Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 5, May -2017

Watershed Delineation of Purna River using Geographical Information System (GIS)

Umang S. Visharolia[1], Narendra J. Shrimali[2], Indra Prakash[3]

[1]*M.E. Hydraulic Structure, Faculty of Technology and Engineering, M.S. University-Baroda*
[2]*Assosiate Professor, Faculty of Technology and Engineering, M.S. University-Baroda*
[3]*Faculty, BISAG-Gandhinagar*

Abstract- *Catchment area and watershed delineation is common task in hydrology. Digital Elevation Models (DEMs) are spatial grids which are used to automate watershed boundary determination. DEM based Arc-Hydro model was run on the dataset of the Purna river basin. Several intermediate results were produced while model run and basic parameter of the Purna river, its catchment area has been defined at the end of model. The result of this study can be used in Rainfall-Runoff analysis and other advance research on the catchment area. Moreover, it would have support for decision making on ground and surface water resource, distribution and management. This study of delineated watershed is further used to calculate hydrologic and topographic features by HEC-geoHMS for developing a Rainfall-Runoff model in HEC-HMS.*

***Key words*:** *Watershed delineation, GIS, Digital Elevation Model (DEM), Arc-Hydro model*

I. INTRODUCTION

Watershed delineation means creating a boundary that represents the contributing area for a particular river outlet. The purna river rises from the Saputara hills of the Western Ghats in Maharashtra whose length from its source to outflow in the Arabian Sea is about 180 km. There are 2 methods for delineating a watershed: Traditional and using GIS (Geographic Information System). A traditional method for watershed delineation from the topographic map contains drawing lines to connecting elevation points and contour lines. It is not an easy task to define watershed lines precisely using topographic map. The manual delineation of drainage networks and catchments from topographic maps has been widely replaced by the automatic extraction from DEM (Digital Elevation Model) [1]. The catchment area of Purna basin is 2431 sq. km. (Water Resource Information System of India). Fig-1 shows manually delineated Purna basin map (guj-nwrws.gujarat.gov.in). In recent times, DEM that extracted from satellite image is widely used to get various information such as terrain slope, gradient, aspect, contour line. Accurate delineation of water- shed plays an extremely important role in the management of the watershed [2]. The research implementation plays an important role in modern water resource management at world and national level. Therefore, modern techniques and methods should be used to define basic parameters of river and its catchment area and the results can be used in research and decision making in near future. The purpose of this research is to define basic parameters of Purna river and its catchment to use in Rainfall-Runoff analysis for this region.

