

# Use of Satellite Remote Sensing and GIS for extraction of Digital Elevation Models using Open source data products and software: Case studies

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**Abstract** - Digital Elevation models have grown to become an integral part of a number of scientific applications. DEMs can be created from the ground surveys, digitizing existing hardcopy topographic maps or by remote sensing techniques. DEM's are now predominantly created using remote sensing techniques with observing the benefits that a large spatial area can be mapped by fewer people at a lower cost. For the present paper, the Digital Elevation model analysis has been done for the area of Chimmini Dam in Echippara in Chalakudy taluk of Thrissur District of Kerala and Idamalayar Dam in Ennakkal near Bhoothathankettu in Ernakulum district of Kerala has been selected for Watershed and Network Delineation

**Index Terms** - Digital Elevation model, Data products, Watershed Network delineation, Geographical Information systems

## I. INTRODUCTION

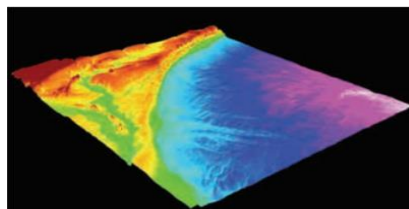
The process of remote sensing involves obtaining information about an object or phenomena without making physical contact with the object. It is used in many departments, such as geography, engineering. An infrared telescope can be used for many purposes like military, intelligence, planning and humanitarian ones. The use of electromagnetic energy for remote sensing involves measuring the physical properties of distant objects. It incorporates geophysical surveying as well as newer techniques that use other parts of the electromagnetic spectrum. It can also be used for earth observation, referring to the process of obtaining information about objects or areas on earth surface through electromagnetic waves.

### 1.1 GEOGRAPHICAL INFORMATION SYSTEM

Geospatial information is associated with maps, integrating location information with illustrative information. It lays a foundation for mapping and analysis that is used in science and almost every industry. Geospatial Information Systems analyse and map all types of data, integrating location information with all types of representations. This provides a basis for scientific analysis and mapping. GIS allows us to display a variety of types of data on one map, such as streets, buildings, and vegetation.

### 1.2. DIGITAL ELEVATION MODEL (DEM)

Digital elevation models (DEMs) are 3-D computer graphics that represent a planet, moon, or asteroid's terrain as elevation data. Discrete global grids are called global DEMs. Digital elevation models are the most common base for geographic information systems that use digital relief maps. It is created from several different sources. DEMs are widely used for calculations, manipulations, and further analysis of an area and more specifically analysis based on elevation. An Elevation Model (DEM) depicts the Earth's surface as it appears flat and bare, including trees, buildings, and other objects. Elevation models without vegetation or manmade features are called DEMs. The digital elevation map represents the elevation of the earth's surface as a digital image where each pixel contains the elevation values at its centre point.



**Fig.1** The coastal and near off-shore DEM, developed by the National Oceanic and Atmospheric Administration (NOAA). Such a DEM provides the necessary morphology to forecast the magnitude and extent of coastal flooding during an extreme storm or tsunami even.

### 1.3. USE OF DEM

The DEM provides a primary input to any model or process quantification involving the earth's topography, and is used across several development areas. It plays a critical role in areas such as infrastructure planning, hydrology, and flow-direction studies. In the contouring of topographic and relief maps, they are particularly useful at greater spatial scales.

- Modeling water flow or mass movements
- Creating physical models (such as raised-relief maps)
- Rectifying aerial photography or satellite imagery

## 1.4. STUDY AREA DESCRIPTION

The following description is about the study areas of all the tasks performed in this project.

### 1.4.1. Watershed & Stream Network Delineation on a basin

**Study Area 1: Chimmini Dam**-The dam is located at latitude  $10.4310^{\circ}$  N and longitude  $76.4910^{\circ}$  E in Echippara in Chalakudy taluk of Thrissur District of Kerala, India. The dam runs along the Kurumali River, a tributary of the Karuvannur River. Thrissur Chimmini dam is the largest in the district. Kule fields and paddy fields receive water from the river and existing canal system through a regulator. The use of a synthetic canal device is not possible in this case.



