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Comparative analysis of watershed divides from digital elevation model of Ayyar watershed, Tamil Nadu using remote sensing and GIS technique

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Abstract

Watershed is the fundamental management tool to conserve the soil and water ecosystem and need to manage based on their requirement for betterment of ecosystem. The demarcation of the watershed divide becomes more important for development and management of the watershed. Ayyar Watershed was taken into consideration of this study. Ayyar River is one of the tributaries of Kavery River. The Ayyar watershed boundary was delineated using the Arc Hydro Tool and ArcSWAT software. The two watershed divides were compared. There are some minor differences between the two watershed divide. According to the analysis of watershed features, the area of the watershed derived from SWAT is 1190.93 km² and Arc Hydro Tool is 1187.73 km² which is 0.27% smaller than SWAT derived watershed boundary. The convex hull type geometry gives the reliable data on both watershed boundaries.

Keywords: Arc hydro tools, DEM, SWAT, watershed

1. Introduction

Watershed is the fundamental management tool to conserve the soil and water ecosystem. Each and every local level watershed need to manage based on their requirement for betterment of ecosystem and human beings. So the demarcation of the watershed outline becomes more important for development and management of the watershed. There are many methods are available for delineation, but the reliable method only represent the ground truth. So the best method has to find out by comparing the methods. Before the advent of satellite technologies, watersheds were demarcated using a ground truth survey and topographical sheets. The DEM (Digital Elevation Model) can now be used to delineate the Watershed and DEM is the spatial raster data represents the elevation of the earth surface.

Arc Hydro Tools is the product of ESRI to aid the researchers for faster and better research. Soil and Water Assessment Tool (SWAT) is one of the software to delineate the watershed automatically. Luo *et al.*, used ArcSWAT and ArcGIS to illustrate the demarcation of the watershed boundary for Ganjiang River, Fiangxiang Polder utilizing two methods: pre-defined streams and improved DEM approach ^[1]. The study presented a novel enhanced methodology for delineating watersheds using an adequate data base and field observations. This methodology ensures that future research, such as agricultural chemical yield and water modeling, will be successful. Premanand *et al.*, used QGIS and QSWAT Software to outline the Patapur micro-watershed border in Karnataka using SRTM DEM ^[2].

With an aid of above concept the study was conducted with aims viz., to delineate the watershed using DEM by Arc Hydro Tool and ArcSWAT and to compare the watershed boundaries between ArcSWAT based and Arc Hydro Tool based.

Material and Methods

Ayyar Watershed was taken into consideration of this study (Figure 1). Ayyar River is the water source for Trichirappalli, Namakkal and small part of Salem district in Tamil Nadu. It rises in Kolli hills and joins in Kavery River. The data base and framework of the study was elucidated in Table 1 and Figure 2 respectively.