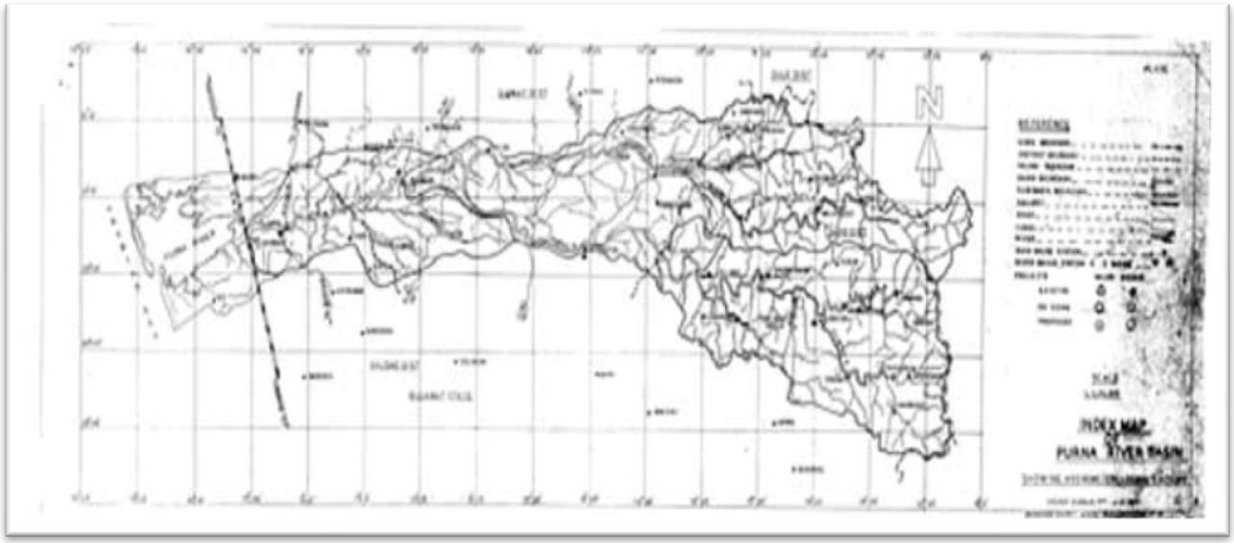

Fig 1: Purna river basin delineated manually

II. STUDY AREA

In fig 2 the location map of Purna basin is shown. The basin lies between 72° 45' to 74° 00' East longitude and 20° 41' to 21° 05' North latitude.The Purna basin can be divided into three prominent physiographic regions, i.e. (i) eastern parts, (ii) the middle reaches and (iii) the coastal zones. The eastern parts of the basin cover a chain of rugged mountain ranges of the Western Ghats running at an elevation of above 1300 m and descending to an elevation of about 100 m at the edges of uplands of the Surat district. The middle reaches of the basin area are marked by high relief zone with ridges and valleys. The hilly zone then merges into the plains through an undulating piedmont coastal zone running parallel to the sea. 2.39% of the total catchment area lies in Maharashtra and 97.61% of the total area lies in Gujarat. The basin receives most of the rainfall from the South West monsoon from June to September. Average annual rainfall in the basin is 1596.8 mm. Soils of Purna basin can be classified into three groups i.e. lateritic soils, deep black soils and coastal alluvial soils.[india-wris]

