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Morphometric characterization of upstream mountainous watershed using geographic information system (GIS): high valley of Tifnoute-High Moroccan Atlas

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Key words: Geographic information system, morphometric characterization, mountain watershed.

Abstract

The National park of Toubkal, was creates in 1942, in the High Moroccan Atlas, one of the regions rich in biodiversity, constitutes in addition, a very interesting cultural heritage. Sheltering more the high summits in North of Africa (Toubkal 4167 meter), and is characterized by very important watershed resources. The high valley of Tifnoute is a basin belonged to this Park; the choice of this research topic was guided by the concern of better, to develop, and preserve this Park. The Morphometric and environmental analysis gives us a general idea about drainage of water, and different characteristics of watershed .To determine a different parameters of the high valley of Tifnoute we used geographic information system (GIS).The results clearly indicate the basin is characterized by a very high altitudes, dendritic drainage and strong slopes, which can influence the environmental lithologie in the study area.

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Introduction

The mountainous basins characterized by a specific lithologie and environnement. Morphometric analysis of basin it's the effective method for the proper management, and to determine a different process of watershed.

Hydrologic and geomorphic processes occur within the watershed, and morphometric characterization at the watershed scale reveals information regarding formation and development of land surface processes (Singh, 1992, Dar *et al.*, 2013 , Farrukh *et al.*, 2013,Nooka *et al.*, 2013). Accordingly, a water resource development plan has also been prepared by integrating land use/cover and slope with morphological parameters of the watershed under GIS environment (Santosh *et al.*, 2012).

The high valley of Tifnoute catchment is a mountainous area, and to have a general idea of hydrological and geomorphologic processes of water we used the GIS to make different maps and to characterize the catchment. Morphometric parameters play a very important role to determine type of water drainage, the relief of basin area.The results of this study show that the degree of slopes, high altitude influences the drainage and the concentration time of water in basin.

Study area

The high valley of Tifnoute catchment occupies a part of southern flank of Toubkal mountain in the heart of the High Moroccan Atlas (Fig.1), and is located between latitudes 30°59'55" et 31'5'38" N and longitudes 7°56'12" et 7°48'3" W . It constitutes the most picturesque, natural and suitable geoenvironmental area of the High Atlas. The Tifnoute river is the principal affluent of Souss River.

Geologically The valley region of Tifnoute shows Neoproterozoic rocks dated to the current Bleida Group (Thomas *et al.*, 2002) corresponds to the lower formations of the Cryogenian age, it is presented in the area of study by minor quartzite outcrops and volcanic and metamorphic rocks assigned to group Taghdout (Thomas *et al.*, 2004).

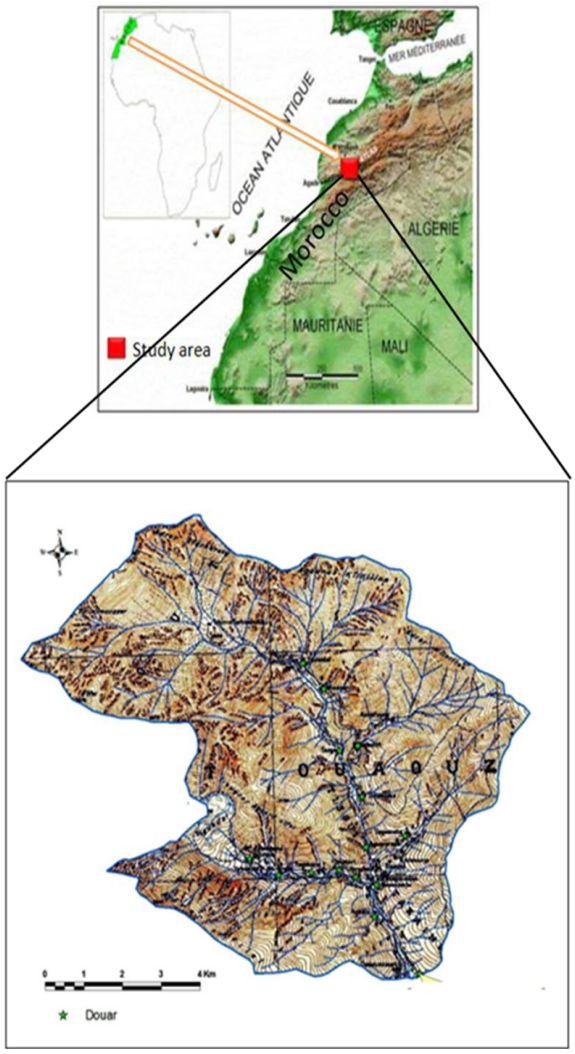

Fig. 1. location of study area.

