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ORIGINAL ARTICLE

Comparative Study of Different Types of Digital Elevation Models on the Basis of Drainage Morphometric Parameters (Case Study of Wadi Fatimah Basin, KSA)

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Abstract
Nowadays there are a lot of geospatial datasets available in the form of different types of Digital Elevation Models (DEMs) which were launched with different resolutions. These datasets are used for studying the physiographical features of the hydrographic basins through the tracing and extracting the elevation points, watershed boundaries, streamlines, flow directions and morphometric parameters assessment. Many researchers have used these datasets to study and evaluate the hydrologic behavior of the basins which is considered as the reflection of physiographic features of the hydrographic basins. In the Middle East especially in Saudi Arabia, the trend of using DEMs increased for hydrographic basin analysis and assessment of hydrologic behavior. So, there is an important question about the accuracy and sensitivity of these datasets which are acquired from different DEMs. This study deals with four types of DEMs, first is derivative from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER 30 m resolution), second is Shuttle Radar Topographic Mission (SRTM 90 m resolution), third is SRTM 30 m resolution and the fourth is the Advanced Land Observing STLT (ALOS 30 resolution). More than 35 morphometric parameters including drainage network, basin geometry, basin texture and basin relief characteristics were measured and calculated using these four types of DEMs and calibrated with topographic maps of 1:250 K and 1:50 K scale and also google earth maps. Results show that the SRTM 30 m is characterized by high accuracy and has a very good matching with google earth maps and topographic map of scale1:50,000. This research is dealing with the comparison of the morphometric parameters of the hydrographic basin based on the type of DEM. It is clear to conclude that the SRTM 30 resolution is the best type for hydrology and water resources study.

Keywords Digital elevation model · DEM · ASTER · SRTM · Basin · Morphometric

1 Introduction

In recent years there is a huge demand for using the geospatial datasets of different DEMs to study and assess the physiographic features and hydrologic behavior of hydrographic basin. So, there is an important question about the accuracy and sensitivity of these datasets which are acquired from different DEMs. This study deals with four types of DEMs (ASTER 30 m, SRTM 90 m, SRTM 30 m and ALOS 30 m resolution).

Summerfield and Hulton (1994) stated that physical aspects of the drainage basin are controlled by topographical features. Pike (2000); Lague et al. (2003) recommended that the topography should be analyzed quantitatively to determine the relative efficiency of its components. Smedberg et al. (2009) described that the rivers represent the landscape in a very sensitive way, in which Whipple (2001); Tucker (2004) added that the fluvial systems exhibit long-term changes in the streams due to variation in climate, lithology and tectonics as also stated by Kirby and Whipple (2012); Whittaker (2012). Rinaldi (2003) concluded that the variations in climate and tectonic movements can affect the fluvial system's response in the form of stream morphological

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modifications, flows and sediments and reshaping of the landforms and landscape at the river banks. Bali et al. (2011) concluded that these changes are displayed as main irregularities in the morphometric parameters of rivers.

According to Hooke (2008); Trimble (2009), despite the fact that researchers are focusing more on process examination, chronology and materials, the analysis of drainage properties still has the main role in geomorphology as said by Prasanna kumar et al. (2013). There are two categories of geo-morphometry, general and specific. Evans (2012) stated that the general geo-morphometry examines the complete land surface form while specific geo-morphometry analyses properties of individual landforms.

Goudie (2004) reported that the morphometric parameters of a catchment are the quantitative features, extracted from the topography, surface elevations, and drainage networks. Some of these parameters are drainage texture, basin geometry and relief characteristics. Ferraris et al. (2012); Jacques et al. (2014) said that analysis of these characteristics gives a base for determining the controls related to structure and lithology in the landscape and getting the history of plate tectonics of the area under study. Use of Digital elevation model (DEM) has many edges over traditionally used topographical maps for morphometric parameters calculation of river basins. A DEM is basically a digital model of land surface terrain which should be of desired accuracy and free from data voids. Integration of DEMs with GIS software is very easy.

According to Sefercik and Alkan (2009), the elevation models available before year 2000 were covering the whole world with spatial resolution of 1 km (Global Terrain in 30 arc/sec—GTOPO-30) and (The Global Land 1 km—Base Elevation Project—GLOBE). But, during the last decade, high resolution DEMs such as the Shuttle Radar Topography Mission (SRTM) (90 m resolution and 30 m resolution), Advanced Land Observation STLT (ALOS) (30 m resolution) and the Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) (30 m resolution) came into existence. DEM data are preferred over traditionally used topographical maps because of their seamlessness and global data coverage. DEMs have been used across the world in many researches in which terrain and drainage features play important role. Many studies on morphometric parameters analysis with DEMs show its application all across the globe (Morris and Heerdegen 1988; Dietrich et al. 1993; Snyder et al. 2000; Korup et al. 2005; Mesa 2006; Wilson et al. 2008; Lindsay and Evans 2008; Ferraris et al. 2012; Jacques et al. 2014; Caraballo-Arias et al. 2014).

In Saudi Arabia, the trend of using DEMs for Wadi basin analysis, water resources assessment and morphometric parameter calculation is increased in recent years (Elfeki et al. 2017; Basahi et al. 2016; Masoud 2015, 2016).

DEM resolution is the main governing factor for the scale of parameters extracted in geo-morphometric analysis (Dragut et al. 2009). Many studies have been studied to assess the accuracy of individual DEMs such as SRTM (Gorokhovich and Voustianiouk 2006; Weydahl et al. 2007) and ASTER (Eckert et al. 2005; San and Suzen 2005; Cook et al. 2012) to look the difference between the extracted morphometric parameters. According to Saran et al. (2009), DEMs of high resolution have more accuracy and a higher extraction and traces for the watershed, tributaries and relief characteristics.

