
ABSTRACT

Remote Sensing and GIS recently had been extensively used in various spatial analyses for different parameters to understand the spatial characteristic to be used in decision making. Remote sensing and GIS provides us with various tools to be used in spatial analysis and one of the most important tools of these is Hydrological tool (Arc-hydro in ArcGIS). Hydrological tools had been used to understand the terrain of the surface and eventually the hydrological characteristics of the given area. In this study a comparative study had been carried out on drainage density using Digital elevation data of different sources that is SRTM with 90 meter resolution and Aster data with 30 meter resolution using the Arc-hydro tool of GIS. Study area is selected from Yamuna middle watershed of Uttarkashi District, Uttarakhand, India which provides a much variation in terrain condition including the elevation and is hard to access most of its areas. DEM has been processed separately for that of SRTM and ASTER and analyzed using Arc-hydro tool of ArcGIS and Drainage density had been analyzed eventually and a comparatively study had been carried out to understand difference in results of the two DEM sources and understanding accuracy. All this spatial analysis is carried out under the GIS environment to make analysis and evaluation easy and fast. Resent High resolution Remote sensing data is used for the assessment of accuracy and validation of the results.

KEYWORDS: ASTER, SRTM, GIS, hydrology, river drainage pattern, watershed delineation

INTRODUCTION

A watershed has been defined as the drainage network draining to a single outlet with its boundaries defined using the highly elevated edges. Thus a watershed is the land area drained by a river/stream system. Rainfall and snow melting from fields, forests, rooftops, lawns, parking lots, and streets flows toward a lake or river and drained through a single outlet point and forms a watershed. The smallest sub-unit of watershed known as sub-watershed is the smallest unit for analysis.

Watersheds are composed of various components such as creeks, streams, rivers, and lakes, and various other components of drainage network. Thus a watershed is a drainage network which involves in the storage and distribution of water through various channels towards the final exit. Thus understand and management of watershed is extensively important for the sustaining the terrestrial and aquatic life on this earth. Thus the study of watershed is to understand the water capabilities under various land features such as forests, Agricultural, wetland, floodplains and other landuse and land management activities.

Different methods had been used for the delineation of watershed including the manual digital method under GIS environment and using Remote Sensing and GIS techniques using remote sensing and GIS data such as Digital

Elevation Model. DEM from two different sources that is of ASTER with 30 meter resolution and SRTM with 90 meter resolution had been used under this study for the analyze and comparison of the watershed of the study area.

Study Area

The study area had been selected from the hilly state of Uttarakhand which is about 80% hill. The watershed which had been selected is from the Yamuna basin and covers an area of 314.752072 Sq km. geographically it lies between 30° 31' 24.392" to 30° 47' 4.946" latitude and 77° 58' 42.762" to 78° 14' 18.175". The watershed covers the border area of two districts namely Tehri Garhwal and Uttarkashi. There are in all 12 sub-watershed in the given watershed which includes Tiyari, Tharsun, Kuwa, Kaslana, Serigad, Duink, Bhatwari, Bhutgaon, Nakot, pantwari, Mandigad, Jaidwar.

