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Evaluation Potentials of Sabalan Volcano Southeast slopes geological heritage by Geotourism perspective

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Abstract

Volcanic landform can be as terrain legacies from the past to the present era be considered. These heritage of land in terms of their unique characteristics can be considered as Geomorphosite in the scientific community and the public. The evaluation of resources is one of the most important tasks of geotourism research.And thereby become profitable and thriving tourism industry in their own district. Sabalan volcano mass is located in the North West of Iran, as one of the main centers of volcanic landform is considered. This volcanic mountain is one of the world's highest freshwater lake in the own caldera. Innovative and thought-provoking in the sight of the human eye development. in sabalan volcano located valuable collection of geological heritage as hot mineral waters, rivers, waterfalls, lakes, beautiful valleys, erosion forms &…. Some of which are rare or even unique in the world and they are very important in terms of geology and geotourism. This paper presents the method of geotourist assessment, which was applied on the example of sites presenting the volcanic activity within Sabalan mountain range. Two stages of assessment are proposed: inventory and valorization. The inventory includes identification of resources, initial selection and characterization. During the valorization, a researcher uses the point bonitation method and takes into account the following indicators: scientific value, location and additional values. The result of valorization process is presented in table which allows comparison and categorization of the selected sites. The assessment of considered region revealed, that selected sites like rock walls, rock forms, abandoned quarries and hills with ruins are characterized by high or medium geotourist value. Consequently, Sabalan is an example of area of a great potential for geotourism development.

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Introduction

Geotectonic base and exogenous processes brought to distinctive complex of natural, abiotic elements within the particular area. These elements construct the overall diversity known as geodiversity. Geodiversity objects should be recognized and study during the special scientific studies among different geodisciplines. Geodiversity is an important and constructive element in Geotourism & tourism. Singular landforms often come to represent wider areas of interest and become the focus of tourism" (Thomas, 2012). Geotourism is emerging as a new global phenomenon (Dowling 2008a). It is a distinct subsector of tourism firmly entrenched in 'geological'tourism. An early definition of geotourism made by Thomas Hose (1995). This was further developed (Hose, 1996) and refined (Hose, 2000), also defined by Joyce (2006), and expanded by Dowling and Newsome (2006). More recently, it has been natural area defined as:

Geotourism is a form of natural area tourism that specifically focuses on geology and landscape. It promotes tourism to geosites and the conservation of geo-diversity and an understanding of earth sciences through appreciation and learning. This is achieved through independent visits to geological features, use of geo-trails and viewpoints, guided tours, geoactivities and patronage of geosite visitor centres' (Newsome and Dowling 2010).

Thus, the character of geotourism is such that it is geologically based and can occur in a range of environments from natural to build, it fosters geoheritage conservation through appropriate sustainability measures, it advances sound geological understanding through interpretation and education, and finally it generates tourist or visitor satisfaction. A key aspect is that it involves all of the wider aspects of tourism activity as geotourism involves requires transport, access, accommodation and services, trained staff, planning and management and reiterates that stakeholders in geotourism can include investors, government planners, environmental groups and universities(Dowling 2009). Moreover, it can be said that Geotourism is an informed and responsible tourism in the nature with the aim of observation and understanding of geology processes and phenomena as well as learning how they shape and progress (Amri Kazemi, 2009).so that is a way to promote geological heritage among general public (Hose, 2000). Geotourism research is a multidisciplinary activity encompassing primarily recognition of geotourist potential.

There is a rich literature devoted to geotourism (generally by geologists and geomorphologists) by which the attractiveness of many geotourism objects are assessed. Many attributes such as type and age of geological formations (including geomorphological factors and and nature influenced formations), geographical location, etc are considered in the assessment process as well as transport accessibility, tourism infrastructures, economic and many other factors (Bruschi and Cendrero, 2005; Bruschi et al., 2011; Coratza and Giusti, 2005; Pereira et al., 2007; Reynard et al., 2007). In addition, there has been a number of books on the subject including Geotourism(Dowling and Newsome 2006), Geotourism in Ethiopia(Asrat et al.2009),Fundamentals of Geotourism: With Emphasis on Iran(Nekouie-Sadry2009),Geology and Geotourism: The Tourism of Geology and Landscape (Newsome and Dowling,2010)and Global Geotourism Perspectives(Dowling and Newsome,2010).

