[noise]
hello everyone and welcome to twelfth lecture of a digital elevation models and application course and this is dms derivative tools so more derivatives which we can drive using digital elevation models especially on j a spill it forms and we will be discussing focusing on that so first we take here is the ah the profile or longitudinal section also called cross section elevation profile topographic profile in literature or in various software different terms are in being used but they ah simply say a topographic profile which you i would like to call as that shows the elevation as a function of distance along the profile route

why route instead of a line has been used here because it is possible to create a topographic profile not only along a straight line ah but along a polyline or an arbitrary line for example ah ah you can create a topographic profile along a drainage line generally which is a arbitrary line or [vocalized-noise] polyline so topographic profile along a straight line a which is very easy to create even using ah your contours ah from a topographic map can also be use to create a topographic profile along a ah straight line but creating a topographic profile along a an arbitrary line as mentioned is possible ah using dems in gis platform and this is the example which is here that a a line has been drawn over a example dm which we have been taken in this course as but example dm and when we [vocalized-noise] put a line here and so a profile is immediately drawn here the example is we are from arc gis arcmap and along all these nodes here it is shown that we can know what exact the elevation values are

so it becomes very handy ah for use the you can change this a length of the axis y axis or x axis and accordingly or you can export these things save as a ah excel file and can do all other things profile data can also be ah taken from this that what is the two d length that is the length of this line what is this three d length that it means including all undulations ah recall the discussion on ah this plenum metric area and surface area so the three d length is always going to be more than two d length then all ah what is the z minimum what is the z maximum and all kinds of values can be calculated ah along a straight line

similarly we can also calculate along an arbitrary line like here so we are having a arbitrary line here and this is an example from older version of a arc view arc view gis has three point two a in which a extension as we news profile extractor and a line has been selected along a drainage line is shown here as a green line and the profile then we derived here this can be again exported and you can ah use further for many other analysis so profile ah this one is very very useful drawing a profile longitudinal profile or topographic profile either along the line that is a straight line or a polyline that is arbitrary line

now this ah these things ah characterizes basically the [vocalized-noise] micro terrain features and this is what ah we want to exploit ah whenever we want to see what are the undulations along a say drainage line or a stream ah or these micro terrain features ah we can use these ah profile tools or can drive profiles like this so here ah what is this is smooth elevation is a generalized elevation is like this but then you are having at places somewhere the convex features which is above smooth elevation we may be having some concave features that is the blue smooth surface and that black line source the topographic profile or elevation profile

so this is useful ah to identify micro terrain features involving ah subtracting a smoothed elevation surface that is the average elevation surface from a actual elevation surface and this can ah give you the ah basically surface roughness or micro terrain features along a line or a polyline and that may be useful for various purposes again and these are the localized deviations and that is what we see here that this concave features and this is how we get the minus values here in case of convex features we will get the positive value so this for identifying and this micro terrain features subtract the elevation values at a location from the [vocalized-noise] average of its surrounding elevation values and the positive derivation deviation values indicates the convex features and like here and whereas negative indicates the concave features like here and the magnitude of the deviation indicates the relative height or depth of the micro terrain feature

so this is how a long a topographic profile we can see or drive the micro terrain features and they say these are usefuls in route alignments these are useful in a [vocalized-noise] for ah finding out the rapids or a undulations or you know ah sudden changes in the elevations along a ah drainage or any other ah polyline ah so like in this example this is the start ah of a line this is the end of a line in between you are having and these locations forbid points are there and this is depicted in a [vocalized-noise] topographic profile start and and in between these number of a points are there so this is planimetric length is given here [vocalized-noise] and this is going to be less than the surface length as we see and all these points ah we know that ah as actual elevation which is this red one and the smooth red one is here and we can find out where ah the [vocalized-noise] the flow will become faster or slower where are the rapids or falls or where are it is a smooth flow and because these ah such information can be useful and while designing a civil structure ah cross a or along a ah drainage line or a stream

