



Watershed Delineation

Using SAGA GIS

Tutorial ID: IGET_SA_003



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Watershed Delineation using SAGA GIS

Objective: To delineate watershed using Digital elevation Model (DEM) in SAGA GIS

Software: SAGA GIS

Level: Intermediate

Time required: 1 Hour

Prerequisites and Geospatial Skills

1. SAGA GIS should be installed on the computer
2. Basic knowledge about the SAGA interface
3. Should have completed *Exercise ID: IGET_RS_001* before starting this tutorial

Reading

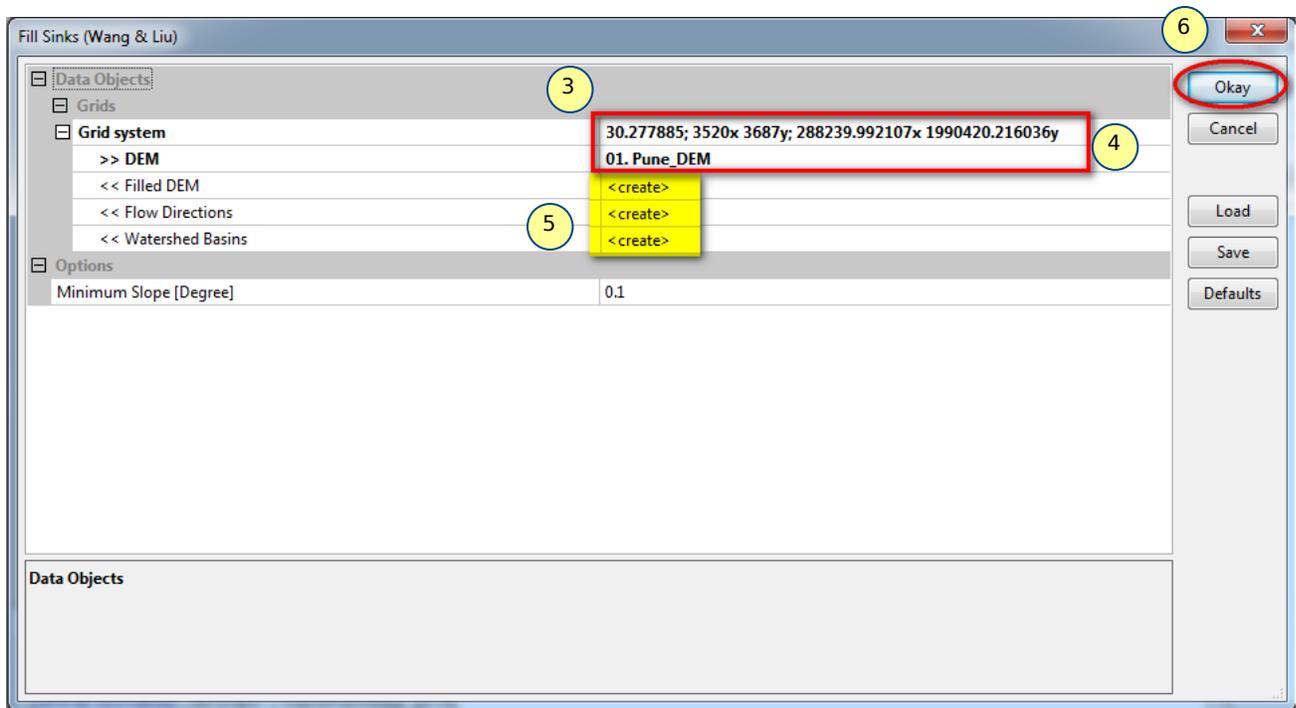
1. <http://water.epa.gov/type/watersheds/whatis.cfm>
2. O'Callaghan, J. F., & Mark, D. M. (1984). [The extraction of drainage networks from digital elevation data](#). *Computer vision, graphics, and image processing*, 28(3), 323-344.

Introduction

Water is the most important natural resource for all living beings. Today, budgeting and managing water resources are increasingly necessary because of increasing anthropogenic activities such as intensive agriculture, urbanization and climate change causing shifts in water cycle. Watershed plays an important role in water resource management. It is a key concept in all hydrological designs and the prerequisite to all hydrological models. Watershed is a piece of land, where all water drains out to a single common outlet. In hilly areas, mountain ridges separate watersheds from each other. We can delineate the area of watershed by using toposheets and Digital Elevation Model (DEM). The manual delimitation of watershed using toposheet is time consuming, requires cartographic knowledge and more over its hard to carry out rigorous analysis on it. Whereas the delineation of watershed using DEM in a Geographical Information System (GIS) provides a better visualization and analyzing capabilities to understand the scenarios of various parameters in the watershed. In this tutorial we will focus on delineation of watershed using a DEM.