The assessment of entire regions and single sites is a key element of geotourist potential, furthermore, it is particularly important for the future geotourism management. The results of the assessment enable to compare and classify the sites and offer suggestions for their promotion, protection and development. The aim of this paper is to present the pattern of geotourist assessment on the example of the volcanic sites in Sabalan.

Methodology of geotourist assessment

The sites, which belong to the sphere of geotourism interest, can be divided according to their individual features into the following categories:

- geotourist resources- all elements which relates to geotourism,
- geotourist sites- resources which are characterized by science, educational and aesthetic value; they can be potential destination of geotourist excursions,
- Geotourist attractions- places/ sites which are appropriately developed and promoted.

In order to identify the resources and select the most valuable geotourist sites out of them, the assessment process is essential. This procedure includes two stages: inventory and valorization. The first step consists of identification of potential sites, their initial selection, and characterization. During the second step, numerical assessment is assigned to the features of selected sites, based on established criteria. The results of valorization allow comparison of the sites and creating the ranking list, which can be useful with regard to future protection, geotourist development or other initiatives.

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Step 1- inventory

One of the essential aims of this stage is to determine the amount and the types of sites inthe described area. This task is executed on the basis of Literature data and field work. During the initial selection, location, accessibility for tourists and condition of outcrop are taken into consideration. This process also includes the detailed descriptions of each of selected sites, that is: location (with GPS co-ordinates), information on geology and geomorphology, accessibility, present uses and infrastructure, protection, condition of outcrop (visibility), other information (cultural, historical values) and photographic documentation. The data collected here are indispensable for the next stage of assessment.

Step 2- valorization

This part of assessment is carried out with using the point bonitation method. This method assumes the assignment of the numerical values (points) to individual features of the site, according to the established criteria and scale. The framework of valorization is based on 3 principal and 13 secondary indicators (Tab. 1). Part of the criteria was taken from existing literature on related field (for example: Otęska-Budzyn, 1992; Pralong, 2005; Reynard et al., 2007). The scale value is from 1 to 2 (for 3 indicators) or from 1 to 3 (for 10 indicators). The value of feature may equals 0 when it is below the proposed criteria.

The sum of all indicators determines the total value of sites (maximum 36) which are taken into account under final categorization. Consequently, the sites with scores over 70% of maximum total value can be considered as sites with high geotourist value, the sites with scores between 69 and 40 %- as sites with medium geotourist value and the sites with scores under 39%- as sites with low geotourist value in the assessed area. The results of valorization stage should be recorded in a table.

Table 1. The indicators and their numerical assessment used during valorization process.

Scientific value (maximum 12) Sc		
Rareness in relation to the area **Rar**	1 2 3	Site one from several similar One of the most important The only occurrence
Condition of outcrop (visibility) **Con**	1 2 3	Partly covered with vegetation, partly damaged as a result of human activity or natural processes Partly covered with vegetation Well exposed
Ilustrativeness **Ilu**	1 2 3	Low illustrativeness Good example of geo(morfo)logical feature or processes Excellent example of geo(morfo)logical feature or processes
Diversity of geo(morfo)logical features/ processes **Div**	1 2 3	Low diversity Medium diversity High diversity
Location (maximum 12) Lo		
With respect to tourist trails **TT**	1 2 3	More than 200 m from tourist trail, easy to find Less then 200 m from tourist trail By tourist trail
With respect to roads (accessible by car) **Ro**	1 2 3	Between 2,5 and 5 km from parking place Between 1 and 2,5 km from parking place Less than 1 km from parking place
With respect to support service (accommodation, catering) **SS**	1 2 3	Between 10 and 15 km Between 5 and 10 km Less than 5 km
Accessibility **Acc**	1 2 3	Difficult, only with special equipment Difficult for some tourists Available for all tourist
Additional values (maximum 12) Add		
Aesthetic value **Aes**	1 2 3	Low Medium High	Subjective value, based on visual singularity of out- crop, quality of panorama, attractiveness forms