Pre-release of ASTER was found to show better outcome than SRTM in west Japan (Hayakawa et al. 2008) while its later release yielded poor results as compared to SRTM in mountainous areas of Turkey (Sefercik 2012). There are very few studies in which the comparison of morphometric parameters extracted from two or more DEM datasets is being done (Lindsay and Evans 2008; Taramelli et al. 2008; Hirt et al. 2010; Hosseinzadeh 2011; Suwandana et al. 2012; Gopinath et al. 2014), although in these studies the focus was to compare absolute elevation parameters with less focus on morphometric parameter derivation.

In this study, the main objective is to do comparison between the available different types of DEMs (ALOS, ASTER and SRTM with different resolutions). The morphometric properties of the Fatimah watershed (Makkah province, KSA) are initially calculated from different DEMs, and then finally compared and correlated to find the best dataset of digital elevation model for geo-morphometric analysis especially for such arid regions.

2 Study Area

Wadi Fatimah basin is situated in the west of Saudi Arabia in Makkah al Muhkarramah province (39°9´E–40°30´E and 21°16´N–22°15´N) as shown in Fig. 1. It covers an area of about 5130 Km^2 and discharges into the Red sea.

Gemorphologically, Fatimah watershed is a typical Wadi system of arid areas starting from high mountains in the east of western side of escarpment ridge of Arabian shield and ending in the western flat sediment coastal plains of Tihama near Red sea. Wadi Fatimah basin elevation starts from 0 at the red sea and rise up to 2317 m with the mean elevation of 717.56 m.

Geologically, Wadi Fatimah basin has a long history, where it comprises of Pre-Cambrian, Tertiary and alluvial deposits (Quaternary) as shown in Fig. 2. Basement rocks of this Wadi occupies about 64% of the study area and are composed of Proterozoic basalt, volcano rhyolite and volcano-clastic with some intrusions of miscellaneous ages and conformations. The Tertiary rocks which consist of sandstone, shale intercalated with conglomerates occupies

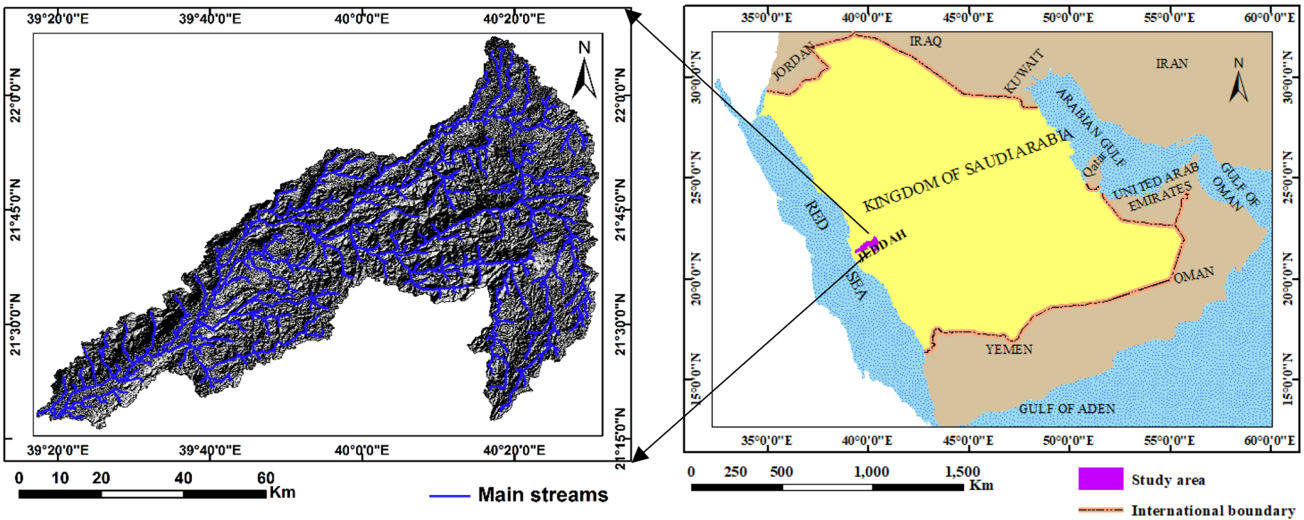

Fig. 1 Location map of Wadi Fatimah

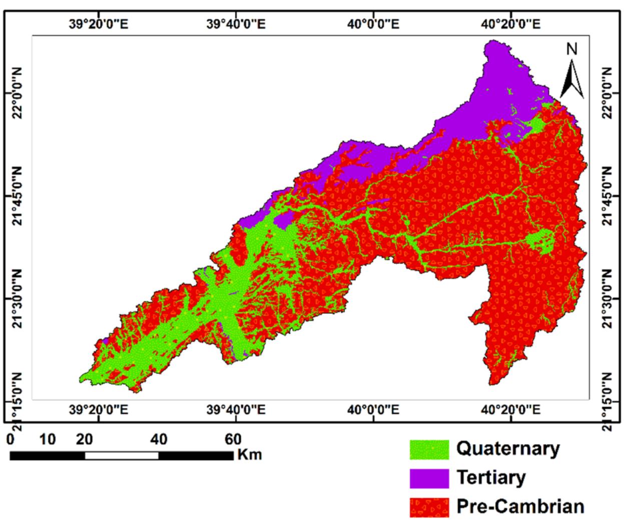

Fig. 2 Geological map of Wadi Fatimah basin

about 14% area of Wadi Fatimah basin and lying beneath the lava and alluvial deposits. Alluvial deposits of Quaternary age occupy about 22% of the study basin which is 2–75 m thick layer and is composed of gravels, sand, sandstone and conglomerates intercalated with some shale.