**Fig 2:** Chimmini Dam

**Study Area 2: Idamalayar dam**-The dam is located at latitude  $10^{\circ}13'18''$  and longitude  $76^{\circ}42'23''$ E in Ennakkal near Bhoothathankettu on the Idamalayar, a tributary of the Periyar River. Its length is 373.00 meters and its height is 101.60 meters. The storage reservoir is used to generate power through a hydroelectric power station with an installed capacity of 75 MW with two units of 37.5 MW each. It's an everlasting source draining a catchment area of  $382 \text{ km}^2$ . The catchment receives annual rainfall of 6,000 millimeters 90% of which occurs during the monsoon months of June to September. The study area is Kunduvampadam, Kongad West near the Dam.



**Fig 3:** Idamalayar dam

## II. LITERATURE REVIEW

**Viswanathan et al (2015)** has done a study on Watershed Delineation for Varahanadhi basin using Open source Geospatial Technology. They analyze the slope, contour and terrain profile of study area and behavior of stream segments, drainage direction, flow accumulation etc. There are 34 river basins in Tamil Nadu including Parambikulam, Aliyar. For hydrological studies and water resources planning purposes they are grouped into 17 river basins, among that Varahanadhi basin for has been selected project study. The spatial extent of the basin is  $11^{\circ}50'$  to  $12^{\circ}28'$  and  $79^{\circ}8'$  to  $18^{\circ}10'$ . In addition to that various factors like Rain fall, soil condition, geological study and geomorphology of our study area have been analyzed. The toposheet has been georeferenced with respect to spatial reference and Digitizing work also carried out.

**Bal Gopal Guru, Janhabi Meher (2016)** they have done Delineation of Mahanadi River Basin by Using GIS and Arc SWAT. Therefore in the present work Mahanadi river basin lying within Odisha (drainage area approximately 65000 sq. km.) has been delineated in to five sub basins based on the five CWC operated discharge sites in Odisha. In the present work Arc-Swat has been used to delineate the watershed with the help of the (digital elevation model) DEM. It was observed that number of sub-watersheds into which the study area is being depicted relies on number of outlets and density of drainage.. The soil data is being found out by the help of the soil map in the grid pattern and was determined by the calculation and viewed in the attribute table after delineation. By the assistance of these small watersheds we can get a concrete idea for the flow of water direction and the occurrence of the slope in the watershed.

### III. METHODOLOGY

#### 3.1. QGIS

QGIS is a popular open-source GIS that supports viewing, editing, and analysis of geospatial data. It supports both raster and vector layers. The Vector data is stored as point, line, or polygon features, multiple formats of raster images are supported. The QGIS project was founded by Gary Sherman in 2002. In June 2002, QGIS was officially registered as a project on the Source Forge webpage. The QGIS project continuously attracted more software developers and users. QGIS can also be used as a graphical user interface to GRASS. QGIS has a small install footprint on the host file system compared to commercial GIS and generally requires less RAM and processing power; hence it can be used on older hardware or running simultaneously with other applications where CPU power may be limited.

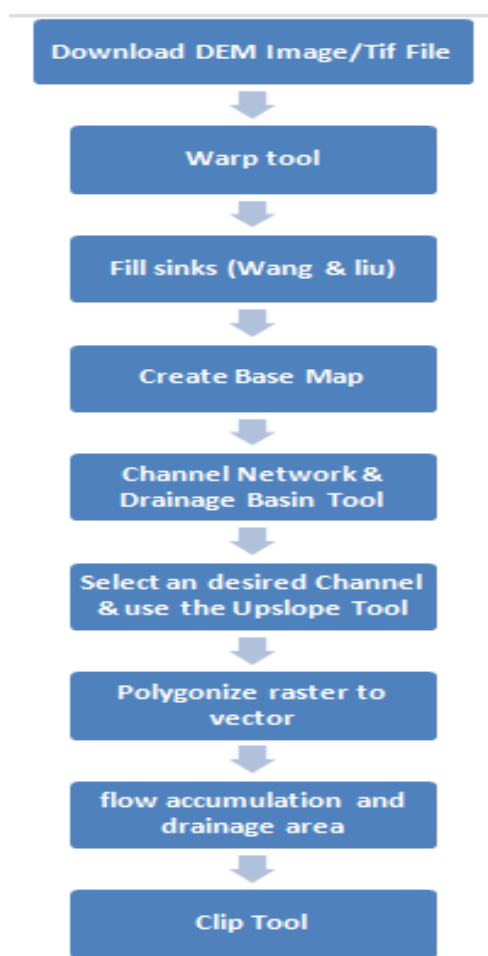
#### 3.2. Watershed & Network Delineation on basin