Development and use **DU**	1	Present use as tourist/cultural/other site
	2	Present use as geological site (element of educational trail)
	3	Present use as geotourist site (with interpretative materials)
Access to geological information **AI**	1	Difficult access or only scientific knowledge
	1,5	Access to general information (Internet, tourist guidebooks)
	2	Easy access, special geotourist publications
Legal protection **LP**	1	Protected as a part of larger area
	1,5	Individual protection as historical, nature site
	2	Individual protection as geo(morfo)logical site
Cultural/ historical value **CH**	To 2	Historical value- 1 Cultural value- 1

Case study

Research area

Sabalan is an inactive stratovolcano in Ardabil province of northwestern Iran (Nabavi, 1976). It is the third highest mountain in Iran and has a permanent crater lake formed at its summit.

Sabalan has a different tourist area such as the Sarein spa. The mountain is known for its beautiful vistas, including the Shirvan gorge, where few climbers ever venture. Its geographical location is 47:50 E and 38:16 N (Fig. 1).

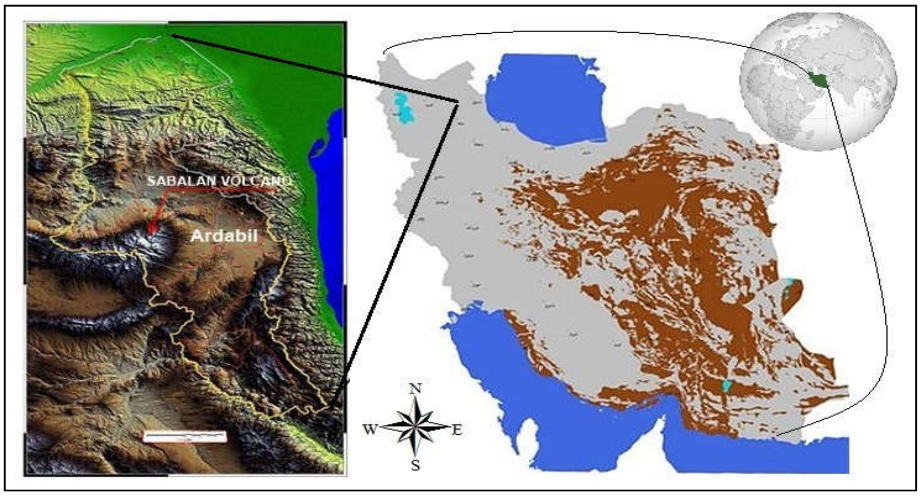

Fig. 1. The geographical locations of sabalan volcanoes in the North West of Iran

The mountain offers many attractions throughout the year. On the slopes of the mountain, the mineral water from springs attracts large amounts of tourists each year; many have faith in healing properties believed to be in the springs. The nomadic people of the area live in small villages, with their round "Yurt" tents appealing to tourism. Sabalan is a volcanic peak, and at 3,600 metres you can see gigantic 'sculptures' which are eroded volcanic stone outcrops which resemble animals, birds and insects. The mountain is located in a continental climate with hot, dry summers and extremely cold, snowy winters. Precipitation falls primarily as snow in late autumn, winter, and spring, and is sufficient to sustain seven glaciers near the summit above 4,000 metres (13,000 ft). The largest of these were more than 1.5 kilometres (1 mi) in length as of the 1970s. There are also extensive rock glaciers, several of which are more than 3 km (2 mi) in length (Fig. 2).

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Fig. 2. Sabalan summit & permanent Crater Lake

Sabalan volcano geology and lithology

Sabalan volcano cone has a big central structure, which is located on a horst system with a trend of W-E. Didone and Jouns (1976) have known as age of Plioquaternary for Sabalan Volcano and some volcanic activities from Sabalan to Miocene while Babakhani, lesquich and Rhio (1978) believe that first lava flow in Sabalan are located on Tuffi and Alyar conglomerates which are equivalent to early Quaternary deposits in Meshkin, Shahr Basin(Amini et all,1999, jahangiry,2007) . In other words , mentioned volcanic activity is initiated during early Quaternary times it is continued to late glacial period (20 to 70 thousand years Agol Doiden and Joumen have divided Sabalan Activity into three parts (Didon and Gemain, , 1976):

