Evaluating the Geomorphological Features and Geotourism Potentials of Harmankaya Canyon (Bilecik, Turkey)*

Levent Uncu, Ebubekir Karakoca
Bilecik Şeyh Edebali University, Bilecik, Turkey

Harmankaya Canyon is located within boundaries of Karahasanlar settlement near Yenipazar district and Harmanköy settlement near İnhisar district in the east of the province of Bilecik. It was declared an area of nature protection under the name of “Harmankaya Canyon Nature Park” in 2012 by the Ministry of Forestry and Water Affairs. This study introduces Harmankaya Canyon, in the first place, by discussing its geomorphological characteristics, which play a significant role in the declaration of canyon as a nature park, along with the formation. Then, it discusses the potentials born by the canyon as a newly emerging destination of geotourism. Harmankaya Canyon was created by Harmanköy Stream, one tributary of Sakarya River, within Bilecik limestones of Mesozoic age. The canyon is 2.3 km long and 650-700 m deep, with a difference of altitude of 136 m between the entrance and the exit. Having quite an impressive view, the canyon was mainly formed as a result of fluvial processes under the control of lithological, tectonic, and climatic factors together. Thanks to its geomorphological characteristics, the Harmankaya Canyon Nature Park offers both sports and social attractions, like geotourism bound by geographical formations, canyoning relying on natural sources, trekking, rock-climbing, rafting, paragliding, and photography. Considering its location close to the larger Turkish cities, such as Istanbul, Bursa, Kocaeli, and Eskişehir and accessibility, the Harmankaya Canyon Nature Park is thought to meet all criteria for a destination of day-trips and weekend excursions for a relief from urban stress or for indulging in nature. SWOT (Strengths, weaknesses, opportunities, and threats) analysis was performed to unveil the touristic potential of the canyon. As a result, it was found to pose far more strengths and opportunities than weaknesses and threats.

Keywords: Harmankaya Canyon, morphometric analysis, geotourism, sustainable tourism, SWOT analysis, Bilecik

Introduction

The rapid political, economic, and technological developments in the world in recent years have, on the one hand, led to an increase in the share of tourism revenue in national economies; and changes in the usual touristic consumption patterns for recreation, recreation, and travel on the other hand. When we look at today’s concept of tourism and profile of modern tourists, it becomes noteworthy that people have alternative pursuits, like “tourism of particular interest” for discovering natural beauties and indigenous cultures in less known

* Acknowledgements: We are grateful to Meral Kavun and Gülşen Uysal who are members of the Canyon and Outdoor Sports Research Association for their visual and verbal contributions to this paper.
Levent Uncu, Associate Professor, Faculty of Science and Letters, Department of Geography, Bilecik Şeyh Edebali University, Bilecik, Turkey.
Ebubekir Karakoca, Research Assistant, Faculty of Science and Letters, Department of Geography, Bilecik Şeyh Edebali University, Bilecik, Turkey.
EVALUATING THE GEOMORPHOLOGICAL FEATURES AND GEOTOURISM POTENTIALS

places in solitude or small groups rather than mass tourism. While the term of natural area tourism used to be mainly associated with ecotourism, which is a segment of tourism purely relying on natural excursions still related to sustainable; the last 20 years have driven geotourism activities forward, which are related to non-living aspects of the natural and cultural environment and completely focused on geological and geomorphological qualities of a specific area (Hose, 2008; Newsome, Dowling, & Leung, 2012; Dowling, 2013, Ólafsdóttir & Tverijonaite, 2018).

In the tourism literature, the term geotourism was first used by Hose (1995) for a type of alternative tourism with particular reference to the rural areas in the UK and concepts of geosite and geopark (Hose, Markovic, Komac, & Zorn, 2011; Newsome & Dowling, 2010). Later, the scope of the term has been enlarged over time to cover geographical formations of touristic value, such as coasts, mountains, valleys, dunes, glaciers, waterfalls, caves, and canyons/gorges and fossil resources, besides geosite and geoparks (Dowling & Newsome, 2006; Newsome et al., 2012; Newsome, Moore, & Dowling, 2013).

