RESEARCH ARTICLE

DELINEATION OF AGRICULTURAL WATERSHEDS USING DIGITAL ELEVATION MODEL AND GEOGRAPHICAL INFORMATION SYSTEM

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Abstract: In practice,watershed is a close boundary in which surface water drains from high slope to low sloppy area. Describing the geographic boundaries of watersheds and sub-watersheds helps in gathering andevaluating data for watershed management.This paper presents the delineation of the agricultural watershed boundaryusing Shuttle Radar Topographic Mission (SRTM) DEM downloaded from the USGS Earth Explorer. The delineation of watershed was done within the boundary of Agricultural College and Research Institute, TNAU, Madurai located in southern part of Tamil Nadu, India.From DEM, flow direction, flow accumulation, stream network and basin map was prepared for the study using the Hydrology Tools in ArcGIS.

Keywords: Watershed, Digital elevation model, Earth

INTRODUCTION

A watershed is a fundamental unit for understanding hydrologic processes and planning and management of water resources. Delineation of the watershed is an important process in which dividing the closed boundary into discontinuous land andchannel segments to analyse closed boundary behaviour (Mishra and Rawat, 2011).Remote sensing along with GIS application aid to collect, analyse and interpret the data rapidly on large scale intermittently and is very much helpful for watershed planning. Digital elevation model (DEM) is efficient to delineate watershed, extract the drainage network, basin boundaries and to evaluate the volume of fresh water available in study site.There is a big variety of platforms that offer DEM which include Shuttle Radar Topographic Mission (SRTM) downloaded from the USGS Earth Explorer website.Many researchers have used DEM and GIS techniques and for watershed delineation and extraction ofdrainage networks and various topographic characteristics of a watershed. Singh *et al.*(2005) extracted important watershed characteristics such as watershed drainage area/boundary, field and channel slope, aspect, and drainage network using DEM and found that DEM of 30 m resolution.Arc hydro tools are flexible to compute a variety of hydrological analysis, by their integration in ArcGIS interface. These tools are reliable to compute watershed characteristics including flow length and catchment boundaries using DEM (Lin *et al.*, 2008). Tripathi *et al.* (2002) used remote sensing and GIS techniques for generation of land use, soil and contour map which were used for runoff modelling for a small watershed in Bihar. With this background, this paper presentsthe delineation of the agricultural watersheds from the Shuttle Radar Topographic Mission (SRTM) DEM downloaded from the USGS Earth Explorer website and parameterization of the watersheds within Agricultural College and Research Institute, TNAU, Madurai located in southern part of Tamil Nadu, India.

MATERIALS AND METHODS

Google Earth image and geo-coordinates was used for Agricultural College and Research Institute, Madurai boundary digitization and it was done in ArcGIS environment.Reconnaissance Survey was done after a rainfall event around the campus to identify pour points and stream network and the GPS locations of major pour points was also noted.Rainfall data over a period of 20 Years (2000-19) was collected and monthly average rainfall analysis was done. The Shuttle Radar Topographic Mission (SRTM) DEM downloaded from the USGS Earth Explorer website was used in delineation of catchment area. ArcGIS has a wide variety of hydrology tools that helps in delineation of watershed and to find the characteristics of the watersheds. From SRTM-DEM, flow direction, flow accumulation, stream network and basin map were prepared for the study using the Hydrology Tools in ArcGIS. The list of tools available is shown in Fig. 1. The flow chart of delineating the watershed from the SRTM DEM is given in Fig. 2.

