ASIAN CITY PLANNERS NETWORK

HYDROLOGY TOOL

GUIDANCE DOCUMENT

A step by step guide to
ArcMap Tools

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WWW.ASIANPLANNER.COM

About ACPN:

Asian City Planners Network is a platform for all the Urban Planners, Spatial Planners, Transport Planners, Housing, Regional and Environmental Planners etc. Under one roof for all the Asian Cities. It is a collection of volunteers maintaining the entire network. Asian Cities today are the most diverse and rapidly changing in the world. With the increase in demand for rapid changes in society. we aim to create a pool of resources for all the urban planning professionals and students. With the available information about the city and with the available pool of knowledge about the best practices for every aspect. At ACPN we dream to plan for cities which are Inclusive, Sustainable, Safe and Resilient wishing to achieve the SDG Goal 11, Pan Asia.

"Cities today are the most complexly intertwined engineered systems, designed to manage infrastructure around the adequate resources and flow of information"

Asian Cities today are more and more dependent on the field of city planning. Yet, they are facing the challenge of under managed resources. At ACPN we try to achieve the simplest idea for the most effective planning of public space in which we live today, trying to follow the dream of 'Building Greater Asia' with inclusive, safer, resilient and sustainable future cities.

We are a network of students who came together and volunteer with self-funds in order to create awareness about our profession called 'Planners' in South Asia.
I call upon all the students to join our drive! #ACPN #KnowPlanning

#StayHomeStaySafe

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ABOUT HYDROLOGY TOOL:

The Hydrology tools are used to model the flow of water across a surface.

Information about the shape of the earth's surface is useful for many fields, such as regional planning, environmental planning, agriculture, and forestry. These fields require an understanding of how water flows across an area and how changes in that area may affect that flow.

When modelling the flow of water, you may want to know where the water came from and where it is going. The following topics explain how to use the hydrologic analysis functions to help model the movement of water across a surface, the concepts and key terms regarding drainage systems and surface processes, how the tools can be used to extract hydrologic information from a digital elevation model (DEM), and sample hydrologic analysis applications.

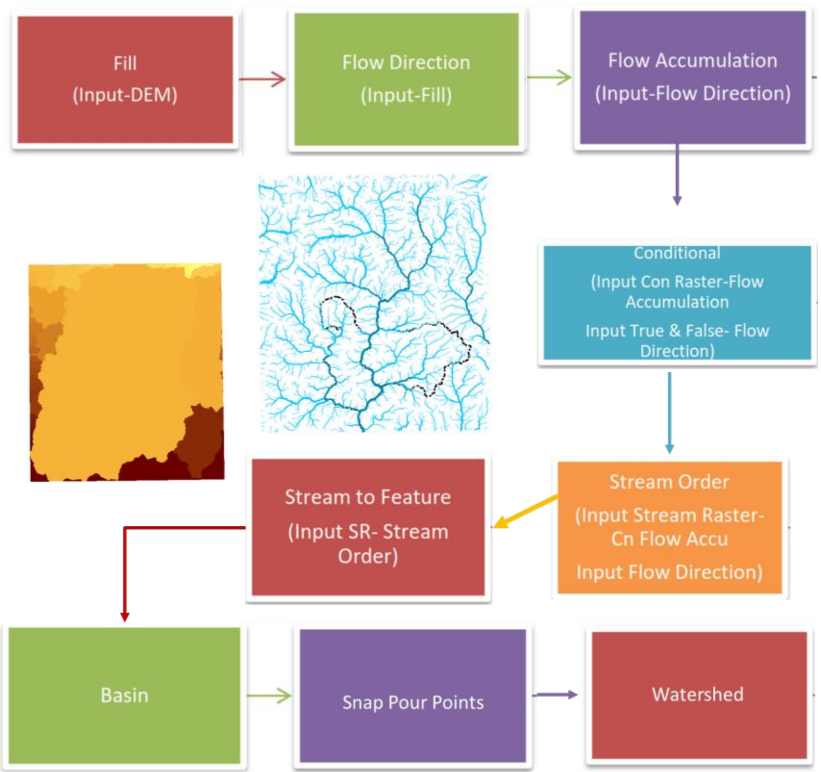
- Understanding drainage systems
- Exploring digital elevation models (DEM)
- Deriving runoff characteristics
- Creating a depressionless DEM
- Creating watersheds
- Hydrological analysis sample applications

The Hydrology tools can be applied individually or used in sequence to create a stream network or delineate watersheds.

Tool	Description
Basin	Creates a raster delineating all drainage basins.
Fill	Fills sinks in a surface raster to remove small imperfections in the data.
Flow Accumulation	Creates a raster of accumulated flow into each cell. A weight factor can optionally be applied.
Flow Direction	Creates a raster of flow direction from each cell to its steepest downslope neighbor.

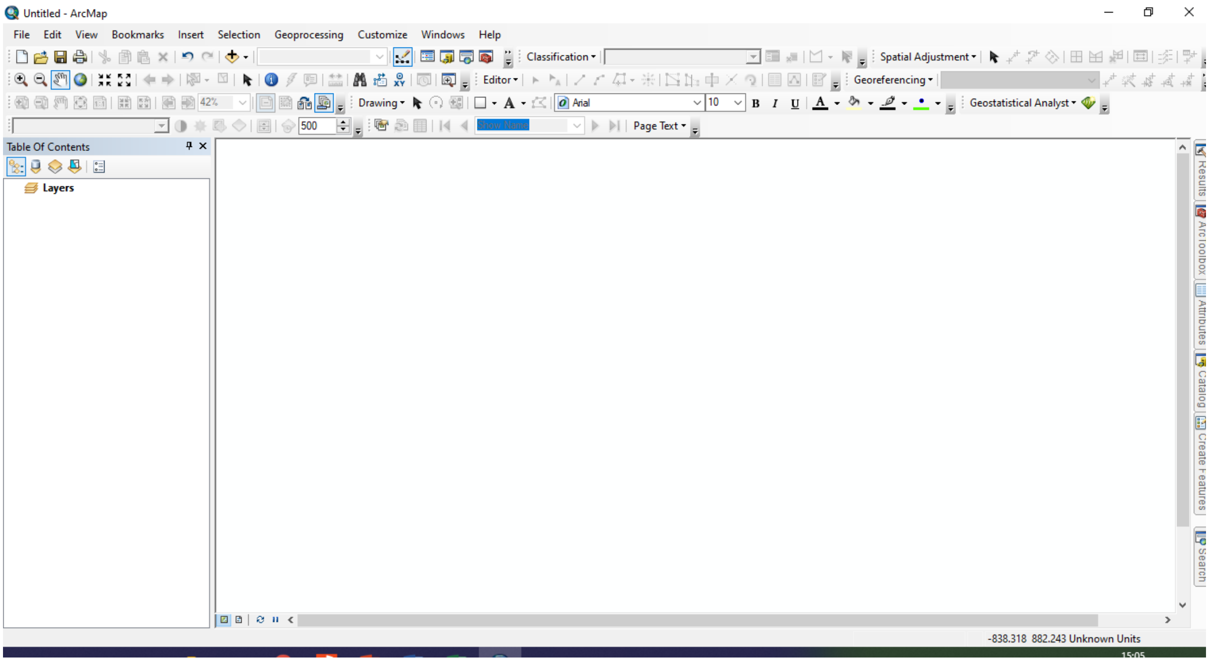
Tool	Description
Flow Length	Calculates the upstream or downstream distance, or weighted distance, along the flow path for each cell.
Sink	Creates a raster identifying all sinks or areas of internal drainage.
Snap Pour Point	Snaps pour points to the cell of highest flow accumulation within a specified distance.
Stream Link	Assigns unique values to sections of a raster linear network between intersections.
Stream Order	Assigns a numeric order to segments of a raster representing branches of a linear network.
Stream to Feature	Converts a raster representing a linear network to features representing the linear network.
Watershed	Determines the contributing area above a set of cells in a raster.

ArcMap Hydrology Process Flow Chart



Note this document is focused on ArcMap only. For, QGIS I would recommend to view this video here.

Step 1: Open GIS (ArcMap)

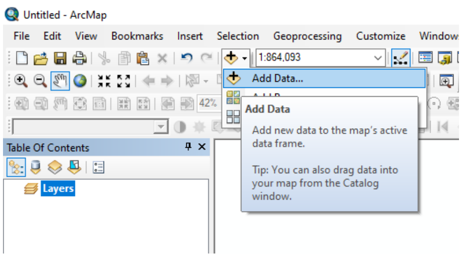


Step 2: Add/Create DEM file into the Data frame.

