



Basin morphometry? It is no longer an issue with HydroMachine toolbox

Mustafa Topsakal¹ · Enes Dogan¹ · Suleyman Sinan Yasak¹ · Furkan Corapci¹ · Hasan Ozdemir²

Received: 11 January 2025 / Accepted: 24 May 2025
© The Author(s) 2025

Abstract

Basin morphometry is a numerically examining the shape and topographic characteristics of a drainage basin. Although basin morphometry analyses with GIS have become increasingly common in recent years, the analyses have long preliminary preparation and calculation processes for large areas. The aim of this study is to produce a new toolbox called HydroMachine with a user-friendly interface that contains variables for river basin morphometric parameters under the ArcGIS Pro 3.4 and ArcGIS Desktop 10.8 software. The toolbox was applied to a single watershed to compare it with other morphometry toolboxes and to the regional river basins with 6945 Strahler watersheds to demonstrate its capability and time-consuming. The results show that this new toolbox reduces time for all processes within 3.5 h in a regional test case, eliminates user errors and comprises 11 basin morphometric parameters. It also allows the ranking of basin morphometric parameters for flood susceptibility.

Keywords HydroMachine · GIS · Basin Morphometry · Strahler Watershed

Introduction

Morphometry is generally defined as the science of numerical analysis of the size, shape and geometric properties of natural or man-made shapes and structures (Clarke 1996; Agarwal 1998; Obi Reddy et al. 2002). It is used in a wide range of fields, from biology to geography, geology to geomorphology. Morphometric analyses are crucial for understanding how structural forms are shaped, what processes they go through and how they change over time. Morphometric analysis, which is also applied in watershed systems, has traditionally been used to study land features in general (Jordan 2003; Sreedevi et al. 2005; Ehsani and Quiel 2008) and river basin systems in particular (Biswas et al. 1999; Srinivasa Vittala et al. 2004; Chopra et al. 2005; Ratnam et al. 2005; Dinagara Pandi et al. 2017; Chissende et al. 2025; Gezahegn and Mengistu 2025).

Basin morphometry is the quantitative study of the shape and topographic characteristics of a basin. The basin morphometry analyses are used in important processes such as understanding the dynamics of river systems, water management planning and evaluating natural hazards (López-Vicente et al. 2009; Conforti et al. 2011; Shaddoud et al. 2025). The most widely accepted principle of basin morphometry is that drainage basin morphology is an indicator of various climatic, geological and geomorphological processes that have occurred over time. The mentioned statement was emphasised in many morphometric studies (Horton 1945; Strahler 1952a, b, 1964; Muller 1968; Shreve 1969; Evans 1972, 1984; Chorley et al. 1984; Merritts and Vincent 1989; Ohmori 1993; Cox 1994; Oguchi 1997; Burrough and McDonnell 1998; Hurtrez et al. 1999; Ozdemir and Bird 2009). Basin morphometry has an essential role in soil properties, understanding erosion mechanisms and landform processes (Evans 1984; Delcaillau 2001; Beneduce et al. 2004; Capolongo et al. 2005; Ponza et al. 2010; Gioia and Schiattarella 2010; Gioia et al. 2011; Shekar et al. 2025). Furthermore, it contributes to the explanation of drainage networks and the three-dimensional geometry of a region. Also, it helps to understand the geological and geomorphological evolutionary process of the region (Singh 1980). Since basin morphometry is a significant topographic

✉ Mustafa Topsakal
topsakalmstf@gmail.com

¹ Institute of Social Sciences, Bursa Uludağ University, Geography, Bursa 16000, Türkiye

² Geography Department, Faculty of Art and Science, Physical Geography Division, Bursa Uludağ University, Bursa, Türkiye