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Geo-and biodiversity in the Parnassos National Park: Ecotourism promotion and nature trails management and enhancement

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Abstract

The "National Park of Parnassos" is a protected area, in order to preserve and protect the rich fauna and flora, as well as the mountain's unique geodiversity (diversity of land-forms, soil, and water). The concept of protected areas rose as a consequence of the need to protect the flora and fauna and the natural landscape in general. The development of ecotourism in a protected area is a "multifactorial" system. Proper assessment requires a multidisciplinary approach and detailed study, in order to carry out its objectives efficiently. Ecotourism should have minimal impact on both the environment and the local culture.

The mountain of Parnassos, crisscrossed by a dense network of trails. Parnassos network of trails includes numerous hiking and mountaineering routes, with various thematic interests and degrees of difficulty. The so-called thematic trails, such as the "nature trails", "geological trails", "botanical trails", "rural trails", etc., offer outdoor recreation and physical activity, but they have been proven to be an indispensable tool, used by the specialists to highlight the characteristics of the natural environment, ecology, biodiversity, geological-geomorphological characteristics and water resources, as well as the historical background, mythology and culture of certain areas. To facilitate these scientific endeavors, the thematic trails have to be developed and managed accordingly.

The main purposes of the present research are to describe the strategy for developing the sustainable tourism, ecotourism, the various types of trails (hiking trails, biking trails, etc.) and to highlight the biodiversity, landscape, geodiversity sites and ancient history and mythology, of the Parnassos National Park, in order to propose improvements over the management and its sustainable ecotourism promotion.

Keywords: *Mt Parnassos; ecotourism; hiking and mountaineering routes; National Parks; protected areas.*

1. INTRODUCTION

Worldwide, protected areas are considered to be institutions of great socio-educational impact that could be linked to the process of education for sustainable tourism development. Protected areas contain some of the planet's most important ecosystems and many also 'serve as important cultural places where people contemplate and understand the natural world through visitation and tourism' (Eagles et al., 2013: 60). The term 'protected area' is used to describe a variety of unique and very diverse habitats and natural areas (Murphy, 2014). The IUCN defines a protected area as a "clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" [1].

National parks (Category II) fall, with wilderness areas, nature reserves, sanctuaries, national monuments, World Heritage sites, and protected landscapes and seascapes and variants on these forms, along the IUCN continuum according to the level of human activity permitted (Dudley 2008). National parks are "large natural or near natural areas set aside to protect largescale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities"[2].

2. MATERIALS AND METHODS

2.1 Geographical location of the study area

Parnassos Mt., the third highest mountain in Central Greece, stretches from the plains of Boeotia in the east to the bay of Itsea in the southwest. Geologically, it is "divided" in two parts. Eastern Parnassos Mt. is dominated by limestone. Here we meet the highest peaks: Liakoura (2457 m), Gerontovrachos (2396 m), Tsarkos (2416 m), Kalogiros (2327 m) and Mavra Litharia (2327 m). On the contrary, the western part, which is dominated by flysch rock, is lower (Paleovouna 1,650 m) and covered in forests.

2.2 Investigation method

For the depiction of the environmental situation (vegetation, flora, fauna, geology, geomorphology, water resources, landscape), archeology and mythology, of Parnassos Mt., involved a series of different stages: the study of bibliographical references, systematic in situ observations (field-work), measurements using the Global Positioning System (GPS) satellite signals, observation and direct digitizing on the basis of different aged aerial photos and satellite images (Google Earth). Also, have been used topographical maps (Hellenic Military Geographical Service, scale 1:50.000 and 1:100.000), geological maps (Institute of Geology and Mineral Exploration, scale: 1:50.000), Digital Elevation Model (DEM) data (Hellenic Cadastre S.A.), habitat types and forest maps of vegetation and land uses (Ministry of Environment & Energy, scale: 1:200.000). All primary data were imported in an opposite database and were transferred in topographical map and onto DEM data using ArcGIS for Desktop 10.3. Measurements were taken using the Trimble Juno 3D Series embedded with software ArcPAD 10.2.