Among them are canyons and gorges the most attractive and preferred landforms for geotourism activities all over the world with their unique outlook and the variety of activities they offer. Canyons and gorges are defined as narrow and deep valleys formed as a result of cleavage by a stream of plateaus or mountains resistant to erosion and surrounded by steep slopes.

In Europe and America, canyons and gorges were started to be visited as touristic destinations in the 17th century as a part of mountaineering activities. In this connection, canyoning became heard as an activity independent on mountaineering for the first time when the Verdon Gorge (Gorges du Verdon) in Southern France was crossed in 1905. In the following period, canyons and gorges have increasingly been considered as touristic destinations. The world’s most popular destinations for canyon and gorge tourism include Grand Canyon (the USA), Verdon Gorge (France), Three Straits (China), Tara Canyon (Montenegro), and Samaria Gorge (Crete) (Bozic & Tomic, 2015).

Turkey is a country with higher average altitude whose geomorphological formation was dominated by tectonic and fluvial processes. For this reason, large rivers and streams opened narrow and deep valleys in the form of canyons and gorgeon plateaus and mountainous areas across Turkey. Those with touristic appeal can be listed as Köprülü Canyon in Antalya, Göynük Canyon, Saklıkent Canyon and Butterfly Valley in Muğla, İhlara Canyon in Aksaray, Ulubey Canyon in Uşak, Ölübe Canyon in Elazığ, Şuğul Canyon in Sivas, Yazılı Canyon in Isparta, Valla Canyon and Ersitlerdere-Karacehennem Canyon in Kastamonu, Şahinkaya Canyon in Samsun, Reşadiye Canyon in Tokat, Ozan Canyon in Malatya, and Cehennem Deresi Canyon (Hell’s Stream Canyon) in Artvin. Nevertheless, most of them remain underappreciated because of their unrevealed geotourism potential and poor publicity.

This study aims to scientifically judge Harmankaya Canyon in Bilecik in relation with geomorphology, formation, and geotourism potential and contribute to the promotion of the canyon at national and international scale as it is not well-known in Turkey although it stands as a potential new destination of special attention with all necessary qualifications besides its close location and accessibility from larger Turkish cities, like Istanbul, Bursa, Kocaeli, and Eskişehir.

Location and Boundaries of the Research Area

Harmankaya Canyon has parts in two different towns as Karahasanlar in the south of Yenipazar county of Bilecik province and Harmanköy in the north of İnhisar County (see Figure 1). As for geographic boundaries,
the land within Western Black Sea Region is located between the western latitudes 40°07′30″ and 40°09′30″ and eastern longitudes of 30°23′0″ and 30°27′0″.

Figure 1. Location and boundaries of the research area.

The canyon is 61 km to the province of Bilecik, 192 km to Istanbul, 151 km to Bursa, 144 km to Kocaeli, and 57 km to Eskişehir. The area of 260 hectares enclosing the canyon was declared area of nature protection under the name of “Harmankaya Canyon Nature Park” on 26.12.2012 by the Ministry of Forestry and Water Affairs.

Material and Method

This study, which intends to unearth the geomorphological features, formation and geo-tourism, and geotourism potential of Harmankaya Canyon, was completed in two stages as office works and field study. First of all, a DEM (Digital Elevation Model) data base was created by using ArcGIS10.2 from 1:25.000 to pography maps as a baseline for the study. Then, morphometric analyses, such as VF (Valley Bottom Width/Valley Height Ratio) and SL (stream length-gradient ratio) indices were applied in order to discover how the canyon had been formed. Obtained results were reinforced with fieldworks. When it comes to determining the geotourism potential of the canyon, SWOT (Strengths, weaknesses, opportunities, and threats) was used as a qualitative analysis. Besides, Harmankaya Canyon was subjected to three separate canyoning classifications by applying the French and American Canyon Rating Systems for the first time and the rating system used by the Canyon and Outdoor Sports Research Association based in Turkey.
Geomorphological Characteristics and Formation of Harmankaya Canyon

Harmankaya Canyon was originally opened by Harmanköy Stream through a plateau extending in northwest-southeast direction between Harmanköy and Karahasanol settlements above 1,000 m (1,154 m on Harmankaya Hill, 1,134 m on Gök Hill) (see Figures 2 and 4). In lithological regards, the plateau is characterized by Mesozoic (Middle Jura-Lower Cretaceous) limestones which are widely scattered in this part of Sakarya Valley. Such limestones are referred to as “Bilecik limestones” in the literature (see Figure 3). Bilecik limestones have a solid texture and also have highly suitable structural properties for karstification and cave formation.