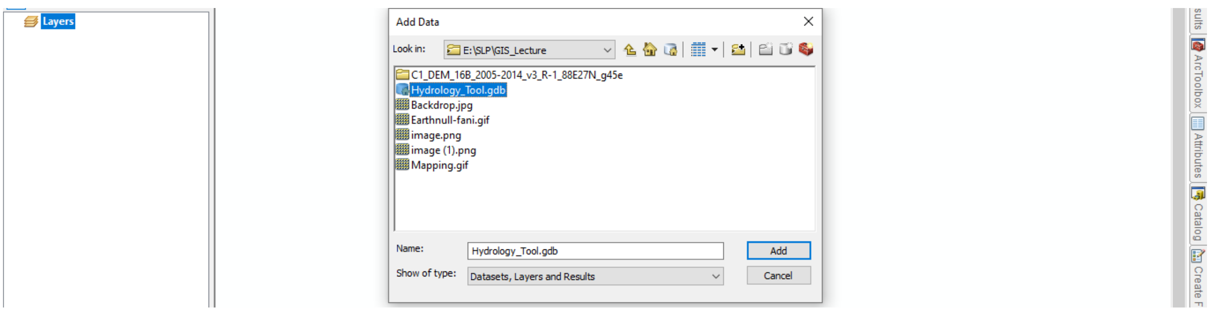
If you need to create a DEM you can, but if you already have the file you just need to add it for the further processing.

I am just adding the file that I have with me downloaded from Bhuvan (Need to know how to download the file, [Click Here]). For this exercise I have attached the .gdb file to perform the further steps with ease.

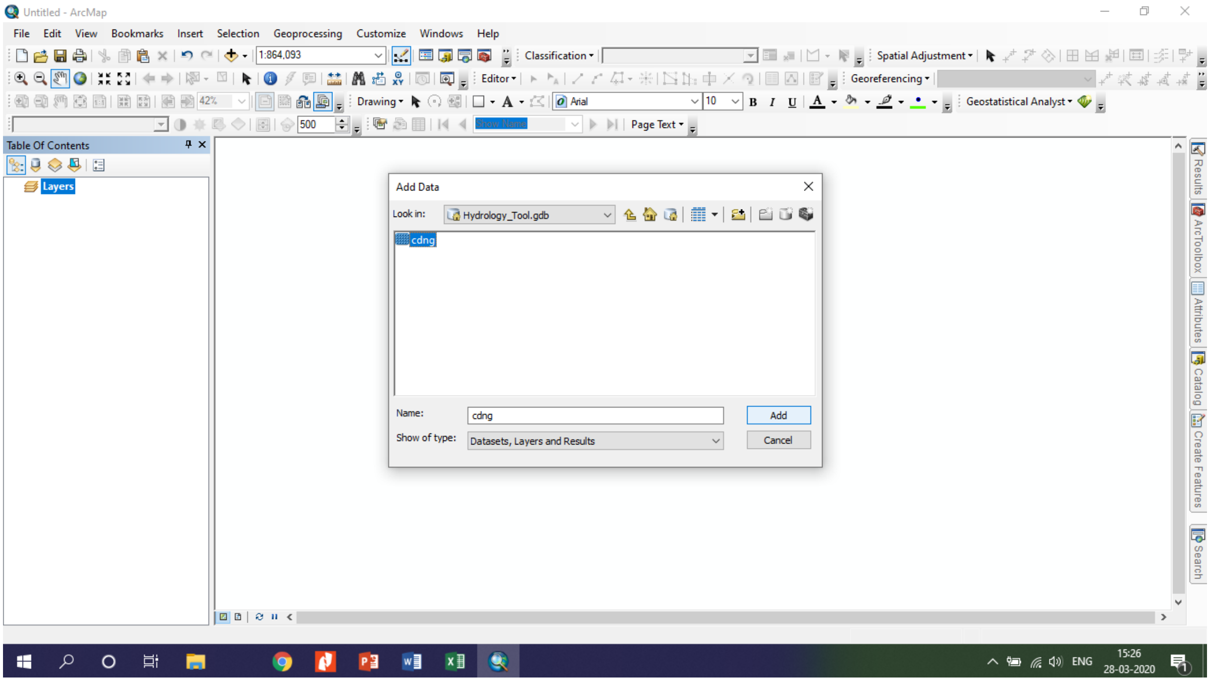
Step 2.1 : Add Data



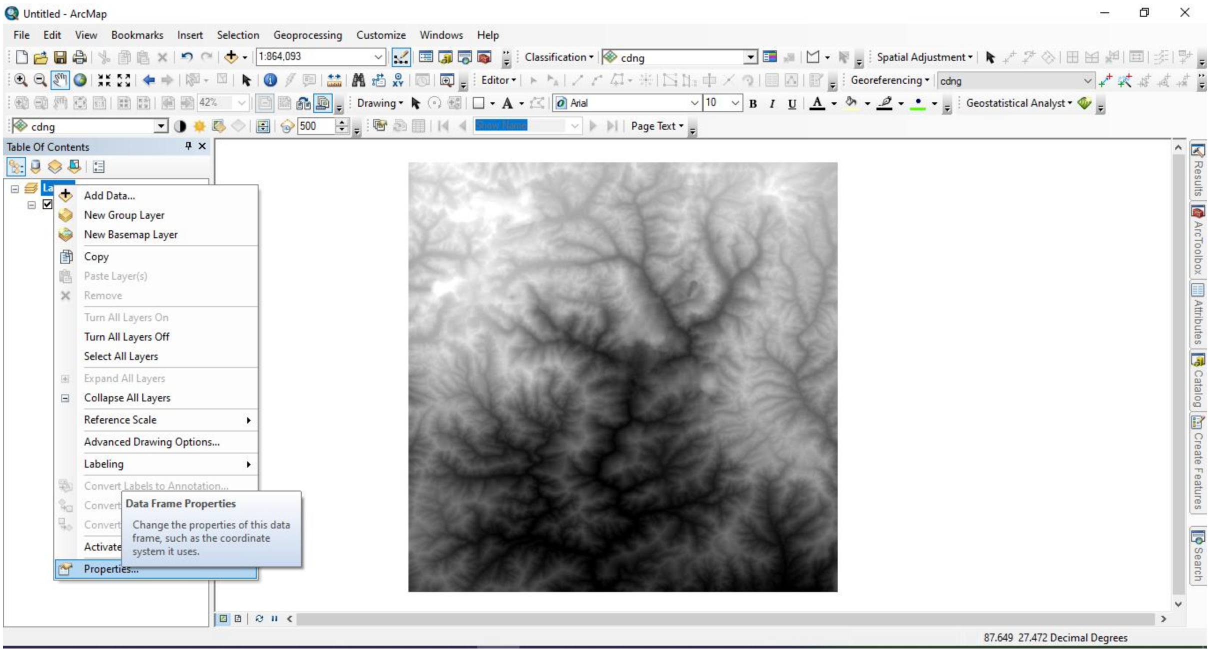
Step 2.2: Select the geodatabase (.gdb) file I have provided you.



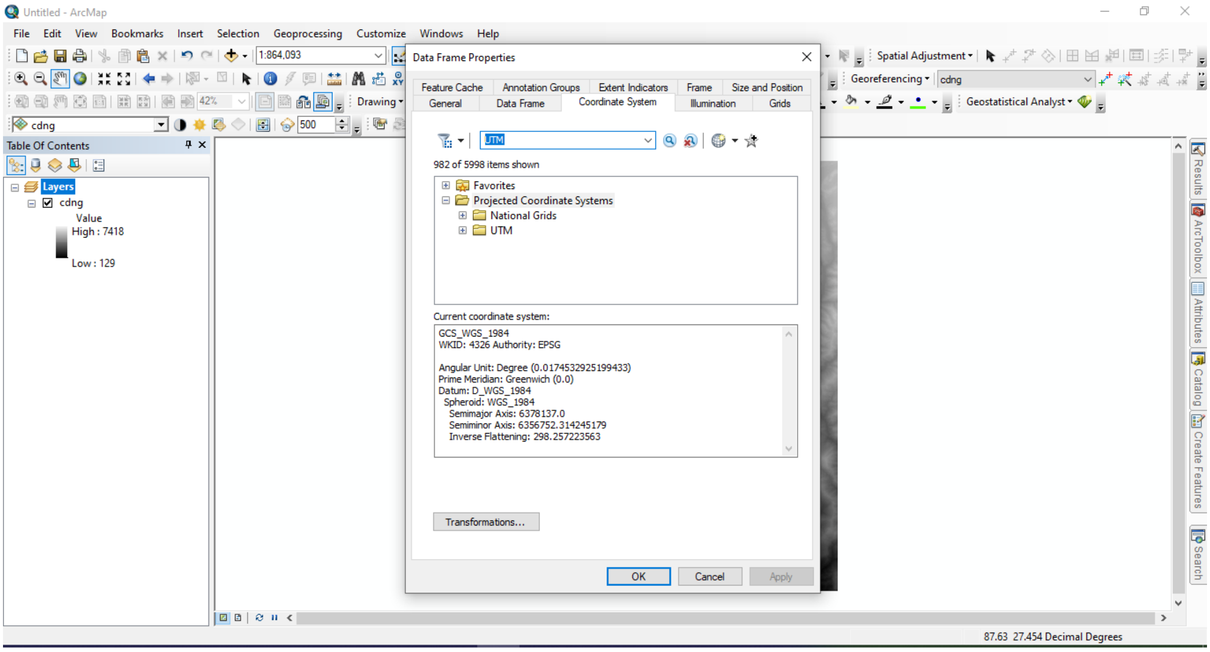
Step 2.3: Select the DEM tiff (here with the name cdng file)