3 Data and Methodology

3.1 Data Used

In this paper, data from four freely available DEMs (ASTER, SRTM90, SRTM30 and ALOS) have been investigated by extracting the tributaries and topographic features, calculation of numerous morphometric parameters and then compared with those of the topographic sheets and the google earth maps. The parameters derived from the DEMs are related to drainage texture, relief characteristics, drainage network and basin geometry. Contour maps, generated from these DEMs, are compared with the contours of the topographic maps (1:250,000 and 1:50,000) to see the difference between them. Some characteristics of the datasets used in this study are as follows:

- DEM of SRTM 90 m resolution: In February 2000, Shuttle Radar Topography Mission (SRTM) was launched by National Aeronautics and Space Administration (NASA) as a first attempt to fulfill the need of high resolution DEM around the globe. This DEM has a spatial resolution of 3 arc-second (Approx. 90 m) (USGS USGS 2004). It uses WGS84 projection in meters and is available worldwide.
- DEM of ASTER 30 m resolution: In June 2009, the data of Advanced Spaceborne Thermal Emission and Reflection Radiometer, Global Digital Elevation Model (ASTER GDEM) was made accessible by NASA for research and academic use (USGS and Japanese ASTER Program 2003). Its coverage extent ranges from 83°N to 83°S and is composed of 22,600 tiles (1 arc-second) in GeoTIFF format. It also uses WGS84 geoid projection.
- DEM of SRTM 30 m resolution: On Sep 23, 2014, the US government stated at a UN summit that the NASA's Shuttle Radar Topography Mission (SRTM) 1arc-second resolution topographic data was to be made available for public use. After this statement all global 30 m resolution SRTM data, which was only available for USA, was

released to public use. (https://www.jpl.nasa.gov/news/news.php?release=2014-321).

- DEM of ALOS 30 m resolution: The Japanese Aerospace Exploration Agency (JAXA) released global dataset of digital surface model (DSM) with resolution of approximately 30-meter (1arc-second). This dataset contains images captured by the Advanced Land Observing STLT (ALOS). The data were made available for scientific research, education and private sector in May 2016.
- Topographic maps of 1: 250,000 scale were acquired from the Ministry of Petroleum and Mineral Resources (MoPM), Kingdom of Saudi Arabia (KSA), this sheet number is NF37-11. This map was compiled in 1982 by the ministry from aerial photography taken during 1980.
- Topographic maps of 1: 50,000 scale were acquired from the Ministry of Petroleum and Mineral Resources (MoPM), KSA topographical maps [sheet numbers 3921-(11, 12, 13, 14, 21, 24, 31, 34, 42), 4021-(13, 14, 31, 34, 41, 42, 43, 44) and 4022-(32, 33)]. The survey of these maps was done in 1970.

General information about data sources used in this study is shown in Table 1.

3.2 Study Methodology

After getting the hard copies of topographical maps (scale 1:250,000 and 1:50,000) from Ministry of Petroleum and Mineral Resources, they were scanned at 300 dots per inch and later they were georeferenced. Standard procedure was adopted to extract the stream network from SRTM, ASTER and ALOS DEMs in GIS environment as shown in Fig. 3, (Band 1986; Tarboton et al. 1991; Gurnell and Montgomery 1999; Maidment 2002). All the DEMs were first filtered by filling the gaps (Jenson and Domingue 1988). Sometimes, there are some inherent data sinks or spikes. These errors need to be removed before starting any analysis (Wood 1996). The above step was done with all the DEM datasets being used in this study. After filling the data voids, stream networks were extracted from these DEMs.

O'Callaghan and Mark (1984) developed a method called D8 which is used to draw the flow direction of the surface runoff (flowing towards the steepest pixel out of 8 neighboring pixels) and is widely applied around the globe. As shown in Fig. 3, after filling the DEMs, flow direction, flow accumulation and threshold was performed to get drainage network in Arcmap 10.2. After that, the stream ordering scheme of Strahler (1954) is used to do the ordering of the drainage network where each of the fingertip tributary was assigned Order 1 and the joining point of two similar order streams give another stream of one higher order. This scheme was applied for the categorization of streams derived from all the DEMs. Figure 4a–d represent the drainage networks of Wadi Fatimah watershed, as extracted from SRTM90, SRTM30, ASTER30 and ALOS30 DEMs, respectively.

All the six datasets (4 downloaded DEMs and 2 surveyed topographical maps) were uploaded in ArcGIS10.2 to do the comparison. Finally, all the morphometric parameters extracted from those six data sets are mapped for comparison.

3.3 Morphometric Parameters Obtained From the DEMs

Using all available DEMs, stream networks and catchments are extracted and then used to calculate more than 35 morphometric parameters. These calculated parameters for each data source are then compared with those of other data sources to determine the most accurate DEM for morphometric analysis. The details of the morphometric parameters compared are shown in the Table 2.

