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International Journal of Hydrology

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Watershed delineation for lake chamo basin, Ethiopia

Abstract

In this study watershed was delineated by using ArcGIS 10.4 for lake chamo basin and necessary procedures was described. Area for lake chamo basin was calculated and the result shows that the total area contributes flow to lake chamo was 8112.98 Kilo meter square based on the delineated water shed. Location map for the water shed was also created. This finding is important for water resource planning and decision making at Sub water shed level to minimize problems in the water shed and take remedial action for water resource planning and management to utilize the limited resource optimally. It was also important to scholars to use as the source of data in the water sheds to conduct further research in the watershed.

Keywords: ArcGIS, watershed, watershed delineation, lake basin, DEM

Volume 6 Issue 6 - 2022

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Received: October 05, 2022 | **Published:** October 21, 2022

Introduction

Water is important for life and without water it was difficult to survive. Due to increasing population, water supply, irrigation agriculture, hydropower generation and industrialization the demand for water was increasing at high rate. So, making decision and monitoring this water resources was the key issue in the world. To do this understanding the bounder of the basin was important and this was done by water shed delineation. Watershed was not only hydrological condition of water bodies but it indicates socio-political and ecological condition of the water system which plays important role to identify socio- economic condition of the entire community and support the livelihood rural development of the community.[1]

Ethiopia was a country having 113 million hectares of land which was covered by different climatic and physiographic characteristics with high water potential resource having 122 BMC surface runoff annually and 2.9 BMC of ground water which was characterized by temporal and uneven spatial distribution throughout the country.[2] The water resource of Ethiopia was grouped into 12 basins which have 8 River basin, 1 Lake basin and 3 dry basins.[3] Among the 12 River basin of Ethiopia the lake basin was said to be Rift valley lakes basin which includes Lake Abaya, Lake Abiyata, Lake Chamo, Lake Hawassa, Lake Langano, Lake Shalla, Lake Ziway.[4–8]

Lake chamo basin was located in the rift valley basin which located in southern Ethiopia and due to deforestation and increase in farming lands around the lake basin was at great problem. There was sedimentation of the lake due to soil erosion. To understand what was happing in the basin delineation of water shed was the main issue. According to[9] the development of computer and information system to delineate watershed based on digital elevation model by using hydrologic model becomes research focus is the key steps and priority. Appropriate and successful delineation of watershed was a precondition for water quality modeling, sediment estimation for watershed management and utilization of the available water.[10]

Different scholar delineated watershed. Such as[4] uses arc hydro to delineate watershed, according to[11] Watershed delineation for Mahanadi River conducted by using ArcGIS and SWAT model,[5] focused on the need of watershed management by using Geospatial techniques. Awareness creation for the entire watershed at required places to utilize rainwater well was created,[6,12] automated watershed evaluation for Flat was done[7] use three ArcGIS packages like Arc hydro tools, TNTmips and River tool with in two DEM to implement a manual correction of DEM by using river burning technique to delineate watershed. In general catchment area and watershed delineation was common in hydrology for water resource monitoring and utilization of water resource optimally. The general objective of this study was delineation of watershed for lake chamo basin by using ArcGIS 10.4 to create boundary map for effective management and monitoring of the lake basin.

Materials and methods

Data required for the study

The shape file of Ethiopia, water body and River for ArcGIS was downloaded from www.diva-gis.org

The shape file of the world at global level was downloaded also from www.diva-gis.org

Digital elevation model was downloaded from https://earthexplorer.usgs.gov

Methodology

Methods for watershed delineation

The collected data was prepared for water shed delineation. By using ArcGIS model the watershed delineation analysis was carried out for this study. The area of the basin was calculated and bas map was created Figure 1, 2.

Mosaic the DEM: Two or more downloaded DEM based on image overlay were loaded in to ArcGIS. By selecting data management tool from Arc Toolbox, from Data management tool raster was selected, then from raster then raster data set was selected, finally from raster data set mosaic the DEM. The function of mosaic was to create the full required DEM for the study area downloaded from earth explorer during download it shows more than one image to download and one image may not cover the entire study area. So, more than two image was downloaded and mosaic Figure 3.