Watersheds are natural hydrological entities that cover a specific aerial expanse of land surface from which the rainfall runoff flows to a defined drain, channel, stream or river at any particular point. The delineation of watersheds and stream networks is one of the most fundamental steps on water resources analysis. Working with QGIS for water resources shows some challenges on the normal water resources workflow since we have to couple raster / vector datasets, coordinate system, and algorithm limitations. In this task, the Tif Image of the study area was downloaded from the USGS Earth Explorer data portal.

#### 3.3. USGS Earth Explorer

The USGS Earth Explorer data portal is for obtaining geo-spatial datasets from our extensive collections. Users can navigate via interactive map or text search to obtain Landsat satellite imagery, Radar data, UAS data, digital line graphs, digital elevation model data, aerial photos, Sentinel satellite data, some commercial satellite imagery including IKONOS and OrbView3, land cover data, digital map data from the National Map, and many other datasets. Users can search by exact location via the interactive map or input specific coordinates to view what data types are available.

##### 3.2.1. Steps for Procedure



IV. GROUPS & DISCUSSION

4.1. Output Result of Watershed & Stream Network Delineation analysis

Study Area 1: Chimmini Dam

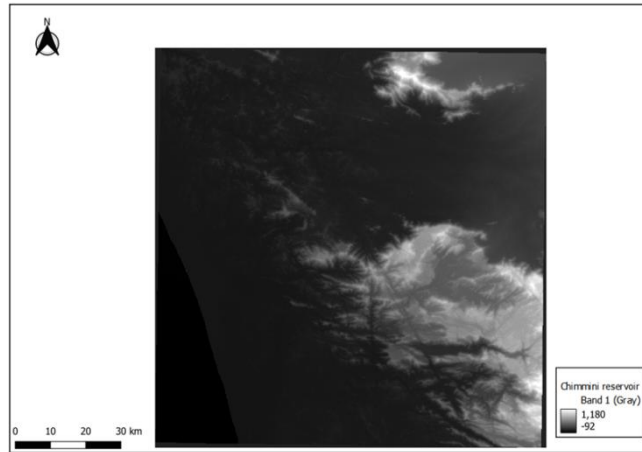


Fig 4 Tif Image of Chimmini Dam

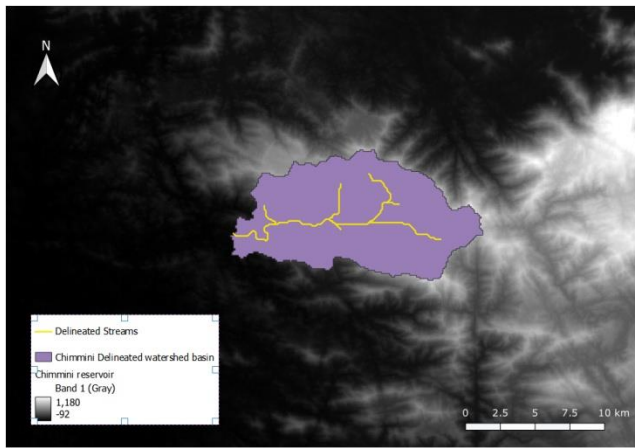


Fig 5 Chimmini Reservoir with Study area

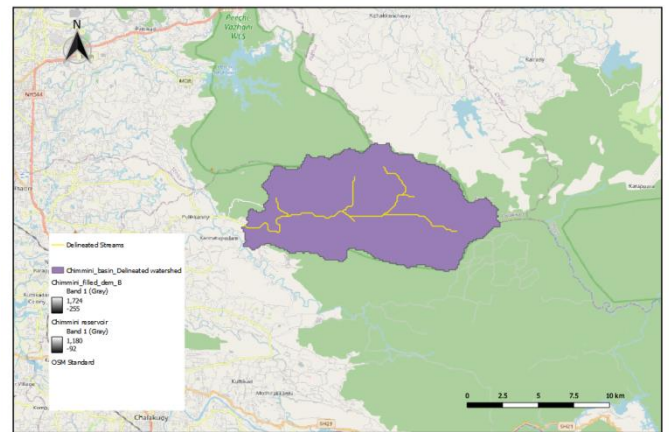


Fig 7 OSM standard map with Chimmini Basin & the delineated Streams

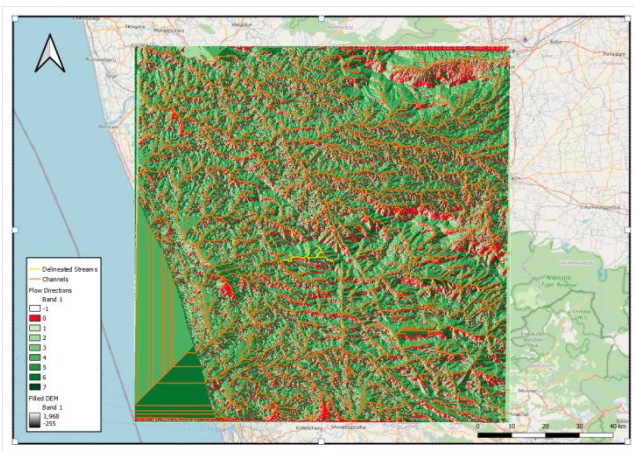


Fig 6 Highlighting the flow directions in the study area with highest to low band values and the channels present in the study area with the delineated stream in the basin

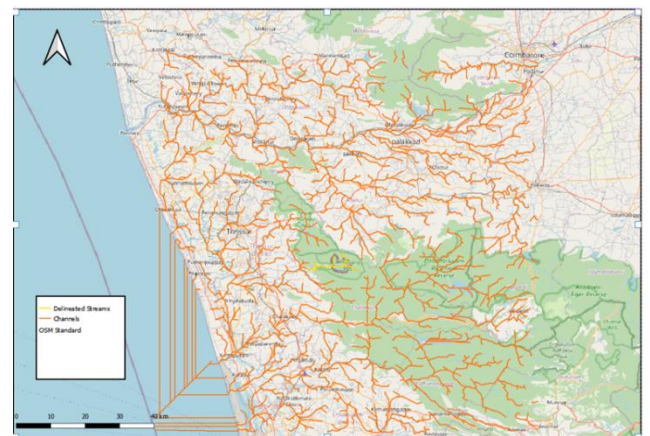
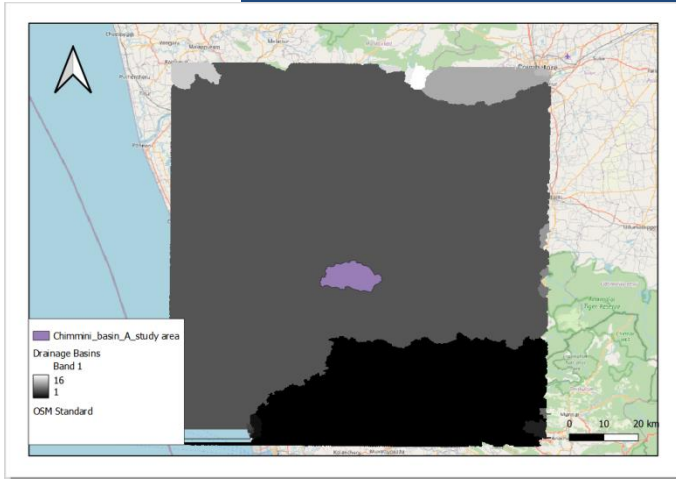
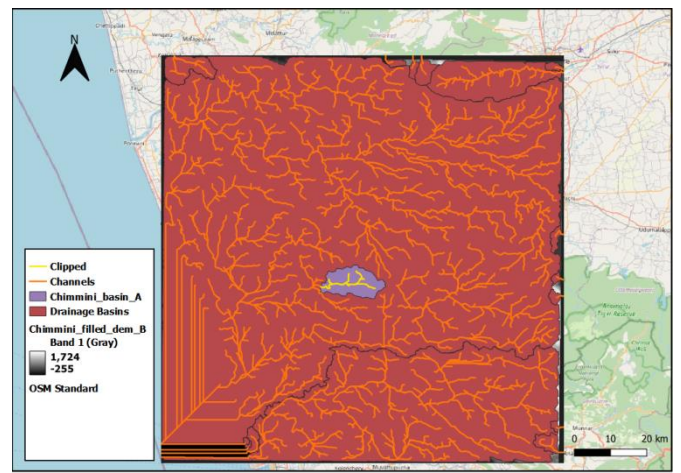