1- Old Sabalan Lava flows lava flows which have been caused in this step embed most portion of Sabalan Mount: Mentioned people have segment Ted this part into 5 steps but Babakhan: and Lesquich Verio summary them into three steps which are: A –Lower andesite which hove outcrop in northern and eastern sides. B- Middle Trachy-Andesite, which makes Sabalan volcano Main Part and it, has extent in all of Sabalan Mount Ridges, C –Dacite lava flow, which is ended in evolution of volcano strata before caldera.
2- Depression: in this central part, early structure is disrupted. Result of this event is creation of circular depression in
3- diameter of 20 km. Contemporary to caldera Depression, some explosive eruptions have been occurred which has been composed of volcanoclastic materials.Mechanism of this activity is explained as it has caused first not avalanches which transport some older fragments with is in glacial valleys .Then explosive materials eruption are contemporary to fall ignimbrite flow and thin pumice which is distributed in Savieh Valley and horrible explosion results in creation of big volumes of ash (Noorollahiet all, 2007,246) . Warm and hot springs with neutral Cl-SO4, acid Cl-SO4and acid SO4chemistries are found within the valley (Bogie et al., 2000). These plot in the immature area of the Giggenbach (1988) Na-K-Mg plot giving geothermometry temperatures of approximately 150°C. One of these, the Gheynarge spring, has a Cl concentration of 1800 mg/kg.
4- Domes and lava flows from Young Sabalan: after falling caldera, volcanic materials are exploded which cause highest part of central part. In this stage, there is with two conical and lava flows. In mentioned stage, some sulfur and volcanic activities from Sabalan have a composition of rhyolite to dacite and big point about these volcanic activities is sodium – bearing alkaline types of these rocks ((fig 3-4).

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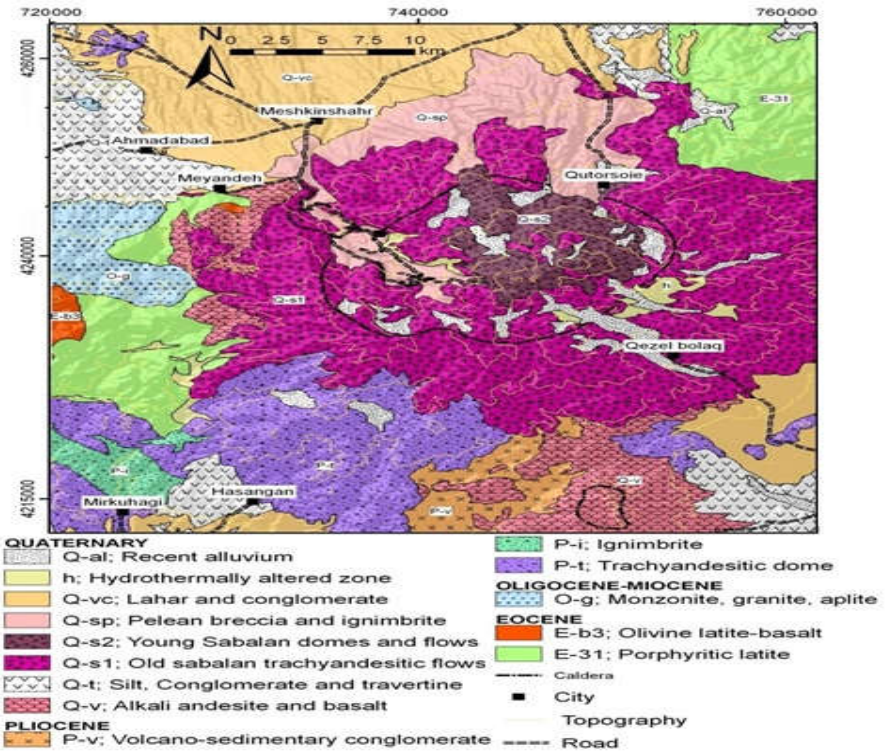

Fig. 3. Geological map of the sabalan volcano taken from Geological map of 1/100000 Ahar