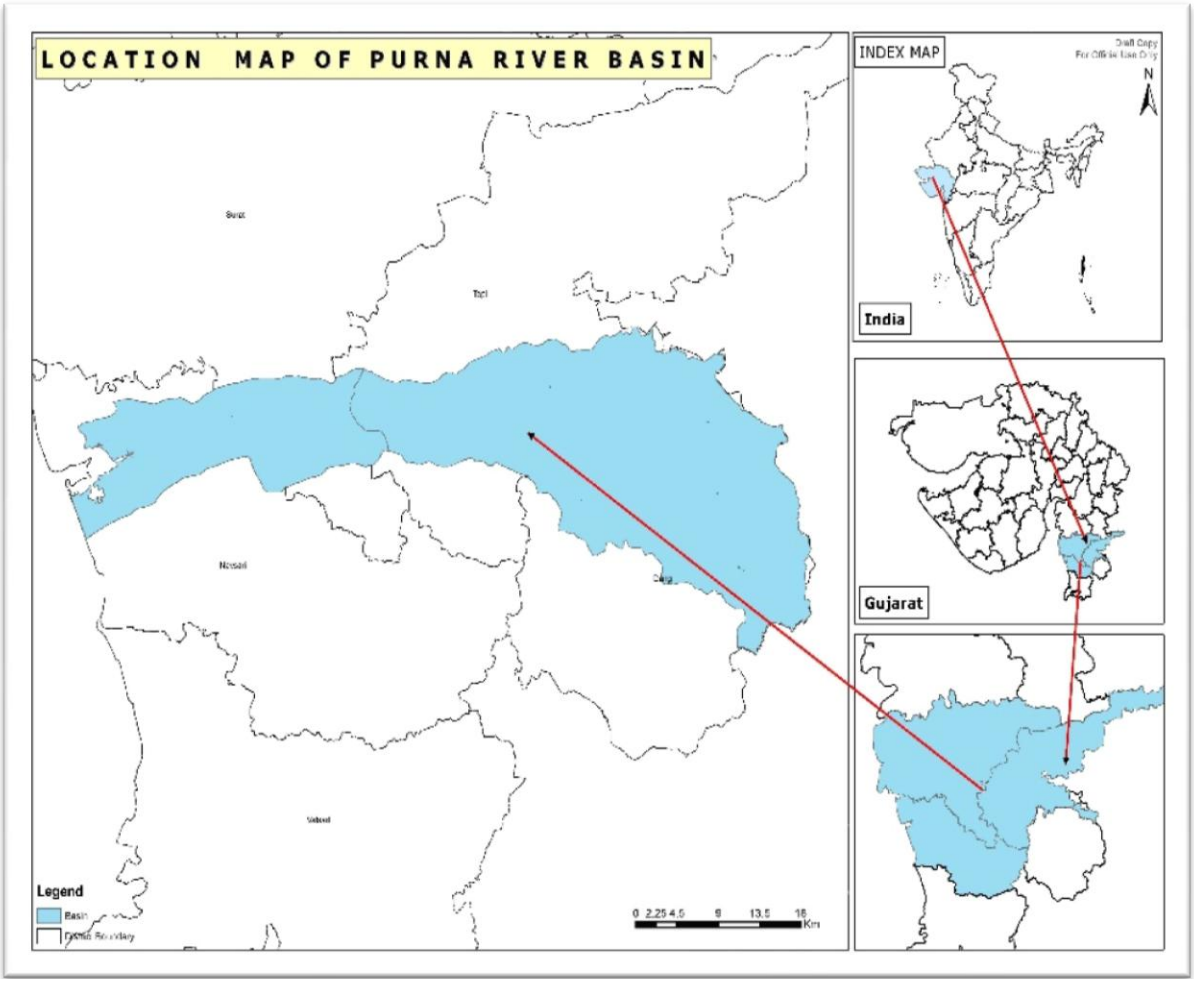

Fig 2: Location map of Purna basin

III. DATA COLLECTION

DEM provided from BISAG (Bhaskaracharya Institute for Space Applications & Geo-informatics) of spatial resolution of 90 m have been used for this study (shown in fig 3). Columns and rows of this raster data are 4063 & 1589 respectively. Spatial extent of this DEM is 21.12 degree at top & 20.69 degree at bottom and 72.48 degree at left & 73.95 degree at right. Spatial reference of WGS_1984_World_Mercator with datum of D_WGS_1984 is used.