Fig 8 Channels in the study area with the delineated stream

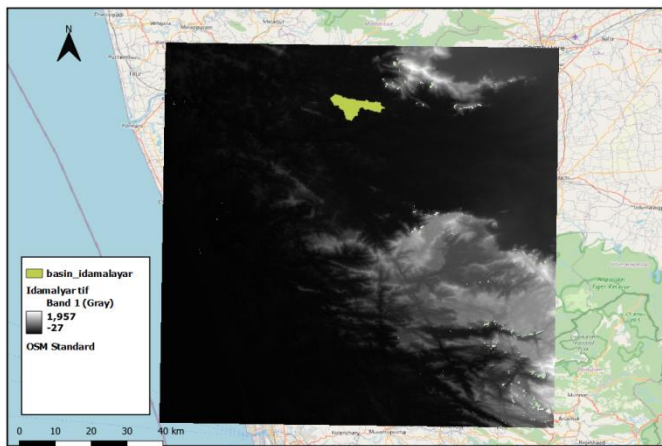


**Fig 9** Chimmini dam basin with clipped stream

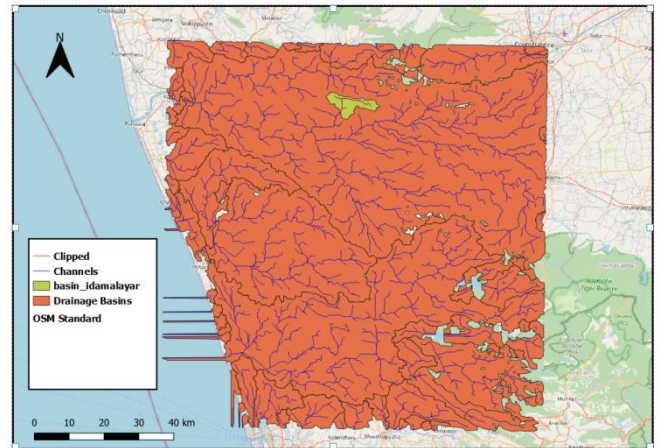


**Fig 10** Drainage basins with the Chimmini Dam basin

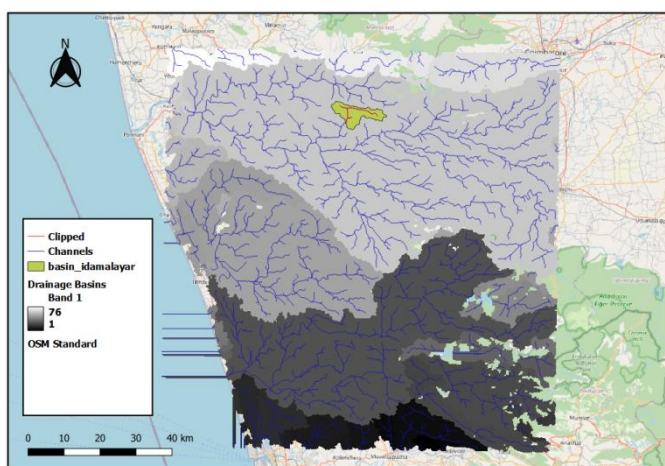
**Study Area 2: Kunduvampadam, Kongad West, near Idamalayar Reservoir**



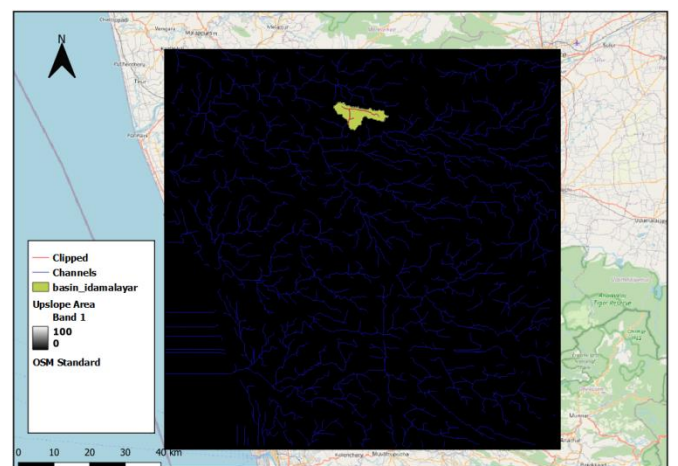
**Fig 11** IDAMALAYAR TIF Image with Study area



