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Research Article

Morphometric Analysis of Saz-Çayırova Drainage Basin using Geographic Information Systems and Different Digital Elevation Models

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Abstract

Drainage basin/watershed analysis based on morphometric parameters has an essential role in watershed management and planning. Reliable delineation of watersheds and drainage networks is critical for hydrological and geomorphological studies. Since access to high-resolution digital elevation models (DEMs) and digital surface models (DSMs) is costly, many researchers need to evaluate low-resolution open-source products. Several data sources produced from different surveying techniques are used in the morphometric analysis. In this study, five different datasets such as Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) GDEM, Shuttle Radar Topography Mission (SRTM) DEM, Advanced Land Observing Satellite (ALOS) DSM, National Aeronautics and Space Administration (NASA) DEM, and a DEM from topographic maps (TOPO DEM), were investigated based on morphometric parameters. The tests was carried out in the Saz-Çayırova Basin, which is one of the critical urbanization and industrialization regions of Kocaeli, Turkey. In this study, the TOPO DEM, whose horizontal resolution is 30 m, was produced from 1:25K scaled digitized topographical maps. It was used for comparative analysis, as in all DEMs sources. The morphometric parameters' result of the TOPO DEM was used as the reference data for comparing the results of the other DEMs sources. In addition, the mean absolute percentage error (MAPE) was used to compute the accuracy between the freely available DEMs and the TOPO DEM for each morphometric parameter. The outcomes of this study reveal that the most consistent results with the TOPO DEM are provided by SRTM DEM, following the NASA DEM.

Keywords: Basin Morphometric Analysis, ASTER GDEM, SRTM DEM, ALOS DSM, NASA DEM, Topographic Maps

Introduction

Water is a fundamental necessity for humans to survive their livelihood and food security and fulfill environmental functions by nature. With the development of technology, the pressures on soil and water resources have started to increase with the growth of the ways and rates of water use the distribution of water resources for many purposes such as drinking utilization, energy production, and irrigation water. River basins and drainage networks play an essential role for a wide range of water and land resources management applications such as flood prediction, contaminant transport, streamflow hydraulics (Jenson, 1991; Gazioğlu et al., 2014; Thomas and Prasannakumar, 2015; Çelik and Gazioğlu, 2020), and basin morphometric analysis (Horton, 1945; Strahler, 1964). For instance, the river carries nutrients, pollutants, or sediments, and water flows to the outlet of the basin in a certain period since it flows from higher to lower elevation (Kumari et al., 2021). Similarly, anthropogenic activities, especially rapid changes in land use/land cover (LULC), significantly impact rivers' flow rates and morphology (Pavanelli et al., 2019). Obtaining reliable information about drainage networks and watershed boundaries based on morphometric analysis is crucial for realizing hydrological, geomorphological, hydromorphological models and integrated watershed management.

The term morphometry consists of "morphe," which means shape/form, and "metria," which means measurement. From a geographic point of view, the term geomorphometry was identified by Pike (2000) as "the science of quantitative land-surface analysis." It comprises the analytic, cartographic, and modern approaches representing bare-earth topography with computer power (Tobler, 2000; Alpar et al., 2004; Gessler et al., 2009; Kaya et al., 2014;2015;2002). Accurately determining drainage networks and basin boundaries is fundamental for basin morphometry studies. Morphometric analysis of drainage basins gives an idea about the basin characteristics regarding basin geometry, slope, topography, soil condition, runoff characteristics, and surface water potential (Sukristiyanti et al., 2018). Also, it provides descriptive information about drainage networks and watersheds. Researchers use several data sources produced using different techniques for morphometric analysis. Topographic maps and databases and field surveying operations are traditional techniques. The information derived from these techniques depends on the scale factor and cell resolution of topographical maps. For example, some researchers have used different scales of topographic data such as 1:25.000, 1:50.000, or 1:100.000 to derive the basin's drainage network and to analyze morphometric characteristics of drainage systems (Esper Angillieri, 2008; Ozdemir and Bird, 2009; Sreedevi et al., 2009). The advanced methods use different resolution DEM data produced from remote-sensing and geographic information system (GIS) techniques (Mark 1983; O'Callaghan and Mark, 1984; Ozdemir and Bird, 2009; Karabulut and Ozdemir, 2019). Some researchers have compared their data sources and resolutions for morphometric analysis. Thomas and Prasannakumar (2015) used ASTER DEM (30 m) SRTM DEM (90 m) and compared two DEMs with the drainage network manually digitized from 1:50.000 scaled topographic maps. Their results demonstrated that SRTM DEM provides more consistent results with reference datasets in delineating the drainage network and extracting the basin morphometric parameters than ASTER DEM. Karabulut and Ozdemir (2019) compared different DEMs and DSMs sources produced by ASTER (30 m), SRTM (30 m), ALOS (30 m), and 1:25.000 scaled topographic maps (10 and 30 m) in two areas that have similar areal and formal features but have different vegetation density. They have selected topographic maps (10 m) as the reference dataset compared with the results of the other basin morphometric analyses. Their results showed that SRTM DEMs in one study area and ALOS DSMs in another gave the most consistent results. Shaikh et al. (2021) have assessed different open data sources such as ALOS, SRTM, Cartosat, ASTER, and Average DEM (produced by averaging the DEM pixels from the other four data sources) to compare various morphometric watershed parameters with the reference dataset. Their outcomes revealed that the SRTM and Cartosat DEM provided viable alternatives for reaching the morphometric analysis following the average DEM dataset.