Before proceeding to delineate watershed using DEM, we need to process the DEM to make sure it doesn't have any sinks in it. Sinks are uncommon depressions in DEM, these may be due to the sampling errors at the time of data collection or due to the manmade features like open cast mines, potholes etc. Filling of these sinks is very important in order to ensure the continuity in the stream flow. This can be achieved using '**Fill Sink**' tool in '**Terrain analysis-Preprocessing**'

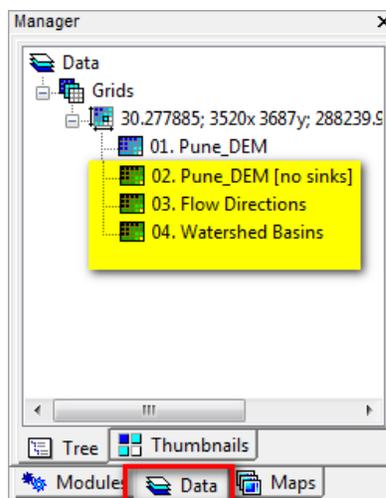
1. Open Saga GIS and load the DEM data "Pune_DEM" from the downloaded data set (Refer: IGET_RS_001).
2. Go to '**Modules** → **Terrain analysis** → **Preprocessing** → **Fill Sinks (Wang & Liu)**'. Click on '**Fill sinks (Wang & Liu)**' to open '**Fill sinks (Wang & Liu)**' module window.
3. In the '**Grid System**' tab add the grid system of currently opened DEM by using dropdown menu.
4. In the '**DEM**' tab selected '**Pune_DEM**' as input.
5. Make sure that all the three options of "Filled DEM", "Flow Direction" and 'Watershed basins' are set to '**Create**' thus will create a new grid for each output.
6. Let the '**Minimum slope [degree]**' value as default and click on '**Okay**'.



7. Model will start executing. Check the message window for the progress of the module. Once the module is executed successfully you will see 'Model Execution Succeeded' message in the message window.



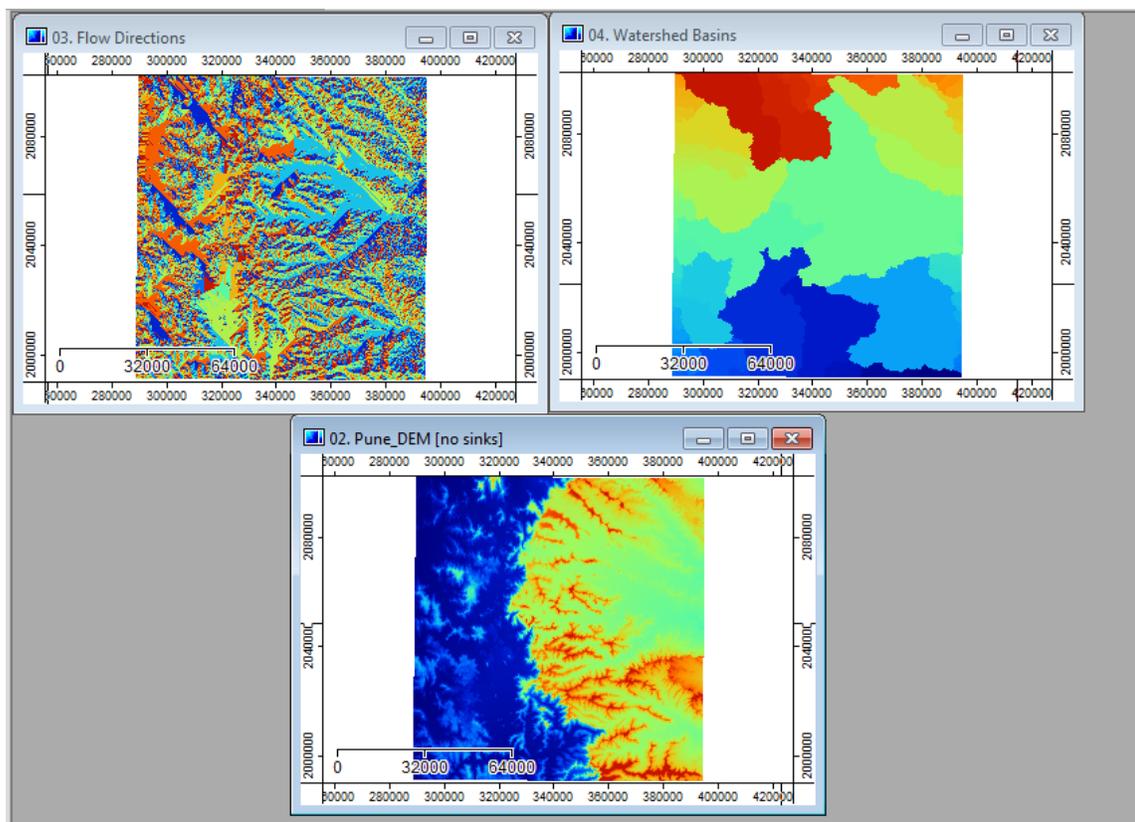
8. Go to 'Data' tab and you will find created grids of 'Filled DEM', 'Flow Direction' and 'Watershed basins' by flow sink module.