because a [vocalized-noise] in in like in civil engineering we want that flow should be laminar flow rather than turbulent flow so if you are having micro terrain features ah abundant micron ah terrain features along a ah stream ah then ah [vocalized-noise] then these should be avoided ah for [vocalized-noise] while designing or finding out a suitable site for such structures maybe bridge piles of bridge and other things now applications of a topographic profile has just indicated that the surface roughness along the line can we explore which is useful for various purposes provides information about micro terrain features again along the line very useful for geological cross section in structure geology we draw geological cross sections generally and the practice is that we draw along a straight line but nowadays it is possible to draw geological sections along a arbitrary line or polyline and topographic profile along a drainage line can provide information about rapids falls etcetera as discussed earlier and these files can provide preliminary information about feasibility of a small hydro sites as well

whether if fall is [vocalized-noise] available or not or a head is available and so this rapids or fall can ah give us that kind of indication [vocalized-noise] now a next thing which we go ah and calculate one of the derivatives of calculating the volume and that volume is useful in cut in fill analysis so we set a a level or plane and then we we would like to find out of a undulating terrain that how much of the earth or soil or rocks have to be removed and below the above the reference surface and how much you know filling would be required below the reference surface

so this calculates the surface volume area in volume of region between a surface and a reference plane so here this is the reference plane if we say that we want to fill all this so here the reference plane is is set to the above and plane height location intersect with the surface and here is a blue what is blue ah what is blue here and if we have to say make it this flat then this much area has to be removed and similarly if we have to fill it and make it flat then this much area has to be filled likewise this cut and fill analysis can be done using [vocalized-noise] digital elevation models and very very useful and like if we have decided along a topographic profile a route alignment maybe for a road or railway track then next thing we would like to know that how much filling we will require or how much cutting will be required or removal of soil or earth or rocks would be required

because a a particular slope is [vocalized-noise] part of the design and that has to be maintained and therefore the reference slope or reference level is and first decided and accordingly then this cut and fill analysis can be done so cut and fill analysis basically is a procedure in which the elevation of a ah landform surface is modified by removal or addition of surface material generally one ah the good [vocalized-noise] analysis can be if it is possible to choose a reference plane in such a manner that the material which is [vocalized-noise] to in order to make a terrain flat ah a part of the terrain flat ah the reference planes would be chosen in such a manner that there should be a minimum ah ah minimum cutting and minimum filling is required means that less earth work if it is possible to sift the reference plane

but if it is not then whatever is required it can be analyzed so in cut and fill analysis the areas and volumes of changes are summarized and like here in a this is schematic that if i have decided that this is my reference plane where a road has to go so and then this much area has to be ah cut and this much volume of rocks or soil will be removed and these are the areas where it would be filled may be filled so likewise and therefore this road will become ah relatively quite a smooth so the basic calculation basically is the difference between the desired elevation here in this case is the black line and the original elevation which is the brown line and the red areas here are showing the areas which would be full filled with the will the material which may be removed from here or here

so they this is in the section but think what what happened in a plan view this is a longitudinal view in plan view it is something like this that if this is the area which has to be made flat which is marked by a polygon then these are the areas ah which are being shown here and the green one which will be cut and these are the areas where flame will be done if elevation level is ah decided here so like marked area for cut and fill analysis along ah the perimeter along this whole area can be seen here and this is what this is the reference surface and in this example is a given around ah [vocalized-noise] some value and whence the reference surface is given then ah you know exactly where things will be cut and where things will be for ah [vocalized-noise] remove or deposit deposited and total volume not only the location but the volume of earth work ah which is required can also be estimated quite easily

now the accuracy of this analysis that is cut and fill analysis especially the volume ah will definitely depend on the spatial resolution or digital elevation model so if it is being done for a small area then [vocalized-noise] higher spatial resolution digital elevation model would be required but it is if it is done for a very large area then maybe a relatively moderate spatial resolution dm can serve the purpose for very accurate definitely ah a high spatial and accurate digital elevation model is required in this particular example the [vocalized-noise] the analysis source that this is the volume of ah fill or earthwork is required where things will be filled this is the volume ah the of soil or rocks would be cut and this much would be the areas in both the cases and this is the perimeter is going to be affected and the elevation or the reference surface in this example was choosing thats sixteen hundred meter