Figure 2. Physical map of the research area.
Figure 3. Geological map of the research area.
The depth of Harmankaya Canyon from the plateau surface is 650-700 m, and the distance between the entrance and exit is 2.3 km. The width of 5 m at the entrance becomes too narrow for one to cross at some points. The base of the canyon is as high as 536 m at the entrance near Karahaslanlar Village, while it decreases to 400 m near Harmanköy exit. The canyon hosts two big waterfalls, one of which is 850 m away from the entrance with a height of 18 m and the other is 2,000 m from the same point at 22 meters, besides several small waterfalls with a height of 1 or 2 meter. The slope of the steep slopes which give the canyon the unique view goes over 80% in the central part. Further on the plateau surface, big caves and stairs on the steep slopes become noticeable. Ardıçlı Cave, which is located right next to the view terrace, can be reached via hiking trail (see Figure 5).
Bilecik limestones accumulated in the Mesozoic Sea located in the south of the land of Sakarya, which lays the geological foundation of northwestern Anatolia. The limestones later began to come to surface as a result of the Alpine Orogenesis. After the onset of the Miocene, it became completely a piece of land. Under warm and humid climatic conditions during the Middle Miocene, karstification began to take effect on the Bilecik limestones. Upon start of the neo-tectonic period, the region came under the influence of the compressive tectonics in north-south axis. The land was then fragmented into blocks resulting from severe tectonic movements occurring throughout the Upper Miocene-Lower Pliocene. Consequently, the rising blocks triggered the formation of the Central Sakarya Plateau and the collapsing ones led to shaping of the Pliocene basins. As a result of the humid climatic conditions and ongoing tectonic movements during the Upper Pliocene and Quaternary, the fracture and crack systems developed in the ascending areas caused recurrence and progress of the karstification and further expansion of the cave systems in the area. During the Upper Pliocene, Sakarya River and its tributaries installed themselves in the area and opened narrow and deep gorges using weak tectonic zones and underground cavities formed by tectonic and karstification incidences.

Harmankaya Canyon is one of the narrow and deep gorges formed in the meanwhile. Bilgin (1980) argued that the Sakarya was rapidly buried in the Central Sakarya plateau by forming occasional meanders and thus formed epigenic straits in the neighborhood. However, stairs on the slopes of the canyon and morphometric indices applied showed that the formation of Harmankaya Canyon cannot be explained by the epigenic events alone because the local tectonic movements in the region and thus the antecedence incidences, too, seem to play a role (see Figures 6 and 7).

As a result of the VF (Valley Bottom Width/Valley Height Ratio) indices applied to three separate intersections from Harmankaya Canyon, the average VF value of the canyon slopes was calculated as 0.04. Such a high figure suggests that ascent caused by tectonism preceded a drastically deep burial of the river bed (see Figure 6).

![Figure 6. Valley Base-Valley Height Ratio Index of Harmankaya Canyon.](image)
Based on this index, seven different SL values (stream length-gradient ratio) were calculated ranging from 246 to 1669 along the valley base of Harmanköy Stream flowing throughout the valley base. However, two anomalies were found as 1448 and 1669 in the valley base, which may have been caused by tectonic-origin cascading rather than rock type differences considering the same lithological characteristics. In particular, anomaly two overlaps with the location of the second waterfall within the canyon (see Figure 7).

To sum up, the results of VF index measurement close to zero and the presence of two anomalies in SL values seems to be an indicator of the young tectonic effects in the region and support our opinion about the antecedence.

**Evaluation of Geotourism Potential of Harmankaya Canyon**

A 260-hectare plot containing and surrounding the canyon was declared a nature conservation area as the “Harmankaya Canyon Nature Park” by the Ministry of Forestry and Water Affairs on 26.12.2012. This decision was justified with the idea of conveying different natural recreation demands of Bilecik Province to future generations within a planned, sustainable, and conservation-use balance.