9. Save the created grids into your project folder by right click on each grid → click on 'Save As' and rename it as per requirements.
10. Now open the first output created by the sink fill module, i.e., '**Pune_DEM [no sink]**' by double clicking on it. This is a sink free digital elevation map which can now be used for delineation of watershed.

Note: Next is Flow Direction grid shows the direction in which each cell on a surface drains. Flow direction is important in hydrologic modelling in order to determine where water drains in a landscape. This is accomplished with the Creating Flow Direction menu choice. For every cell in the surface grid, saga grid processor finds the direction of steepest downward descent. Computed flow directions are symbolized in saga as 0=N, 1=NE, 2=E..... 7=NW.

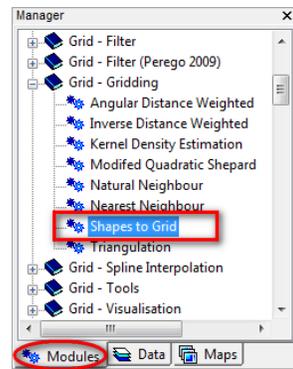
11. Open flow direction grid and check the description and details from properties tab to understand the concept of flow direction in much better way.
12. And the third grid created is of watershed basins. Watershed basins for entire area can be calculated using this module.



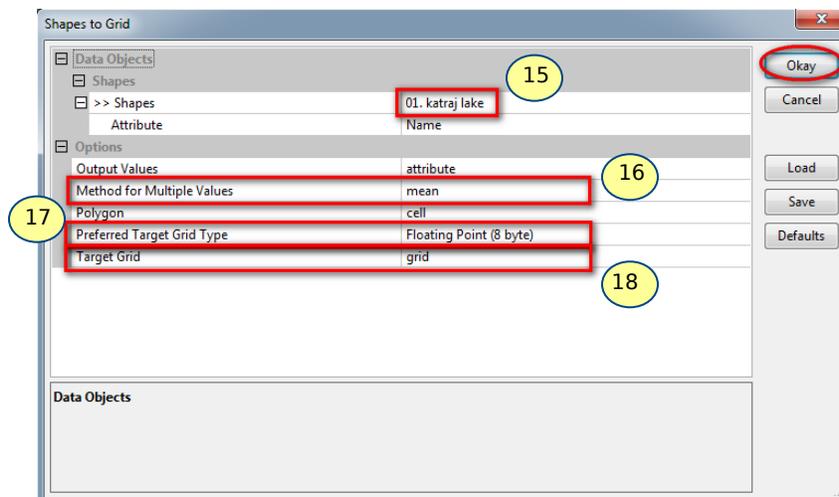
Now we will move on to the next step of delineating watershed of particular area of interest. In the following section we will focus on delineating the watershed region of *Katraj Lake*. To

accomplish this, you are supplied with a shape file named '*Katraj_lake*' in downloaded dataset. However, SAGA GIS need this layer in grid format. Thus, we will convert the '*Katraj_lake*' shape file into grid format using '*Shape to Grid*' module.