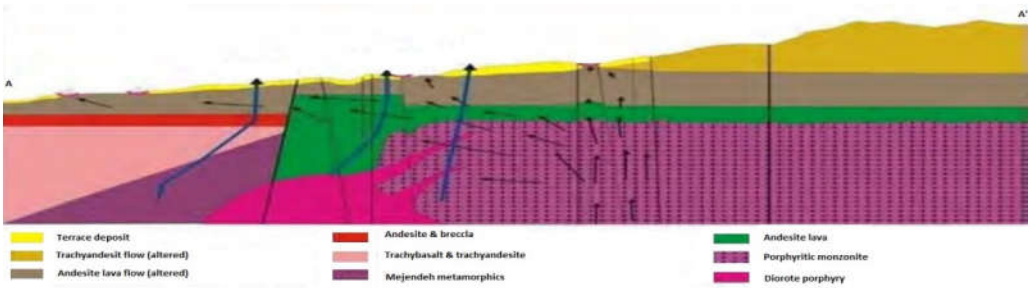

Fig. 4. Cross-sectional volcano Sabalan (from SKM report to SUNA, 2003)

Sabalan is characterized by a large number of the representative, valuable and magnificent rock outcrops hot springs, rivers, waterfalls, lakes, beautiful valleys, erosional features and ... that some of them are unique on earth which are the witnesses of geological history and can be used in geotourist context.

Results of geotourist assessment

Within the range of Sabalan Volcano Southeast slopes, six groups of sites are distinguished: tectonic & glacial lake (2), rock forms (small and single outcrops were passed over) (23), hot spring (4), water fal & cave (4) and Wild life habitat (2). All of them are generally located in the Southeast slopes of the described area (Fig. 5). Predominantly, the outcrops are the relics of andesite lava flows. The rock walls can be found in the main and lateral ridge of the range.

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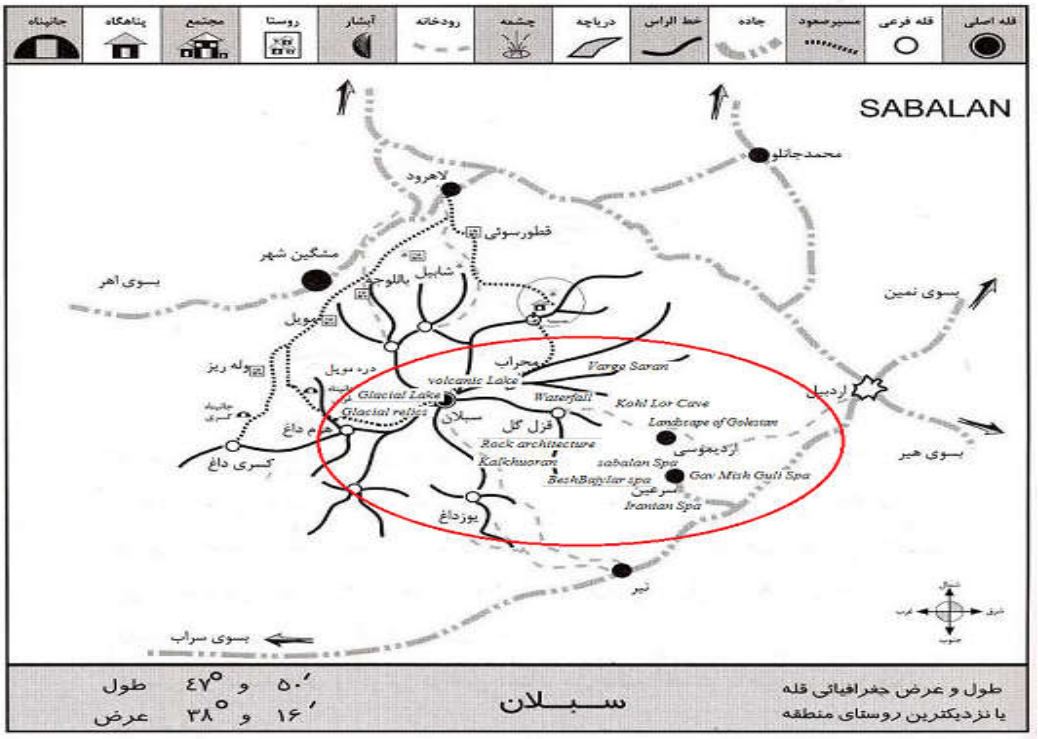

Fig. 5. The sketch map of Sabalan with location of the identified and selected sites.