2.3 Protected areas of Parnassos National Park

The “Natura 2000” is a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right. It stretches across all 28 EU countries, both on land and at sea. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Bird Directive (Directive 2009/147/EC, Special Protection Areas SPAs) and the Habitats Directive (Council Directive 92/43/EEC, Special Areas of Conservation SACs). Stretching over 18 % of the EU's land area and almost 6 % of its marine territory, it is the largest coordinated network of protected areas in the world. At Parnassos National Park has been instituted the according protected areas (Figure 1) :

a. The Special Protection Area (SPA) “Oros Parnassos”- GR2410002 as an important area for the reproduction and residence of birds under protection status, b. The Special Area of Conservation (SAC) “Notioanatolikos Parnassos - Ethnikos Drymos Parnassou – Dasos Tithoreas, Spilaiovarathro” - GR2450005 to ensure the preservation and restoration of habitats and species of flora and fauna.

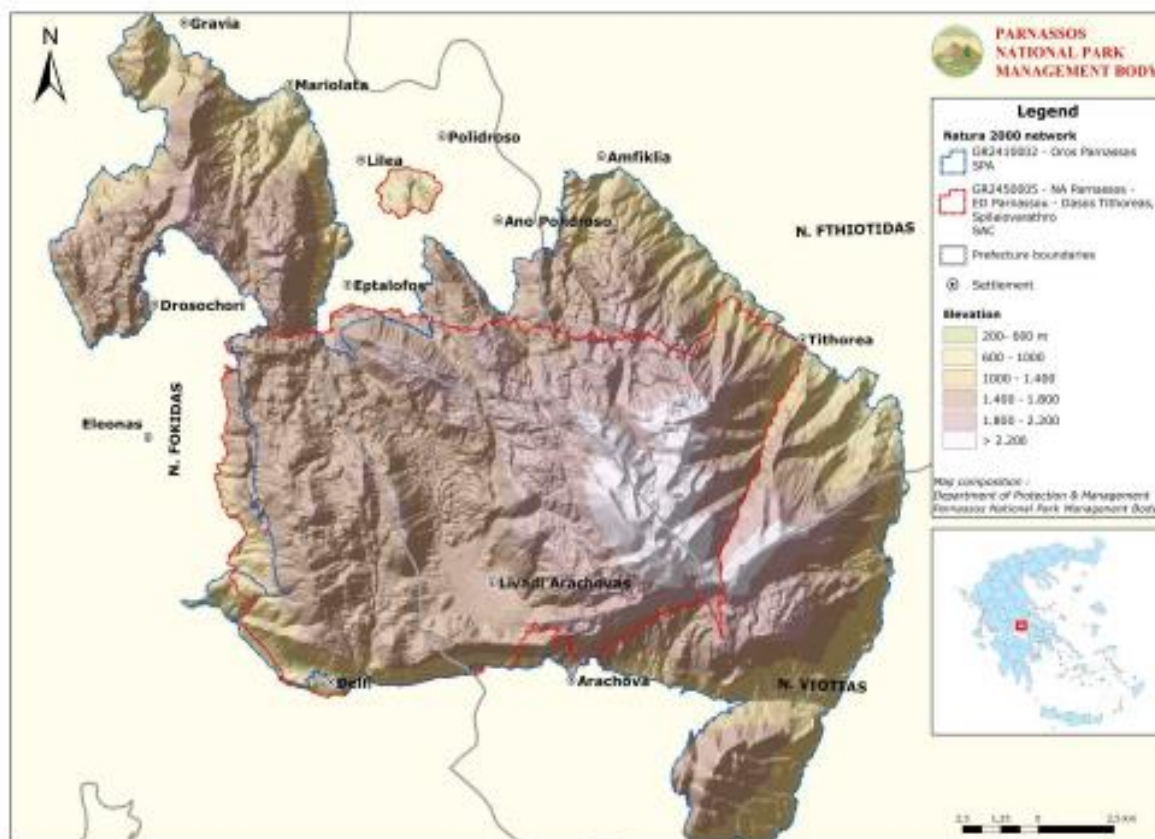


Figure 1. Map of the protected area Parnassos National Park

2.4 Habitats - Flora - Fauna

The geographical position of Parnassos Mt, its varied terrain of ravines, steep and minor slopes, curved peaks, rocky elevations, valleys etc., but also anthropogenic influences, have contributed in the shaping of the distinct conditions, this interesting geomorphology is made the area remarkably rich in flora and fauna.