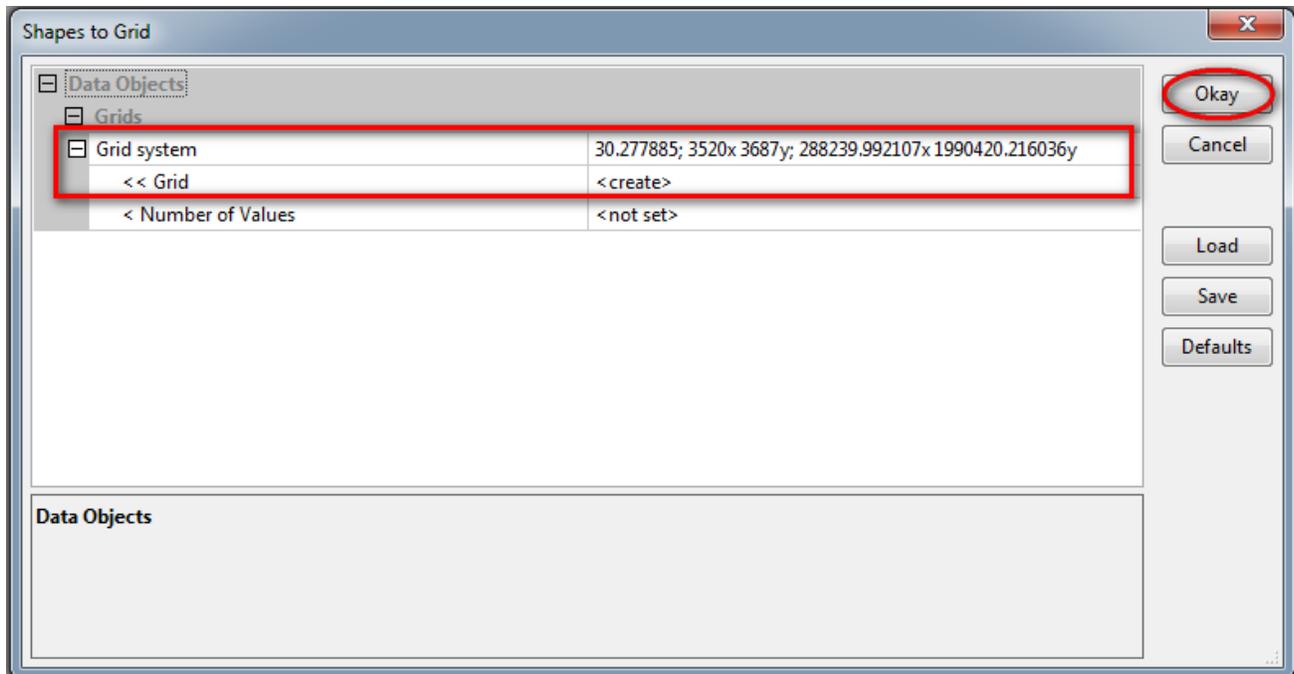
13. Open the vector data '*Katraj_lake.shp*' from the given dataset.
14. Navigate to '*Modules*' tab and expand the '*Grid-Gridding*' toolset (Refer figure below). And double on '*Shapes to Grid*' module to initiate the conversion process.



15. In the '*Shapes to Grid*' window, under '*Shapes*' tab input the shape file '*Katraj_Lake*' and select '*Name*' from the dropdown menu of '*Attribute*' tab.
16. Under the '*Options*' section, select '*Mean*' from the dropdown menu of '*Method for Multiple Values*'. This tells the conversion algorithm to take the average if two or more alike values are found in the vector file.
17. Select '*Floating Point (8 byte)*' from dropdown menu of '*Preferred Target Grid Type*'
18. Select '*Grid*' from the dropdown menu of '*Target Grid*'. Once everything filled as per below figure click on '*Okay*'.



19. Now a new window will pop-up asking to choose a grid system to assign for new grid. Assign the same grid as of '*Pune_DEM*' using dropdown menu and make sure '*Create*' is selected against '*Grid*'. Click on '*Okay*' to proceed.