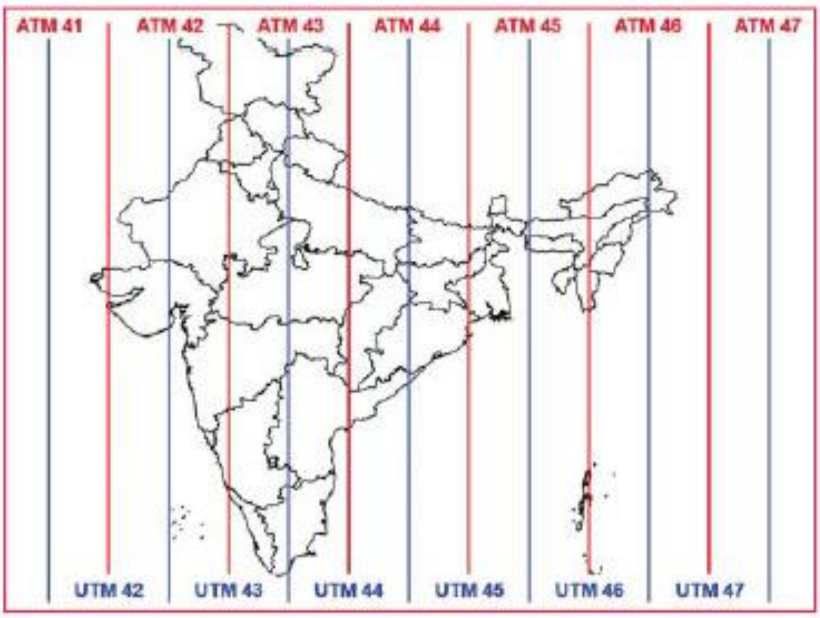
Step 2.4: Before proceeding further, first set the spatial reference. To do so click on Layer (Data Frame) then properties. Click on coordinate system from the



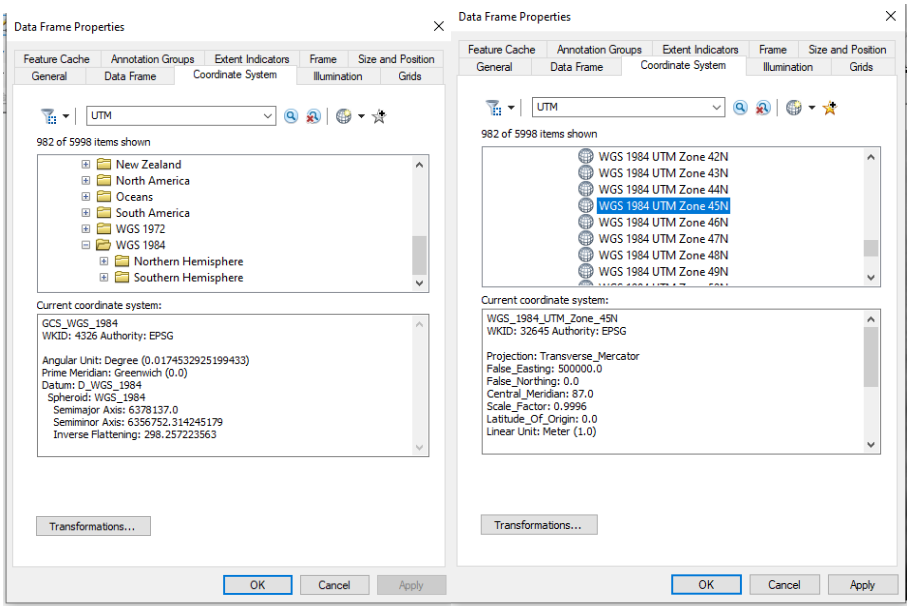
Search for UTM.



You can refer the map below to know what UTM zone your study area will be. For now, the DEM file corresponds to the Sikkim region.

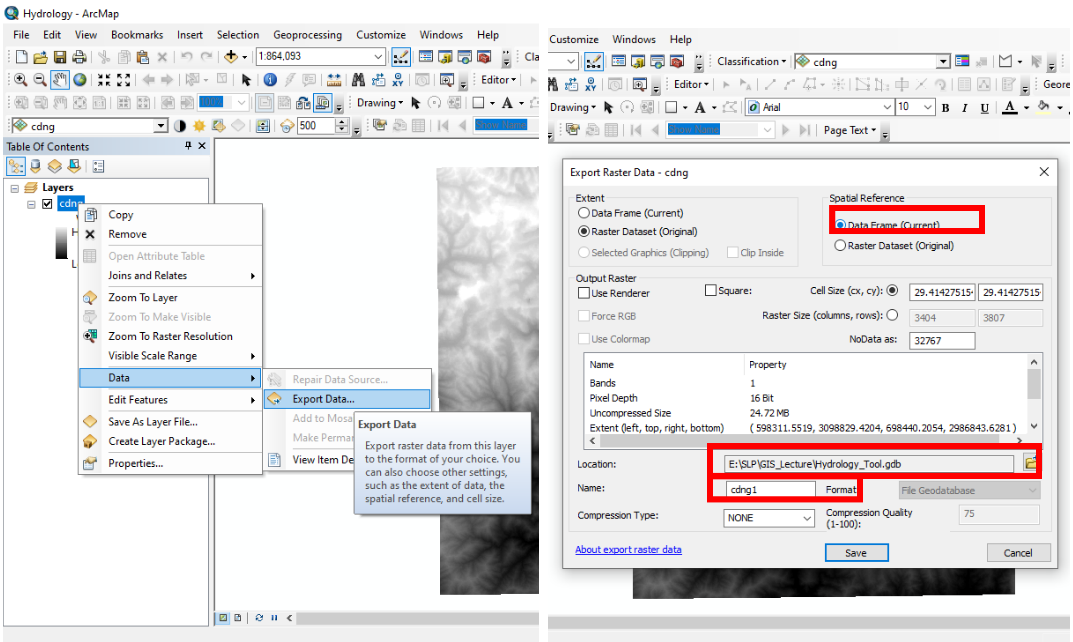


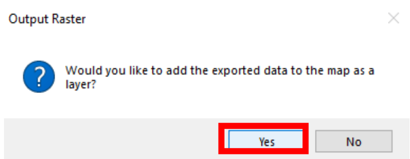
Select UTM>WGS 1984>Northern Hemisphere>WGS 1984 UTM Zone 45N>Ok!



Step 2.5: Project the original DEM file to UTM.

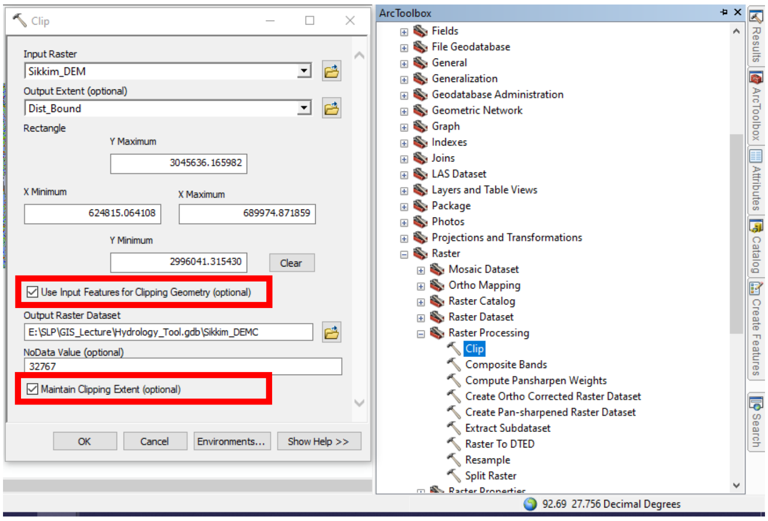
Right click on the cdgn (DEM file)>Data>Export Data>Click on Dataframe on Spatial reference on top right (as shown in fig. below)>Change Name>Sikkim_DEM>Ok! (Note:Mind the Location before clicking OK, select the preferred output, here save everything in the given .gdb file)





Step 2.6: Mosaic or Raster Clip. Many times the study area you need to perform Hydrology analysis will either be larger need two titles of DEM or smaller. In case of larger area, you need to perform Mosaic (if you donot know how to, Click Here). In case the study is area is smaller, then raster clip need to be performed.