In order to strike the fragile conservation-use balance between the source and visitors and benefit from the recreational tourism potential in the optimum way in areas under protection, a visitor management plan is needed (Koçan, 2013).

In the scope of this plan, the General Directorate of Nature Conservation and National Parks installed facilities for visitors such as picnic and seating areas, information signs, country coffee house, dressing rooms, masjid, parking lot, toilets, children’s playground, walking path, and a viewing terrace have been installed in the canyon (see Figures 8 and 9).
In order to explore the geotourism potential held by Harmankaya Canyon and its vicinity, SWOT (Strengths, weaknesses, opportunities, and threats) analysis was applied as a qualitative research method. The way was paved for the analysis by the field study, our consultation with the local government and people, and the 2014-2023 regional plan by BEBKA (Bursa-Eskişehir-Bilecik Development Agency). As a result, the
opportunities and challenges concerning the canyon, as well its strengths and weaknesses were displayed below (see Table 1).

Table 1

**SWOT Analysis of Harmankaya Canyon**

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Availability of Harmankaya Canyon</td>
<td>1. Insufficient promotion and marketing activities to realize the geotourism potential</td>
<td>1. Potential of alternative tourism</td>
<td>1. Presences of marble and stone quarries nearby</td>
</tr>
<tr>
<td>2. Canyon and surrounding qualified as nature park</td>
<td>2. Lack of accommodation facilities</td>
<td>2. Natural and virgin area</td>
<td>2. Danger of falling stones or rocks in the canyon</td>
</tr>
<tr>
<td>5. Eligibility for outdoor sports, such as rock-climbing, paragliding, rafting, and mountain biking</td>
<td>5. Lack of a first aid team in case of emergency</td>
<td>5. Presence of urban places nearby</td>
<td></td>
</tr>
<tr>
<td>6. Suitability for outdoor activities like camping and trailer camp</td>
<td>6. Insufficient training of the locals about tourism</td>
<td>6. Increase of interest in canyoning tourism</td>
<td></td>
</tr>
<tr>
<td>7. Inviting area for nature photography</td>
<td>7. Lack of a first aid team in case of emergency</td>
<td>7. Increase of interest in outdoor sports and nature photography</td>
<td></td>
</tr>
<tr>
<td>8. Presence of karstic caves nearby</td>
<td>8. Lack of telephone network within the canyon</td>
<td>8. Local government and some societies’ support for geotourism</td>
<td></td>
</tr>
<tr>
<td>9. Waterfalls in the canyon</td>
<td>9. Lack of telephone network within the canyon</td>
<td>9. Availability of 1st degree archeological sites on the western hill of the canyon</td>
<td></td>
</tr>
<tr>
<td>10. Canyon location not far from big cities</td>
<td>10. Increase of interest in outdoor sports and nature photography</td>
<td>10. Potential of leisure and recreational activities</td>
<td></td>
</tr>
<tr>
<td>11. Transport up to canyon exit and entrance</td>
<td>11. Scarcity of academic research on the area</td>
<td>11. Eligibility for tourism facilities attracting private investors</td>
<td></td>
</tr>
<tr>
<td>13. Quality of Sakarya River eligible for water sports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Presence of Yenipazar Pond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Rich natural and cultural assets in Yenipazar and İnhisar districts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Diversity of flora and fauna</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As also seen in Table 1, Harmankaya Canyon itself along with the surrounding natural formations, such as Sakarya River valley, karstic caves (İnkaya, İnhisar, and İnhisaraltı) in the close vicinity and the area’s historical and cultural richness represent the strengths of this area for geotourism. On the other hand, it features some weaknesses, such as insufficient promotion for alternative tourism and accommodation facilities and the lack of adequate training on tourism in the local population. As for opportunities, the area’s extremely favourable conditions for geotourism and especially the support and interest of Bilecik Municipality, Ministry of Forestry and Water Affairs, Directorate of Nature Conservation and National Parks (DKMP), and BEBKA (Bursa-Eskişehir-Bilecik Development Agency) can be taken as opportunities. Lastly, the canyon faces a big threat due to the marble and stone quarries on the plateau surface, which degrades the natural appearance of the canyon (see Figure 10).
Classification of Harmankaya Canyon Against Canyon Rating System