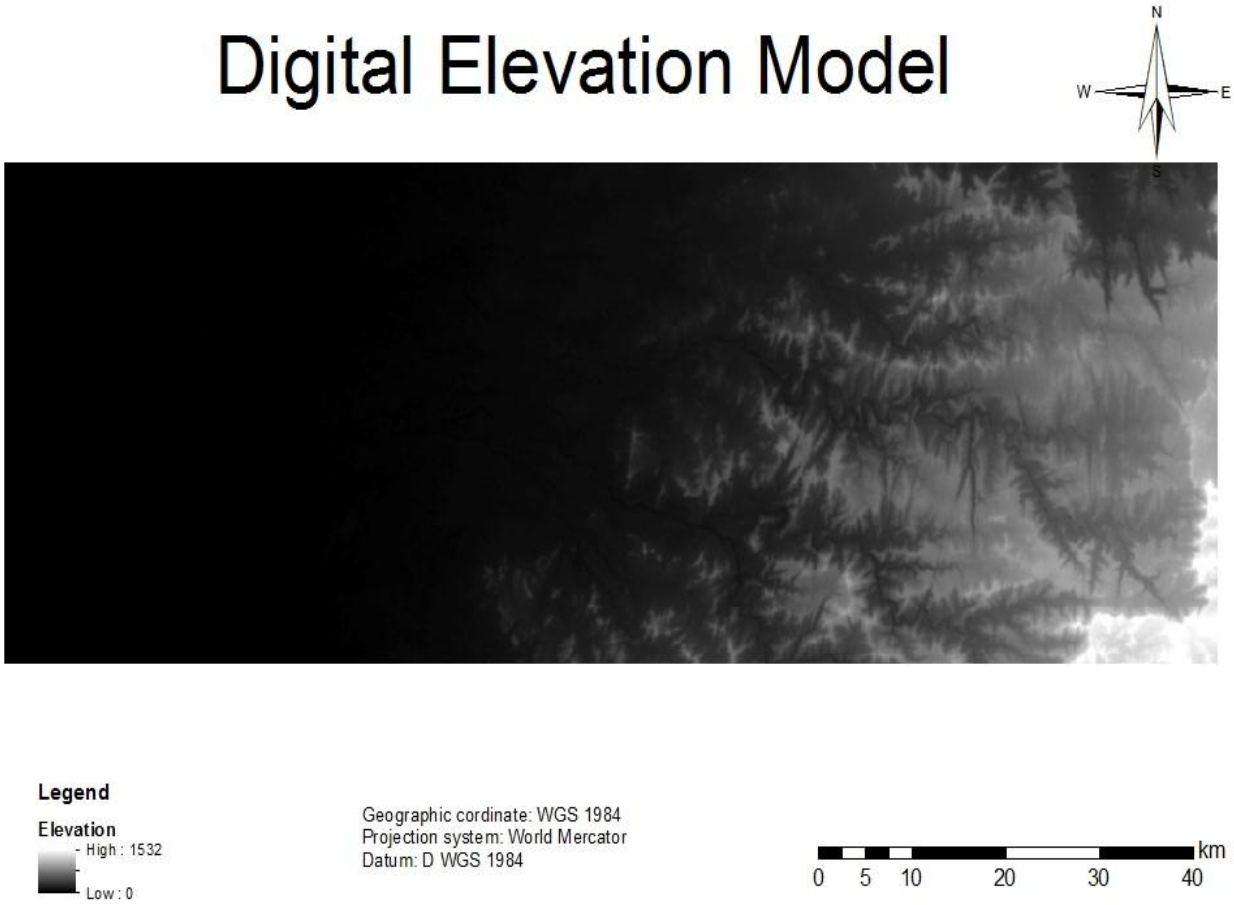

Fig 3: DEM used for study; source: BISAG

IV. METHODOLOGY

Using Arc-Hydro model, basic parameters of Purna river and its watershed have been defined. Based on the tutorial manual of "Arc-Hydro Tools" the following flowchart (fig 4) is drawn. Primary data used for this model is DEM. Several intermediate results like flow direction map, flow accumulation map, catchment map, drainage map etc. are generated. As output watershed map and watershed centroid are obtained. The detailed methodology is described in flowchart (fig 4).

V. RESULTS

DEM based Arc-Hydro model was run on available data set. Depending on the quality and resolution of the data, results can differ from actuality. Fourteen intermediate results were obtained in this process including watershed boundary, centroid of the watershed and outlet of watershed. Intermediate results are shown in fig 4. The final results of watershed area, watershed perimeter can be seen in the attribute table of the output 'Watershed' shapefile. These results are shown in the table 1.

Sr. No.	Name	Value
1	Area of Purna watershed	2511.29 km^2
2	Perimeter of Purna watershed	1141.56 km
3	Centroid of Purna watershed	20^o 56' 54" latitude & 73^o 31'4" longitude