The quality and importance of the Parnassos National Park is based on the ecological and aesthetic value of its natural elements, especially on its biodiversity, and in the cultural value of its archaeological and historical elements. From ecological point of view, a variety of vegetation types which are excellent structure, are maintained and among them there exist special priority habitat types such as: 6220 *Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* (Figure 2b), 6230 *Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas, 9530 *(Sub-) Mediterranean pine forests with endemic black pines, 9560 * Endemic forests with *Juniperus* spp. Other important habitat types that included in the protected area of Parnassos Mt. are: 4060 Alpine and Boreal heaths, 4090 Endemic oro-Mediterranean heaths with gorse, 8140 Eastern Mediterranean screes, 8210 Calcareous rocky slopes with chasmophytic vegetation, 9340 *Quercus ilex* and *Quercus rotundifolia* forests. Except from habitat types, at the study area are included many endemic species of plants *Centaurea musarum*, *Silene guicciardii*, *Euphorbia orrahimidis*, *Paeonia parnassica* (Figure 2a). Some of endangered plant species are included in Annex II of Directive 92/43/EEC (*Paeonia parnassica*, *Bupleurum capillare*). The Parnassos Mt. is also important for the significant number and variety of protected avifauna species, particularly birds of prey. In Annex I of the Directive 2009/147/EC fifty five (55) birds (e.g. *Circus gallicus*, *Aquila chrysaetos*, *Bubo bubo*, *Dryocopus martius*, *Dendrocopos medius*, *Dendrocopos leucotos*, *Sylvia rueppelli*) of the region are listed. As for other fauna species, thirteen (13) mammals (e.g. *Rhinolophus hipposideros*, *Rhinolophus ferrumequinum*, *Myotis myotis*, *Barbastella barbastellus*, *Dryomys nitedula*) six (6) amphibians (e.g. *Bombina variegata*, *Rana graeca*, *Triturus alpestris*), fourteen (14) reptiles (e.g. *Testudo marginata*, *Podarcis muralis*, *Lacerta viridis*) and ten (10) invertebrates (*Zerynthia polyxena*, *Parnassius mnemosyne*, *Parnassius apollo*, *Lucanus cervus*, *Grossiana delphica*, *Mormus funereus*), are listed in Annex II of the Directive 92/43/EEC. More common species such as the fox (*Vulpes vulpes*), weasel (*Mustela nivalis*), marten (*Martes foina*), wild boar (*Sus scrofa*) and wolf (*Canis lupus*) are also present at the



Figures 2a, b. *Paeonia parnassica* (Fig. 2a).

Habitat type 6220* Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* at "Varko" area (Fig. 2b) (Photos by Lanara T.).

2.5 Geological setting – Geomorphology

The morphology of the land relief, in the wider region of the Parnassos National Park, is defined by the mountainous massif of Parnassos with steep slopes, gorges and intense morphological contrasts. Mt Parnassos is the third highest mountain in Central Greece (Sterea Ellada), after the mountains Gkiona (Pyramida 2510 m) and Vardousia (Korakas 2495 m). The dominant structural elements are its limestone steep tops, with highest peaks Liakoura (2456 m), Kalogiros (2397 m), and Gerontovrachos (2396 m) in the eastern side of the mountain (Figure 3a). Due to the predominance of limestone (76.6%) on Mt Parnassos, karst phenomena are formed from its dissolution [4]. As a result, Parnassos Mt. is mostly characterized by an underground drainage system and lack of surface flow, with sinkholes and caves, forming many karst springs at the foot of the mountain (Figure 3b).



Figures 3a,b. The eastern side of Parnassos Mt. (Fig. 3a).
The entrance of Mparoutospilia cave (Fig. 3b) (Photos by Lanara T.)

Other karst formations are dolines and poljes [5]. Karst formations are an important element of the landscape and geomorphology of the region, such as the Eptastomos Sinkhole, Spilaiovarathro Polidrosou, polje of Livadi Arachova, Korikion Andro Cave (or else, Korykio Andro - Korikio Andro - Corycian Cave), Neraidospilia Cave, Mparoutospilia Cave, Drakokarkaros.