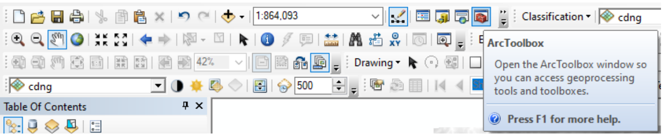
Toolbox>Data Management Tools>Raster>Raster Processing>Clip



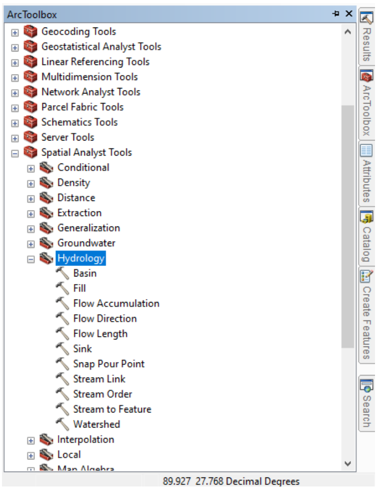
Input: Sikkim_DEM; Output:Sikkim_DEMC; Note: Check both boxes in the dialogbox highlighted in red in above picture. Or You can skip this step!

Step 3: Open Hydrology Tools.

Click on Arc toolbox in the top ribbon.

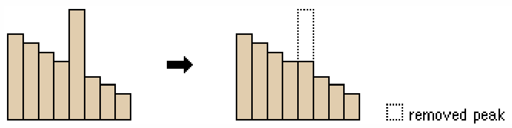


The Toolbox popup appears, Select Spatial Analyst>Hydrology.

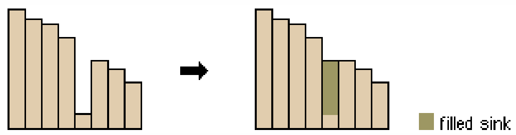


Step 4: Fill

The first step is Fill; a sink is a cell with an undefined drainage direction; no cells surrounding it are lower. The Fill tool uses the equivalents of several tools, such as Focal Flow, Flow Direction, Sink, Water shed, and Zonal Fill, to locate and fill sinks. (As shown in the figure below).



Profile view of a peak before and after running Fill



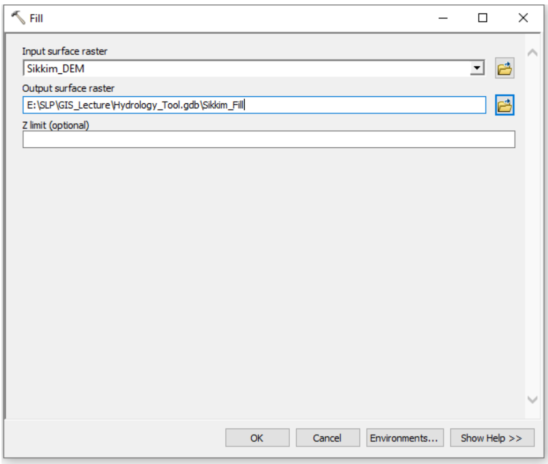
Profile view of a sink before and after running Fill

So simply Fill, sinks in a surface raster to remove small imperfections in the data.

So, to perform fill; Toolbox>Spatial Analyst>Hydrology>Fill.

Input: Sikkim_DEMC.tiff ; Output: Sikkim_Fill.tiff

OK!



HELP!!

Input surface raster

The input raster representing a continuous surface.

Output surface raster

The output surface raster after the sinks have been filled.If the surface raster is integer, the output filled raster will be integer type. If the input is floating point, the output raster will be floating point.

Z limit (optional)

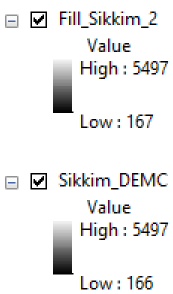
Maximum elevation difference between a sink and its pour point to be filled.

If the difference in z-values between a sink and its pour point is greater than the z_limit, that sink will not be filled.

The value for z-limit must be greater than zero.

Unless a value is specified for this parameter, all sinks will be filled, regardless of depth.

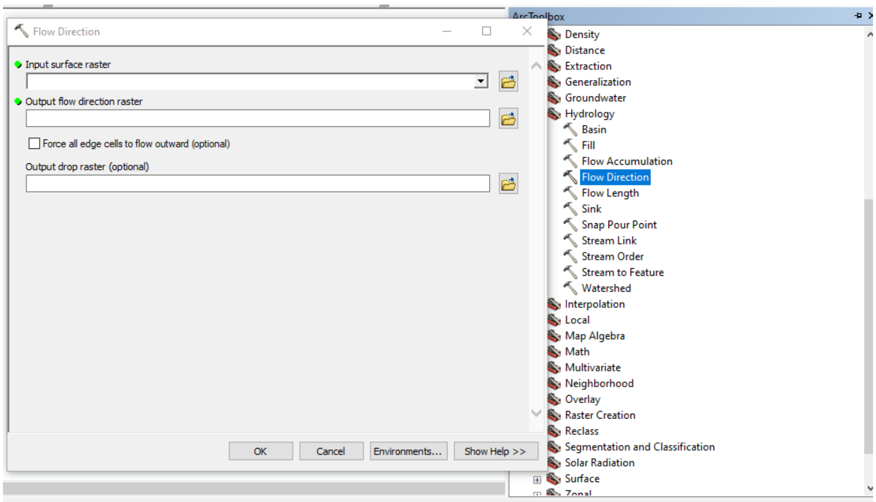
Notice the low value changed, due to the Fill tool.



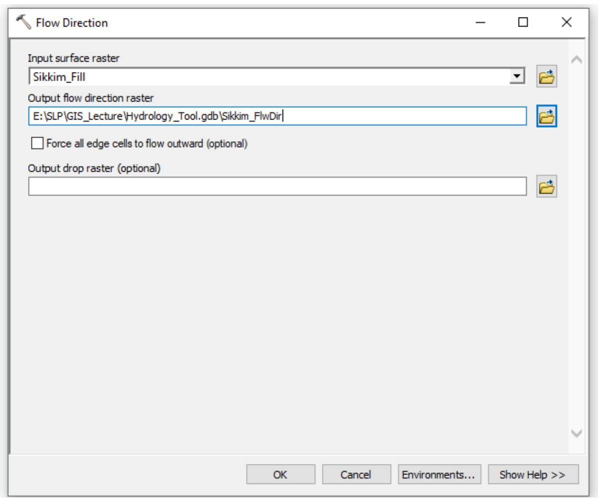
Step 5: Flow Direction

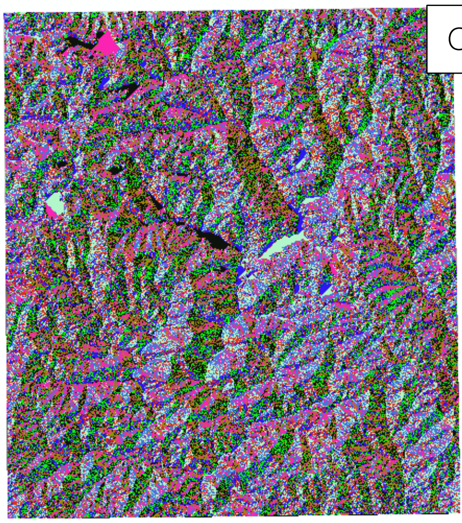
Click on Hydrology>Flow Direction.

Creates a raster of flow direction from each cell to its steepest downslope neighbor.

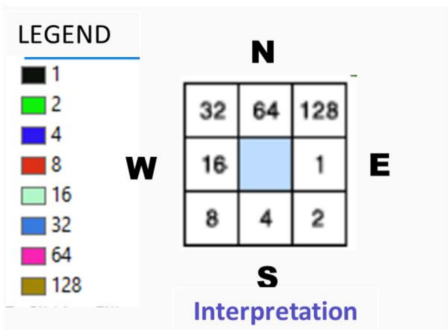


Input: Sikkim_Fill; Outpu: Sikkim_FlwDir





OUTPUT



Note: This is very important if you are doing RUNOFF!!

HELP!!

Input surface raster

The input raster representing a continuous surface.

