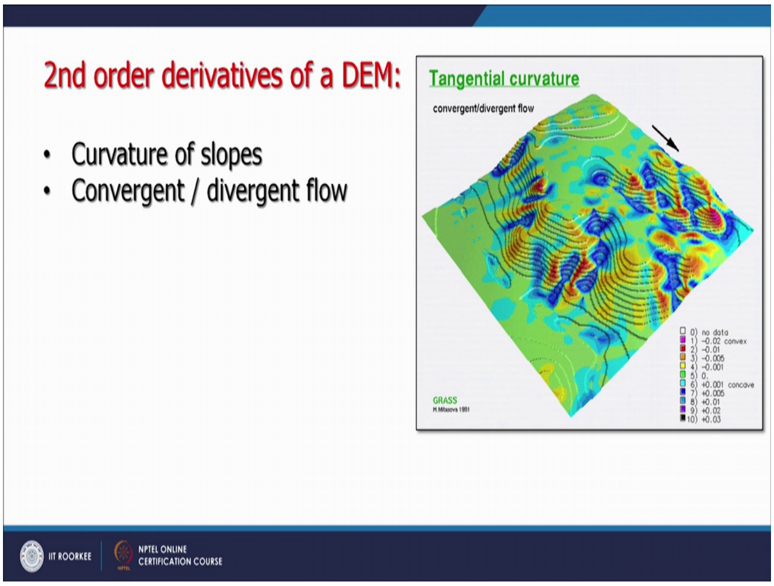

So, curvature of the slopes, down slope curvature or a cross slope curvature profile or plant curvature they all will come here. So, the curvature of slopes are considered as second order derivatives, then convergent and divergent flow that we have already discussed. So, that we will also considered as a second order derivatives; few more can be put in second order, and now in third order types of derivatives of a digital elevation model, may be drainage network which we will be discussing which can be derived through surface hydrologic modeling.

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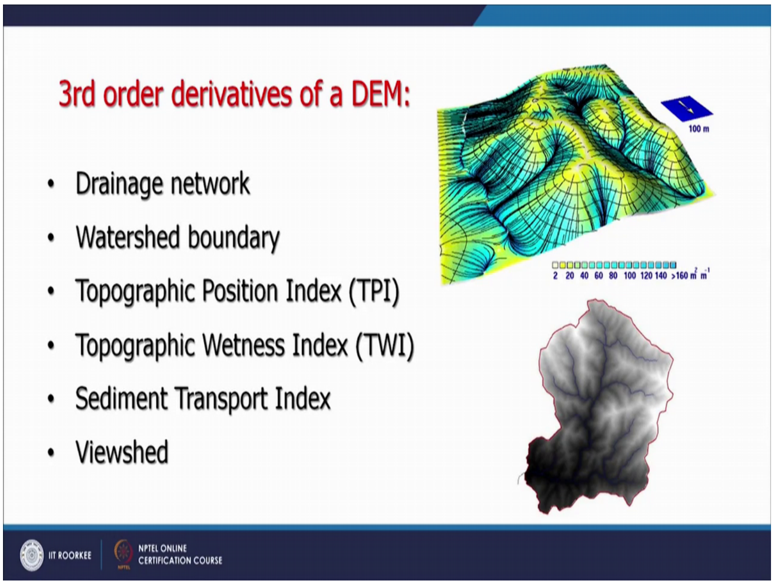

So, in next topic we will be taking in rather next two topics we will be discussing, how these drainage networks using a digital elevation model, implying a surface hydrologic modeling on a G I S platform can be derived. So, this drainage network is considered as a third order derivative, because it requires several stages of processing, may be watershed boundary, maybe we consider as a subset kind of process as a third order derivative. And a few indices which we have discussed in this a course; that is one example is topographic position index, may be topographic or wetness index and may be sediment transport index.

So, all these indices which we have discussed, they are also considered under this third order types of derivatives and view shed analysis which we will be discussing later, after the surface hydrologic modeling topics, two discussions on that after that we will be discussing. So, the one more derivative of digital elevation model is view shed analysis that is also considered under this third order and derivatives of a digital elevation model.