2.6 Mythology – History

According to Greek mythology, Parnassos Mt. is named after the hero Parnassos, who founded a city with the same name on the mountain. The city was destroyed during the deluge of Deucalion; however, its inhabitants, notified in time by the howling of wolves, fled to higher ground and were saved. They built there a new settlement in memory of the event, which they named Likoria, meaning “the howling of wolves” [6]. The study area has a rich historical and cultural heritage, with significant monuments and archaeological sites that can contribute to the cultural tourism development of the region. The worldwide famous archaeological site of Delphi (the Delphic Oracle, the Ancient Theater, the Stadium and the Museum) is the second most visited destination in Greece. The archaeological and folklore museums, religious monuments, historical

bridges together with local cultural events and folklore festivals based on local traditions and products form an attractive tourism destination [2].

The "landscape of Delphi" is a wider area that includes in the archaeological site of Delphi, the traditional Olive Yard "Elaionas Amfissas" and the valley of the Pleistos River. It has been declared as a protected area since 1981 and is consisted by two protection zones (A and B zone) [7]. Apart from the monuments of the archaeological site of Delphi, the Temple of Athena Pronaia, the Gymnasium and the Castalia Spring, the wider area of the valley includes numerous monuments and archaeological sites, from prehistoric to modern times, with special archaeological, historical, aesthetic value [8]. The mentioned above, together with the natural environment that highlights the Delphic landscape, contributed to a cultural center of enduring value.

3. RESULTS AND DISCUSSION

3.1 Thematic trails at Parnassos National Park

The study area constitutes an ideal ecotourism destination, endowed with a unique natural environment and landscape, flora and fauna, rich cultural heritage and lively traditions, warm local hospitality and gastronomy, mountain shelters, hiking trails and climbing routes, mountain bike, horseback riding (Region of Central Greece). The most attractive tourism resources of Parnassos territory include mountainous areas, caves, canyons, waterfalls, archaeological sites, byzantine/ medieval monuments, traditional settlements (Figures 4a&4b).



Figures 4a,b. The archaeological site of Delphi (Fig. 4a).
The "Tripi" waterfall (Fig. 4b) (Photos by Lanara T.)

The mountain of Parnassos, crisscrossed by a dense network of hiking trails and mountaineering routes (Table 1), is one of the ten Mountainous National Parks of Greece. Due to the modern lifestyle, trail walking and hiking offers unique opportunities for contact with nature, biodiversity, ecology and cultural heritage, ecotourism of each region. The so-called "thematic trails" (Figure 5) such as "nature trails", "geological trails", "cultural heritage trails" are significantly "tools" used by specialists for highlighting the characteristics of the protected area, the geo-ecological characteristics as well as the historical and artistic value [9].

Table 1. Selected “thematic trails” at Parnassos National Park

	Points of interest / Trail features:	Trail signs:	Recommended visitor season:	Degree of difficulty:
Delphi – E4 – Kroki	The traditional settlement of Delphi and the archeological site, “the landscape of Delphi” outstanding views, the wild beauty of the steep slopes, rocky cliffs “Phaedriades”, wildflowers, the panoramic view towards the gulf of Corinth, the settlements Itea – Crissa, “Amfissa” Olive grove	Good directional signs (red - white square mark) and from Kroki to Delphi signs E4 trail (yellow - black - white square frame)	February to November	Medium to Moderate
Paleopanagia Livadi Arachovas – “Korikion Andron”	Livadi Arachovas’ polje, outstanding view, the beautiful chapel St. Triada surrounded by perennial kerme oaks, “Korikion Andron” Cave, the entrance of cave: the panoramic view towards the gulf of Corinth, Kirfi Mt. and Gerodovrachos (2396 m), flora and fauna of Mt. Parnassos	Good directional signs (red - white triangular frame)	February to November	Easy to Moderate
Tithorea- Od.Androutsou cave	The traditional settlement of Tithorea, Kahala gorge, waterfall, outstanding views, ruins of ancient fortification, the wild beauty of the steep karstic slopes, the beautiful chapel St. George surrounded by perennial oaks, Od. Androutsos karstic cave, flora & fauna of Mt Parnassos, the fir forest (<i>Abies cephalonica</i>)	Good directional signs (red - white square mark)	April to November	Medium to Moderate
Tithorea- “Tripi” waterfall	The traditional settlement of Tithorea, Kahala gorge, outstanding views, ruins of ancient fortification, the wild beauty of the steep karstic slopes, geomorphology, waterfall “Tripi” 80 m height	Not good directional signs	May to September	Difficult to Moderate
“Varko” – Ag.Nicholaos – “Petra” Eptalofou	The Parnassos National Park, priority habitat types, the fir forest (<i>Abies cephalonica</i>), flora & fauna, wetland ecosystems	Good directional signs (red square frame)	April to November	Easy to Moderate
Mparoutospilia cave	The geology of the region, limestone formations, the gorgeous entrance of Mparoutospilia cave	Good directional signs	April to November	Easy to Moderate