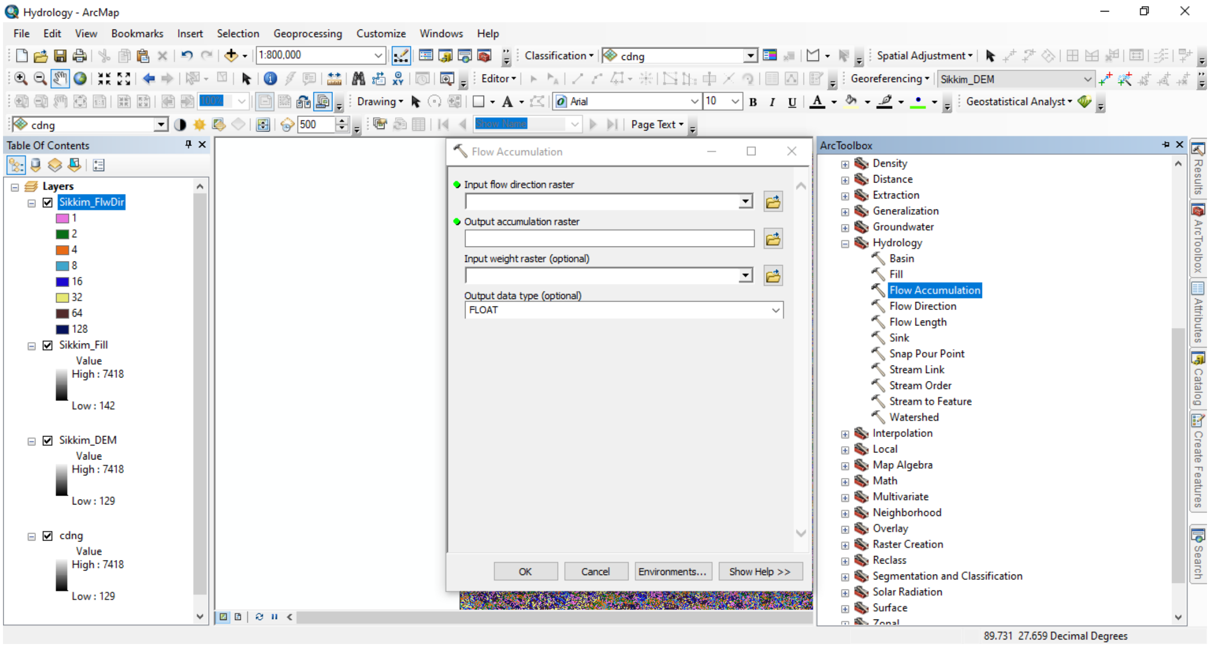
Output flow direction raster

The output raster that shows the flow direction from each cell to its steepest downslope neighbor. This output is of integer type.

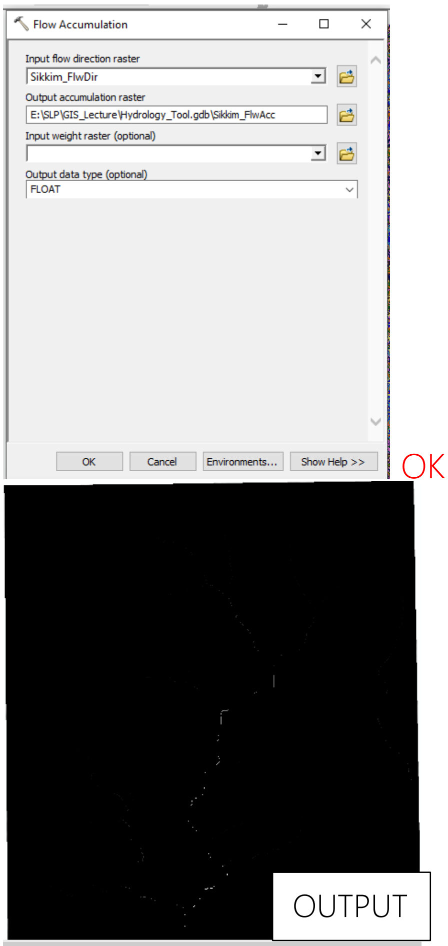
The output of the Flow Direction tool is an integer raster whose values range from 1 to 255. The values for each direction from the centre are shown as above.

Step 6: Flow Accumulation

Creates a raster of accumulated flow into each cell. A weight factor can optionally be applied.



Input: Sikkim_FlwDir ; Output: Sikkim_FlwAcc



OK!

HELP!!

Input flow direction raster

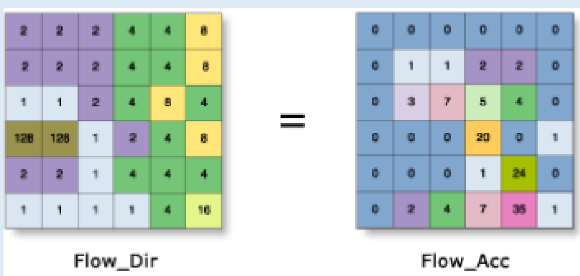
The input raster that shows the direction of flow out of each cell.

Output accumulation raster

The output raster that shows the accumulated flow to each cell.

Input weight raster (optional)

An optional input raster for applying a weight to each cell.If no weight raster is specified, a default weight of 1 will be applied to each cell. For each cell in the output raster, the result will be the number of cells that flow into it.

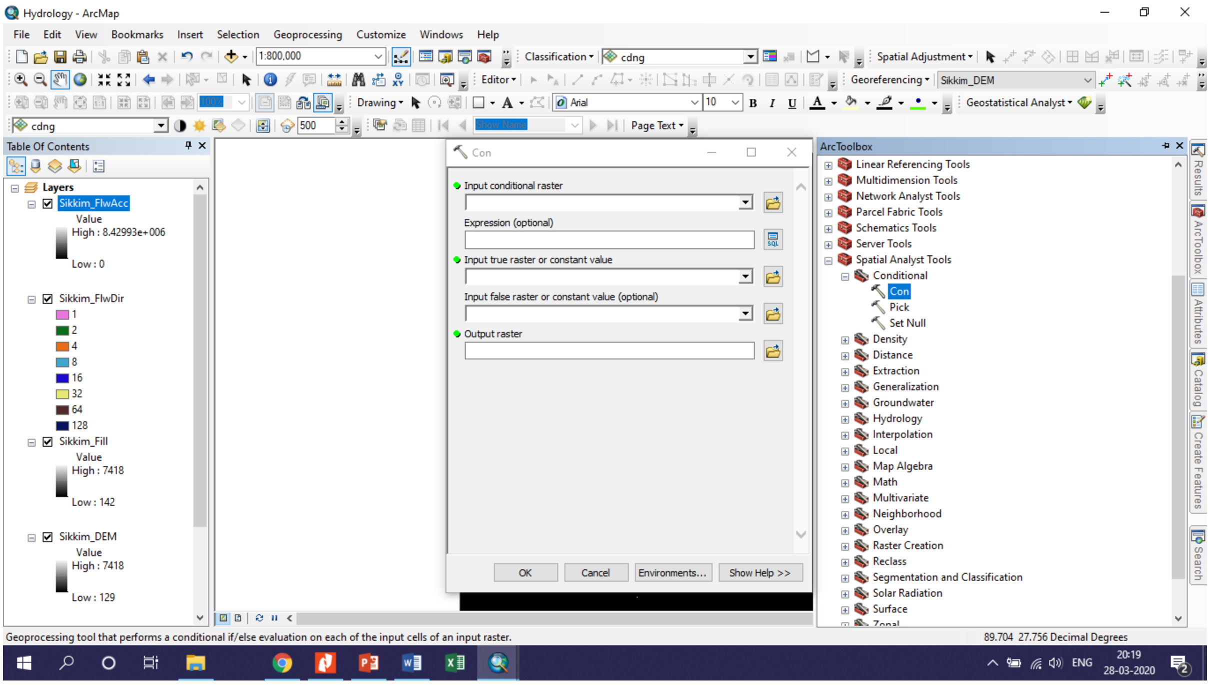


Step 7: Conditional (Con)

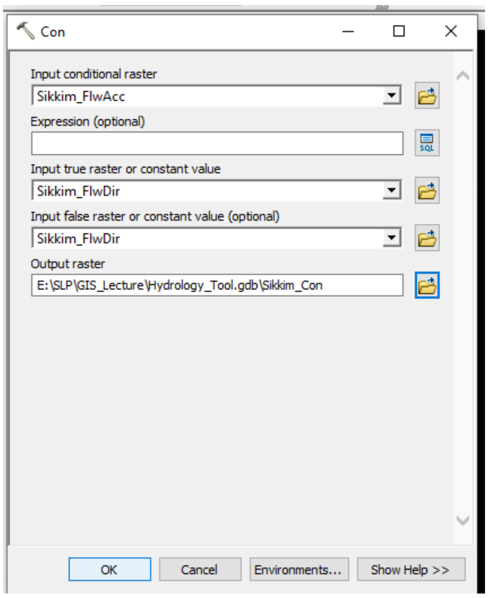
Reminder: Before going anyfurther save the .mxd!!