Table 1 Information about the DEMs and the Maps used in this study

Sr. no.	Production authority	Topographic maps and DEMs details	Survey year/date of release	Spatial resolution/ scale
1	NASA, USA	SRTM DEM: N021E039-N022E040	2000	90 m
2	NASA, USA	ASTER GDEM: N021E039-N022E040	2011	30 m
3	NASA, USA	SRTM DEM: N021E039-N022E040	2015	30 m
4	EORC, JAXA	ALOS DSM: N021E039-N022E040	2016	30 m
5	MoPM, KSA	Map no. NF37-11, first edition 1982, compiled from aerial photography taken during 1980, produced by Aerial Survey Department (A.S.D) Ar Riyad.	1980	1:250,000
6	MoPM, KSA	Map no. 3921-(11,12,13,14,21,24,31,34,42), 4021-(13,14,31,34,41,42,43,44) and 4022-(32,33), first edition 1978, compiled from aerial photography taken during 1970, produced by Pacific Aero Survey Co., Ltd. under supervision of A.S.D Ar Riyad.	1970	1:50,000

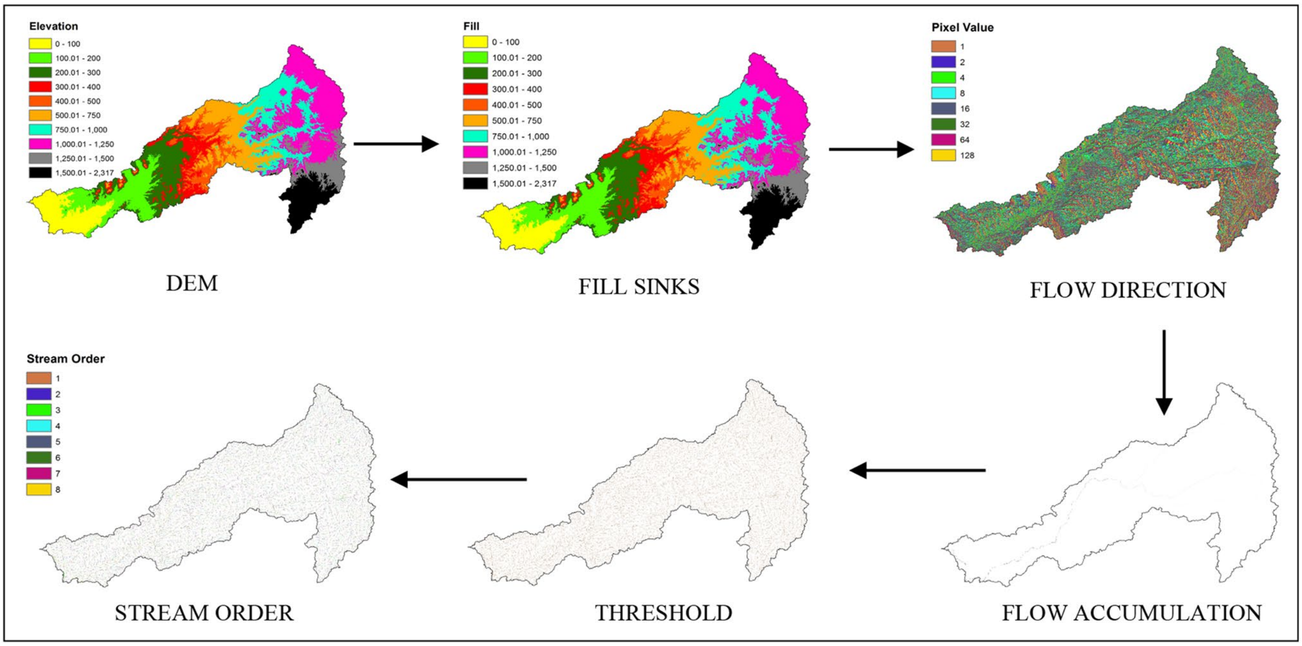

Fig. 3 Stepwise procedure of getting stream order out of DEM

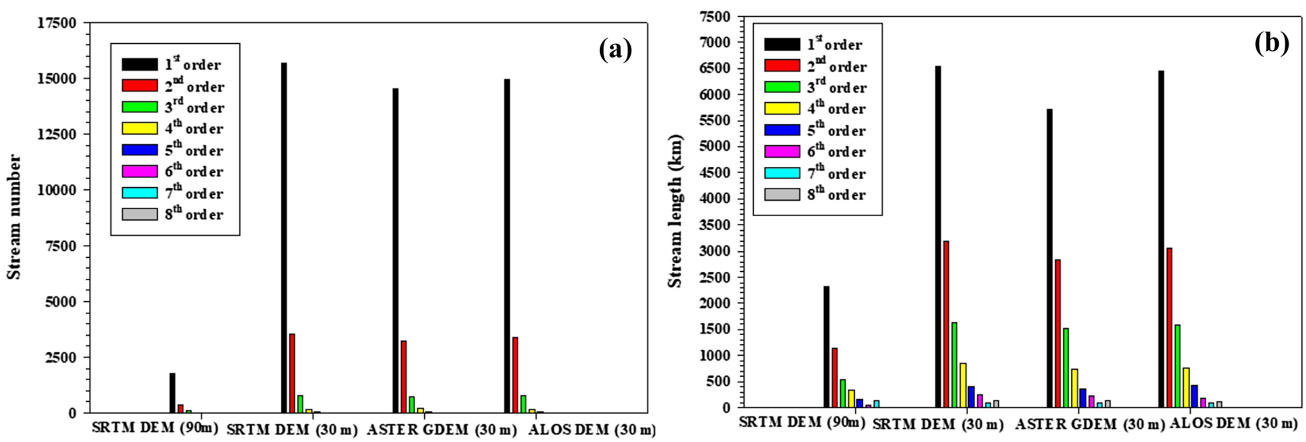

Fig. 4 Comparison of stream numbers (**a**) and stream lengths (**b**) derived from different DEMs

The parameters in Table 2, were derived from all the DEM datasets and then matched with each other to find out which DEM is providing us better results. The contours extracted from these DEM datasets were also compared to contours on google earth, topographic maps of 1:250 k and 1:50 k scale considering 1:50 k scale topographical map as standard. Table 3 shows all the morphometric parameters extracted from different DEM datasets.