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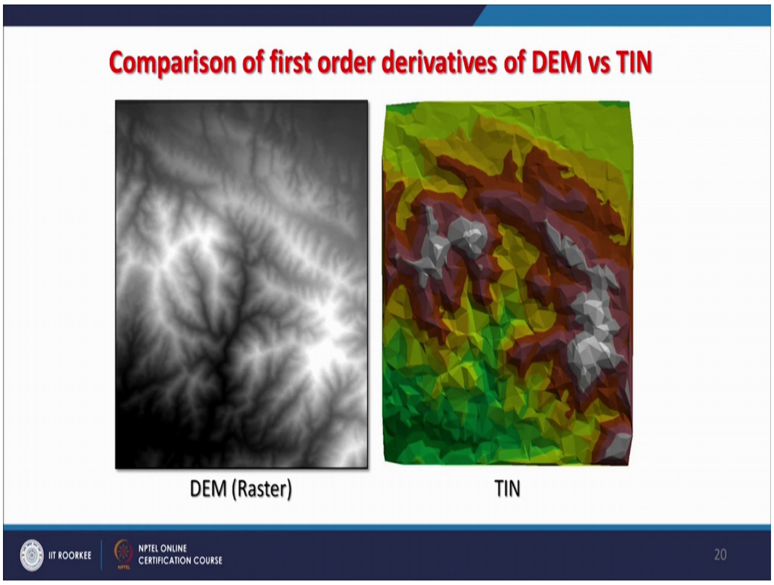

One more brief topic I would like to discuss in this particular part of a lecture is the comparing basically digital elevation models and TIN both are surfaces, but both are not raster. As you know the D E M is a raster structure whereas, TIN is a not raster structure. So, when I created run raster either using contours or point line point data or maybe a remote sensing based technique, I get the result something like this. Two things we have to observe here in both while comparing D E M and TIN is the boundary area and how inside it is.

So, when a typical terrain, when we create a digital elevation model, it looks something like this for the same area, for the same example digital elevation model TIN has been created here, but the boundaries though inside, because it is having shed. So, it is not shed a relief model here, if I created shed a relief model, it still that would look completely different, then the same terrain is being represented through tin. So, if once the model is changed and rather than raster if we go for tin, the terrain looks completely different. So, this one has to take care about this, depending on our requirements we should choose different models.

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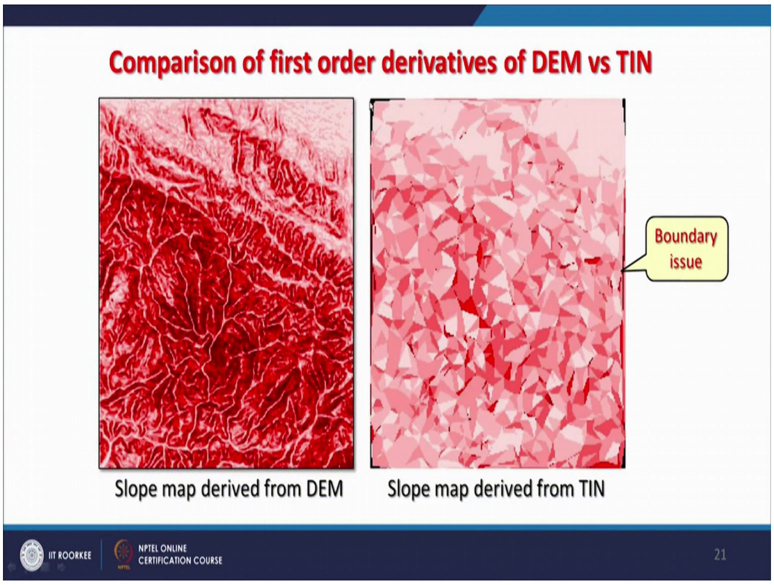

Similarly, if I derive the slope, there is first order derivative using a digital elevation model my slope map looks like this. Whereas, when I derive the slope map using the tin, my slope map looks again completely different, because for each triangle which is a planner here in tin, is a giving you the information about the slope whereas, in case of raster, each cell value or each cell is giving a slope value and therefore, both maps are looking completely different. Same issue will come at the boundary, because at the boundary you do not have further triangles and therefore, or at the boundary you will have problems.