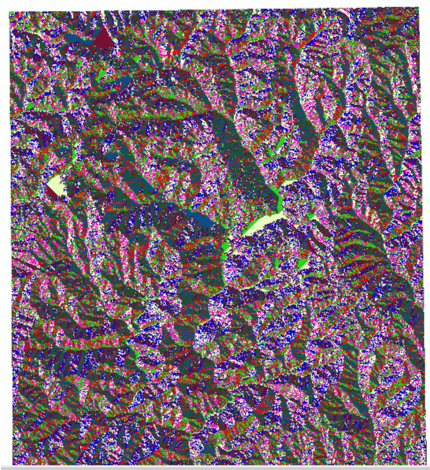
Spatial Analyst>Conditional>Con

Performs a conditional if/else evaluation on each of the input cells of an input raster.



Input Conditional raster: Sikkim_FlwAcc ; Input true &False raster: Sikkim_FlwDir; Output: Sikkim_Con

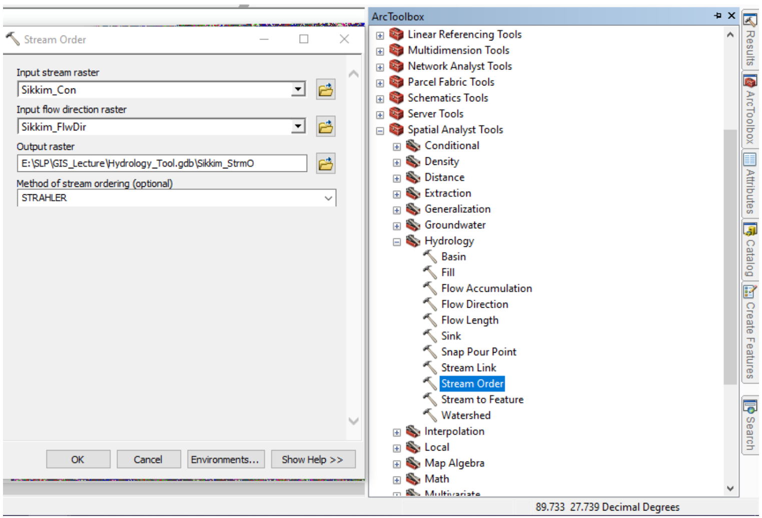




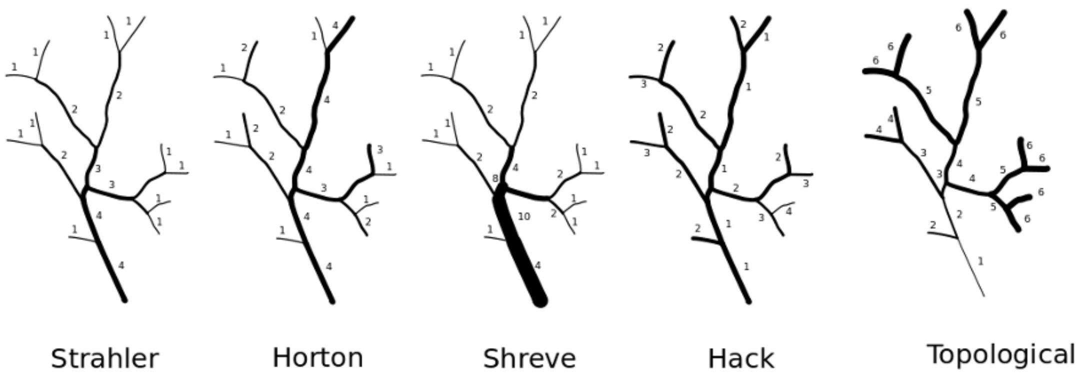
<Output

Step 8: Stream Order

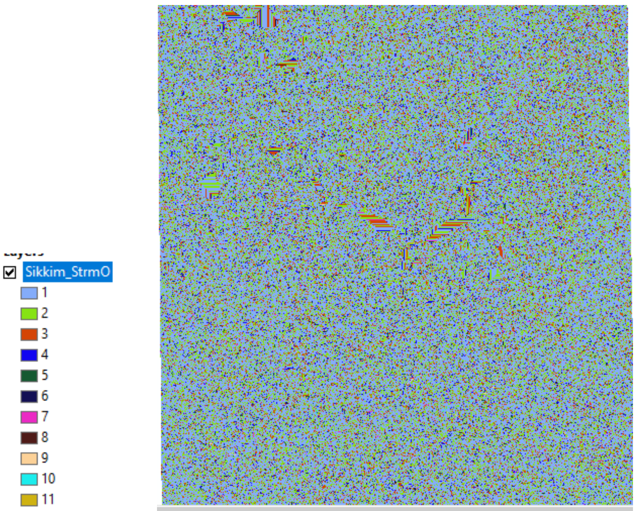
Assigns a numeric order to segments of a raster representing branches of a linear network.



Input Stream Raster: Sikkim_Con; Input Flow Direction: Sikkim_FlwDir; Output raster: Sikkim_StrmO; Method of Stream Ordering (default).



Famous Stream Order Methods

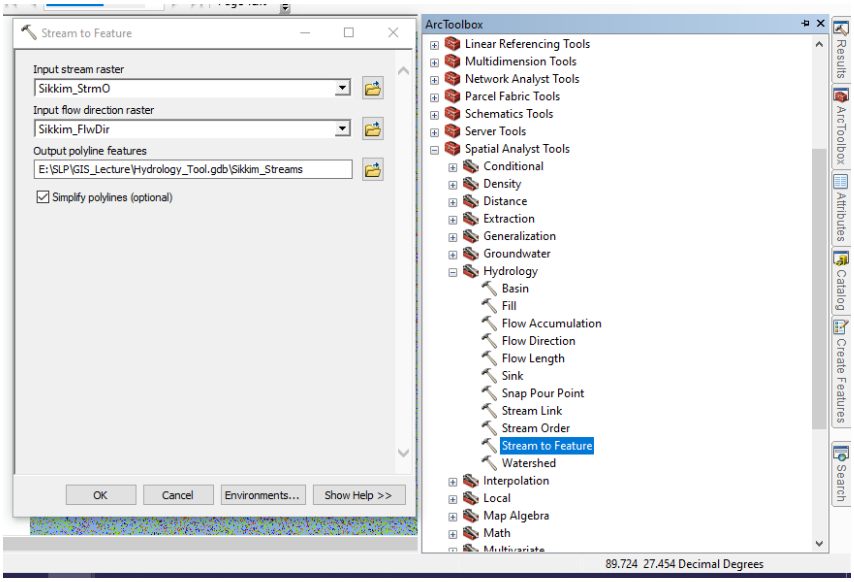


<Output

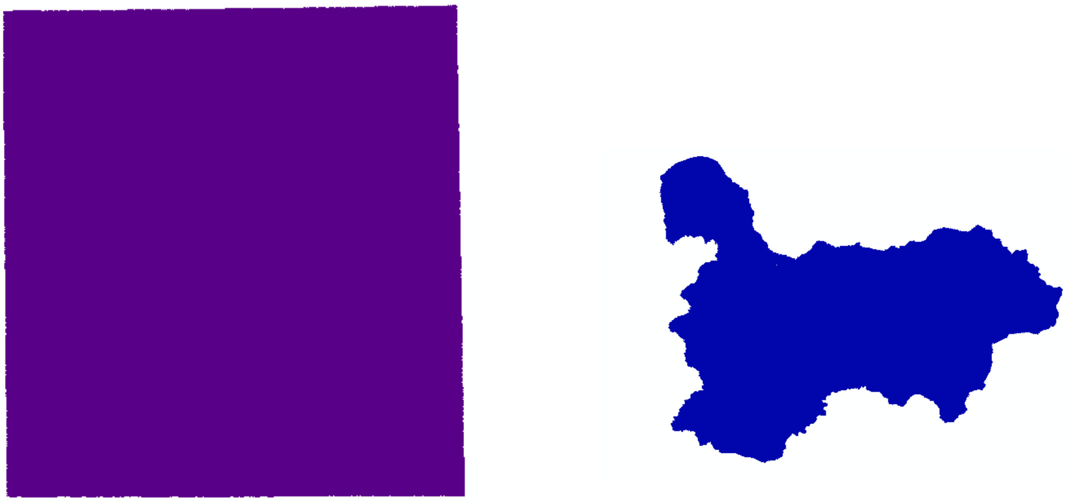
Higher the no. bigger the stream.

Step 8: Stream to Feature

It converts the raster to vector layer from the Stream ordered layer.



Input Stream Raster: Sikkim_StrmO; Input flow direction: Sikkim_FlwDir; Output: Sikkim_Streams



^ Output; If you have clipped the file you will see this ^

What is it?? Right, that is a good question. These are streams till lower order, we do not need them always at this scale. So, the next step is to view them.