so depending on the terrain depending on the requirement whether ah this analysis can also be done for a sloping surface in this examples what we are thinking only about it and flat reference surface but in some cases a sloping surface may be involved so accordingly the analysis can also be performed now here again as we have discussed the z factor in case of slope and aspect so in case of ah ah this profile and especially in the volume calculations the z factor will play very important role z factor basically [vocalized-noise] it is about how much because two scales are or two resolutions are there so x y or horizontal scale is there there is a vertical scale and these two are generally different in digital elevation models except if you are working in a utm projection

where everything in meters that means horizontally scale and vertical scale both are in meters but if somebody is working in d d or in some map projections then z factor has to be said accordingly ah otherwise the entire calculation may go completely wrong remember this most in most of the gis software the z factor as default is set one and one means that horizontal axis and or horizontal scale and vertical scale are same but generally as i have mentioned except in case of utm these are not same so z factor ah must be taken care the z factor ensures the accuracy of volume calculations when the surface z values are expressed in a different units of measure then x y units

so vertical ah x a vertical scale and horizontal scaled when are they are different then accordingly the z factor should be said the output text file ah ah through this cut and fill analysis will store the full path to the surface the parameter used to generate results and the calculated area and volume measurements so like in previous example ah which i have shown here these are in mapping units these values which you are [vocalized-noise] getting all are in mapping units if they are in meters everything in meters like in utm then it is very easy to calculate but if they are not then accordingly the ah the z factor should have been chosen and accordingly you will get the value so values will come through all these analysis in mapping units so map in case of you utm mapping units are ah meters in case of a like nun projection when values are in d d or degree decimal and the the if the same output file is specified in multiple runs of the tool the preexisting records are maintained and the results are appended to the table

so you keep analyzing and then later on you ah can choose the which one here is the example of cut and fill analysis results in arc gis like here ah that the tin example is here raster example and other the plane a plane height is given differently the reference plane is either above or below the z factor is changed accordingly and here in z factor one that means the horizontal axis and vertical axis are same area in two d is coming like this three d is coming like this and volume is like this and of course for ah this one ah all these three will be ah zero ah because it is below and the above again you are having when plane height is chosen twelve fifty then ah things will change the area and two d will change three d will change and so on and so forth

so likewise if reference plane is change values will change if a z factor is change values will change so these things have been depicted here by taking surfaces of a ah given location at two different time periods like instead of ah ah you might be having two digital elevation models representing two different and times maybe ten years time difference or so on so forth then you can know many other things also so this is the example here that the taking difference of a given location at two different time periods it identifies reasons of surface material removal addition in areas where the surface has not changed so in a in case of a large project after few days of work a few months of work one would like to assess that how much work has been achieved really

so that if we are having a high resolution digital elevation model before work is started and in middle of the work then ah then we are having that means two elevation difference ah two elevation models and there is a time difference then therefore we can calculate where the ah more removal or more addition ah [vocalized-noise] is required or where things have not changed for example here this is the original state say in the year in nineteen eighty this is the scenario in nineteen ninety and then ah we can create a ten years time difference ah surfaces so here a erosion or ah out or removal has taken place here deposition has taken place

so likewise [vocalized-noise] we can we can assess ah that means bringing a time ah factor here and instead of going just for three d now we are going for a fourth dimensional and involving in our ah volume analysis the time domain [vocalized-noise] fourth dimension as well so they if if at all we are having two different and digital elevation models may be of same resolution but belonging to two ah different timings of the same area then such kind of calculations ah can be done it is now possible because when we drive digital elevation models using ah sar interferometry and in between some episode like maybe a flooding or maybe an earthquake might have occurred so if we are having say two years five years time difference between two digital elevation models drived from sar interferometry using radar data then how much land has changed where erosion or subsidence has taken place very exactly ah ah upliftment has taken place ah the the this ah cut and volume kind of analysis can also be performed their time and domain or time component has also been incorporated

but the prerequisite here that we should have at least two surfaces ah belonging to two different timings now here ah that how it is exactly calculated that like this is the ah before raster and the raster before an event has taken place and this is after the event has taken place so now only the ah difference which we are looking and it tells ah the this is how things have changed here and there likewise ah here the out raster this one will ah be some as subjected to cut and fill these two surfaces so in in this case what happens basically one surface becomes your reference surface