So, this one has to remember. Second another important thing is, as you have seen that we can create a subset of a digital elevation model or subset of a raster, where there is a digital elevation model or a satellite image. We can always easily create a subset of a raster, but it is not possible to create a subset of a tin, and because if I put the same polygon boundary as I have shown in the example while creating a subset of a digital elevation model, then what would happen at the boundaries, because then I will not have any triangles left, and therefore, it is not possible by any means to create subsets of a tin. So, if area of interest is smaller then there are ways to create a TIN for that area, but again the boundary issue, but the TIN will always remain.

So, I am taking few examples, the first one we have taken about the overall digital elevation model and a tin. Now here we are having a slope map derived from digital elevation model, slope map derived from tin, boundary issue is a still there.

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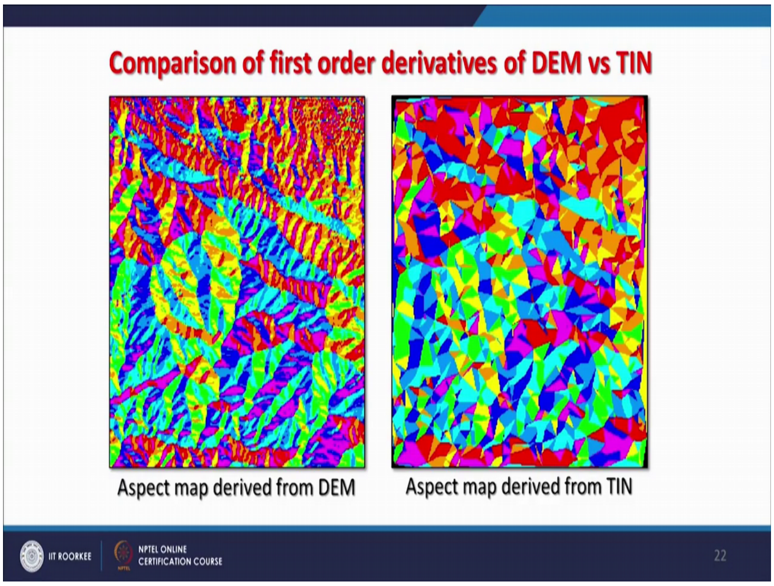

Now, aspect map. So, aspect map looks a quite close and not as different as slope in case of slope maps, but still it is not as similar as a slope aspect might derived from a digital elevation model same problem the boundaries who will also be here.

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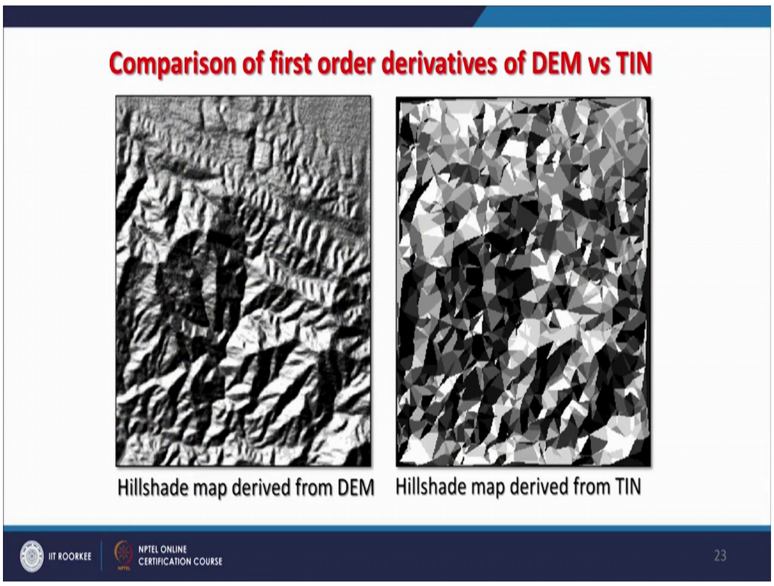

If I derive a hillshade and put it everything in gray scale them. Generally hillshades we put in a hill grayscale then they for the same area to looks like this, and in case of a TIN it looks like this and again the boundary issue will be there, because the input TIN is having boundary problem, so whatever the derivatives which we are having through that tin, will also be carrying those boundary issues; otherwise it is possible to derive.