4 Results and Discussion

4.1 Morphometric Properties, Comparison, and Flow Direction of Four Different DEMs

Figure 4a, b shows the comparison of streams numbers and stream lengths, respectively, derived from different DEMs. It is prominent that the longest stream lengths and maximum number of streams was obtained from SRTM30, ASTER30 and ALOS30 which means that the finer the resolution, the more stream counts will be found. Moreover, all the 30 m resolution DEMs gave 8th as the highest order stream while

Table 2 Morphometric parameters and their details

Morphometric parameters			Symbol	Formula	References
Drainage network	1	Stream orders	u	Hierarchical rank	Horton (1945); Strahler (1952, 1957,1964)
	2	Stream numbers	Nu	Nu = N1 + N2 + N3 + …Nn	Strahler (1952)
	3	Stream length	Lu	Lu = L1 + L2 + …Ln	Horton (1932)
	4	Bifurcation ratio	Rb	Rb = Nu/Nu + 1	Horton (1945); Strahler (1957,1964)
	5	Weighted mean bifurcation ratio	WMRb	$\mathrm{WRMB} = \sum(\mathrm{Rbu}/\mathrm{Rbu}+1)\frac{(\mathrm{Nu+Nu+1})}{\sum N}$	Strahler (1952)
	6	Main channel Length	MC	GIS software analysis	
	7	Main channel index	MCi	Ci = (main channel length)/(maximum straight of the main channel)	Mueller (1968)
	8	Sinuosity	Si	Si = VL/LB	Gregory and Walling (1973)
	9	Rho coefficient	ρ	$\rho = L_u r/\mathrm{Rb}$	Horton (1945)
Basin geometry	10	Watershed Area	A	GIS software analysis	Schumm (1956)
	11	The basin length	LB	GIS software analysis	Schumm (1956)
	12	The basin perimeter	Pr	GIS software analysis	Schumm (1956)
	13	Basin Width	W	$W = A/\mathrm{LB}$ (km)	Horton (1932)
	14	Circularity ratio	Rc	$\mathrm{Rc} = 4\,\pi\,A/\mathrm{Pr}^2$	Miller (1953)
	15	Elongation ratio	Re	$\mathrm{Re} = \left(2\sqrt{A/\pi}/\mathrm{LB}\right)$	Schumm (1956)
	16	Texture ratio	Rt	$\mathrm{Rt} = \sum \mathrm{Nu}/\mathrm{Pr}$	Horton (1945)
	17	Form factor ratio	FFR	$\mathrm{FFR} = A/\mathrm{LB}^2$	Horton (1932)
	18	Inverse shape form or Shape factor ratio	Sv	$\mathrm{Sv} = \mathrm{LB}^2/A$	Horton (1932)
	19	Basin shape index	Ish	$\mathrm{Ish} = 1.27A/\mathrm{LB}^2$	Haggett (1965)
	20	Compactness ratio	SH	$\mathrm{SH} = \mathrm{Pr}/2(\sqrt{\pi A}$	Horton (1945)
	21	Fitness ratio	Fr	Fr = channel length/perimeter	Melton (1957)
	22	Lemniscate shape	Ls	$\mathrm{Ls} = (3.14)\,(\mathrm{BL})^2/(4\,\mathrm{A})$	Chorley and Morley (1959)
Drainage texture	23	Stream frequency	F	$F = \sum_{i=1}^{K} \mathrm{Nu}/A$	Horton (1932, 1945)
	24	Drainage density	D	$D = \sum Lu/A$	Horton (1932, 1945)
	25	Drainage intensity	Di	$\mathrm{Di} = F/D$	Faniran (1968)
	26	Length of overland flow	Lo	Lo = 1/2D	Horton (1945)
	27	Infiltration number	FN	FN = (F)(D)	Faniran (1968)
	28	Drainage pattern	Dp	Stream network using GIS software analysis	Horton (1932)
Relief characteristics	29	Maximum elevation	H_{max}	GIS software analysis using DEM	
	30	Minimum elevation	H_{min}	GIS software analysis using DEM	
	31	Relief	Rf	Rf = highest elevation-lowest elevation	Strahler (1952)
	32	Internal relief	E	$E = (\mathrm{E85}–\mathrm{E10})$	Strahler (1952)
	33	Mean Elevation	Hm	GIS software Analysis using DEM	
	34	Relief ratio	Rr	Rr = (Rf/LB)100	Schumm (1956)
	35	Slope index	SI %	SI = (E/0.75VL)100	Majure and Soenksen (1991)
	36	Mean basin slope	Sm	GIS software analysis using DEM	
	37	Ruggedness number	Rn	Rn = Rf. D	Melton (1957)
	38	Hypsometric Integral	HI	$\mathrm{HI} = (\mathrm{Elev}—\mathrm{Elev}_{min})/\mathrm{Elev}_{max}—\mathrm{Elev}_{min})$ Elev is the mean elevation, Elev_{max} is the maximum elevation and Elev_{min} is the minimum elevation	Strahler (1952)

Table 3 Morphometric properties of Wadi Fatimah basin derived from different DEMs