Table 1: Results obtained from Arc-Hydro model for Purna watershed

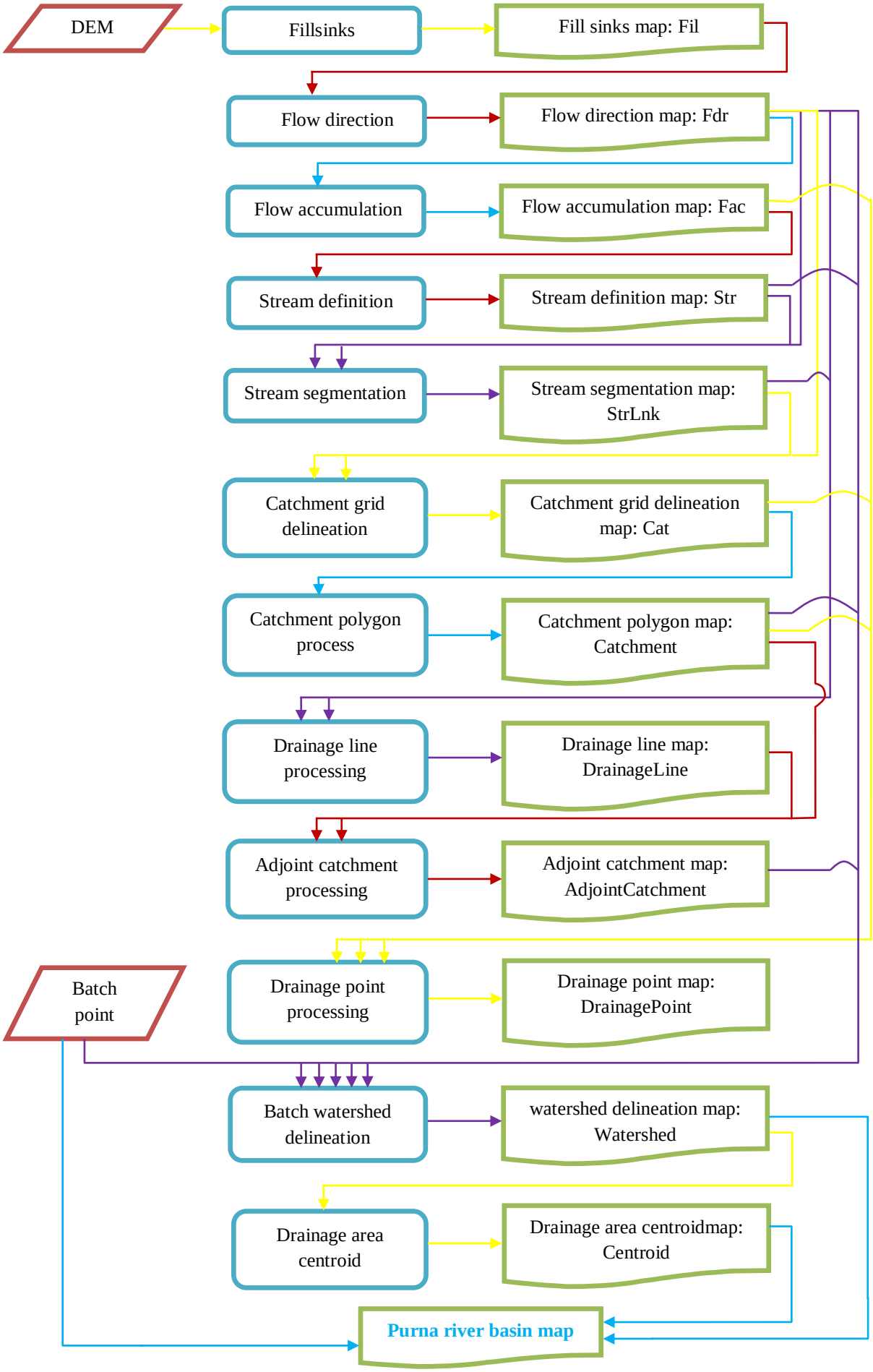

Fig 4: Methodology Flowchart of Arc-Hydro model

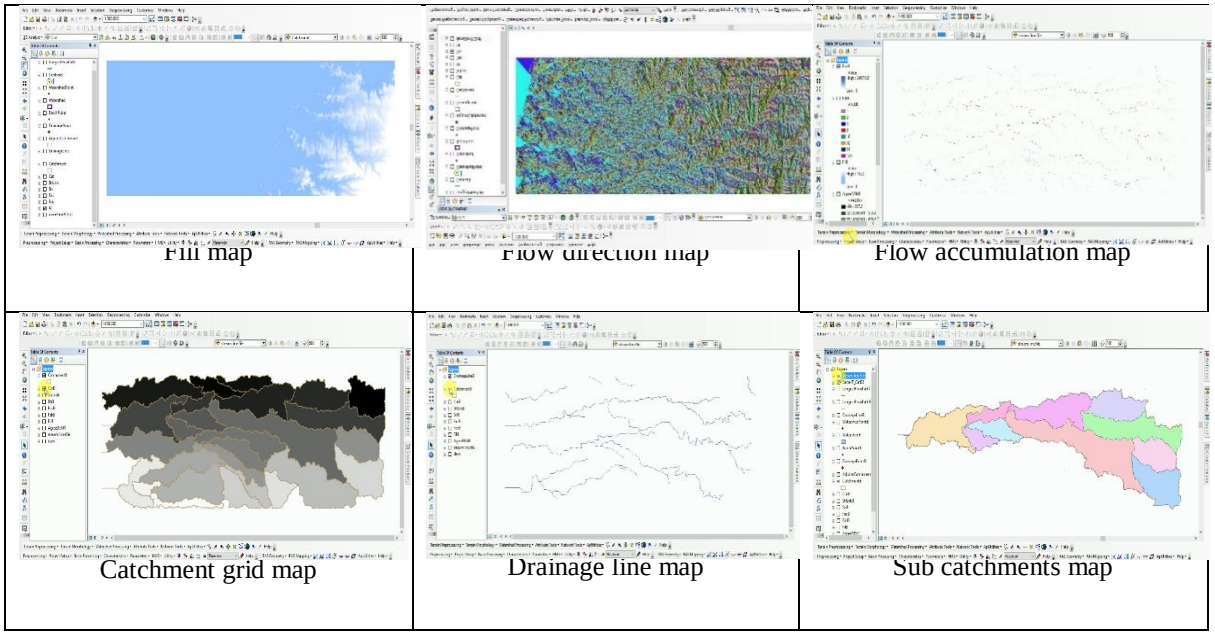

Fig 5: Intermediate results of Arc-Hydro model

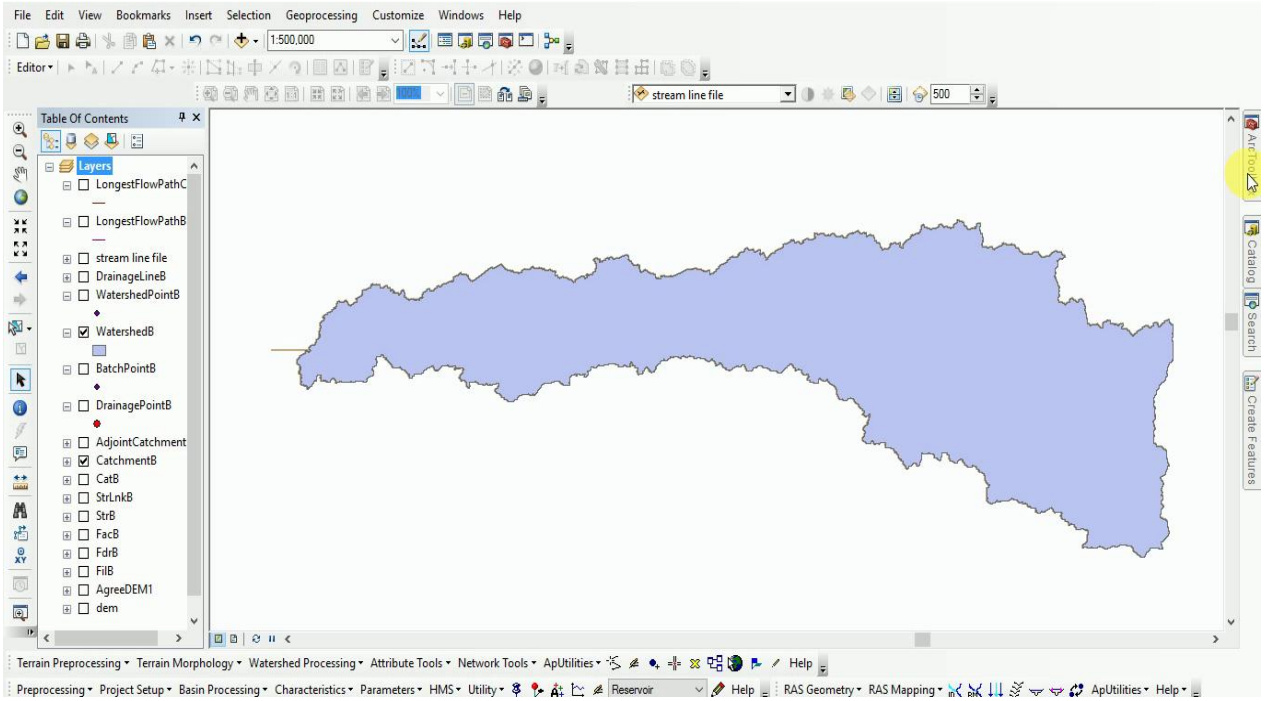

Fig 6: Purna watershed delineated from Arc-Hydro model

VI. CONCLUSION AND DISCUSSION

Here the calculated Purna river basin area from DEM is 2511.29 km^2which is 80.29 km^2 (3.3%) more than the basin area information provided by Water Resource Information System of India.This may happen because of the methodology difference between manually delineation and delineation from satellite data. For different satellite data, this result may vary according to the spatial resolutions of data. This delineated watershed shapefile can be further used to divide basin into sub-basin and calculate their hydrologic and topographic features by HEC-geoHMS for developing a Rainfall-Runoff model in HEC-HMS.

VII. ACKNOWLEDGMENT

I would like to thank BISAG (Bhaskaracharya Institute for Space Applications & Geo-informatics) for providing the required support and platform for this study.

