# Stream Proximity

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For sustainable and equitable agriculture, there is a need to differentiate areas with the differential natural propensity to access to water. Streams define an essential natural feature that divides the landscape into two types of zones. Identifying the zone of influence depending upon the type and order of stream impacting the water budget in its proximity. A buffer area is found out with respect to the order of the stream and such zones are formed resulting into two classes i.e. stream zones and non-stream zones, which will lead to enhancing the zoning and water budget computation results.

**Stream:-**

A stream is a body of water with surface water owing within the bed and banks of a channel. The stream encompasses surface and groundwater fluxes that respond to geological, geomorphologic, hydrological and biotic controls.

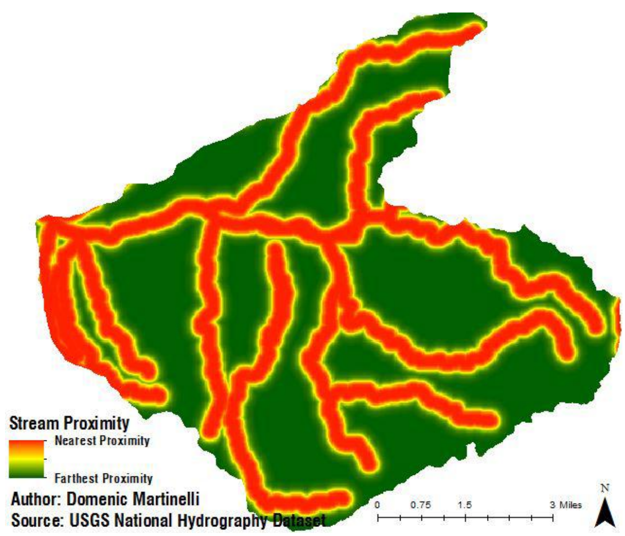


**Figure 1 Stream Proximity Map**

**Stream Proximity:-**

Stream proximity is basically defined as the area surrounding the stream which is likely to be influenced with respect to water and soil conditions than that of the area far from the proximity of the stream.

**The need for Stream Proximity Maps**

The area nearby streams are likely to have more water. So if such zones having more water nearby streams are identified then the construction and allocation of wells can be effectively done. We have a rough idea of groundwater recharge at a particular point (by plugin input) and if the extraction in wells is identified then appropriate water balance can be tracked and maintained accordingly with relevant interventions. It can be logically concluded from the water budgeting process that the area having stream(s) is likely to have better outputs than that of the area not having streams nearby. Parameters like soil quality, water holding capacity i.e. water availability are likely to be positively influenced near the stream proximity zones than that of non-stream proximity zones. So, it becomes the primary need to understand and formulate a methodology to derive such proximity-based maps for better capturing the essential factors determining or influencing cropping patterns and water management.

**Formulating the stream proximity map generation:-**

Generation of proximity-based maps is formulated as below:-
Inputs:- DEM (Digital elevation model)

Intermediate Outputs:-Raster of Accumulation, Drainage Direction, Stream Segment & Order