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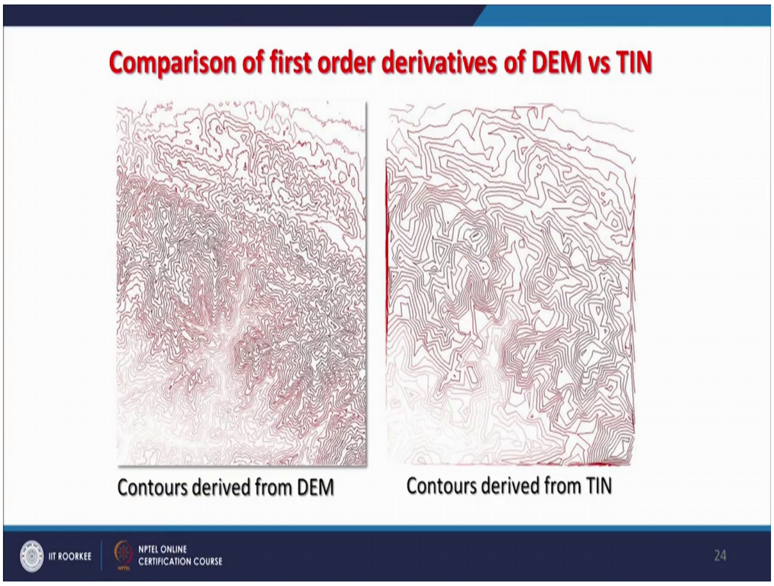

If I derive the contours; that is the reversal of a digital elevation model going from continuous data to discrete data, raster to vector. Then I if I choose the same contour interval here and the base level and a starting point and a contour interval, then I get two completely different contour maps; one from derive from raster that is D E M, one from derive from TIN and again the issue of boundary will come.

In case of a digital elevation model all contours, these will end at this at sharply at the boundary whereas, many of these are having a some bending problem, some other issues, because of the unit here is triangle.

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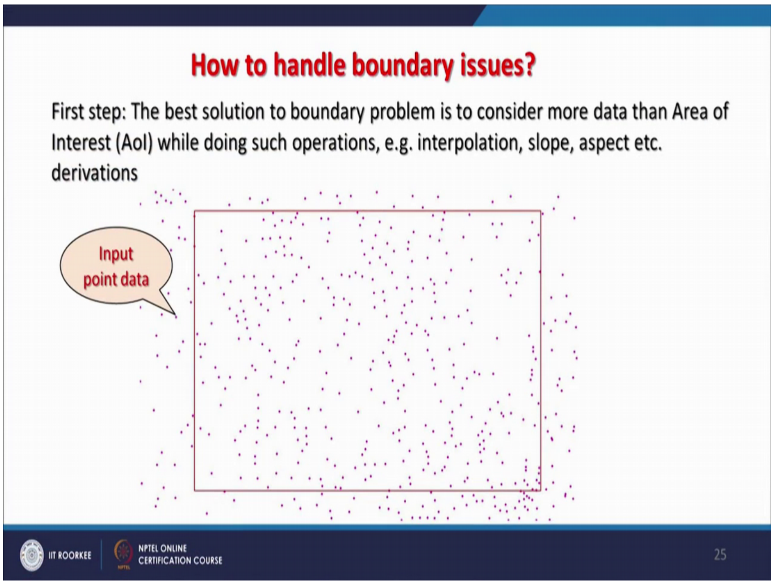

So, how to handle this boundary issue, and this say the best approach which I developed here is that first, one should have data more than of your area of interest, if that is available then this boundary issue can be solved quite easily. Otherwise even in a generating a digital elevation model using the point data exactly for the same area will create problems at boundary.

So, it is better that the best solution to boundary problem is to consider more data than area of interest. So, the extent of that point data should be more than your area of interest or extent of you air area of interest. As shown here that the point data are going beyond my area of interest, my area of interest is shown here in the form of rectangle, and when I do the interpolations. The interpolations will be done within the, these points and elsewhere then it would be extrapolated. And once the surface is created I can extract for my area of interest.