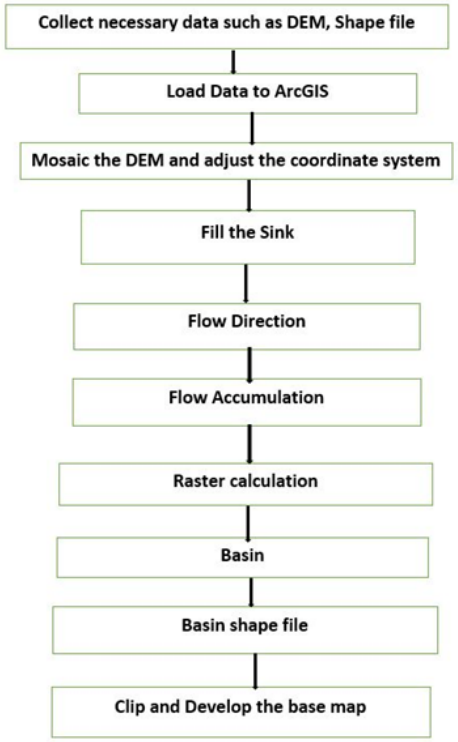

Figure 1 Flow chart for Watershed delineation methods.

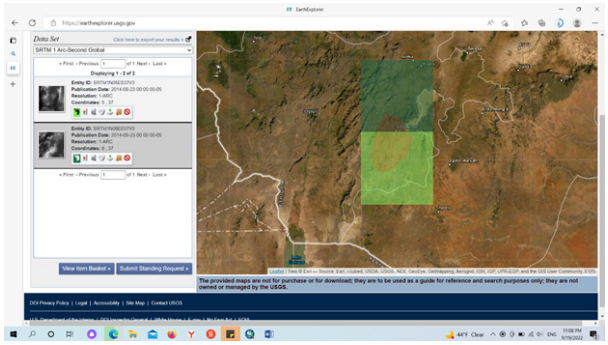

Figure 2 Image for Downloaded data.
Data downloaded from usgs.org

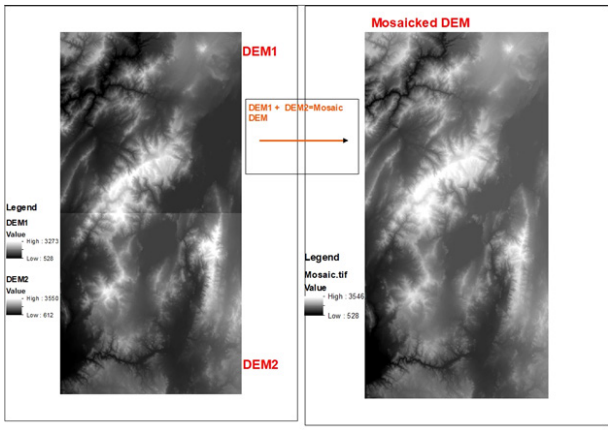

Figure 3 Mosaicked DEM from two raster Data set.

Fill the sink: Filling the sinks was very important to remove maximum and minimum elevation which affect water flow in the watershed in the direction of water flow. To create fill of raster from the mosaic DEM from the Arc Toolbox spatial analysis tool was selected, from spatial analysis tool hydrology then fill tool was selected and fill raster was created for lake Chamo river basin Figure 4.

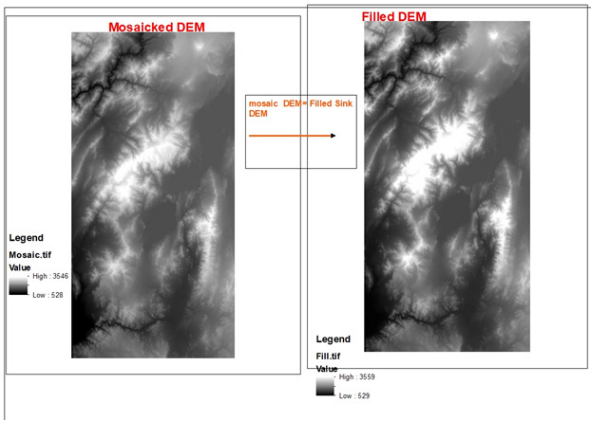

Figure 4 Filled sinks of DEM.