Final Output:-Proximity Stream Map

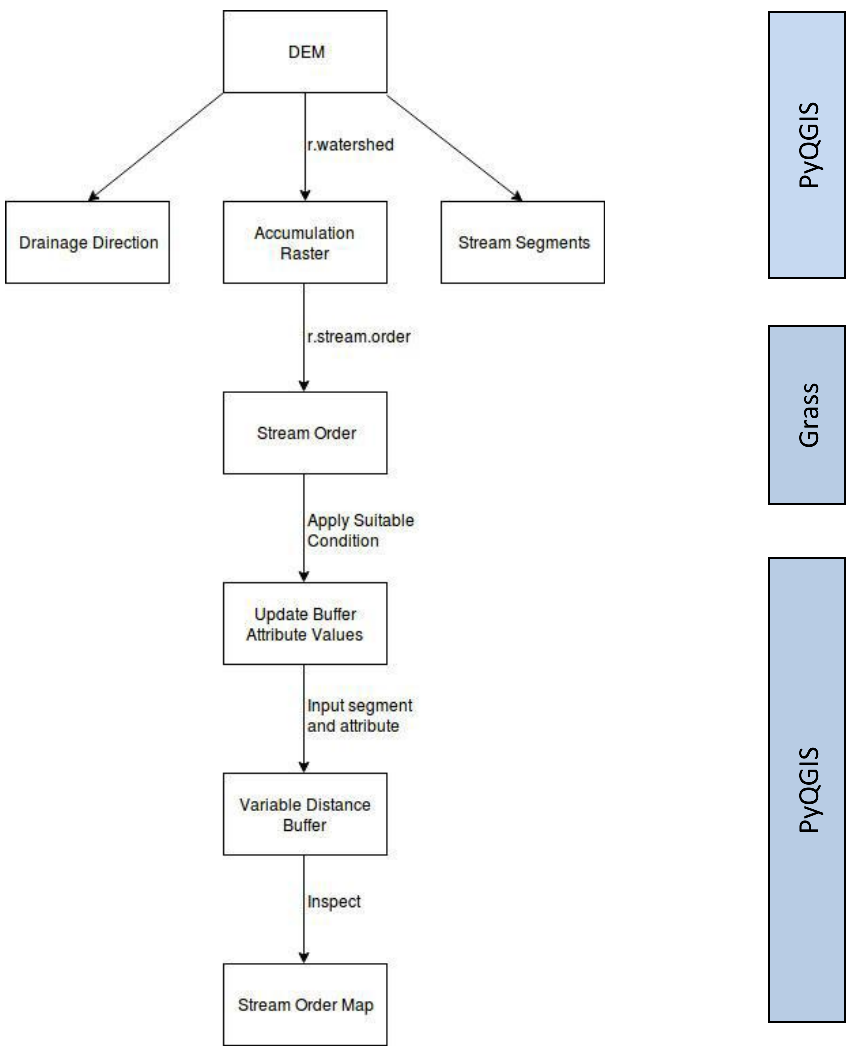


Figure 2 Stream Proximity Steps

**Steps:-**

1. Load DEM of interest in QGIS.

Figure 3 DEM of interest

2. Run r.watershed command from processing toolbox to generate Drainage Direction, Accumulation, Stream Segment raster files.
3. Give appropriate value for the minimum size of an exterior watershed basin(200-330 for small
village area)

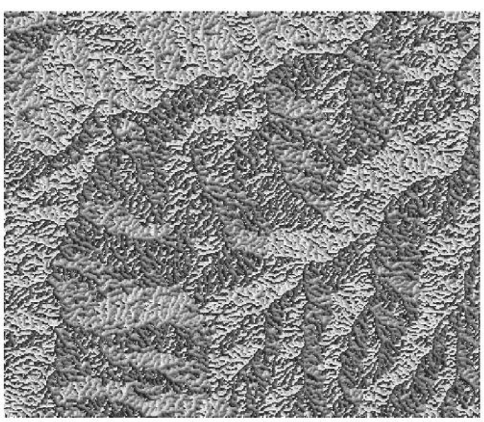

Figure 4 Drainage Direction

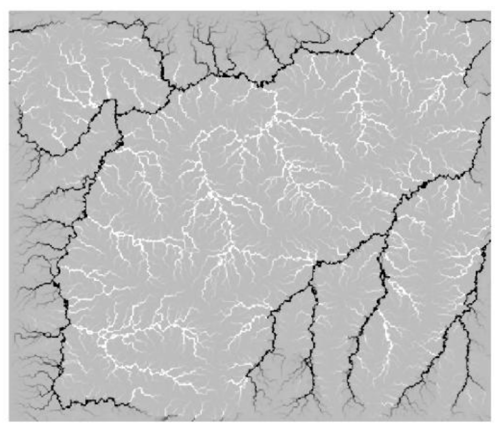

Figure 5 Accumulation

Figure 6 Stream Segment

4. Use the above-generated output in GRASS to generate stream order
5. Before you use "r.stream.order" it is expected to run "g.region" over the input DEM in GRASS itself to make it align with region settings.
6. Then the r.stream.order command can be used to generate the required stream order vector and/or raster file.
7. Load the stream order output of GRASS in QGIS.

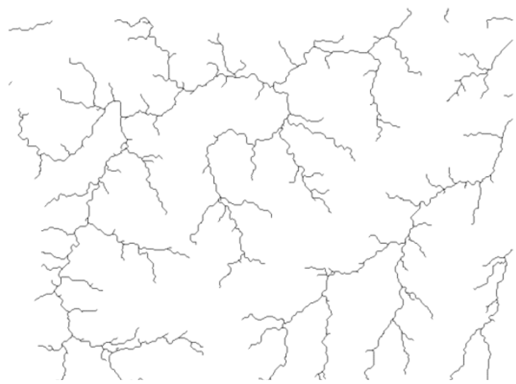

Figure 7 Stream Order output

8. Add an additional attribute to the loaded stream order layer as \buffer".
9. Depending upon the requirement of buffer size the values of the attribute is accordingly updated.
10. The layer with updated attribute values is given as input to the Variable distance buffer function available in QGIS with attribute value set as \buffer".