So, this way I can solve the boundary problem; otherwise what would happen if I am having data, point data only for a given boundary, then within my area of interest there will be areas of extrapolation, and that extrapolation generally will create wrong elevation value. So, in order to avoid that thing, the input points extent should be larger, bigger then the area of interest, this is one way of solving this issue of boundary.

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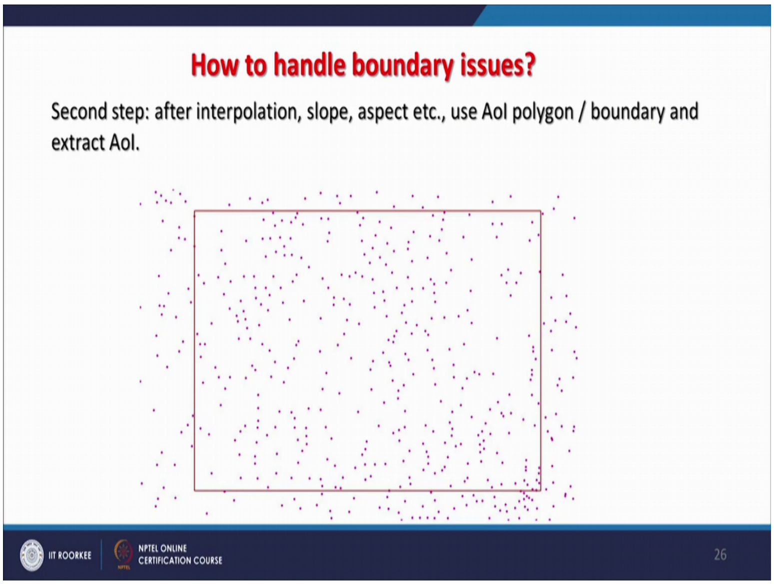

The second step in this one that once I do the interpolations, then slope aspects etcetera can be derive using this polygon or boundary or exact l o i.

So, I can choose at that time that for what area I would like to derive this thing. So, this is the way the example is shown here.

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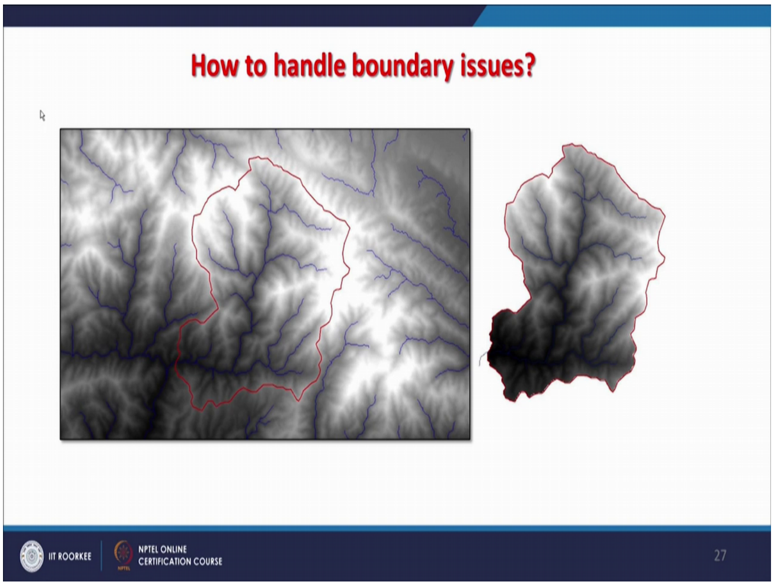

How to handle the boundary issue, this is a repeat example in that sense that I can extract the data, once a digital elevation model is generated for my area of interest in this case the area of interest may be like this. Now exactly my area of interest is this. This was the say distribution of point data, input point data for which I have used for interpolations to create a surface. Now I can extract my area of interest like this. So, within my area of interest, there will not be major issue a boundary and there will not be any extrapolation beyond these observations. So, that is the advantage of this thing.

Now, a few more derivatives which can be derived using digital elevation models, very popular analysis nowadays is hypsometric analysis can be done quickly. In 3 4 slides I am going to cover this one.