Although many studies have been conducted to investigate the accuracy of DEMs, studies examining them in terms of morphometric parameters of the basins are not yet sufficient. In addition, studies focused on basins, especially in urbanized and industrialized regions, are entirely lacking. This study aims to measure the accuracy of DEMs obtained from different data sources on urbanized and industrialized topography in morphometric analysis. This research was conducted in the Saz-Çayırova Basin, located within the borders of Kocaeli province, on the Marmara coast of Turkey, where urban/industrial sprawl and population growth are intense. The morphometric parameters of this study area were examined using five different DEM sources (namely ASTER GDEM, SRTM DEM, ALOS DSM, NASA DEM, and Topographic DEM). Unlike the other studies, NASA DEM was used to investigate basin morphometric parameters for the first time. The morphometric parameters' result of topographic DEM (TOPO DEM) was used as the benchmark data to compare the results of the other DEMs sources. A DEM resolution of 30 meters was chosen for all data sources for a more accurate comparison. Besides, MAPE (Mean Absolute Percentage Error) was computed to reveal the accuracy of these DEMs through morphometric analysis in addition to the general comparison results.

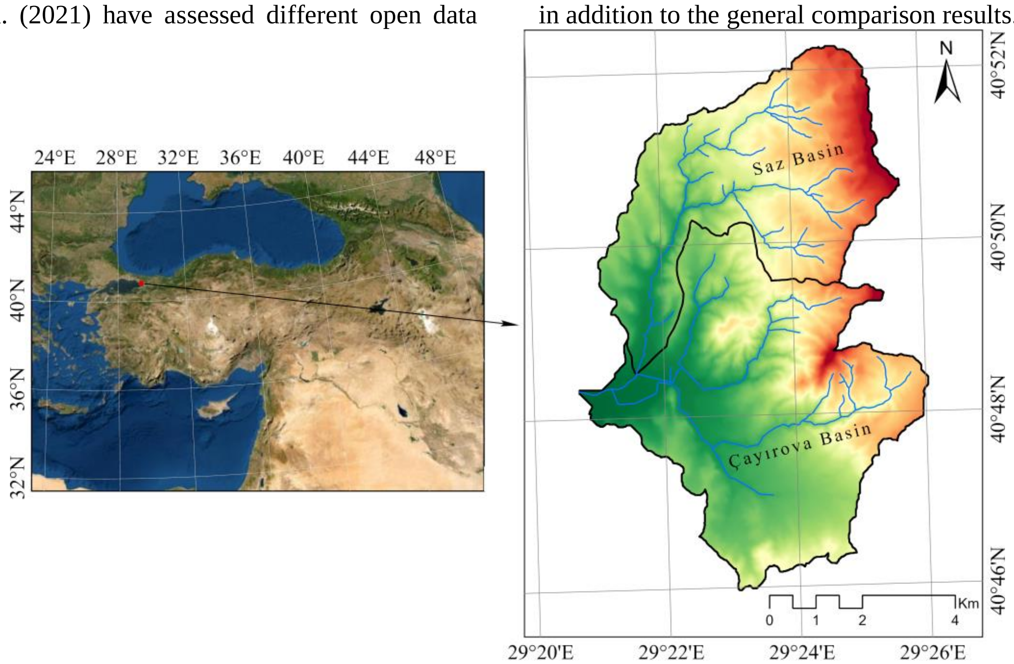

Fig. 1. The study area.

Materials and Methods

Study area: general physiography and climate

The Saz-Cayirova Basin, which lies within a sub-basin of the Marmara Basin in the northwest part of Turkey, was chosen as the study area (Figure 1). Saz and Cayirova are two neighboring streams that share an industrialized and urbanized small-scale catchment. The sub-basin areas of the Saz and Cayirova streams are approximately 20 and 30 km^2, respectively. The total length of the two-stream tributaries is 10 km, and their width varies between 2 and 20 m (Oruc et al., 2020).