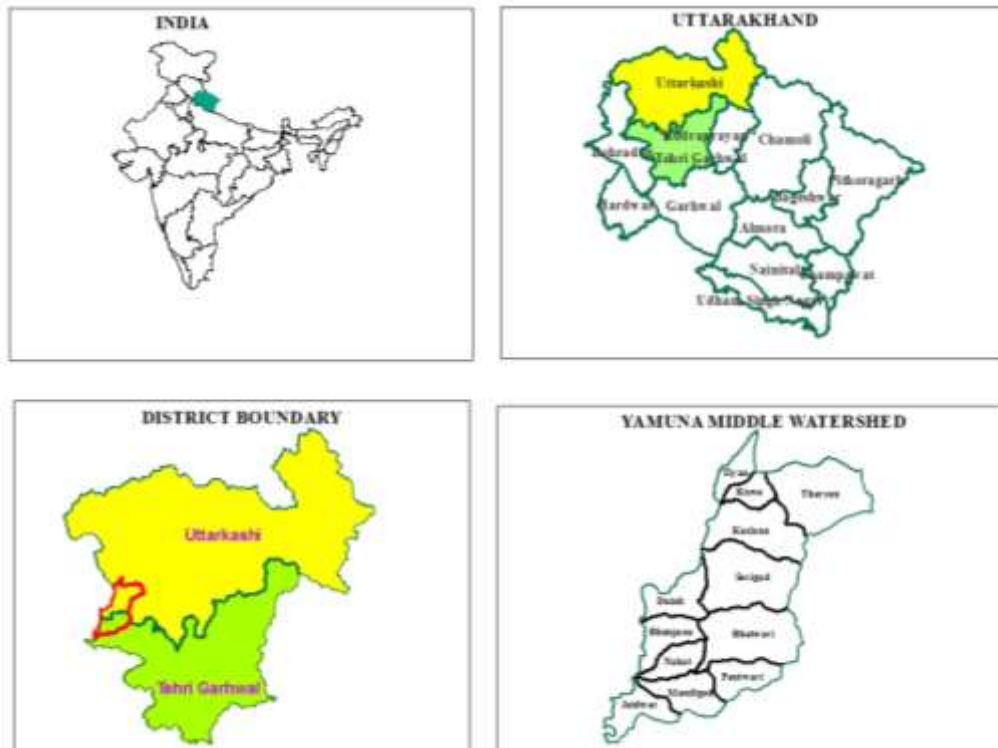


Fig.1 Study area of Yamuna middle watershed

Methodology

Methodology adapted is of GIS and remote sensing techniques. Hydrological analysis tools in GIS software had been used to reduce the time of analysis. The first step is to extract the study area boundary. Then the Digital Elevation Model had been clipped using the extracted boundary. Digital Elevation Model from two different sources having different resolution including ASTER with 30 meter resolution and SRTM with 90 meter resolution had been processed and sinks had been filled to develop the sink free DEM using the arc-hydro tool. Flow direction, Flow Accumulation, Flow length and flow path had been calculated using Arc-hydro tool. The projection system used for the data sets used is Lambert conformal conic (LCC) using datum WGS84.

Drainage density is calculated by dividing total length of streams divided by the total area of the watershed under study. Thus Calculation of Drainage density is don't by uses the following formula and using a threshold value:

$$Dd = \text{Sum}(L)/A$$

A= Area of study area.(Km²).

In GIS this calculation and spatial analysis of drainage density has been done using the GIS tool drainage density of ArcGIS to make the process fast and easy. The Yamuna basin is characterized by its hilly terrain and part of river Yamuna and some major tributaries and disintegrated drainage network which shows the monsoon period. Survey of India toposheet is also used for identification and analysis of drainage lines but although it is based on field survey but it is old. Thus CARTOSAT-1 and LISS IV merged satellite image with 2.5 resolutions had been used for validation for any abnormality of different drainage features by overlaying the derived drainage over it. CARTOSAT-1 and LISS IV merged satellite image shows the latest drainage lines clearly. It is not easy to delineate the boundary due to its terrain variation and due to its unstable drainage Patten.