Sabalan Volcanoes Lake, that's a very beautiful cone-shaped lake. Sides of this lake covered with snow and ice all year (Fig. 6). This lake is oval shaped with diameters of 140 and 80 meters, the mountain has a special beauty. Except the summer in other seasons of the year is frozen, Sabalan Lake is one of the world's highest freshwater lake considered. And the water is clear blue and greenish. With the view of chemical components of the water is Calcic and sodic sulphate very light and rich in silica. Lake-floor has been established via basalt, andesite, and trachyte and the water is supplied only through the snow. Water surface Approximately 25 meters below the edges volcanic cones (Alizadeh, 1991).

Fig. 6. The Sabalan Lake

The Rock architecture are located nearby the ridge and on sides of valleys. They were formed by the selective weathering of rock of vertical fissures and platy jointing and/or by gravitational slopes slide the frost weathering was the reason of their origin (Fig. 7-8).In the case of hills with ruins, rock ground was considered, as well as the material used to building. The most stunning of such sculptures is an eagle statue known as Ghartal, seemingly gazing over its surroundings to maintain control over the Sabalan slope and valley from atop. This amazing views of the people of Azerbaijan has a special value, And people mentioned their symbol of strength and honor (Fig. 9).

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Fig. 7. The highest rock wall in Sabalan, remnant of the andesite lava dike.
Fig. 8. The part of Rock architecture

Fig. 9. View from Eagle Rock (Qartal) near the summit of Mount sabalan

Hot springs and mineral water: There are many hot springs and mineral Sareyn in which caused of faults has emerged Sareyn. And this region is one of the most important centers of the hot springs Middle East has become. In addition, every year the Host presence of millions tourists from the remotest parts of the country and other countries. One of the hot springs water is Gavmish Goli with an average value of 85 liters per second and the water temperature 46 degrees Celsius, and the water colorless and slightly smelly tart. The spring's anions consists of carbonate, bicarbonate, chloride, sulfate, and cations including calcium, magnesium, sodium, and is Potassium.

Sardabeh Waterfall, is located in E 48 02 N 38 15 Ardebil area on the eastern slopes of sabalan Mount. That is one of the beauties of this mountain range. This place is famous mostly because of the famous spa has a healing effect (Fig. 10).

Fig. 10. View from Sardabe waterfall

As it turned out, the most magnificent rock walls and quite a lot of rock forms and quarries are unavailable because of restriction of legal protection, their location (away from tourist trails) or lack of access (relief, vegetation). Out of 39 sites, 13 were selected to further characterization. The results of the second stage of assessment and categorization of sites are presented in table 2. Four sites obtained the score over 70% of maximum total value and they were recognized as the most valuable for geotourism. The middle geotourist value was attributed to nine sites. The Sabalan volcanic Lake with glacial relics appears to be the most valuable geotourist sites in the assessed region (Fig. 2). It is worth noticing that scarce site in Sabalan is developed with a view to geotourism. The relation between geotourism and geo conservation affects the popularization of Earth science. Thus, the protected areas are predisposed to practice geotourism (Alexandrowicz, 2006).

Discussion

This paper focuses on assessment process from the perspective of geotourism. The proposed method, with quantitative and qualitative aspects, allows an overall and detailed assessment, which results, can be comparable. Its framework bases on two stages: inventory (with identification, initial selection, and description) and valorization (with numerical assessment and classification). The valorization includes 3 principal and 13 secondary indicators. In the case of geotourist assessment, it was affirmed, that the scientific value is as crucial as location or additional values. The most attractive geotourist sites should be valuable, as well as picturesque, unusual and conveniently located. It is worth emphasizing that the criterion like size of site was not considered. In the case of Sabalan, initially only sites with the size distinguishing them from the surroundings were taken into account, thus this feature was not considered as a significant one during the following valorization. The gathering all results into one table facilitate the quick comparison of sites, their total values, and also their assessment of each of established indicators. The disadvantage of the propagated point bonitation method is an element of subjectivity because the given value depends on the opinion of the assessor. However, elaborated criteria and scale allow recognizing the general assessment as relatively objective. Moreover, the project of geotourist trail in this region should be considered. In Figure 11, we observe several geomorphosite existing in the regions