The Saz-Çayırova Basin is in the transition zone between the Mediterranean and the Black Sea climate characterized by hot, humid summers and cold rainy winters. The annual average precipitation and temperature are 720 mm, and 15 °C, respectively. The catchment area is under the prevailing wind direction of NE (70%). The geological features of the stream were evaluated with the help of geological maps and field studies. The basin where the Saz Stream branches are located has predominantly low mineralization (siliceous), while the basin where the Çayırova branches are located has high mineralization (calcareous and alkaline). The abandoned metallic sulfide mining site, extracted lead (Pb), zinc (Zn), and copper (Cu), is located on the NW and SE parts of this study area, Pelitli Settlement of Gebze District in Kocaeli. In the mining site, 110.000 tons of geological reserves have been determined (MTA, 2010).

Data sources, processing, and methodology

In this study, five different data sources, namely ASTER GDEM, SRTM DEM, ALOS DEM, NASA DEM, and TOPO DEM gathered from different sources were used (Table 1).

Table 1. Characteristics of the different digital elevation models (DEMs)

Dataset	Horizontal Resolution (m)	Method	Data Collection Period
ASTER GDEM V3	30	Photogrammetry	2011
SRTM DEM V3	30	Interferometry Synthetic Aperture Radar	2000
ALOS DEM	30	Photogrammetry	2006-2011
NASA DEM	30	Interferometry Synthetic Aperture Radar	2000
TOPO DEM	30	Photogrammetry, Geographic Information System software, and field survey	2018-2022

ASTER, SRTM, NASA, and ALOS DEMs can be downloaded from the Earth Explorer of USGS (URL-1), the NASA EOSDIS Land Processes Distributed Active Archive Center (URL-2), and the Earth Observation Research Centre (EORC) of JAXA (URL-3) websites, respectively. TOPO DEM was created using 1:25.000 scale topographical maps. The elevation (contours and elevation points) and hydrography (streams, channels, lakes, and coastline) data of the current topographic databases produced by the Turkey General Directorate of Mapping (TGDM) in the Geographic Coordinate System (WGS 1984) were used to generate 30-meter resolution DEM. For further analysis, the four DEMs excluding TOPO30 DEM were reprojected into Universal Transverse Mercator (zone 35) Projection to have the same measurement units for x, y, and z directions. This dataset was used as benchmark data for comparing the basin morphometric results of ASTER, SRTM, ALOS, and NASA DEM.

ASTER GDEM was a multi-spectral advanced imager in December 1999 by the Ministry of Economy, Trade, and Industry (METI) of Japan and Japanese Aerospace Exploration Agency (JAXA) onboard the TERRA spacecraft of NASA. This DEM was generated from a compilation of cloud-free ASTER stereo-pair images acquired with nadir and backward angles over the same area, and then it was released in 2009 (Tachikawa et al., 2011). Its coverage spans from 83°N to 83°S latitude, encompassing 99% of Earth's land area. ASTER GDEM is available in geo-tiff format by 1°×1° tiles at one arc-second resolution (Bildirici and Abbak, 2017). The vertical and horizontal datum of the ASTER is EGM96 and WGS84, respectively.

The SRTM project was jointly realized by NASA, the National Imagery and Mapping Agency (NIMA), the German Space Agency (DLR), and the Italian Space Agency (ASI). It was introduced on 11 February 2000 to obtain worldwide topographical information. Data on the Earth's landmass was collected between ±60° latitudes (JPL, 2021). Initially, the 3-arc second version of these data was released. Since 2014, SRTM DEM has had access to 1-arc seconds outside the United States of America to open up new analytical options for DEM (Shaikh et al., 2021).

In addition to the mentioned above DEMs, the ALOSWorld3D 30 m DEM (AW3D30) was released free of charge by the JAXA in 2016. This dataset is based on archived data of Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) and a Phased Array Type L-band Synthetic Aperture Radar (PALSAR) onboard (Karabulut and Ozdemir, 2019). Using millions of images, the JAXA generated worldwide DEM. The image has a 2.5 m pixel size (spatial resolution), but the DEM was generated at a 5 m resolution commercial version and distributed at a particular cost.