As revealed by the SWOT Analysis, one of the greatest geotourism opportunities offered by Harmankaya Canyon seems, it goes without saying, the sports activity of crossing the canyon also known as canyoning in the literature. Canyoning has lately gained rapid development as a part of special tourism in Turkey. Canyoning is an activity performed together with sports, such as walking, swimming, jumping, and rock climbing, using many techniques and equipment along a specific route in the canyon. It also covers a number of other disciplines concerning nature sports, such as mountaineering, rafting, hiking, and caving.

The first crossing across Harmankaya Canyon was realized by a team of Bursa Mountaineering Club (BUDAK) in 2003. Since then, groups of local and international athletes hold crossing events on an annual basis.

Since canyoning is now held at international scale, several canyon “rating systems” are employed worldwide in order to obtain an idea about the quality of canyons that are suitable for canyon crossing. Of these systems, the French rating system of the French Federation of Mountain and Climbing (FFME) and the one developed by the American Canyoneering Association (ACA) have international validity. Apart from these, some countries have developed their own rating systems. One of them is the canyon rating system, which includes eight levels and also intermediate levels, developed by the Canyon and Outdoor Sports Research Association (KAD) in Turkey.

In grading of canyons; a number of factors are used including the difference of altitude between entrance and exit, distance, availability of an emergency exit, access to entrance and exit points, narrowness of canal bed, the amount and flow of water running in the canyon, rope landings, dangers in the water, number of accommodation, number of natural and artificial stations, quantity and quality of necessary technical materials, amount of horizontal passage and climb, temperature of the water and duration stayed in water, and rock structure (Bayraktar, Kılınç, & Erkocaoğlu, 2018).

According to the calculations made against the criteria above, Harmankaya Canyon falls under V4 A4 IV** in the FFME’s rating system, 3 C2 R III** in the ACA, and Class 6 in the KAD’s grading (see Table 2).
Table 2

*Canyon Rating System Results of Harmankaya Canyon*

<table>
<thead>
<tr>
<th>FFME</th>
<th>V4 A4 IV**</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACA</td>
<td>3 C2 R III**</td>
</tr>
<tr>
<td>KAD</td>
<td>Class 6</td>
</tr>
<tr>
<td>Longest landing</td>
<td>18 m</td>
</tr>
<tr>
<td>No of landings</td>
<td>4 m</td>
</tr>
<tr>
<td>Air line</td>
<td>1.7 km</td>
</tr>
<tr>
<td>Land destination</td>
<td>2.3 km</td>
</tr>
<tr>
<td>Entrance longitude</td>
<td>30.445081</td>
</tr>
<tr>
<td>Entrance latitude</td>
<td>40.150925</td>
</tr>
<tr>
<td>Entrance height</td>
<td>536 m</td>
</tr>
<tr>
<td>Exit longitude</td>
<td>30.427428</td>
</tr>
<tr>
<td>Exit latitude</td>
<td>40.139514</td>
</tr>
<tr>
<td>Exit height</td>
<td>400 m</td>
</tr>
<tr>
<td>Entry-exit altitude difference</td>
<td>136 m</td>
</tr>
</tbody>
</table>

According to the FFME: V4 A4 IV** (V—vertical difficulty, A—water difficulty, IV—crossing time/duration, **—quality),

V4 = Difficult, weak to moderate water flow which may break the balance or cause water penetration; landings difficult to access or longer than 30 meters, landings with sequential narrow waiting areas; ground where rock can damage the rope; discharge in ponds; climbs and side passages that require security precautions.

A4 = Long time of stay in cold water; moderate flow, stable jumps of 5-8 meters, forced jumping to a certain point less than 5 meters, siphons in long width and depth below 1 meter; long and steep shifts.

IV = flood rescue in less than 1 hour; escape in 2 hours; entry-exit in 8 to 24 hours.

** = Canyon worth entering several times.

According to the ACA: 3 C2 R III** (3—land/technical difficulty, C—water, R—risk, III—duration, **—quality),

3 = Medium level canyon; distinct natural or artificial stations, pothole.
C2 = Strong discharge containing siphon.
R = Not recommended for beginners.
III = One day.