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Fig. 11. Examples types of volcanic sediment and erosion

Tab. 2. The result of geotourist assessment of volcanic sites in Sabalan

Indicators / Sites	Rar	Con	Ilu	Div	ΣSc	TT	Ro	SS	Acc	ΣLo	Aes	DU	AI	LP	CH	ΣAd	Total value	
volcanic Lake	۳	۳	۳	۲	۱۱	۳	۱	۲	۲	۸	۳	۲	۲	۲	۱	۹.۵	۲۹	High Geotourism value
Glacial relics	۲	۲	۲	۱	۷	۲	۲	۳	۳	۱۰	۳	۲	۲	۱.۵	۱	۹.۵	۲۶.۵	
Waterfall	۲	۲	۲	۱	۷	۲	۲	۳	۲	۹	۳	۲	۲	۱.۵	۱	۹.۵	۲۵.۵	
Rock architecture	۳	۱	۲	۱	۶	۲	۳	۳	۳	۱۱	۱	۳	۲	۱	۱	۸.۵	۲۵	
Glacial Lake	۲	۲	۱	۲	۷	۲	۳	۳	۲	۱۰	۳	۱	۱	۱.۵	۱	۷.۵	۲۴.۵	Medium Geotourism value
Iranian Spa	۲	۲	۱	۱	۶	۲	۳	۲	۲	۹	۳	۱	۱	۱.۵	۱	۷.۵	۲۳.۵	
sabalan Spa	۲	۲	۱	۲	۷	۲	۲	۲	۲	۸	۳	۱	۱	۱.۵	۱	۷.۵	۲۲.۵	
Kohl Lor Cave	۱	۲	۱	۲	۶	۱	۲	۳	۳	۹	۱	۲	۲	۱	۱	۷	۲۲	
Kalkhuoran	۲	۲	۱	۲	۷	۱	۱	۳	۲	۷	۳	۱	۱	۱.۵	۱	۷.۵	۲۱.۵	
Gav Mish Guli Spa	۱	۲	۱	۲	۶	۳	۱	۳	۲	۹	۲	۱	۱	۱	۱	۶	۲۱	
BeshBajylar spa	۱	۲	۲	۱	۶	۳	۱	۲	۲	۸	۲	۱	۱.۵	۱	۱	۶.۵	۲۰.۵	
Landscape of Golestan	۱	۲	۱	۲	۶	۱	۱	۳	۲	۷	۲	۱	۱	۱	۱	۶	.۱۹	
Varge Saran	۱	۱	۱	۱	۴	۱	۲	۳	۲	۸	۲	۱	۱	۱.۵	۱	۶.۵	۱۸.۵	

Conclusions

Accuracy in economic performance of countries that are successful in tourism field, we realize that tourism can have a huge impact on income and economic growth of the country and sometimes it acts more successful than the important industries. Therefore, tourism development as well as Geotourism is one of the effective ways in the country's economy dynamics. Geotourism can have the most harmony with sustainable development and all economic, cultural, social and environmental dimensions. Therefore, the necessary infrastructures should be provided for Geotourism development and paving the way to achieve the above goal.

The presented method is distinguished by two main advantages: simplicity and comprehensiveness. What is more, it can be applied to diverse areas, independently of their size or number and kind of sites in their limits. With using this method, the assessment of volcanic sites in Sabalan was carried out. On the basis of its results, it was affirmed that a large number of sites related with volcanic activity are characterized by geotourist potential. Thus, several sites with the highest value should be properly developed and promoted as. All of these findings hope to contribute to the greater understanding of geotourism development and a more straight forward way of planning and management. It also helps the authorities, from responsible in charge to researchers, to evaluate and monitor the process with greater understanding. Geotourism experts may benefit from the knowledge to establish and operate priorities for geotourism projects and researches.

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