REFERENCES

[1.] M.A.E. Bastawesy, R. R. Ali and A. H. Nasr, "The use of remote sensing and GIS for catchments delineation in northwestern coast of Egypt: An assessment of water resource and soil potential", The Egyptian Journal of Remote Sensing and Space Science, Vol. 11, 2008, pp.3-16
[2.] N. Donia, "Application of Remotely Sensed Imagery to Watershed Analysis; A case Study of Lake Karoun Catchment, Egypt," Thirteen International Water Technology Conference, IWTC, Hurghada, 2009, pp 1035-1049
[3.] Ochir Altansukh, "Tuul River and Its Catchment Area Delineation from Satellite Image", Computational Water, Energy and Environmental Engineering, 2012, 1, pp 9-23
[4.] HEC-GeoHMS, Geospatial Hydrologic Modelling Extension, User's manual: Version 10.1, U.S. Army Corps of Engineers, Hydrologic Engineering Centre.
[5.] http://www.india-wris.nrsc.gov.in/wrpinfo/index.php?title=Purna
[6.] https://guj-nwrws.gujarat.gov.in/showpage.aspx?contentid=1748&lang=english
[7.] http://nptel.ac.in/courses/105101010/downloads/Lecture13.pdf
[8.] https://www.epa.gov/sites/production/files/2015-07/documents/lecture-3-watershed-delineation.pdf