Morphometric properties	SRTM DEM (90 m)	SRTM DEM (30 m)	Aster GDEM (30 m)	ALOS DEM (30 m)
Drainage network				
Stream orders	7	8	8	8
Stream numbers	2261	20,210	18,797	19,376
Stream length (Km)	4672.463	13054.642	11582.419	12671.024
Bifurcation ratio	3.424	3.259	3.133	3.226
Weighted mean bifurcation ratio	4.577	4.447	4.436	4.395
Main channel length	142.099	143.314	133.238	116.165
Main channel index	1.532	1.551	1.665	1.465
Sinuosity	0.897	0.907	0.943	0.832
Rho coefficient				
Basin geometry				
Watershed area	5373.780	5392.225	5130.570	4997.440
Basin length	158.320	158	141.330	139.650
Basin perimeter	635.102	714.700	643.100	650.830
Basin width	33.942	34.128	36.302	35.785
Circularity ratio	0.167	0.132	0.156	0.148
Elongation ratio	0.522	0.524	0.572	0.571
Texture ratio	3.560	28.277	29.229	29.771
Form factor ratio	0.214	0.216	0.257	0.256
Inverse shape form or Shape form ratio	4.664	4.629	3.893	3.902
Basin shape index	0.272	0.274	0.326	0.325
Compactness ratio	2.444	2.746	2.533	2.598
Fitness ratio	0.224	0.200	0.207	0.178
Lemniscate shape	3.661	3.634	3.056	3.063
Drainage texture				
Stream frequency	0.421	3.748	3.663	3.877
Drainage density	0.869	2.421	2.257	2.535
Drainage intensity	0.483	1.548	1.663	1.529
Length of overland flow	0.575	0.206	0.221	0.197
Infiltration number	0.366	9.073	8.271	9.831
Drainage pattern	Dendritic	Dendritic	Dendritic	Dendritic
Relief characteristics				
Maximum elevation	2309	2332	2317	2345
Minimum elevation	0	0	0	2
Relief	2309	2332	2317	2343
Internal relief	1210	1060	755	1085
Mean elevation	715.680	713.176	717.680	766.740
Relief ratio	0.014	0.014	0.016	0.017
Slope index	0.011	0.009	0.007	0.012
Mean basin slope	7.456	10.150	8.740	11.470
Ruggedness number	2.007	5.645	5.231	5.941
Hypsometric integral	0.310	0.305	0.309	0.327

the only one SRTM90 DEM gave 7th order as the highest as shown in Fig. 4b.

The results showed that the DEM resolution plays important role in the extraction of morphometric parameters. Bifurcation ratio and weighted mean bifurcation ration for all the DEMs was approximately the same. However, the highest order channel length found to be the same for SRTM90 and SRTM30 while it was the lowest for ALOS30 as shown in Fig. 4a. Most of the physical characteristics of the basin such as area, basin length and elevations are close to those values of the SRTM

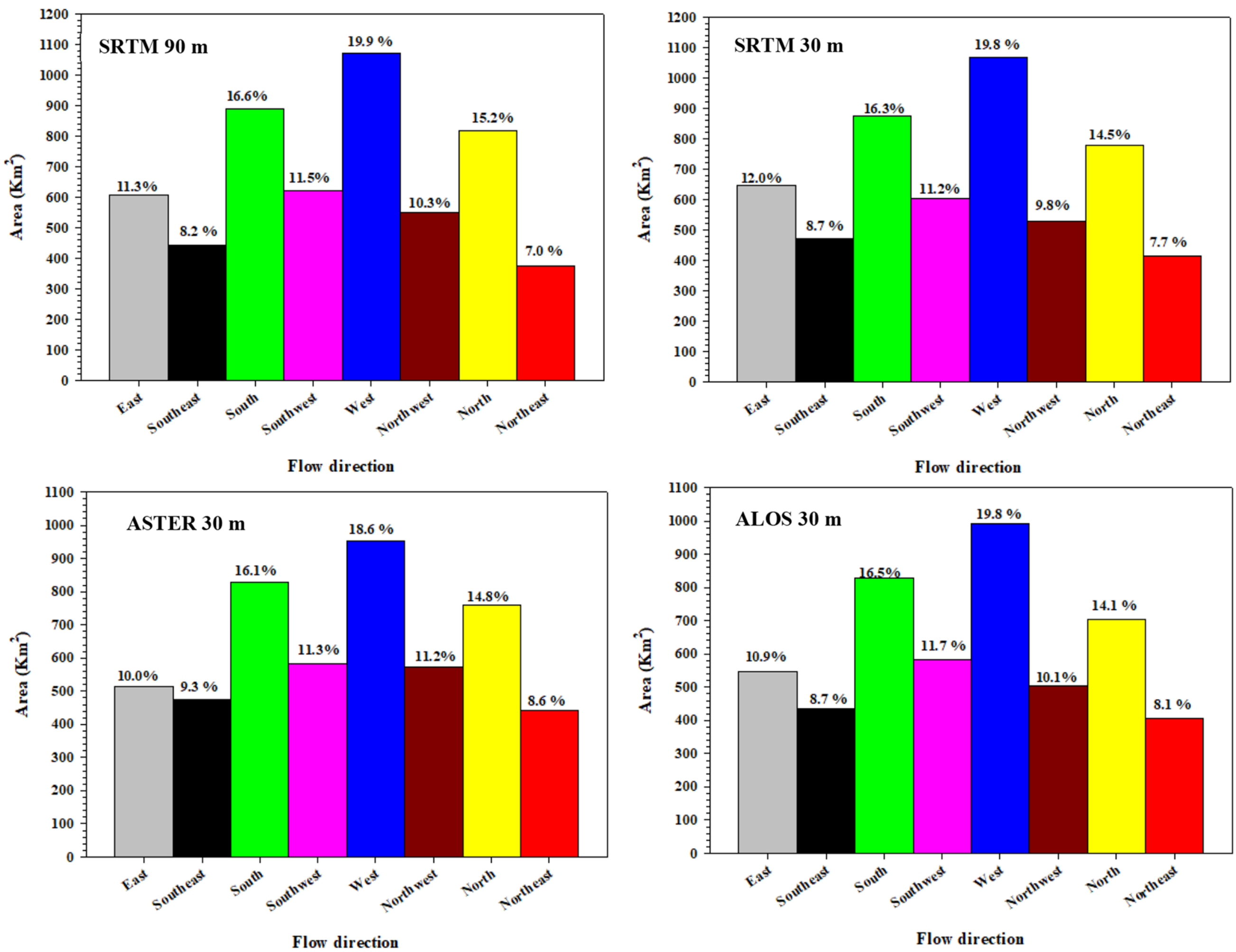

Fig. 5 Flow direction frequency distribution histogram of Wadi Fatimah basin with different types of DEMs