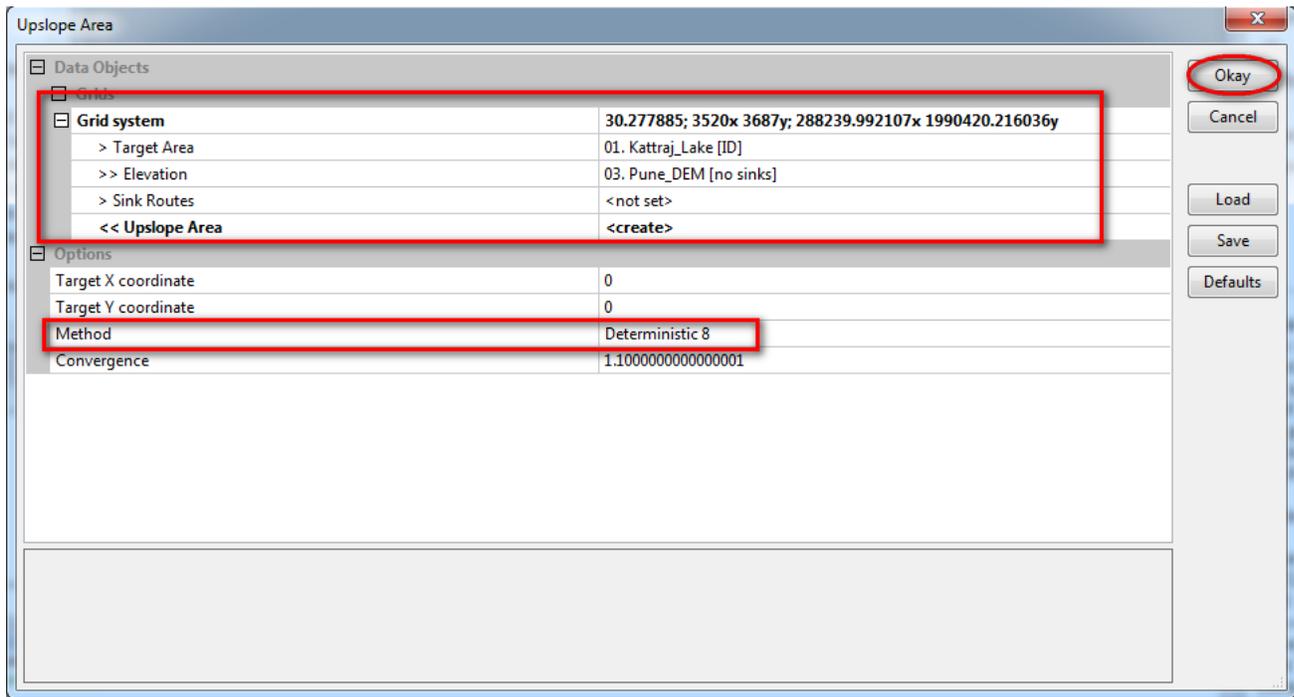
20. Make sure module executed successfully from the message window.

At this point we have all required layers to delineate the watershed region of *Katraj Lake*. We will use '*Upslope Area*' Module in '*Terrain analysis-Hydrology*' section to accomplish the delineation of *Katraj Lake* watershed.

21. Navigate to '*Modules*' tab and expand the '*Terrain analysis - Hydrology*' toolset and double click on '*Upslope Area*' tool.
22. In the '*Upslope Area*' popup window. Select the grid system from dropdown list.
23. Go to next row to select '*Katraj_Lake*' from dropdown menu against the '*Target Area*' tab.
24. Select '*Pune_DEM [no sinks]*' as elevation source from the dropdown menu against '*Elevation*' tab.
25. Ensure that the '*Sink Routes*' is selected to '*not set*', because we already processed our DEM to remove sinks.
26. Go down to '*upslope Area*' tab and ensure it is selected to '*Create*'.
27. Go under the '*Options*' selection, select '*Deterministic 8*' from dropdown menu against Methods. And leave other option in this section as default.

Note: The Deterministic 8 (D8) algorithm is chosen in this tutorial because it is found to be the best option when generating watershed maps. This D8 algorithm assumes that each cell of the Filled DEM has unidirectional water flow, whereas the other algorithms assume that one cell

can have water flowing in multiple directions. To make a more accurate and understandable watershed delineation map the D8 algorithm is considered best.



28. Once all the details are filled as shown in above figure, click '**Okay**' to start module execution. It may take few minutes, wait for execution successful message in message window.
29. Open the new grid created '**Upslope Area**' from '**Data**' tab by double clicking on it. Zoom in to see proper extent and export the watershed to create a watershed map of *Kattraj Lake*.