The NASA DEM is a modernization version of the different DEMs sources such as ASTER, Ice, Cloud, and land Elevation Satellite (ICESat) and Geoscience Laser Altimeter System (GLAS), and associated products reprocessed from the SRTM data (Uuemaa et al., 2020). It has been distributed in 1°×1° tiles at one arc-second resolution and consist of all land from 60°N to 56°S latitude. The main objective was to provide voids filling and eliminate other limitations present in the SRTM dataset (Crippen et al., 2016). Before performing the basin morphometric analysis of this study area, different steps were implemented on all the datasets using the ArcHydro toolbox of ArcGIS 10.5 software. Firstly, each DEM was hydrologically corrected using fill sinks and stream burning processes to fix errors like sinks and peaks in the data. Then, a flow direction process (representing the flow direction from each cell) was performed on the filled datasets using the hydrologic analysis. After this operation, flow accumulation (defining the accumulated number of cells upstream representing the upstream catchment area) grids were derived from the hydrologically corrected DEMs, and 1% of the maximum flow accumulation value was used as the number of cells to define stream (Olivera et al., 2002). Finally, the drainage lines and watershed boundaries of this study area were determined using specified batch or pour points on the flow accumulation dataset for each DEM dataset. Basic descriptors and selected morphometric parameters were then calculated, and their general assessment results were compared with the TOPO DEM result. Last but not least, Mean Absolute Percentage Error (MAPE) was computed using Equation 1 to evaluate the accuracy of different DEM sources based on basin morphometric analysis. Finally, their parameters' results and percentage errors were compared with the results of TOPO DEM (Figure 2).

$$\mathrm{MAPE} = \frac{100}{n}\sum_{i=1}^{n}\left|\frac{(\mathrm{TOPO\ DEM})_i - (\mathrm{Other\ DEM})_i}{(\mathrm{TOPO\ DEM})_i}\right| \qquad \text{(Eq. 1)}$$

where n shows the number of morphometric parameters.

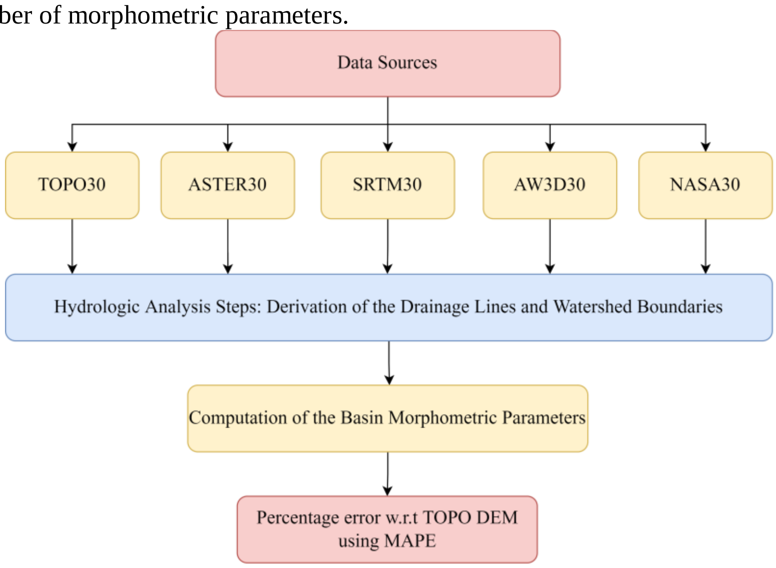

Fig. 2. Flowchart of the methodology

Table 2. The selected morphometric parameters and their expressions

Sr. No	Morphometric parameters	Unit	Formula	References
Basic descriptors				
1	Basin perimeter (P)	km	Perimeter of basin	GIS software
2	Basin area (A)	km^2	Area of basin	GIS software
3	Stream order (U)	-	Hierarchical rank	(Strahler, 1964)
4	Stream number (N_u)	-	Hierarchical ordering	(Horton, 1945)
5	Stream length (L_u)	km	Length of the stream	(Horton, 1945)
Linear Characteristics				
6	Bifurcation ratio (R_b)	-	$R_b = N_u/N_{u+1}$	(Strahler, 1964)
7	Length of overland flow (L_g)	km	$L_g = 1/2D_d$	(Horton, 1945)
8	Texture ratio (T)	km/km	$T = \Sigma N_1/P$	(Smith, 1950)
Areal Characteristics				
9	Drainage density (D_d)	km/km^2	$D_d = \Sigma L_u/A$	(Horton, 1945)
10	Drainage frequency (F_d)	km^2	$F_d = \Sigma N_u/A$	(Horton, 1945)
11	Gravelius index (K_g)	-	$K_g = 0.282\, P/\sqrt{A}$	(Gravelius, 1914)
Relief Characteristics				
12	Time of concentration (T_c)	hour/minute	$T_c = 0.39\sqrt{A} + D_d^2$	(Sharifi and Razaz, 2014)
13	Ruggedness number (R_n)	-	$R_n = R \times D_d$	(Strahler, 1958)
14	Basin relief (R)	m	$R = H_{max} - H_{min}$	(Schumm, 1956)

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Results and Discussion

The quantitative evaluation of the Saz-Çayırova basin has been performed by computing various morphometric factors. In the morphometric analysis of drainage networks, these factors are classified into linear, areal, and relief characteristics. The selected morphometric parameters and their explanation for each DEM source are given in Table 2.