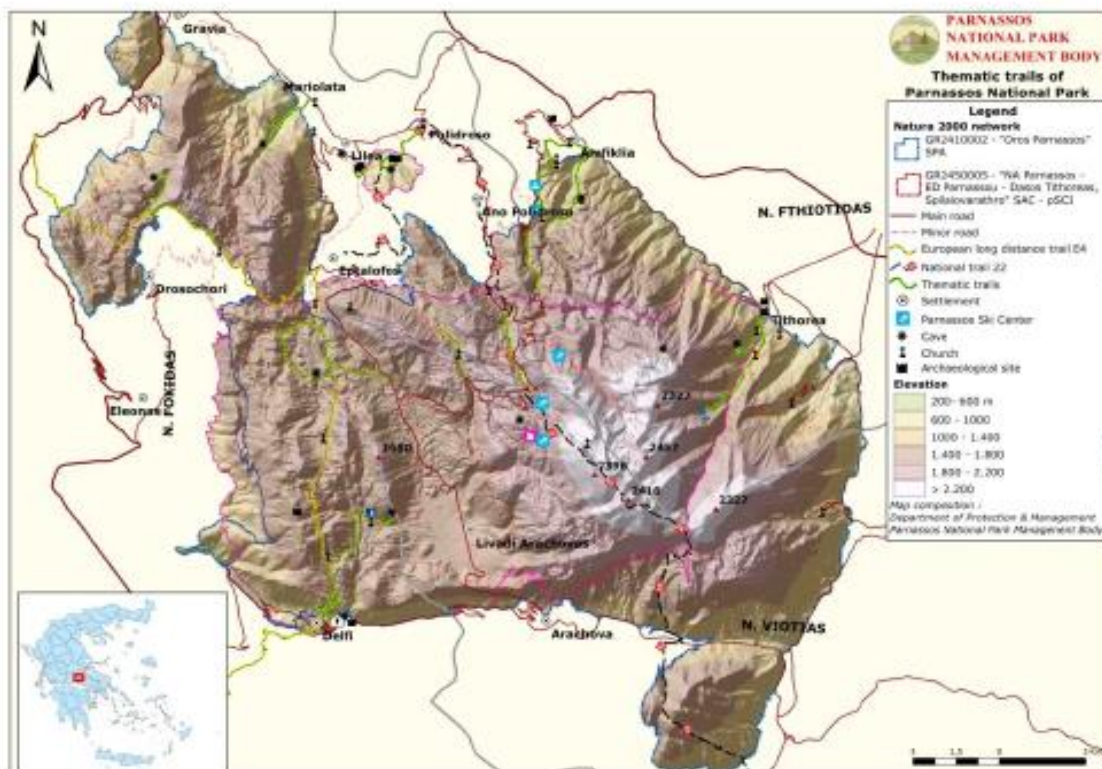


Figure 5. Map of "thematic" trails at the protected area of Parnassos National Park

3.2 Trail management and enhancement

The minimum conditions required for the proper development and implementation of ecotourism activities in protected areas, is the proper design of the paths, the systematic maintenance and monitoring, the calculation of the ecosystem's carrying capacity, the raising of awareness among the visitors to environmental protection, the application of conservation measures and procedures and the highlighting of particular characteristics of the natural environment, landscape and cultural heritage. Without the necessary planning, problems will inevitably emerge and the local environment will be depredated, as a direct effect of conventional or mass tourism [10].