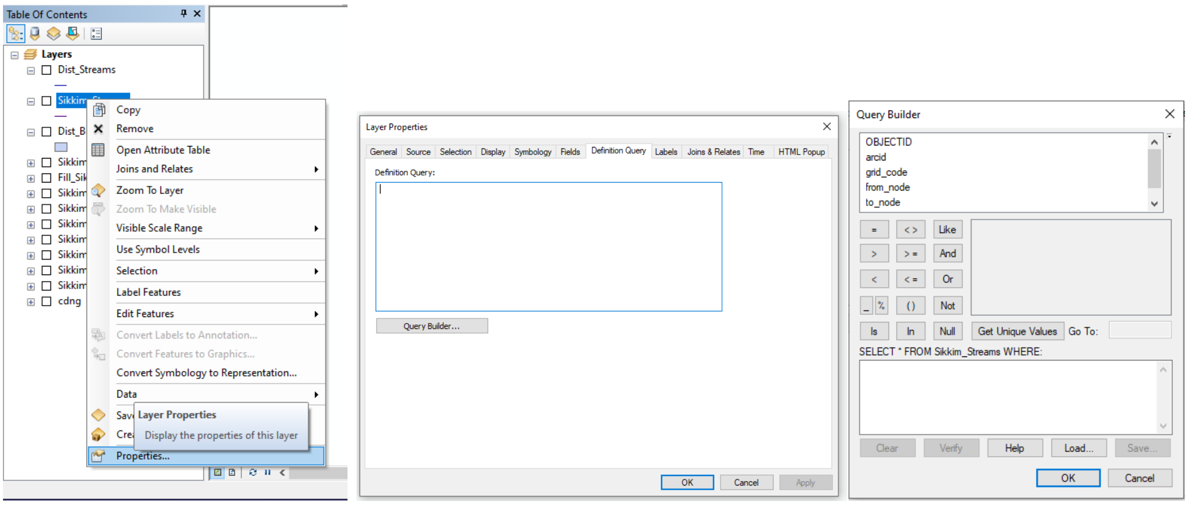
Note: Sometimes the streams to feature takes time, so it always need patience! ☺

Step 9: Definition Query

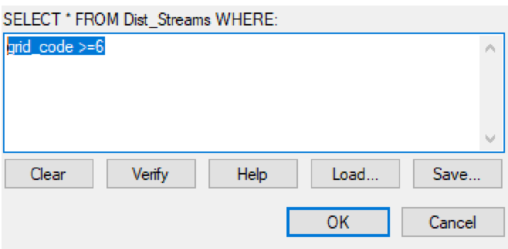
Right click on the stream layer (remember it is a vector now).

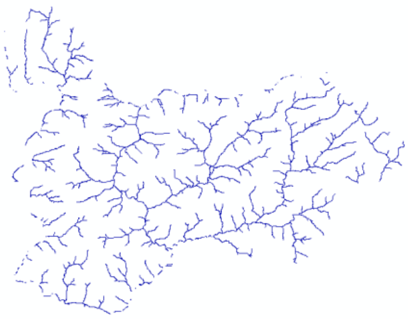
Definition Query is a SQL based calculation and selection tool, which performs and shows only as per the expression you enter. Here, we need to select the streams above certain order say we wanted to higher stream orders. Hence, we perform as shown below.

Properties>Definition Query> Query Builder

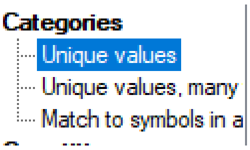


Now select grid code. Then >= 6 (it means we want to see only those streams above order of 6)> OK

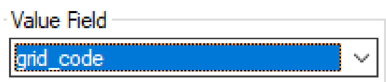




To make it more visual, click on properties>Symbology>Categories>Unique Value



>Value field

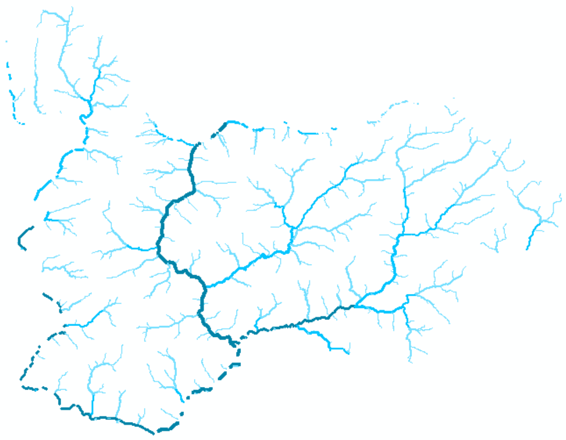


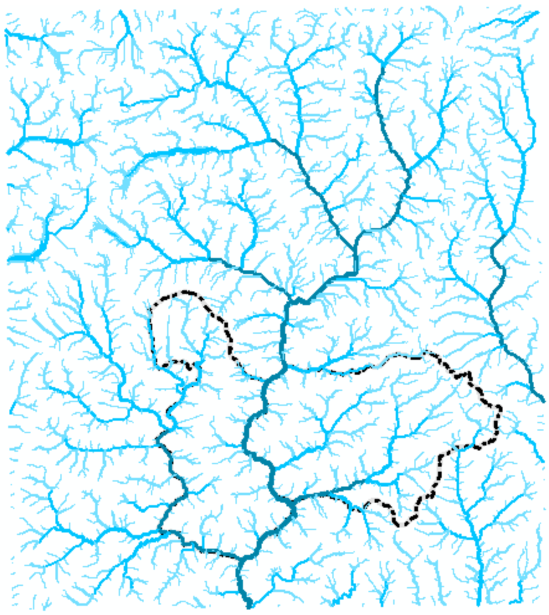
>

.

You can change color scheme of the orders like shown in below.>Apply

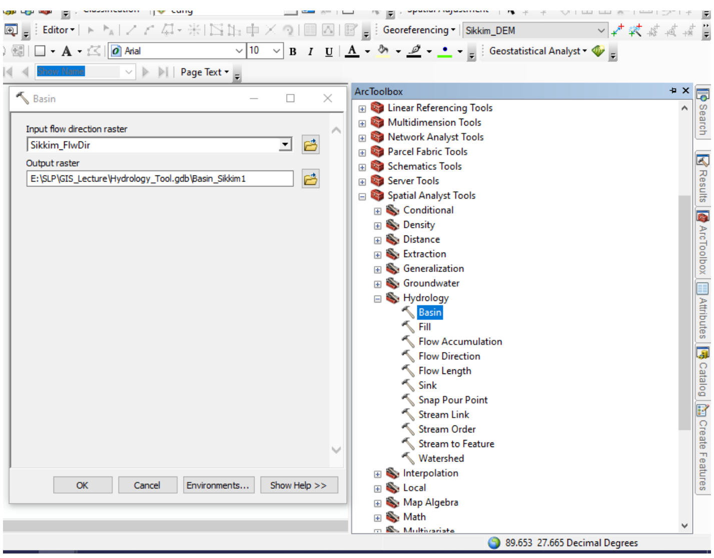
Symbol	Value	Label	Count
	<all other values>	<all other values>	
	<Heading>	**grid_code**	
	6	6	?
	7	7	?
	8	8	?
	9	9	?
	10	10	?
	11	11	?





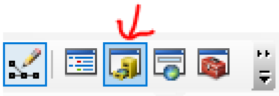
Step 10: Basin

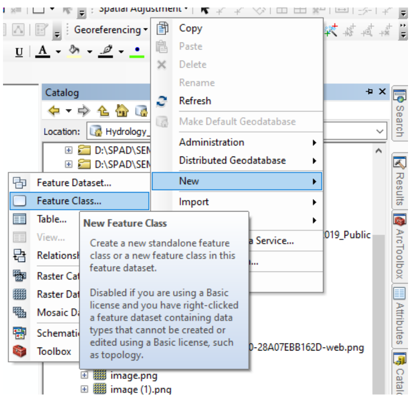
Creates a raster delineating all drainage basins. Input>FlowDiection.