**Fig 12** Channels flowing through the Drainage basin and the Kunduvampadam with water channels and clipped streams



**Fig 13** The Drainage basins in the Idamalayar reservoir with Channels



**Fig 14** Channel Network with the Upslope area in the reservoir

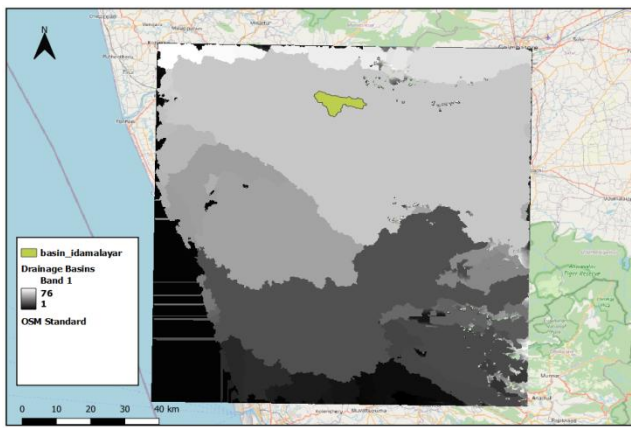


Fig 15 drainage basin with study area

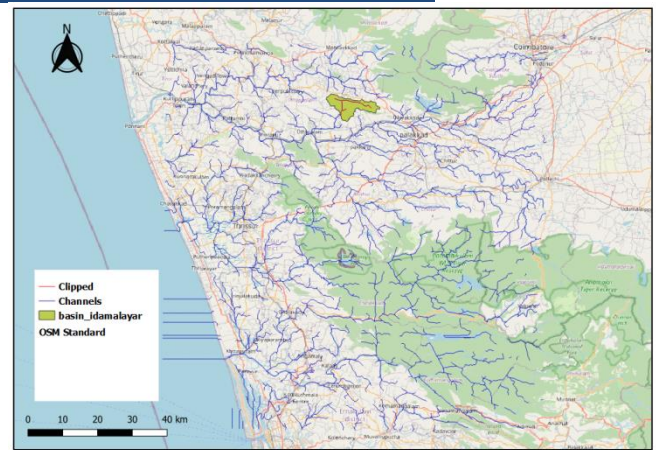


Fig 16 Water channels flowing through the whole area and in the study area

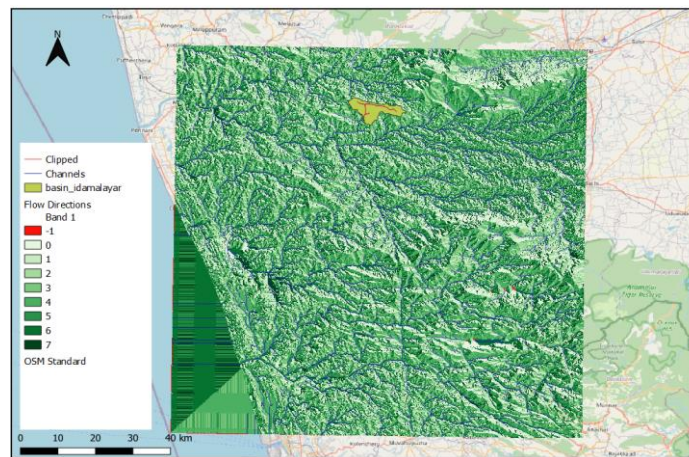


Fig 21 Flow directions

#### IV. CONCLUSION

GIS automated watershed tool are used in the delineation of watershed. The technological advances provided by GIS and the increasing availability and quality of DEMs have greatly expanded the application potential of DEMs to many hydrologic, hydraulic, water resources. GIS Arc Hydro provides increased efficiency, a typical hydrographical analysis was performed using GIS and using traditional methods.

In this paper the watershed and stream network delineation analysis has been performed for two different areas. All the output results have been shown above.

Therefore, in conjunction with proper ground truthing GIS can be used for delineation of streams and watersheds. Also the estimation of other watersheds aspects can also be performed.

#### IV. References

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