Flow direction: From the created fill raster data flow direction was calculated. From spatial analysis tool of Arc Tool box hydrology was selected and from hydrology flow direction of the lake Chamo was generated Figure 5.

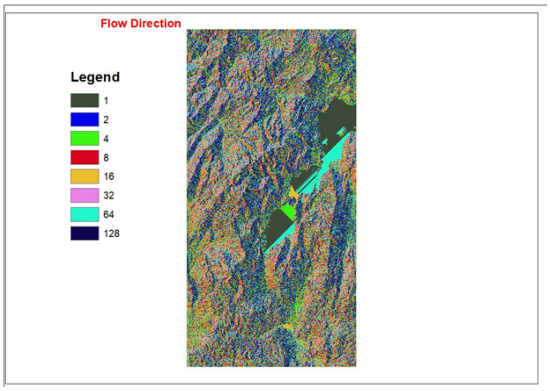

Figure 5 analyzed Flow Direction.

Flow accumulation: From generated flow direction by using spatial analysis tool box then hydrology flow Accumulation tool was selected and flow accumulation was generated Figure 6.

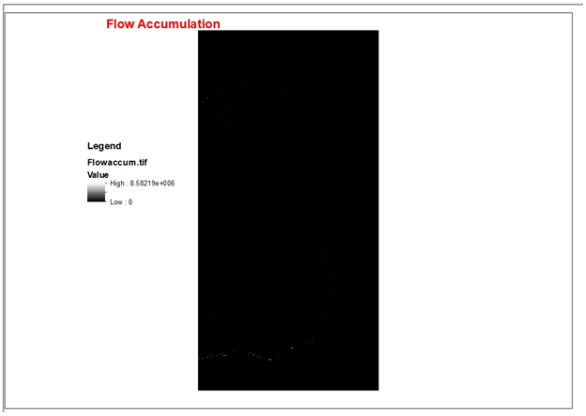

Figure 6 Generated flow Accumulation.

Raster calculation: by using map Algebra from hydrology tool raster calculation was done by using flow accumulation greater than 8000 cells of the raster forms stream networks and stream network was created Figure 7.

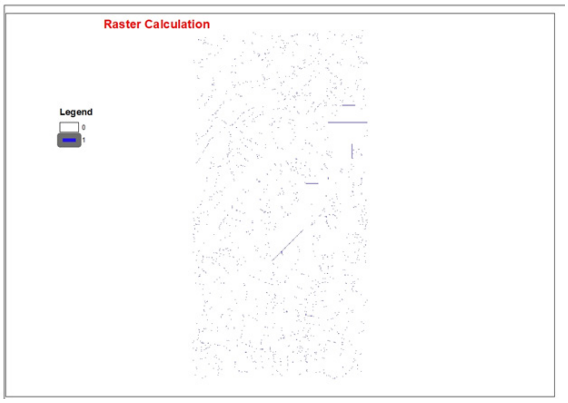

Figure 7 Raster Calculated for flow Accumulation.

Basin: The basin of the watershed was created by using spatial analysis tool then hydrology and finally select basin by using flow direction as input data and basin raster file was generated Figure 8.

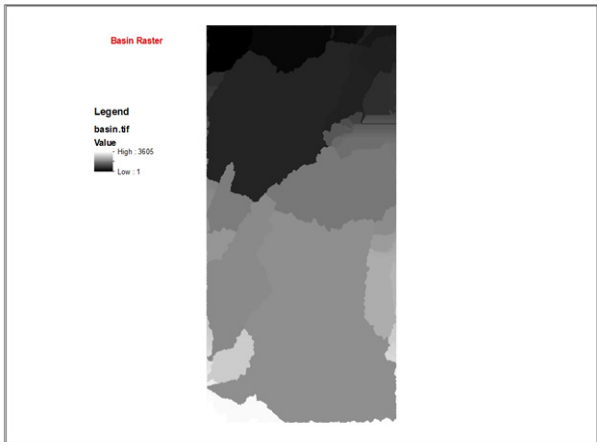

Figure 8 Generated Basin raster for flow direction.