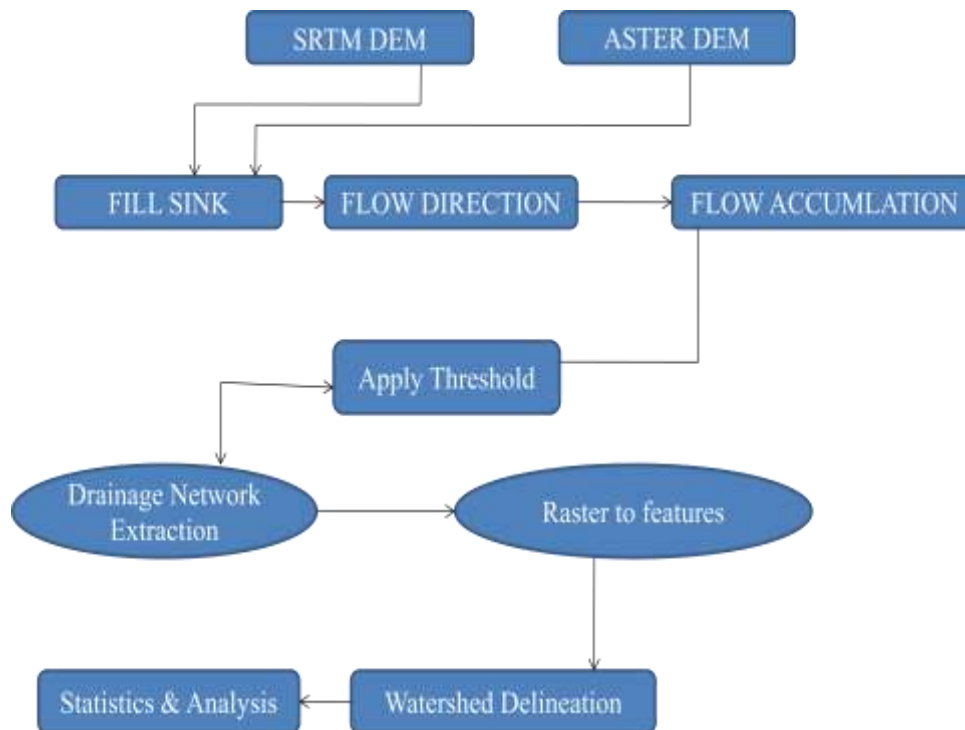


Fig 2: Watershed delineation methodology flow chart

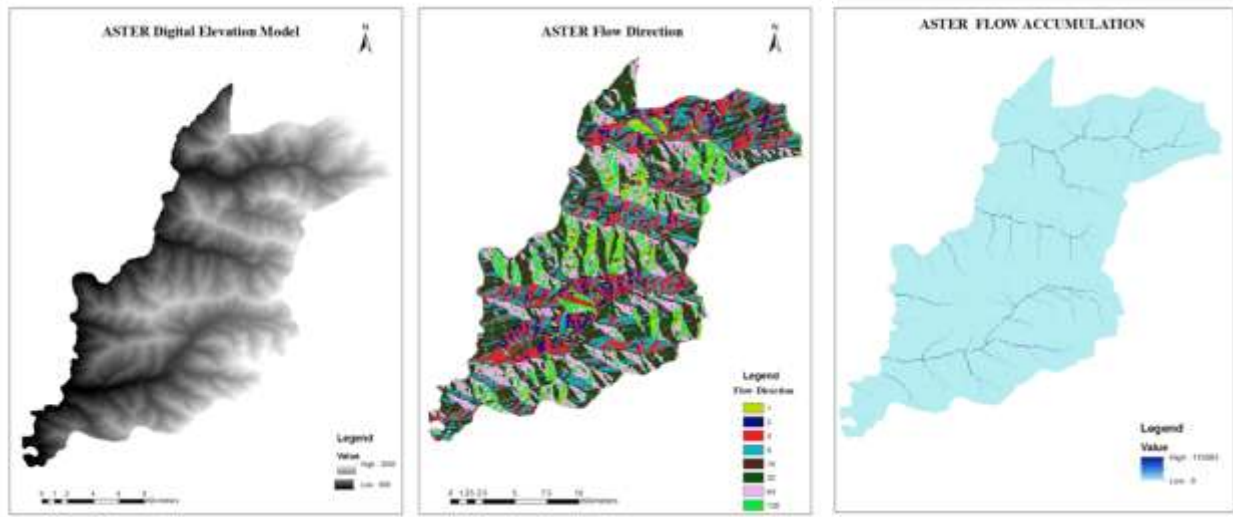


Fig:3 Flow Direction and Flow Accumulation of ASTER DEM

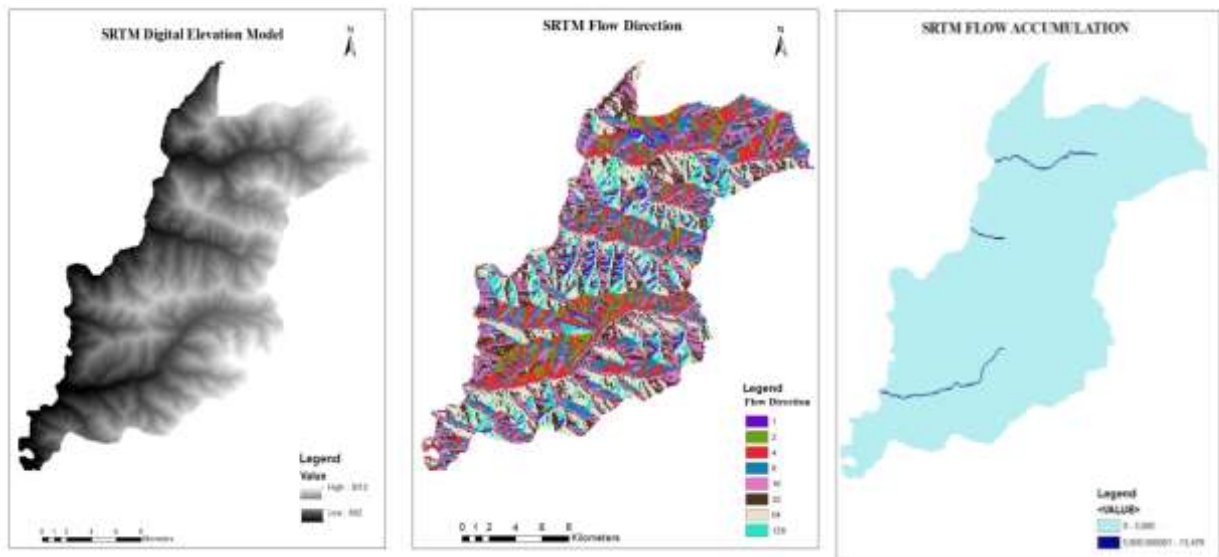


Fig:4 Flow Direction and Flow Accumulation of SRTM DEM

Morphometric parameters

Slope angle (degree) and relative height (m) were derived using the Digital Elevation Model is used for morphometric analysis. Slope is generated in GIS environment using the raster calculator tool of ArcGIS. The slope angles further re-classified into 6 classes.

The relative height is calculated as:

$$Hr = (H - H_{min}) / (H_{max} - H_{min})$$
 H=mean height of the area,
 Hmin=minimum height of a watershed
 Hmax=maximum height of a watershed.

Table: 1 Morphometric parameters

Parameter	SRTM DEM	ASTER DEM
Drainage Density	1.861011	1.7943
Relative height	0.4862	0.50021
Slope angle (degree)	0-90	0-69

RESULTS AND DISCUSSION

Trial and error method had been adapted to arrive at a threshold value for the required drainage density is arrived at by trial and error method where the watershed boundary derived from digital network matches the digitized boundary most accurately. The threshold value of flow limitation for ASTER of 30 meter resolution is higher than that of SRTM DEM is higher Drainage density is high in ASTER DEM as compare to SRTM DEM.

Differences in Slope angles are analyzed by using the histogram values of DEM in correspondence with the slope class. Slope angle depends on the elevation and the relative elevation values of the adjustment pixels which is different for both SRTM as well as ASTER. The slope angle of the DEM depends on the elevation values as well as relative differences in elevation value of adjacent pixel which are varying for SRTM and ASTER DEM. The comparative study of both SRTM and ASTER DEM shows much variation in streams elevation, standard derivation, Drainage density, Relative height, Slope angle and mean value.

Table 9. Stream Ordering

Stream order	ASTER DEM	SRTM DEM
1st	1004	114
2nd	440	45
3rd	248	40
4th	117	-
5th	61	-

CONCLUSION

In the hilly terrain it was found that both the SRTM and ASTER DEM had showed much difference not only due to variation in the resolution differences of data but also the terrain of the study area is much varied. All these factors greatly affect the accuracy of terrain characterization both spatially and with difference in the altitude.

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