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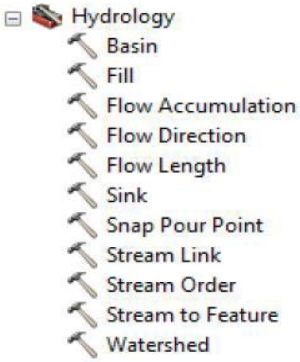

Figure 1. Hydrology Tool Box

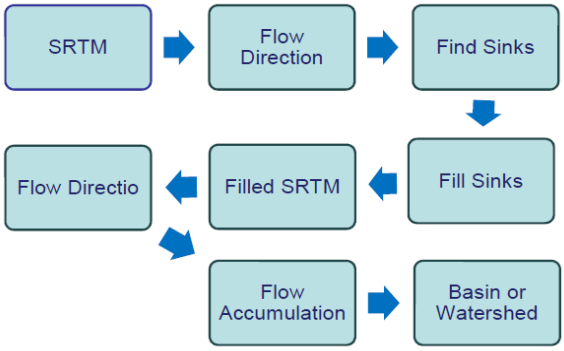

Figure 2. Delineation of Watershed

RESULTS AND DISCUSSION

Analysis of Rainfall data over a period of 20 Years (2000-19) gave average annual rainfall of 897 mm.The figure 3 shows the average monthly rainfall over 20 years and October and January month received maximum and minimum rainfall respectively. The elevation of the study area was obtained from SRTM DEM and it was found that higher elevation of the study area is 161 and the lower elevation is 135 (Figure 4). The contour map (140 to 160m) at an interval of 5m for the study area is presented in figure 6. This helps in planning farming and soil erosion control practices.The flow direction map (figure 7) provides a raster (or pixel format) of flow direction from each cell to its abrupt low slope neighbours. The drainage network of study area was also identified and presented in figure 8. Finally, 4 major watersheds were identified within the boundary of study area and depicted in figure 9. The drainage pattern in watersheds was dendritic. Hence DEM is effective to delineate watershed of the study site using Arc Hydro tool in ArcGIS interface. The maps generated here would definitely prove useful for further application and obtaining a broad sense rainfall runoff analysis and agricultural planning.