Table 1 below describes stram order and buffer distances in meter. These distances can be changed in programme based on hydrological and geological observations.

| Sr. No | Stream Order | Buffer size(m) |
|---|---|---|
| 1. | 1 | 10 |
| 2. | 2 | 15 |
| 3. | 3 | 20 |
| 4. | 4 | 25 |

Table 1 Stream Order and Buffer size

11. The required stream proximity map is generated.

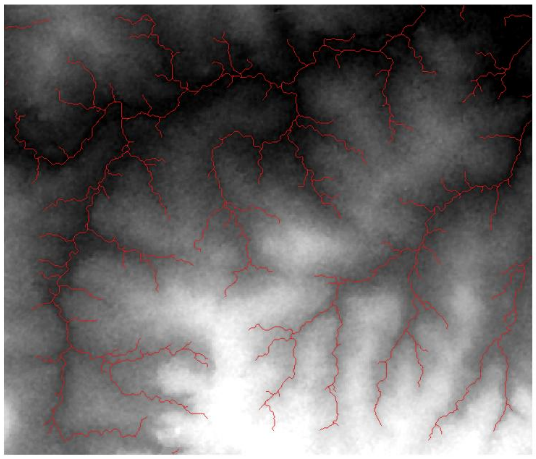

Figure 8 Input DEM

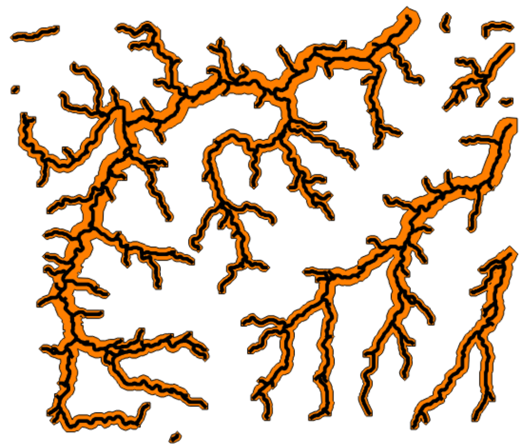

Figure 9 Stream Proximity

12. The map is further inspected manually and updated accordingly if required.

**Stream Order and Stream Proximity:-**

It can be observed from the stream network that the ordering followed for the stream order evaluation keeps the buffer almost same even if new streams are added. It is expected that the stream width should increase in size and so it's ordering resulting in an increase in the size of the buffer or proximity around the streams. The argument follows from the logic that as the stream flows and other streams are merged with the stream the zone of influence will be more than that of the consistent (non-significant ) buffer size. The disadvantage of this method is the lack of distinguishing the main channel which may interfere with the analytical process in highly elongated catchments. The stream order basically used here is that of Strahler's which can be seen below:-

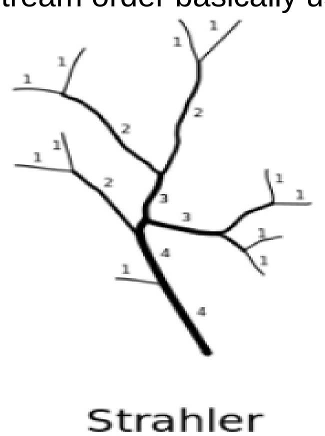


Figure 10 Strahler Stream Order

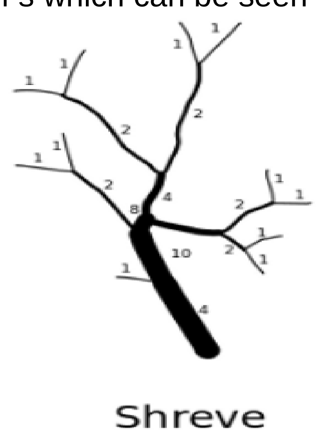


Figure 11 Shreve Stream Order

So in order to increase the buffer size or stream proximity, we make use of different stream order called as Shreve stream magnitude which assigns the stream order based on the number of streams merging the respective stream.

The modified results can be seen below:-

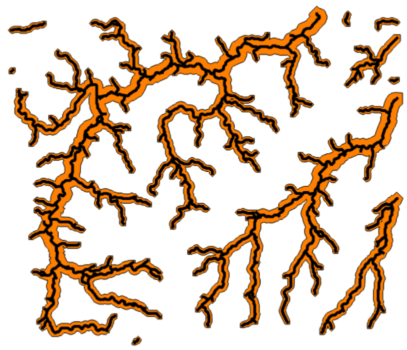

Figure 12 Stream Proximity based on Strahler Stream Order

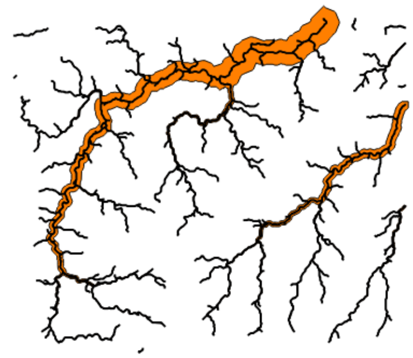

Figure 13 Stream Proximity based on Shreve Stream Order

**Conclusion and Future Work:-**

The purpose of planning across the region for equitable development will be better served by factoring in, the zones of natural bias of water access. There is still a lot to explore like various factors impacting the water availability and cropping patterns which are also required to be backed up by validation through ground results. Village or zone level rain-gauges will increase model accuracy significantly.

As per table 1 variable buffer size can be used based on hydrological and geological observations.

The model can be integrated with yield and economic parameters to allow for cropping pattern advisory. Integration of groundwater flows and improved zoning based on aquifer properties can be done.