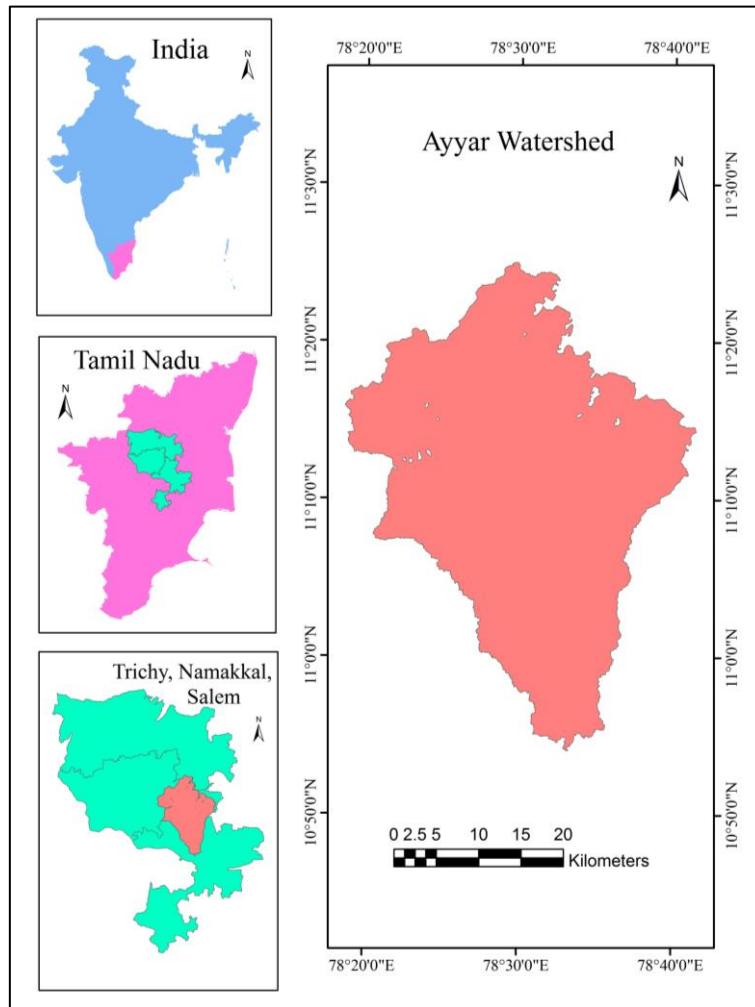


Fig 1: Position of the study region

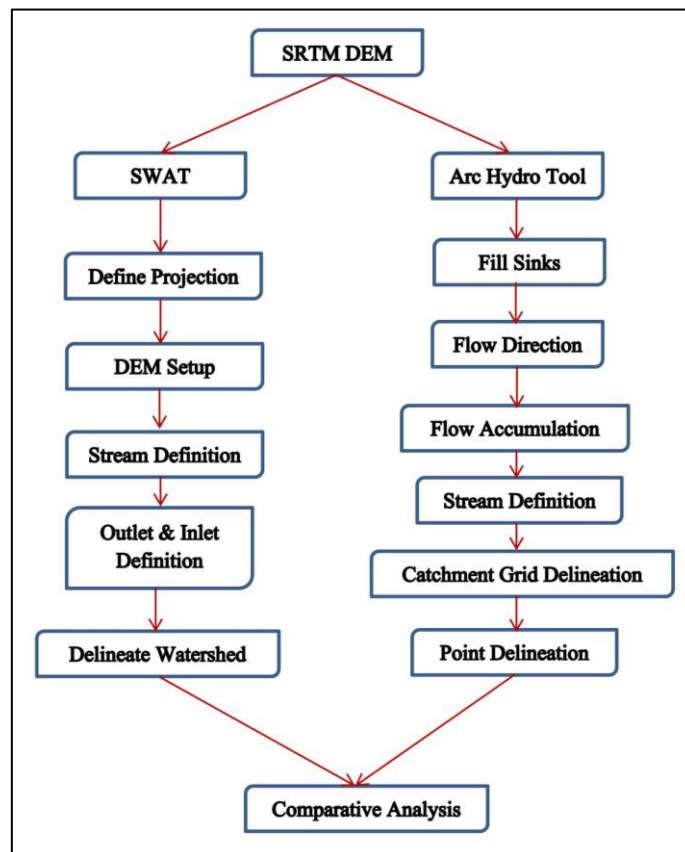


Fig 2: Framework of the study

Table 1: DEM data Collection and its description

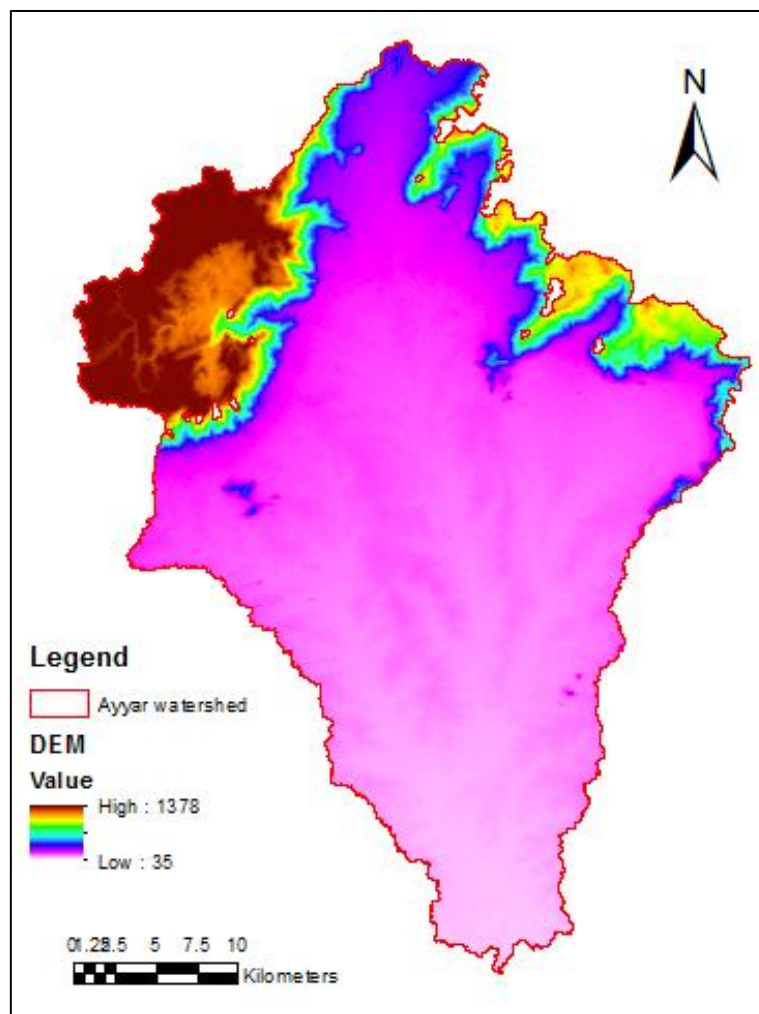
S. No	Particulars	Srtm Dem
1.	Spatial Resolution	30 m
2.	Format	Geo-TIFF
3.	Datum	WGS84
4.	Projection	Geographic
5.	Coverage	Global
6.	Source	www.earthexplorer.usgs.gov