Table 3 highlights the results of morphometric assessment for the Saz-Çayırova basin using the TOPO and other freely available DEMs, respectively. These parameters have been compared in the below-mentioned sections.

Basic Descriptors

Basin Perimeter and Area

The physical features and stream networks such as perimeter and area are significant in the basin hydrology. The basin area is where precipitation collects and drains into a river outlet. The basin perimeter is the total measurement of the watershed borderline. The perimeter derived from NASA30 DEM was close to the TOPO30 result compared with other DEMs. On the contrary, AW3D30 gives a maximum error for finding the basin perimeter (Figure 3). Compared with the TOPO DEM result, although other data sources give approximately similar results, NASA DEM is closer to TOPO DEM. Therefore, it is considered best suited to the Saz-Çayırova basin for boundary identification.

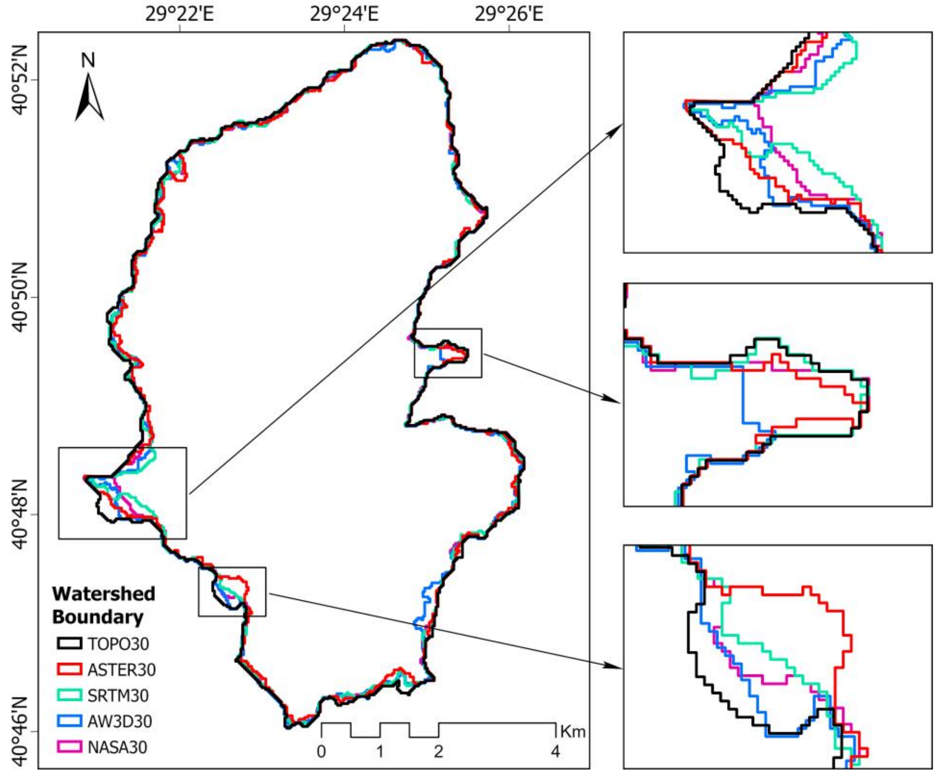

Fig. 3. Watershed boundaries from different DEM sources

Stream Order, Stream Number, and Stream Length

The mapping and ordering of stream channel networks are fundamental topics in hydrology, geomorphology, and water resource management. Stream order is a technique for characterizing the constituent parts of a drainage network. Strahler's (1957) scheme is most widely used in basin morphometric analysis. Ordering can start from the outlet and move upstream, or it can start from each source and move downstream (Gülgen, 2017). Based on the TOPO DEM, the Saz-Çayırova basin has been identified as the fourth-order river basin (Table 3). Contrary to NASA DEM results, this ordering is also ensured using other DEMs

Stream number comprises the total number of tributaries in each stream order. The total number of streams derived from ASTER, SRTM, and NASA (54, 55, and 51, respectively) is relatively lower than TOPO DEM (61). The stream numbers are inversely related to stream order, and the exact relationship is relatively observed in this study area. Figure 4 shows the stream number's result for each order of the stream network derived from TOPO DEM and other DEMs sources. The higher number (50.82%, 51.85%, 50.91%, 50.77%, and 50.98%, respectively) of first-order streams for TOPO30, ASTER30, SRTM30, AW3D30, and NASA30 source suggests less permeability of the formation in this stream order.