30 m. Based on the flow direction histogram, it was found that there is no noticeable difference between them as shown in Fig. 5. On the other hand, based on the slope of the basin, it is clear to see the similarity in the slope of the ASTER 30 m and SRTM 30 m while both SRTM 90 m and ALOS 30 m are not matching with the others as shown Fig. 6.

4.2 Calibration of the DEMs Accuracy

Because of the hypsometric curve is representing the elevation values and their corresponding areas and also is reflecting the age behavior and activity of the basin, the hypsometric curve shape is considered the best parameter to select the suitable DEM for studying the hydrologic behavior of the basin. Figure 7a, b show the results of hypsometric curves and altitude of Wadi Fatimah basin which extracted from the different DEMs. It is clear that the results show that ALOS 30 m does not match the other types of DEMs.

In addition, because the capacity curve expresses the relationship between the elevation and corresponding water volume, this calibration could depend on it to select which DEM is suitable to study the hydrologic behavior of the basin. By calculating and plotting the capacity curves of Wadi Fatimah basin using Watershed Modeling System (WMS) code based on the same location of the actual dam coordinates as outlet point, it is clear to conclude that the best and suitable DEM for Wadi Fatimah basin is SRTM 30. Where the capacity volume of the calculated value (19×10^6 m^3) of Wadi Fatimah basin is very close to the actual value as shown in Fig. 8.

Ragheb (2015) reported that the google earth is one of the important reference and base maps for calibration and for studying with high degree of accuracy (less than 2 meters). Based on Ragheb (2015) it is clear to conclude that the SRTM 30 m is more accurate than the other tested DEMs. Denker (2005) used GTOPO30 (30″ resolution) and SRTM3 (3″ resolution) and compared it with national DEMs