Basin shape file: From the generated basin raster file by using conversion tool polygon of the watershed was created Figure 9.

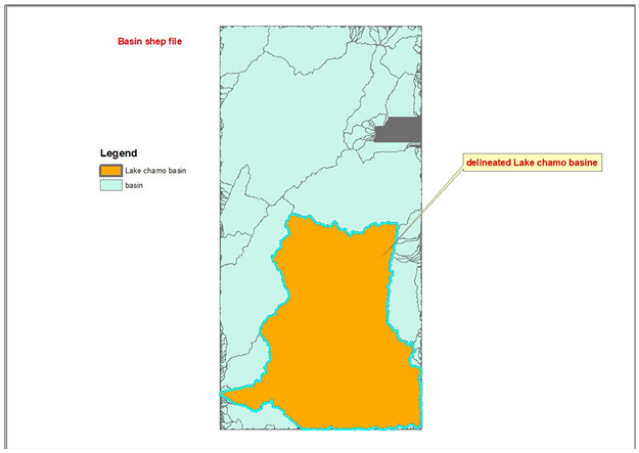

Figure 9 Shape file of the basins converted from created raster basin.

Stream flow polyline: By using conversion tool from Arc Toolbox stream flow raster file was converted from rater to polyline Figure 10.

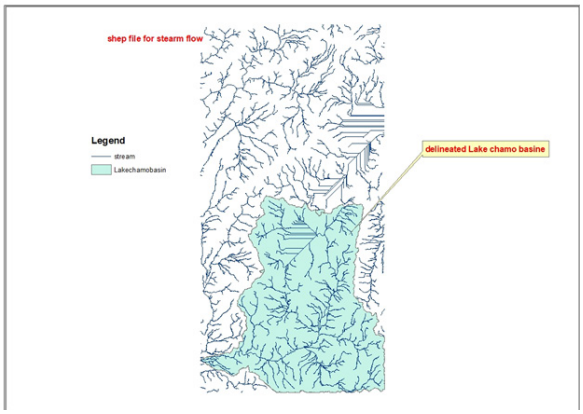

Figure 10 Shape file for stream flow converted from raster calculated DEM.

Clip: By using selection tool the watershed of the study area was selected and clipped by making layer from the selected shape file or by using Reprocessing tool and the watershed of the chamo lake was generated. In similar way steam line for the watershed was clipped at the extent of clipped watershed boundary Figure 11. The delineated watershed was clipped to within the great rift vally basin as a sub basin of rivet valley. This was the study area of the project Figure 12.

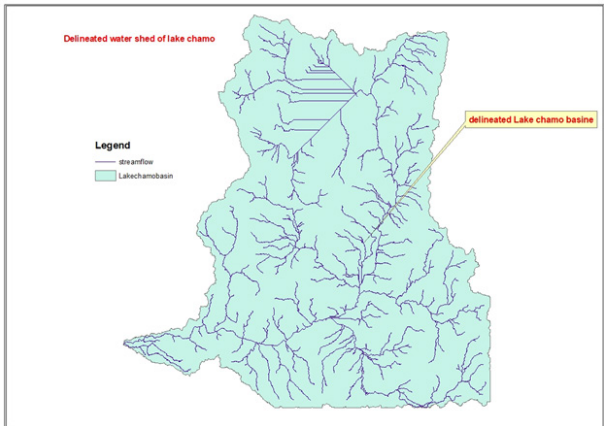

Figure 11 Clipped watershed of lake chamo and stream flow.