Table 3. The results of morphometric parameters derived from five different DEM sources

Morphometric parameters	TOPO30	ASTER30	SRTM30	AW3D30	NASA30
Basic Descriptors					
Basin perimeter (P)	48.84	52.24	51.30	52.56	49.14
Basin area (A)	51.85	50.11	50.33	50.30	50.45
Stream order (U)	4	4	4	4	5
Stream number (N_u)	61	54	55	65	51
Stream length (L_u)	50.62	54.80	54.26	55.50	49.42
Linear Characteristics					
Bifurcation ratio (R_b)	3.58	1.78	2.59	1.71	2.16
Length of overland flow (L_g)	0.51	0.46	0.46	0.45	0.51
Texture ratio (T)	0.63	0.54	0.55	0.63	0.53
Areal Characteristics					
Drainage density (D_d)	0.98	1.09	1.08	1.10	0.98
Drainage frequency (F_d)	1.18	1.08	1.09	1.29	1.01
Gravelius index (K_g)	1.90	2.06	2.02	2.06	1.94
Relief Characteristics					
Time of concentration (T_c)	226	236	236	239	224
Ruggedness number (R_n)	0.31	0.34	0.34	0.35	0.31
Basin relief (R)	311.59	311	312	314	314

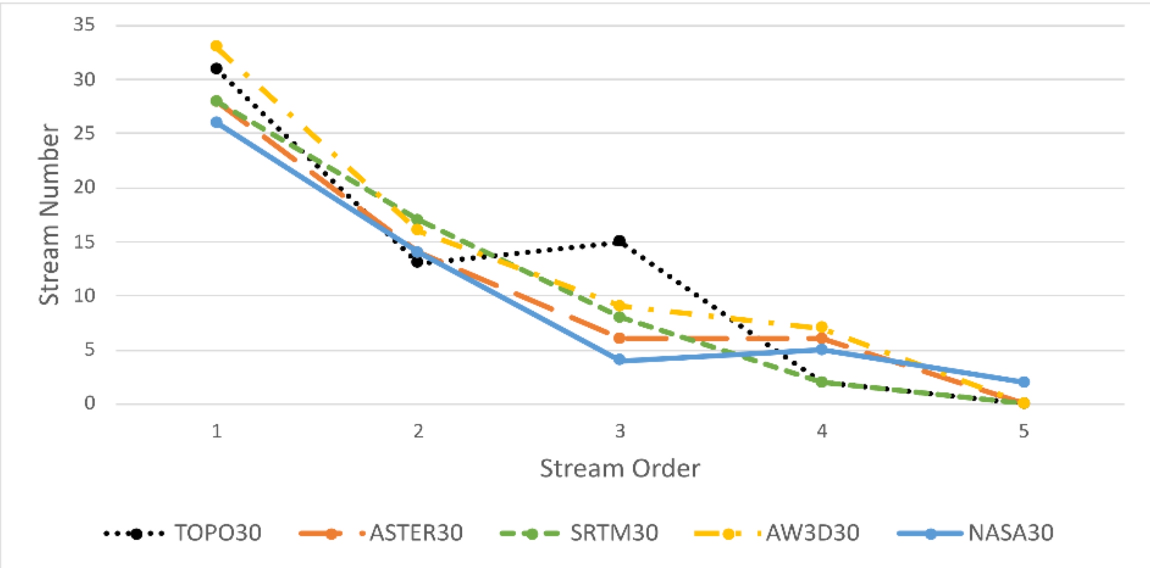

Fig. 4. The relationship between the stream number and stream order.

Stream length is a cumulative sum of stream order lengths in a basin. It indicates the behavior of surface runoff on the basin, which has an essential role in the drainage basin network. Figure 5 shows the extracted stream network results derived from TOPO DEM and other DEMs sources. The total length of streams of the Saz-Çayırova basin derived from TOPO30 (50.62 km) is closely followed by NASA30 (49.42 km), while ASTER30, SRTM30, and AW3D30 have a relatively more significant value (54.80, 54.26, and 55.50 km, respectively).