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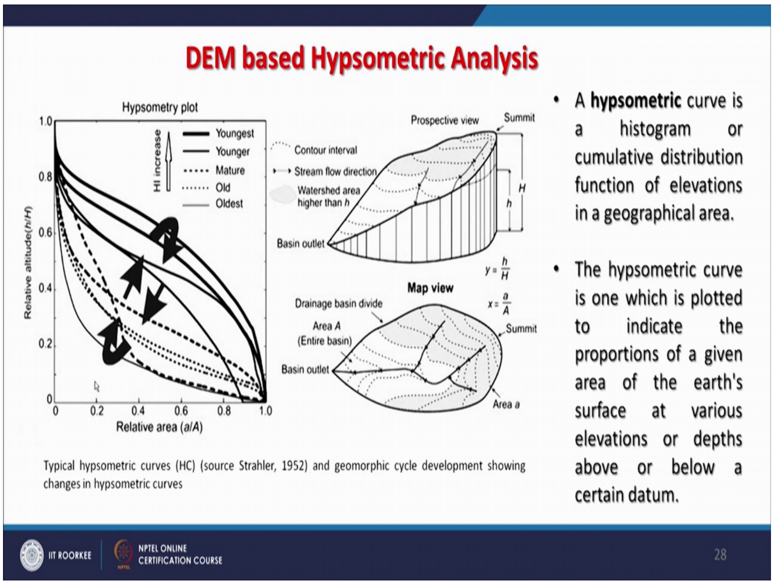

Basically this a hypsometric curves and these a different curves will tell how slopes are buried, and whether the basin or drainage area is having a very younger terrain or it has matured. So, in that way and generally these hypsometric plots are based on the relative area at different elevations. So, on X axis we are having the relative area, and on Y axis we are having relative altitude. Here in through these schematics it is shown, but we here that for example, if this is the plan view of a digital watershed, and these are the different contour lines are shown.

So, these drainage area can be analyzed for hypsometric analysis, and we can tell whether it is a young, old or a mature. So, hypsometric curve is a histogram of cumulative distribution function of elevation in a geographic area, as we have seen the cumulative distribution function of elevations. And hypsometric curve is one which is plotted to indicate the proportions of a given area of earth's surface at various elevations or depths above or below a certain datum.

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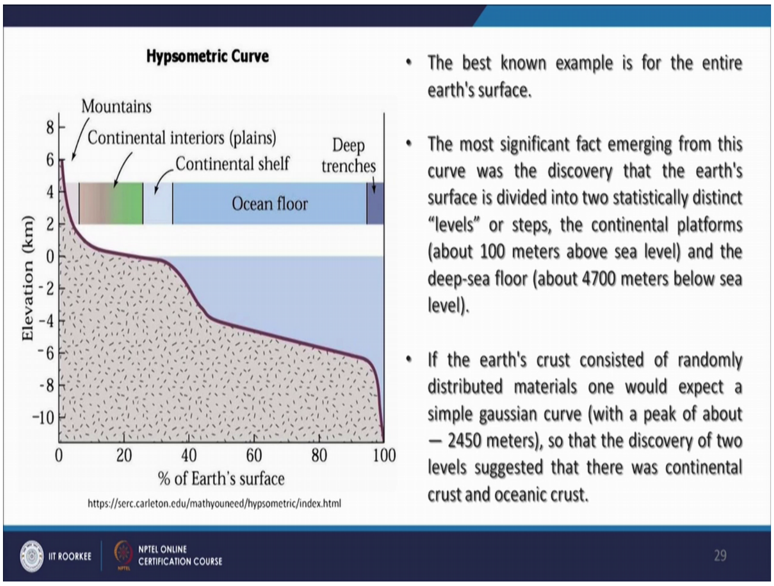

This is the hypsometric curve for the entire earth, as we move the percentage of the earth the in terms of area, as we move that a large my large part of the area. Here is a in form of mountains, but as we go and then the sea, the oceans comes here and likewise the elevations are here. So, this is a very generalized hypsometric curve for the entire earth. We show the best known example for the entire earth surface, and the significant of this that the curve was discovery that earth's surface is divided into two statistically distinct levels, and that is the continental platform, and in between of course, we can divide a continent itself and then ocean part as well, and if the earth crust consisting of randomly distributed materials; one would expect a simple Gaussian curve which is not there.