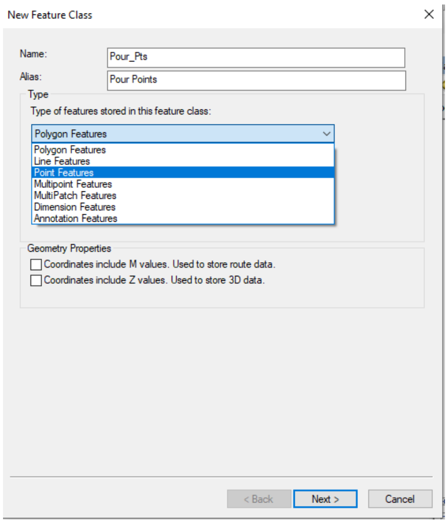
^Output

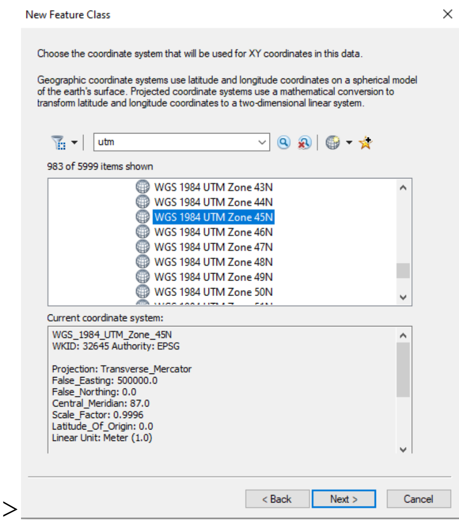
Step 11: Snap Pour Points

 Catalog>go the .gdb location> Right Click>New>Feature Class



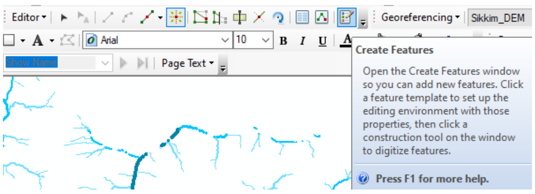
>dialog box>

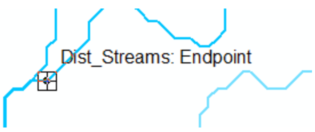




>Name>Alias>Type of Feature>Point>Click Next>

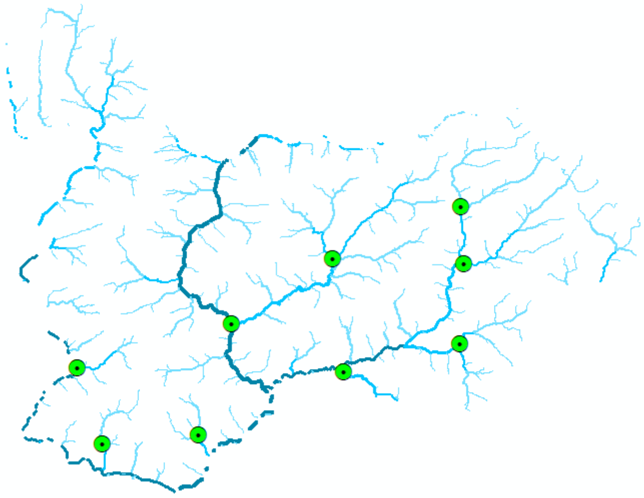
>Select the UTM 45N (similar to Step 2.4) >Click Next>Click Next>add one more filed with name PP(Feature type Double)>Finish

Step 11.2: Keep the Stream layer on>start editing (for pour points)>Click on create features> 

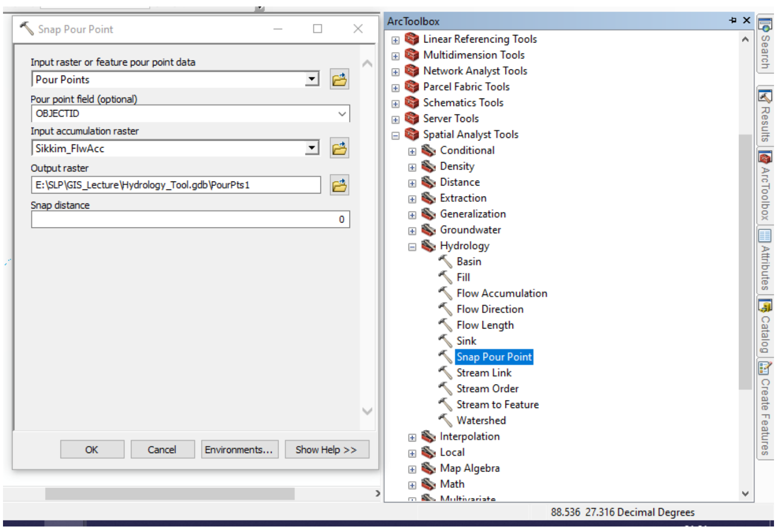
>Select pour points>create points where you think outfall are if know, otherwise create point on the nearest stream order link such as 

>

Create as many points you need watershed for.(as shown below)



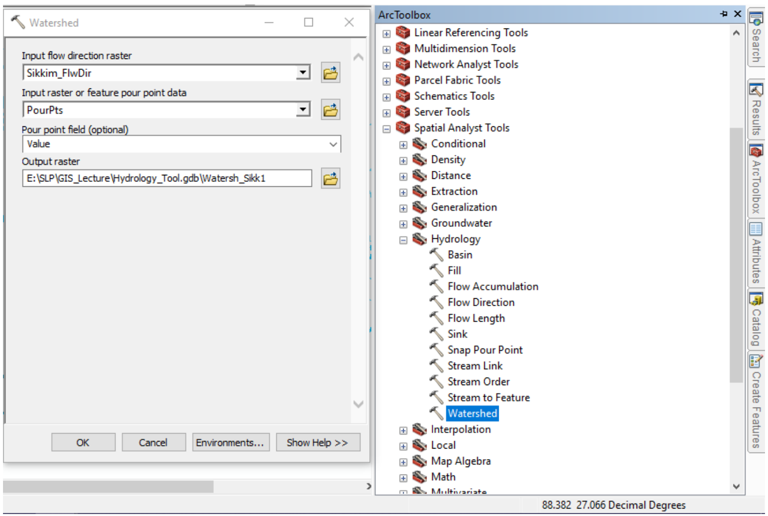
Step 11.3: Toolbox>Spatial Analyst>Hydrology>Snap Pour Points>Input raster or pour points feature: Select the created pour points>Input flow accumulation: Select Sikkim_FlwAcc>Give output raster name:_______>Select Snap Distance to 0 (>OK!

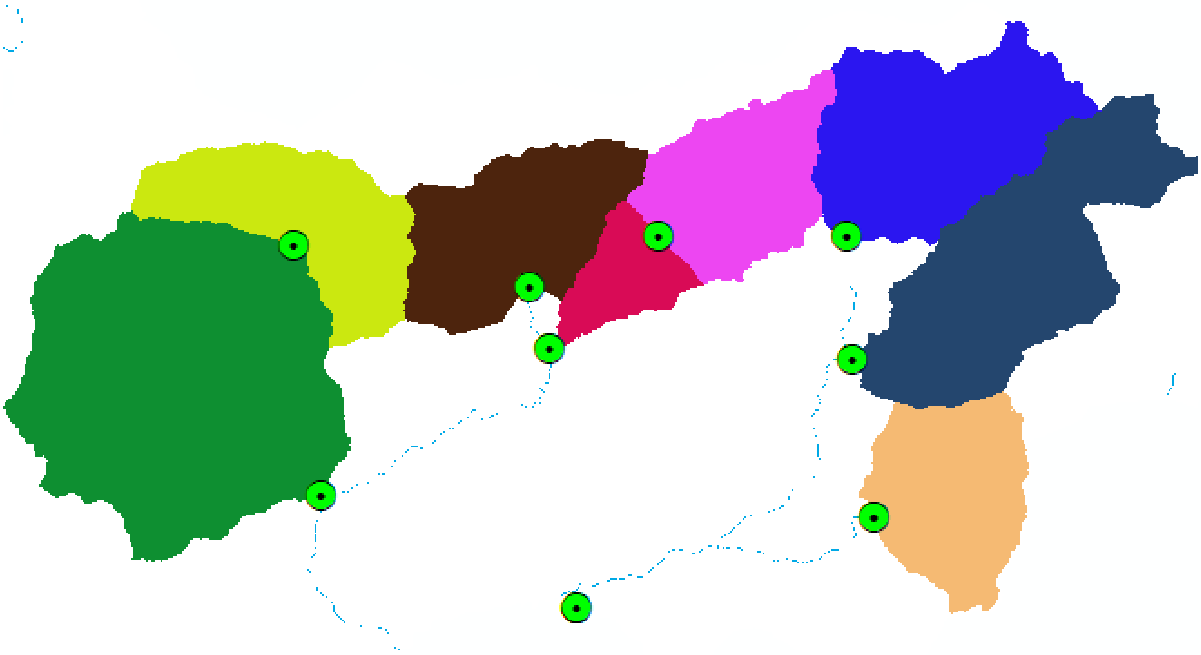


< Output

Step 12: Watershed

Hydrology>Watershed>Input flow direction: Sikkim_FlwDir>Input rater or feature pour point data: Select the snaped pour points data>Set output name to Watershed> OK!!





^Final Output

Note: Watershed delineation depends upon where are the pour points taken.

For More Guidance Documents, contact dc.acpn@gmail.com