The watershed boundary was delineated using the Arc Hydro Tool and ArcSWAT software. The two watershed divides were compared visually. For comparison of the watershed divides, the statistical tools viz., Minimum Bounding Geometry and Zonal Statistics as Table of ArcGIS software were used. The feature of the watershed was analyzed using five different type of geometry as Rectangle by area, Rectangle by width, Convex hull, Circle and Envelope. Pryde *et al.*, compared the watershed boundaries derived from three different sources viz., watershed was delineated by hand, 90 m spatial resolution SRTM DEM and 30 m spatial resolution ASTER DEM with the aid of Spatial Analyst extension of ArcGIS software. The study concluded that the accuracy of the watershed delineation mainly depends on accuracy of the DEM.³

Result and Discussion

The elevation map of the Ayyar watershed divide derived from ArcSWAT and Arc Hydro Tool was illustrated in Figure 2 and 3 respectively. The elevation of the Ayyar watershed is decrease from North to South. The elevation of the study area varies between 35 to 1378 m in ArcSWAT output and between 66 to 1378 m in Arc Hydro Tool output. Visually, there are some minor differences between the output of Arc Hydro Tool and ArcSWAT software (Figure 4). According to the analysis of watershed features, the area of the watershed derived from SWAT is 1190.93 km² and Arc Hydro Tool is 1187.73 km² which is 0.27% smaller than SWAT derived watershed boundary (Table 2).

Area and Perimeter of the Ayyar watershed was calculated through the Minimum Bounding Geometry tool with different geometry type (Table 3). When considering the SWAT derived Ayyar watershed boundary, the results shows that the convex hull and circle geometry gives same results as area of the watershed is 1484.56 km² and watershed's perimeter is 148.2 km. The rectangle by area and rectangle by width geometry type gives same results as area of the watershed is 1916.38 km² and watershed's perimeter is 177.23 km. Out of five geometry type, the envelope geometry results high area and perimeter value are 2370.94 km² and 197.28 km.