Linear Characteristics

Bifurcation ratio

Depending on the Strahler stream order method, the Bifurcation ratio is expressed as the ratio of the number of streams of any order to the number of streams of the next higher-order (Horton, 1932; Strahler, 1958). For the developed stream network on nearly homogeneous lithology and geology, this ratio is between 2 and 5 (Chow et al. 1988). The value R_b derived from TOPO30 is significantly higher than other DEMs sources. However, the R_b value (2.59 and 2.16, respectively) obtained from SRTM30 and NASA30 is close to the R_b value of TOPO30 and these low the R_b reflects the elongated shape of this study area (Figure 3).

length of overland flow

Length of overland flow (L_g) reveals the relationship between the factors controlling surface erosions, depending on the drainage density of the basins. This parameter is directly related to drainage density. The results derived from TOPO30 and NASA30 are identical (L_g = 0.51). The values L_g obtained from the other three DEM data other than NASA30 differ from the reference level but are significantly close.

Texture ratio

Texture ratio (T) is the ratio of the total tributaries in the first order to the basin perimeter. It is an essential factor in basin morphometric analysis, which depends on the underlying slope, soil type, climate, rainfall, vegetation, and infiltration capacity aspect of the terrain. The obtained T values from ASTER30, SRTM30, and NASA30 reveal that the number of tributaries in the first order that flows water to the mainstream is low. However, the T value generated from the AW3D30 is precisely the same as the reference value.

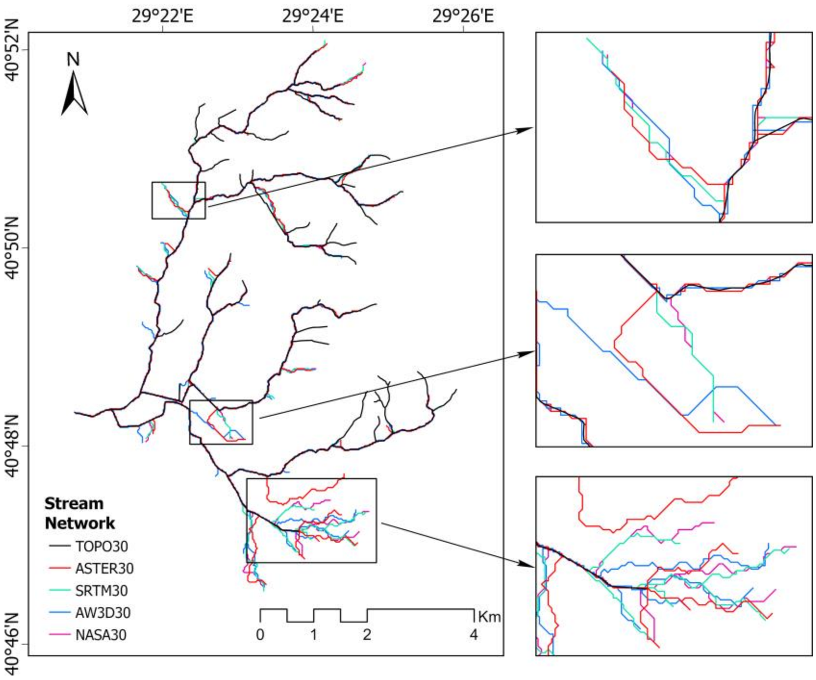

Figure 5. The extracted stream networks from different DEM sources

Areal Characteristics
Drainage density

Drainage density (D_d) is obtained by dividing the total drainage length in the basin by the catchment area. It provides essential information regarding the infiltration capacity of the land, climate and runoff potential, and vegetation cover of the basin (Thomas and Prasannakumar, 2015). The low drainage density results for all DEMs indicate a coarse texture of this study area. While the results derived from TOPO30 and NASA30 are identical (0.98), all DEM sources' results reveal that surface water seeps into the underground and a basin with resistant rocks. This situation leads to additional time for the travel time of water and high groundwater recharge potential due to a high permeable surface.

Drainage frequency

Drainage frequency (F_d) is defined as the total number of stream segments per unit area (Horton, 1945). It is directly related to permeability, infiltration capacity, and basin relief. The results F_d derived from all DEM sources show considerable variability in Table 3 (1.18, 1.08, 1.09, 1.29, and 1.01 km^2, respectively). Therefore, the low results for all DEMs can also be attributed to relatively lower relief, higher infiltration capacity, and dense vegetation cover.

Gravelius index

Gravelius Index (K_g) or compactness coefficient is an index that explains basin shapes and is the ratio between the basin perimeter and the perimeter of a circle with the same basin area (Gravelius, 1914). This index value is 1 for an ideally circular watershed. Index values derived from all sources reveal that it indicates more deviation from the circular nature of the basin and produces similar results.