** = Quite good, worth crossing.

Class 6 according to the KAD: Canyons where water flow never stops, though decreases. In such canyons, extra risks are brought by water (whirlpool, siphon, waterfall, and flood risk etc.). Depending on the area and the precipitation rate, blurred and muddy water can cause additional risks. In this type of canyons, water clothes are mandatory. There is a possibility that there may be frequent changes in the internal structure. It contains a small or large number of water drops between 7 and 18 meters. Technical equipment is mandatory. Double guides are mandatory, one on the point and the other in the back.

As seen above, both local and international rating systems indicate that Harmankaya Canyon is characterized as having a medium level of difficulty, particularly suitable for one-day crossings, and a fairly good and efficient crossing thanks to the splendid landscape. It can be shown as evidence that regular canyon
crossings are held at certain times especially by members of the Canyon and Outdoor Sports Research Association (see Figure 11). Additionally, training on canyon crossing is run by the KAD on a volunteer basis.

![Figure 11. Canyon crossing by the Canyon and Outdoor Sports Research Association (A-B), participants jumping over waterfalls (C) and rock climbing (D).](image)

**Conclusion and Recommendations**

Province of Bilecik is currently underdeveloped regarding tourism activities other than cultural tourism despite its intact natural beauties, cultural assets, and rich history. Although the province covers a small land, Bilecik hosts many natural assets with geotourism potential due to its geological and geomorphological features varying in short distances. Harmankaya Canyon, which is discussed in this study, is thought to be the leading one among all.

Cut through Mesozoic Bilecik limestones by Harmanköy Stream, a tributary of the Sakarya, the canyon under discussion offers a highly fascinating landscape in geomorphological aspect due to its length of nearly 2.3 km and depth of 650 to 700 m. Harmankaya Canyon seems to be a geotourism destination in its own right thanks to its geographical within the overall landscape. Moreover, the canyon and its environs hold suitable conditions for recreational activities covered under special-interest tourism including mainly canyon crossing/canyoning and others, such as trekking, paragliding, rock climbing, rafting, tent and trailer camping, mountain biking, and photography.

Although canyon crossing/canyoning is only developing in our country, it is a significant recreational tourism activity that has been carried out for many years at international level. For this reason, it is of great importance to identify a canyon and its location in international grading classifications. This spot has much appeal for training inexperienced groups in addition to professional athletes due to its medium level of difficulty and possibility of one-day crossing excursion (crossing duration of six to 12 hours) and familiarity with the route due to the previous experience of crossing. As a matter of fact, the interest in the canyon has been boosted by posting of the canyon pass-through photos on the web page of the Canyon and Outdoor Sports Research Association. This fact can be transformed into an advantage and the number of visitors can be
increased by planning one-day or weekend special tour programs to cross the canyon.

Besides the existing geotourism potential held by Harmankaya Canyon, the 1st degree archaeological site on the western slope of the canyon and old settlements with genuine textures (such as Harmanköy) make it attractive for cultural tourism as well. Hence, it is thought that in addition to promotional activities targeting optimal use of the area for geotourism and cultural tourism, it would be highly accurate to train the local population in underdeveloped villages nearby about tourism in order to raise their awareness. Indeed, the annual “Harmankaya Outdoor Sports Festival” organized by Harmanköy and Vicinity Culture and Tourism Society since 2013 seems to be of crucial for promotion of the canyon.

Both Harmankaya Canyon and its surrounding area were declared a nature park and taken under preservation since declaration of natural park in 2012. However, the marble quarries just above the canyon plateau ruin the unique view of the canyon and the nature. They also pose a risk for those who participate in sports activities around the canyon and visitors. We think it would be exceptionally appropriate to close down these quarries because it seems extremely important to benefit from the canyon and surrounding resources by taking into account the balance of protection and use and to leave it as a legacy to future generations. As long as such a cycle is managed properly, an increasing number of visitors will be able to enjoy the natural recreational areas without damaging the nature in and near Harmankaya Canyon Nature Park. On the other side, socio-economic status of the local residents will be improved.

References