**Fig 2:** ArcSWAT – Watershed divide

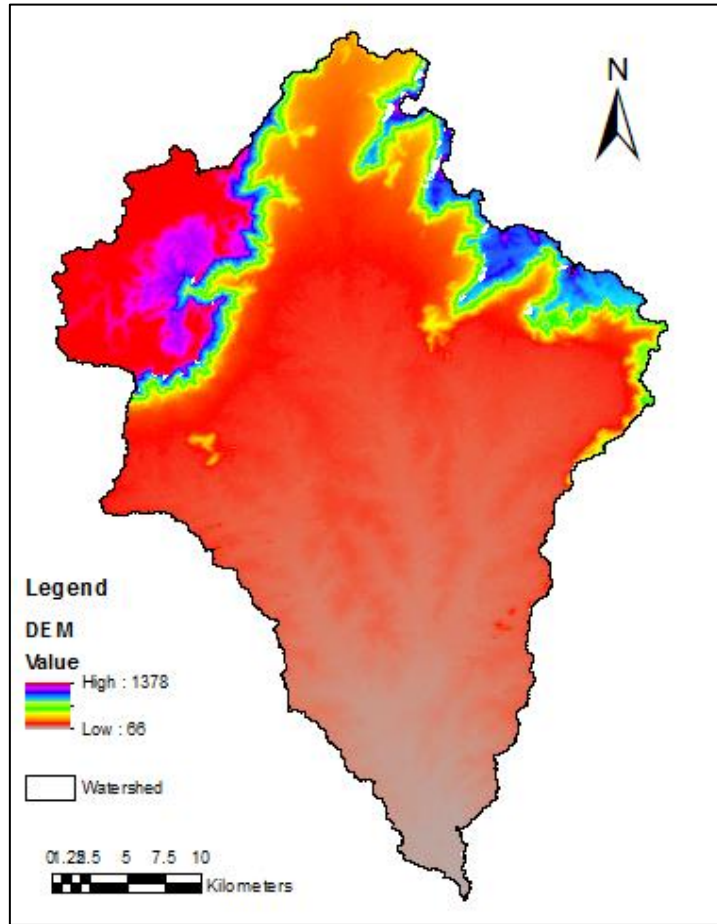


Fig 3: ArcHydro Tool – Watershed divide

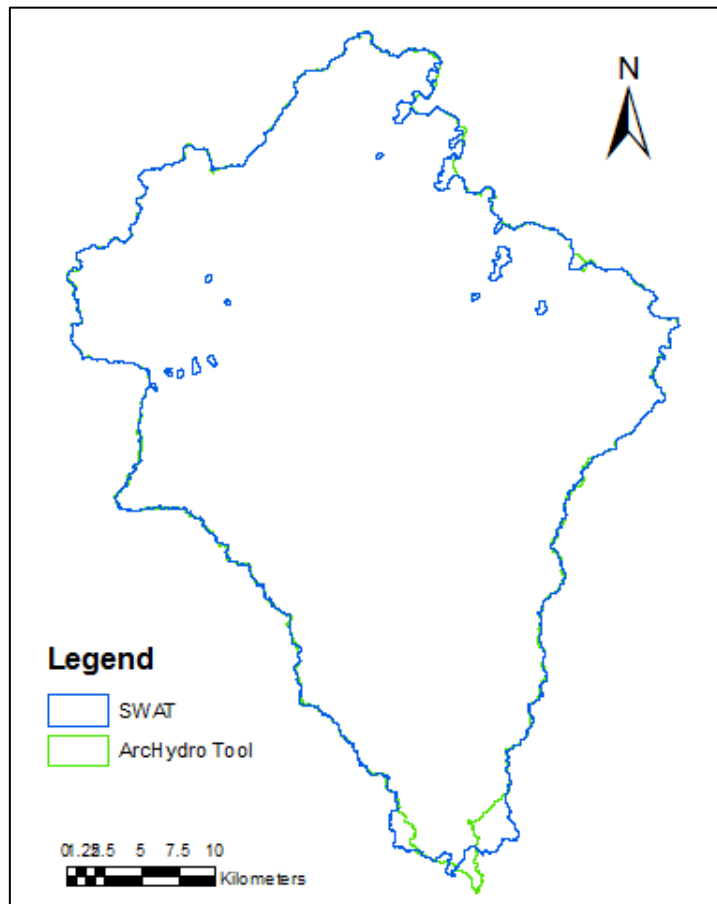


Fig 4: Comparative analysis of output maps

Table 2: Output of Zonal statistics as Table Tool of ArcGIS software

S. No	Particulars	SRTM DEM	
		SWAT	ArcHydro Tool
1	AREA (Km ²)	1190.93	1187.73
2	Min	35	66
3	Max	1378	1378
4	Range	1343	1312
5	Mean	315.72	319.43
6	Std	323.47	325.07
7	Sum	395458791	399035876
8	Variety	1317	1311
9	Majority	151	151
10	Minority	35	66
11	Median	167	168

Table 3: Output of Minimum Bounding Geometry Tool of ArcGIS software

Software/ Geometry Type	SWAT		ArcHydro Tool	
	Area (sqkm)	Perimeter (km)	Area (sqkm)	Perimeter (km)
Rectangle by Area	1916.377	177.2312	1909.464	177.2255
Rectangle by Width	1916.377	177.2312	1909.464	177.2255
Convex hull	1484.564	148.1989	1453	149.2173
Circle	1484.564	148.1989	2721.626	184.935
Envelope	2370.942	197.2826	2417.11	199.513

When considering the SWAT derived Ayyar watershed boundary, the results shows that the results represents that the rectangle by area and rectangle by width geometry results same as area of the watershed is 1909.46 km² and perimeter of the watershed is 177.23 km. Circle geometry type shows high area and envelope type shows high perimeter. When considering both watershed divides, the circle geometry of Arc Hydro Tool derived boundary shows high area of the watershed and envelope geometry of Arc Hydro Tool derived boundary shows high perimeter of the watershed which is not reliable data of the watershed. The convex hull type geometry gives the reliable data on both the watershed boundaries.

ASTER and SRTM Published by UWM Digital Commons 2007, 1-10.

Conclusions

The Ayyar watershed divide was delineated successfully through the ArcSWAT and Arc Hydro Tool software through Digital Elevation Model. The comparative analysis shows that the minor differences between the both divide visually. The convex hull type geometry gives the reliable data on both watershed boundaries. According to the analysis of watershed features, the area of the watershed derived from SWAT is 1190.93 km² and Arc Hydro Tool is 1187.73 km² which is 0.27% smaller than SWAT derived watershed boundary.

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