Material and method

Remote Sensing and GIS is an advance technology for morphometric analysis (Shashikant *et al.*, 2013). In our study area we used GIS technique to determine morphometric characteristics like slopes map and digital elevation map. Contour map was created through digitalization process by MapInfo Professional software for length, perimeter, area etc. Drainage system map is delineated using Moroccan topographic map NH-29-XXIII-I a 421 of Jbel Toubkal on 1/50 000 scale. The digital elevation model (DEM) with 27 meter resolution was used to prepare elevation and slope maps.

Results and discussions

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimensions of its landforms (Clarke ,1996, Rekha *et al.*, 2011,Magesh *et al.*, 2013). In the order to characterize the physical environnement of the high valley of Tifnoute, we determinate the morphometric parameters of the catchment area. The results of morphometric analysis of the watershed are shown in the (Table 1).

Table 1. Morphometric parameters.

Morphometric Parameters		Watershed
Surface (km²)		66.3
Perimeter (km)		39.8
Compactness coefficient		1.4
Concentration Time		2h24mn
Form factors	Length (km)	12.3
	Width (km)	7.7
Altitude (m)	Average	2663
	Maximum	4104
	Minimum	1675
	Median	2650
Average slope (degree)		32.7

-Form factor: Form factor is the ratio of area of the basin and square of the basin length (Horton, 1932, Shashikant *et al.*, 2013).The basin of high valley of Tifnoute has a lengthened form; this form will allow a light damping of the streaming and will induce low peak output of rising.

- Surface and the perimeter of the basin: was determined with digitalization process by MapInfo software. The high valley of Tifnoute is a mini watershed with 66, 3 km² in surface and 39, 8 km of perimeter.

- Basin relief: The relief of a catchment area is reflected by its hypsometry (Fig.2). The maximum relief it's the difference between lowest and highest points of watershed and it was determined by digital terrain model using GIS (Fig.3). The high valley of Tifnoute it's characterized by highest elevations, which the maximal altitude is 4104 meter in the sea level.

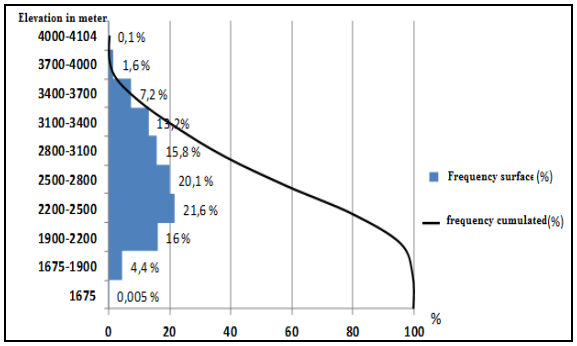

Fig. 2. Hypsometry of high valley of Tifnoute catchment.

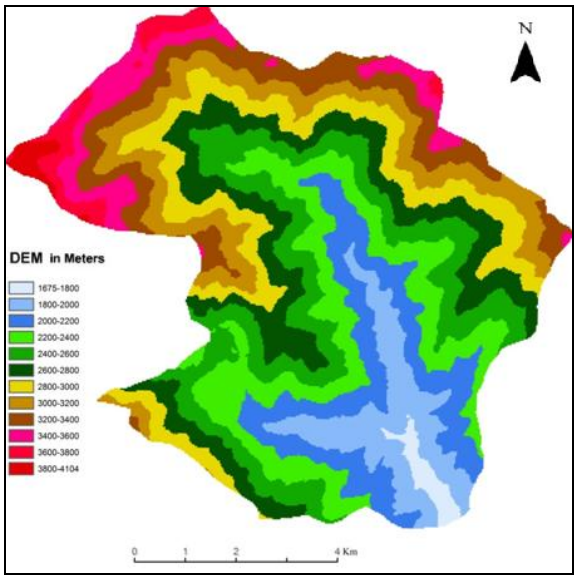

Fig. 3. Digital elevation map (DEM) of high valley of Tifnoute.