so the earlier one the first one before raster becomes the reference surface and the after raster ah becomes your ah the target surface and accordingly that calculations can be done so from a cut and fill analysis point of view is ah no ah [vocalized-noise] material but only thing you know in conventional cut and fill analysis generally we take reference surface is a flat but in this chain detection analysis we are taking two different digital elevation model so thats the major difference here when the cut and fill operation is performed by default is specialized renderer is applied to the layer that highlights the locations of cut and fill analysis and likewise here we may get the minus values we may get the positive value so we know that these are the areas where a net gain has to [vocalized-noise] that means the it will be filled these are the areas which ah which has ah the things will be removed or a loss is shown here

so likewise such analysis can be formal so this determined is in the attribute table of the output raster and which considered positive [vocalized-noise] volume and two v ah ah volume to where the material was cut or removed or where negative values where it has been added or filled so likewise it can be done now what are the applications view ah while discussing this ah cut and fill analysis or before that the topographic profiles we have discussed some applications but for completeness we will go one by one that the with the cut and fill analysis the following ah things can be that ah we can identify regions of sediment erosion and deposition in a river valley ah ah which may be very helpful in case of erosional studies or ah some other studies as well

calculate the volumes and areas of surface material to be removed or areas to be filled around a mining site may be along a road maybe for a railway track may be for a highway and so on so forth so this is a very very useful and i we can using this cut and fill analysis we can identify areas that become ah frequently inundated that means ah for flooding also ah cut and fill analysis because the one example i have shown where a reference surface was choosing ah ah and you assume that this is the filling surface and that filling surface may be because of water so if we set a label for water that inundated areas can also be identified ah during a might be a mudslide in a study to locate safe area for a stable land or may be simple flooding where instead of mud we are having the water [vocalized-noise]

cut and fill analysis can also create maps based on input surfaces before and after that means for change detection studies displaying the areas and volumes of surface material that have been modified by the removal or addition of surface material cut and fill also ah can ah in this case the input raster surface must be coincident that means they both ah should belong to the exactly of same area and probably a same resolution then we get the better results accurate results and that is they must have a common origin and this is a very easily can be done in nigeria as platform and therefore accurate results as i mentioned the z factor or z units should be ah same as x y units so z factor has to be ah taken care otherwise all results may go completely wrong and ah if they are not same like ah a horizontal axis and vertical axis then z factor has to play a major role example here is if the x y units are in meters and z units are in feet you could specify a z factor of this one

or maybe z factor [vocalized-noise] z units might be in degree decimal then it becomes if further a very small value so likewise ah we can employ ah all cut and fill analysis for various purposes and ah this attribute table which will which will be generated through this cut and fill analysis ah can present the changes in the surface ball loom following the cut and fill operation positive values will indicate the volume difference indicate the reason before and that raster surface or a reference surface and have been cut that is the material removed negative values will indicate where the filling is ah required and when cut and fill is performed ah from a a non gis platform ah default render is applied ah that is the ah basically which will highlight the location of ah cut and fill as we have seen in few examples and this can be and this can be very helpful

the renderer draws areas that have cut in blue and that area may be in so the color schemes depend on and different softwares but generally red is maybe for cut or maybe for fill and accordingly ah the other color would be the area that have not changed are displayed generally in gray color or maybe in white colors so [vocalized-noise] is mentioned that in [vocalized-noise] soil burg earth work rock works ah the cut and fill is the process of constructing a railway road or canal whereby the amount of material from its cut roughly matches the amount of fill needed to make nearby embankment or minimizing the amount of construction labour this is what i have been saying that if the choice of reference plane is there

then ah we should achieve ah through this cut and fill analysis a reference surface in which minimum earth work would be required that means [vocalized-noise] even in a say ten square kilometre area at some places the soil or earth or rocks might might be required to be removed but within that area ah that will be consumed for filling and therefore no extra material either will go from that area or will come and this ah this will provide a complete of imagination and can be a very good approach for this so this brings to the end of ah this [vocalized-noise] digital elevation models derivative to in which we have discussed topographic profile and applications cut and fill analysis and bringing time domain as well and its applications so thank you very much [noise]