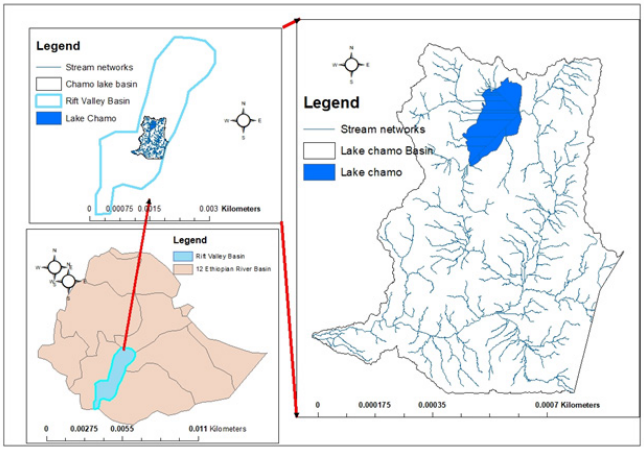

Figure 12 Generated watershed of lake Chamo Location in the river basin of Ethiopia.

Area of the watershed was calculated by projecting the clipped watershed shape file in to projected coordinated system and the by opening attribute table and create field area and calculate the area by using calculate geometry. Bas map for the study area was developed by using Geoprocessing tool and clipped to the required target map.

Results

By using special analyst tool of hydrology the water shed was delineated and the result shown the delineated watershed have area 8112.98 Kilo meter square Figure 13.

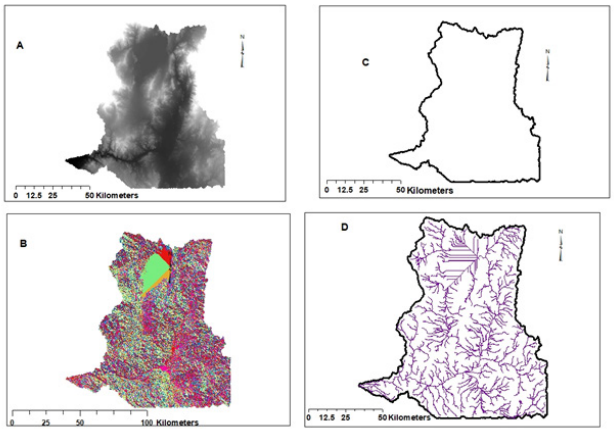

Figure 13 A- DEM of the watershed Clip, B- flow Direction generated, C-Shape file clipped D- The generated watershed with stream flow.

Discussion

The watershed of lake Chamo was delineated by using ArcGIS 10.4 and base map was created for study area. The area for the water shed was calculated by using Geometric calculation and the result was 8112.98 Kilo meter square. The base map of the area was created for planning water management strategies and making decision to set implementation of water management to utilize the mater resources optimally in the water shed without affecting socio economic activity and ecological characteristics of the water body Figure 14.

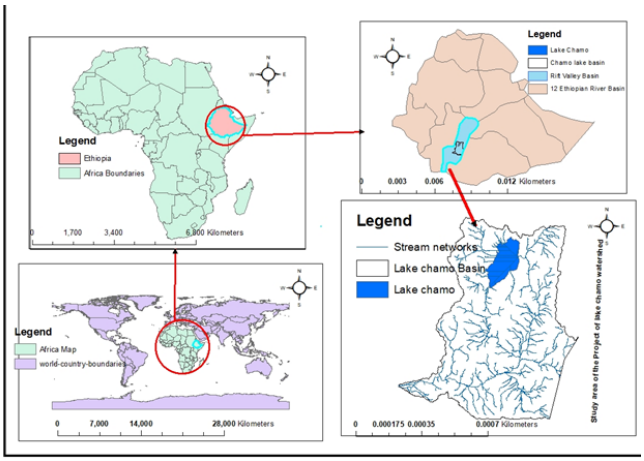

Figure 14 General map of Lake Chamo water shed for the research project.

Conclusion

Boundary for lake chamo watershed was developed and area for this water shed was calculated. The bas map for the lake chamo basin was created.

Recommendation

In the watershed due to deforestation and increasing in farming agriculture land degradation was the main problem in must be addressed for in order to manage this limited natural resource of water.

Rational of the study

In lake chamo basin due to increased farming system land degradation was very high and high soil erosion due to that there was change in of the water level due to sedimentation and this needs monitoring of the water shed of the lake. To monitor the water shade understudying the boundary of the basin was the primary point.

Conflict of interest

I declare that there is no conflict of interest for publication of this paper.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Availability of data and materials

The data collected and or analyzed during the current study were available from the corresponding author on request. The corresponding author had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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