Relief Characteristics
Time of concentration

Time of concentration (T_c) is the longest time required for a particle to travel from the watershed divide to the watershed outlet. It is one of the essential components in determining the hydrograph shape and the hydrograph peaks. In this study, the concentration-time is computed using the Sharifi and Razaz (2014) formula (Table 2). According to the all DEMs sources results in Table 3, the value T_c derived from NASA30 (224 minutes) is significantly closer to that of TOPO30 (226 minutes), while ASTER30, SRTM30, and AW3D30 have a comparatively higher value (236, 236, and 239 minutes, respectively).

Ruggedness number

Ruggedness number (R_n) is obtained by multiplying the basin relief and the drainage density. It generally deals with the longitudinal gradient (Strahler, 1958). The ruggedness number depends upon underlying geomorphology, geology, steepness, climate, and slope of that region. In this study area, while the results derived from TOPO30 and NASA30 are identical (0.31), the other DEM sources have similar results compared to TOPO30. The low values R_n obtained from the Saz-Çayırova basin indicates the erosion's mature and maximum denudation stages.

Basin relief

Basin relief (R) is the vertical distance between the outlet and the point with the highest elevation of the watershed. While identifying the watershed's erosion properties, it is proved to be a crucial parameter (Shaikh et al., 2021). The R values derived from all DEM sources have similar results, and the difference between them is mainly due to the varying vertical accuracy of the data.

Determining the accuracy of DEM sources

The NASA DEM has performed better than other DEMs for most parameters. However, a few parameters also exhibited consistent ASTER DEM, ALOS DEM, and SRTM DEM (Table 3). Besides, some morphometric parameters have a positive variation, whereas some have an entirely negative variation for each DEM source. For example, the Gravelius index exhibits a positive variation, while the bifurcation ratio demonstrates a negative variation for each DEM in Table 3. On the other hand, some of the morphometric parameters demonstrate a positive variation for a few DEMs, whereas a negative variation for some other DEMs. For instance, concentration-time has a positive variation for ASTER30, SRTM30, and AW3D30, whereas it is harmful to NASA30 DEM.

Similarly, the drainage frequency has a negative variation for ASTER30, SRTM30, and NASA30 but has a positive variation for AW3D30. Therefore, MAPE has been used to provide better analysis and statistically identify the best performing DEM in the morphometric analysis to address such conditions (Table 4). A less than 10% MAPE value indicates that the forecast is acceptably accurate. A MAPE greater than 10% but less than 25% indicates low accuracy.

Table 4. MAPE results of different DEM sources concerning TOPO30

Error	ASTER30	SRTM30	AW3D30	NASA30
MAPE (%)	10.49	8.62	10.02	8.11

In this study, an analysis of fourteen morphometric parameters has been conducted. When the percentage error values in Table 4 are examined, NASA DEM is the best-suited method for the morphometric analysis of the Saz-Çayırova Basin. On the other hand, according to SRTM30 and NASA30 results, ASTER DEM and ALOS DSM were not provided relevant results compared to TOPO DEM. Apart from the NASA DEM, the SRTM DEM was also performed high accurate forecasting well.

Conclusions

The present study investigates the usability of different DEMs in terms of morphometric parameters in an industrialized and urbanized small-scale watershed. The selected various morphometric parameters (linear, areal, and relief aspects) such as bifurcation ratio, length of overland flow, texture ratio, drainage density, drainage frequency, Gravelius index, time of concentration ruggedness number, and basin relief were implemented on the Saz-Çayırova basin using five different datasets: ASTER DEM (30 m), SRTM DEM (30 m), ALOS DEM (30 m), NASA DEM (30 m), and TOPO DEM (30 m) derived from 1:25.000 scaled topographical maps.

According to the general assessment results, NASA DEM gave the closest results to the reference data in almost all the parameters implemented in this study area. This situation was directly related to the data generation process (modernization version of different DEMs and reprocessing from SRTM data). On the other hand, each DEM source gives only a few morphometric parameters the best result. Therefore, MAPE is considered in this study for determining the overall accuracy of DEMs. Finally, the MAPE outputs of this study reveal that the most consistent results with the TOPO30 DEM are provided by SRTM30 DEM, following the NASA30 DEM for this study area (8.11% and 8.62%, respectively). The reason for the production of different parameter values from other DEM sources may be due to the inability to fully reflect the surface topography characteristics of the region due to intense urbanization and industrialization. Further studies will be performed on basins with distinct characteristics to a more precise comparison of morphometric parameters.

Acknowledgments

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