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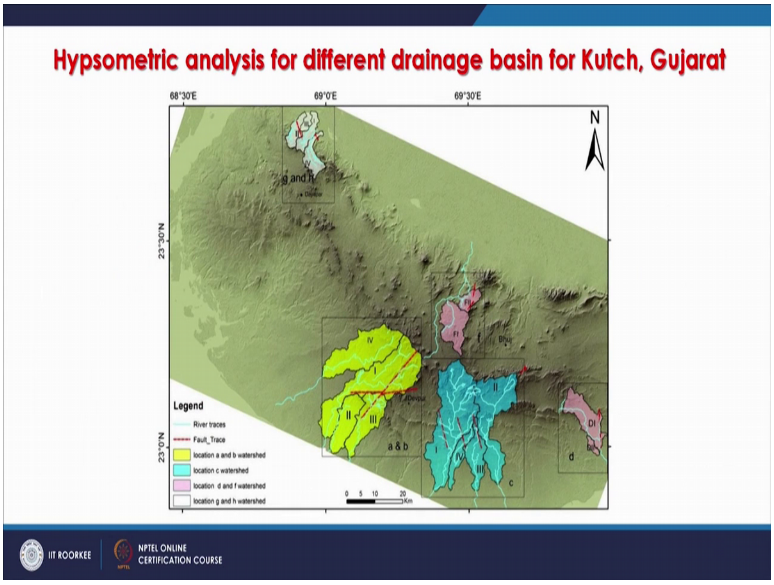

So, this is how a generalized hypsometric curve of the earth will look. Let us take some specific example, this is example from Kutch Gujarat, there are few basins which have been chosen for this analysis.

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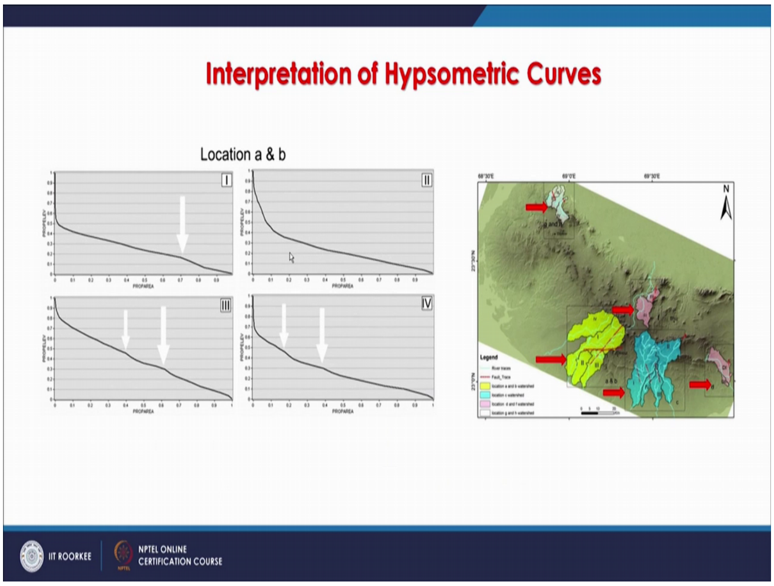

And what we see here that there hypsometric curves are coming like this for all these basins; 1 2 3 4, and these are indicating how young or old they are, and likewise for all these bandwagon basins.

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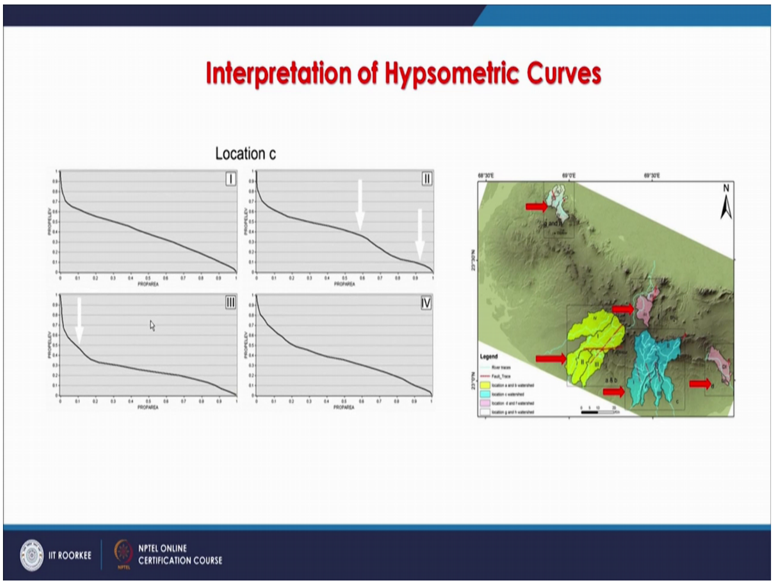