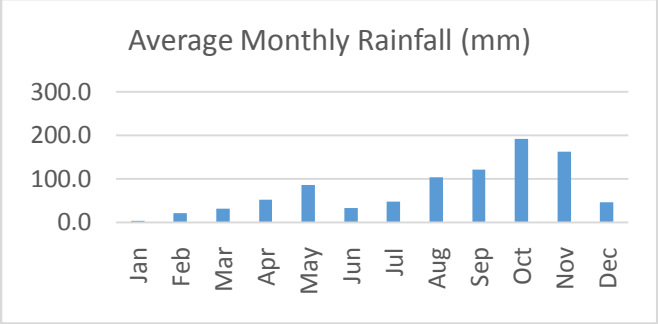

Fig. 3. Average Monthly Rainfall Analysis for the study area

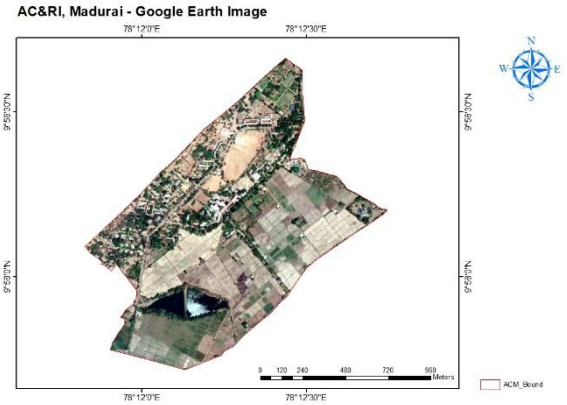

Fig. 4. GoogleEarth Image of study area

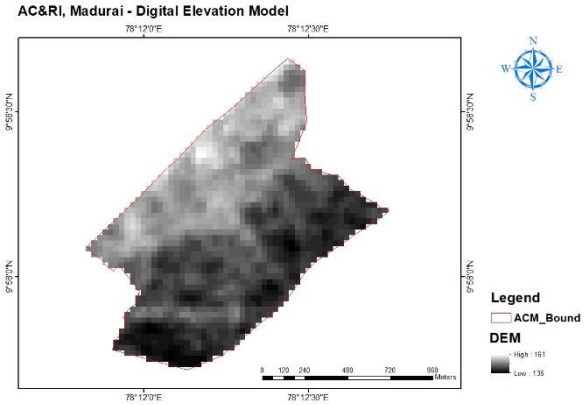

Fig. 5. Digital Elevation Model of study area

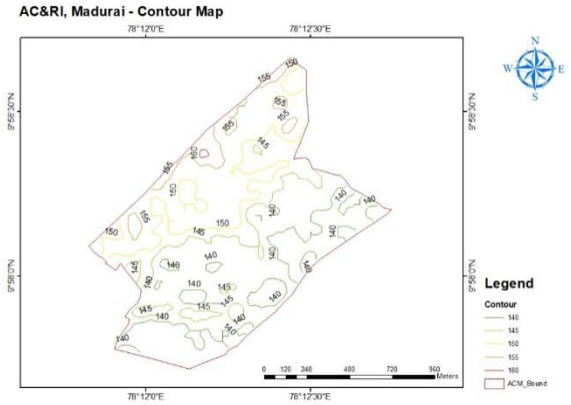

Fig. 6. Contour Map of study area

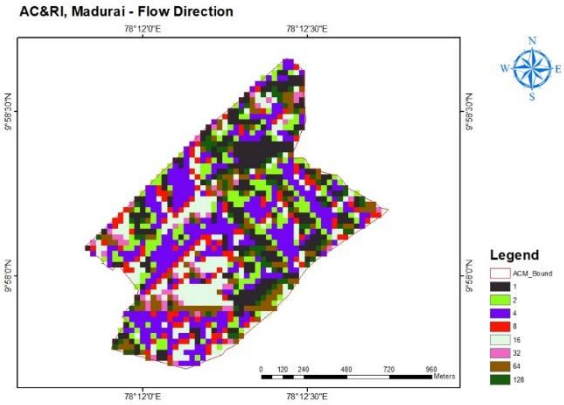

Fig. 7. Flow Direction Map of study area

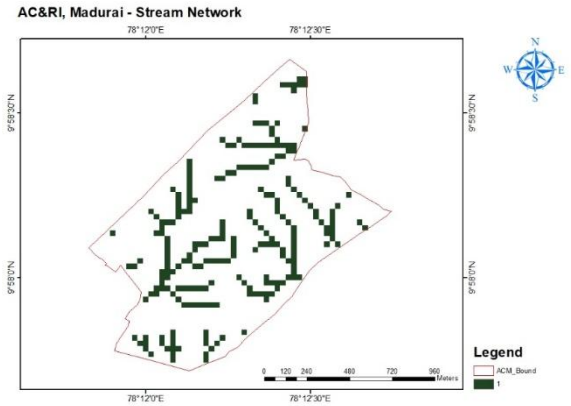

Fig. 8. Stream Network Map of study area

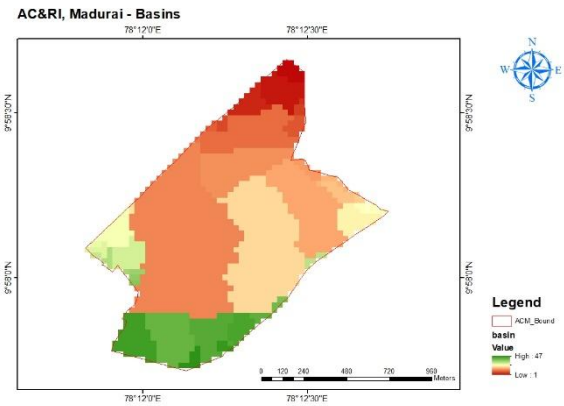

Fig. 9. Watershed boundary of study area

SUMMARY AND CONCLUSION

Using DEM, delineation of watershed, contour lines of along with delineation of drainage lines was done.Information on watershed characteristics of the study area is very helpful to other researchers and decision makers involved in planning and management of the watershed. The results obtained from this study are specific to studythe watershedandreveals the applicability of GIS to extract watershed characteristics using DEM.

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