- Hydrographic drainage: Drainage density gives an idea about the physical properties of the underlying rocks in the study area (Sandeep *et al.*, 2013).It is delineated in Moroccan topographic map using GIS (Fig.4). Drainage pattern map proved that is dendritic, with a high density for highly permeable subsoil; the watershed also indicates a fast hydrological answer with high potential.

-Slopes map: Using digital terrain model and GIS the map of slopes was created (Fig.5). The map indicates a greater degree of slopes in the basin, this average slope is an important characteristic which informs about the topography of the basin and it influences the time of water concentration.

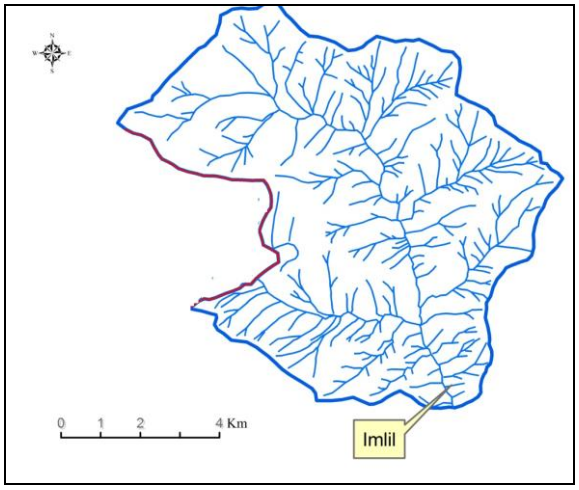

Fig. 4. Drainage system map of high valley of Tifnoute.

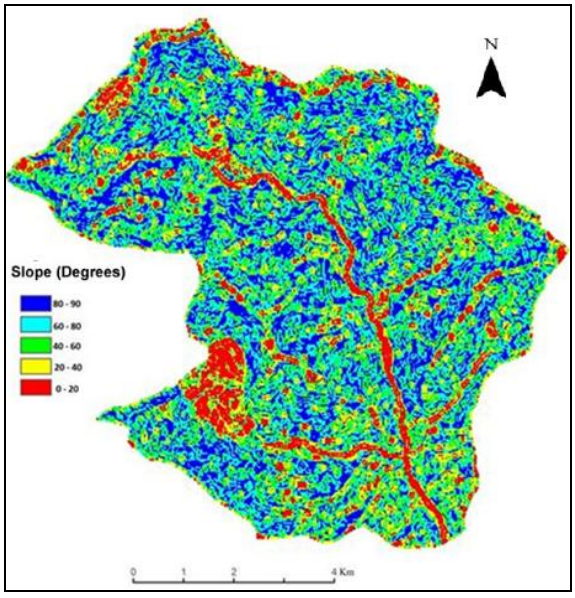

Fig. 5. Slops map of high valley of Tifnoute.

-Concentration Time of water: is defined as the maximum duration necessary to a drop of water to traverse the hydrological way between a point of the basin and the discharge system.

The concentration time in this watershed is short and is influenced by the strong lithologie and highest reliefs.

The high valley of Tifnoute is a small basin characterized by highest elevations and a greater degree of slopes in the basin. Drainage pattern map proved that is dendritic with a high density for highly permeable subsoil; these parameters show that the study area is most sensitive and likely to produce materials of erosion.

The morphometric characterization helped us to determinate a various watershed parameters and constitutes a global idea about drainage system .The morphometric analysis in the study area show that the high valley of Tifnoute watershed characterized by a high elevation and greater slops. The relief and the absent of vegetation in the study area can influence a erosion of sediment problem .so we must integrated management and planning in conservation of biodiversity and natural resources in upstream watershed of high valley of Tifnoute .

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