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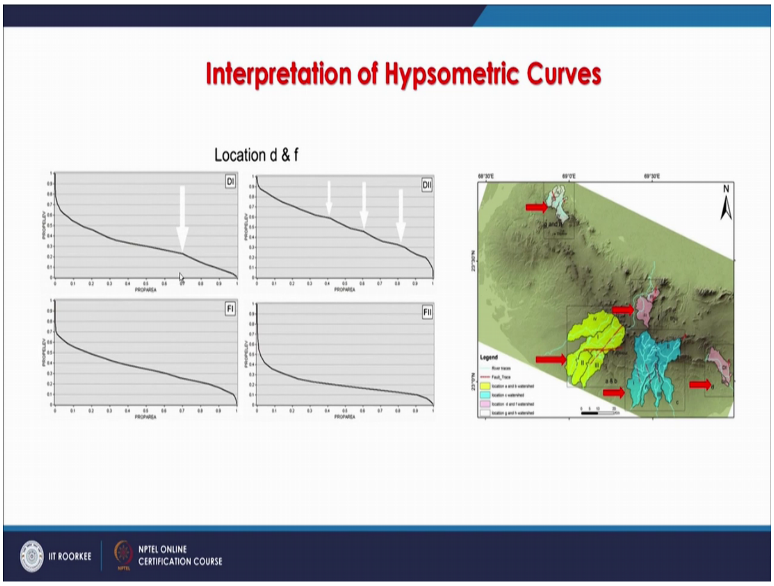

Which we are seeing here for the location c, location d and f which we are seeing and location g and h which are here.

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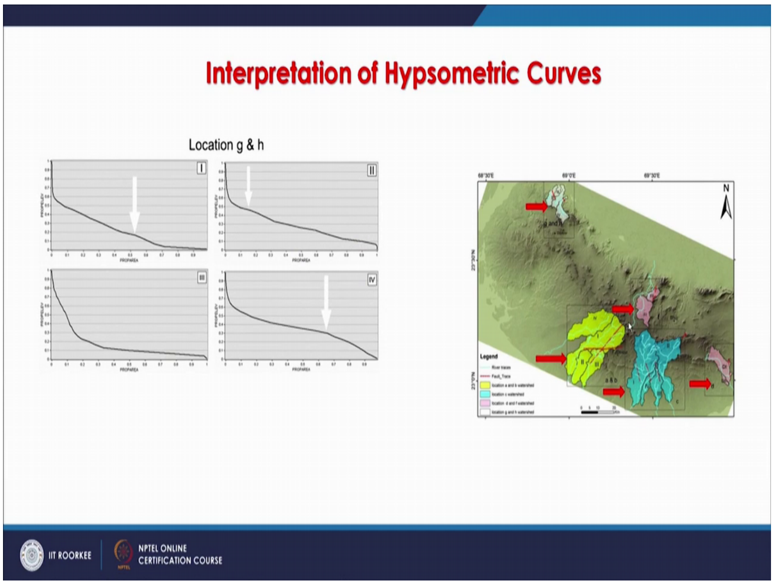

So, by this way we can also assess a how old or how young a terrain is. So, you can derive landforms, you can derive slope aspect and various other, but also you can assess the age of a terrain in terms of how much, because a young terrain like Himalaya, Himalayan terrain is a young mountain system, and if you derive for a hypsometric curve for a basin, you would find that it is going quite high and that indicates that it has not yet a stabilized, a lot of erosions are taking place. Whereas, if you go in different parts of the earth, where things have stabilized, not young mountains then you will get a very low hypsometric curve. So, likewise we can classify our basins, based on their basically relative age using hypsometric curves. So, this brings to the end of this particular discussion.

Thank you very much.