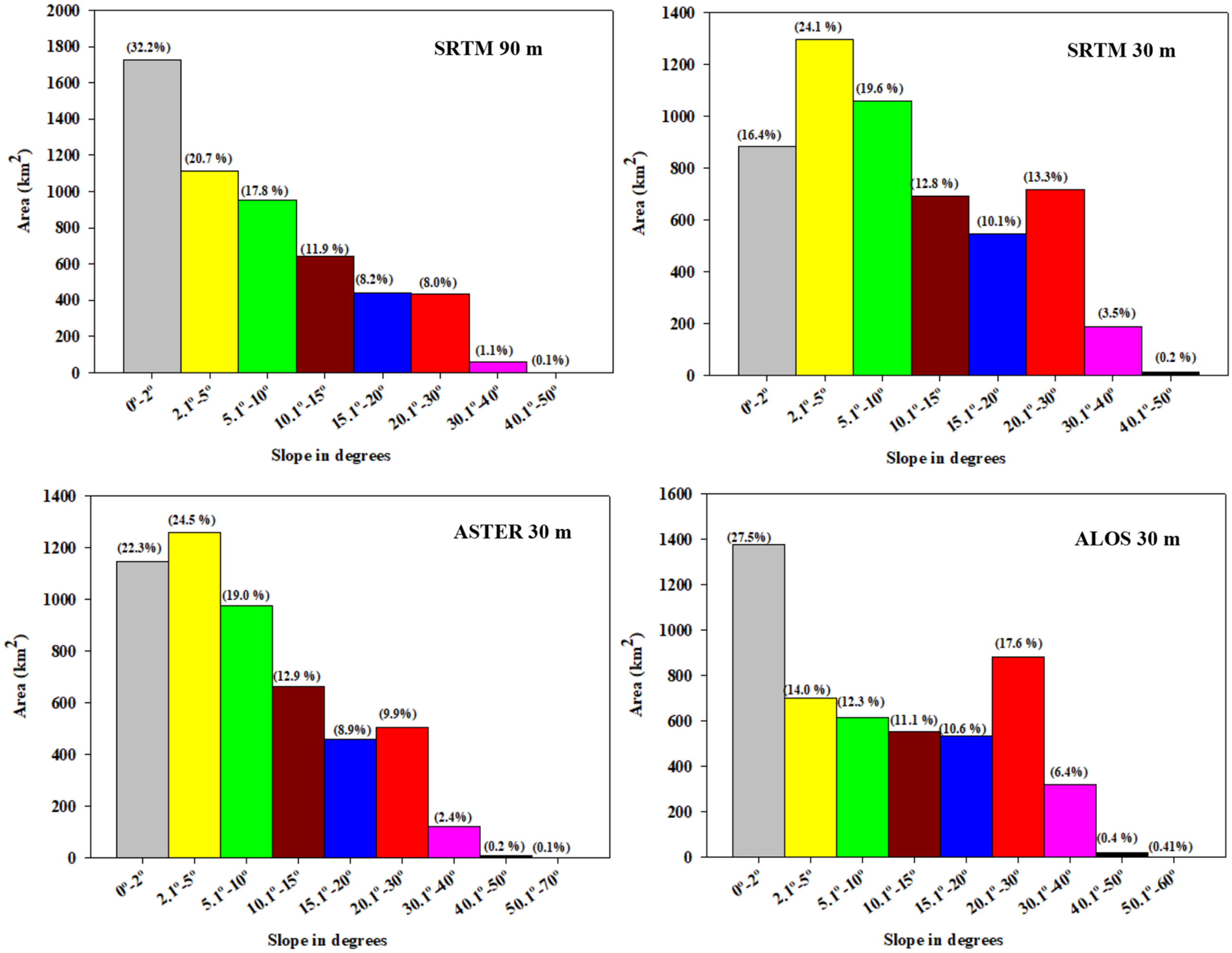

Fig. 6 Slope frequency distribution histogram of Wadi Fatimah basin with different types of DEMs

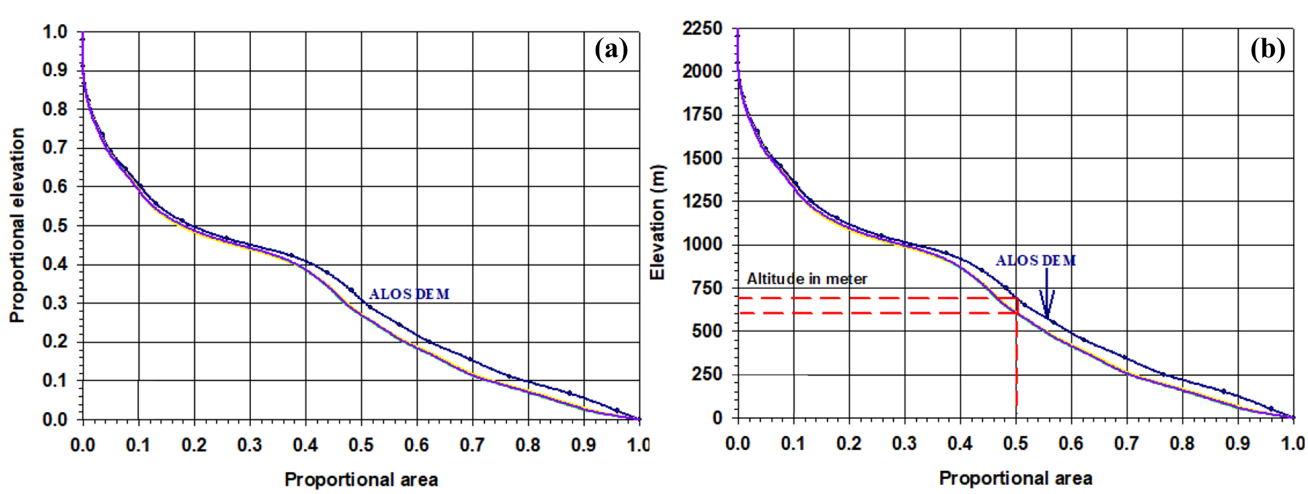

Fig. 7 Hypsometric (**a**) and altitude (**b**) curves of Wadi Fatimah basin with different types of DEMs

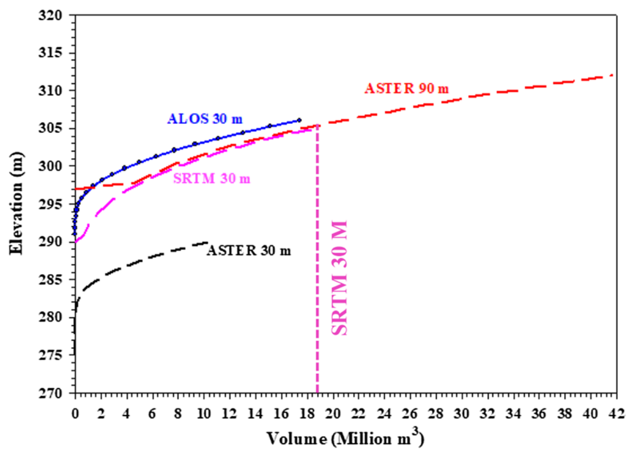

Fig. 8 Capacity curve of Wadi Fatimah dam with different types of DEMs

for Germany (1″ × 1″) and revealed that SRTM3 data exhibit a standard deviation of 7.9 m while GTOPO30 DEM, shows standard deviation of 6.8 m with respect to the best national model. Kiser and Kelly (2010) made a comparison between GPS and DEM derived elevation estimates and found that GPS elevation was higher than DEM elevation with a mean difference of 6 m. Dawod (2008) assessed the performance of seven global geopotential models (GGMs) using a local geodetic dataset in Egypt. Das et al. (2016) compared DEMs extracted from ASTER, SRTM, Cartosat-1 and topographical maps of 1:50 k and 1:250 k. It was concluded that the DEMs extracted from ASTER and 1:50 k topographical maps are more accurate as compared to others.

5 Conclusions

Environmental research such as hydrology, geography, climate change and water resources are based on the accuracy of topographic information. DEMs are created based on a different data bases due to which the accuracy of each DEM differs from others. This research is dealing with the comparison of the morphometric parameters of the hydrographic basin based on the type of DEM. It is clear to conclude that the SRTM 30 is the best DEM for studying and investigating basins' hydrology and water resources as it matches the results of google maps and topographic maps of 1:50 k. It is found that, both SRTM 30 and ASTER 30 are very closed to each other and also in accordance with the google maps and the topographic maps of 1: 50 k as of the slope aspect. More research is needed to identify better options for morphometric analysis using satellite data.

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