The efficient management of a trail, the protection and enhancement of the landscape and the natural and built environment that surround it, need compliance to the relevant rules in to be maintained. These rules include proper signage, regular maintenance and, in some cases, monitoring and guarding as well as promotion. The appropriate signage and maintenance are prerequisites for the safe use of the trails. Consequently, trails have to be managed systematically, namely to be maintained in a satisfactory level of cleanliness and safety conditions. This applies to the maintenance of constructions too. The proper design and construction of new trails or "improved" routes in the pre-existing trails can reduce the cost of maintenance and management while increasing the promotion of the surrounding area and the quality of information provided to the visitor. Combining the above can create favorable conditions for the attainment of the purposes the trail is created for.

According to [11], signs are probably the quickest and easiest way to leave the trail user with a positive impression. If the signs are high quality, well maintained, and properly located, other trail problems which are harder to solve are often over-looked (e.g., wet areas). Consistent signs are the quickest way to increase the trail's identity and the public's support for the trail. Other objectives are to: 1. Provide positive exposure of the trail to attract more users, 2. Educate the user about the trail through trailhead kiosks, 3. Reassure the user that he/she is on the right trail and will not get lost, and 4. Control trail usage and create a safer, more enjoyable, environmentally friendly experience. These objectives are to be balanced with aesthetic considerations to avoid "sign pollution".

The right timing and frequency of the maintenance checks are some more of the needed actions. According to [12], the only way to maintain appropriate service levels is developing an annual program of inspection, maintenance and cleaning for each trail. Otherwise, the decisions related to maintenance will be made by the staff and they will, consequently, be depended on their availability. The frequency of checks and maintenance depend on the season and the intensity of the use of each trail. The condition and resulting maintenance demands of a trail is affected by the amount and type of use the trail receives. Each trail has a usage limit. The usage limit however, is determined by more than just the amount of use. The usage limit is influenced by the following factors: environmental conditions impacting the trail, quality of site selection, ground cover and terrain, trail construction, adherence to maintenance requirements, and the volume and types of trail use [13].

It is important to determining the carrying capacity, namely the maximum number of visitors the trail, and the fragile area of Mt. Parnassos, can accommodate without degrading the environment and the protected ecosystems. Furthermore, it is considered necessary to inform the visitors about the "Rules & Regulations" of the trail. At the same time a "Visitor Monitoring & Management Program" should be developed by the competent body. The results of this "Visitor Monitoring & Management Program" alongside the findings concerning the effects caused by the presence of visitors in the protected areas, can give its managers the possibility to systematically improve and apply a constantly rejuvenated "Rules & Regulations". As a consequence, this process contributes positively to the reduction of the environmental impact of the presence of visitors and use of the trail. Meanwhile, the "revolving monitoring program" of visitors and its systematic updating will help to the accurate identification of the target group of visitors. This will enable the competent bodies in creating the appropriate conditions and infrastructure to meet the needs and requirements of visitors (e.g. handicapped, cyclists, etc.).

4. CONCLUSIONS

A dense network of paths is can be found at Parnassos Mt. and in the limits of Parnassos National Park. The trails of the Parnassos Mt., are of great ecological (geo- and biodiversity), archaeological, scientific and research interest. Parnassos network of trails includes numerous hiking trails, walking trails, recreational trails, trekking trails, and mountaineering routes, including thematic trails (nature trails, geological trails, ecological trails, cultural heritage trails). Following their route, the traveler can enjoy many of the special features, geo- and biodiversity, archaeological sites and offer hikers

opportunities for exercise, recreation and environmental education. These include, among others: 1. the extensive fir forests, 2. rare and impressive species of plants and rich fauna, 3. the fragile environment of mountain meadows and small temporary ponds of high altitude, 4. the karst landscape, dolines and poljes (polje at Livadi Arachova), karst springs, 5. the impressive gorges (Kahala gorge), steep slopes and intense morphological contrasts (twin rocks of the Phaediades), 6. Sinkholes (Eptastomos Sinkhole, Karkaros of Lilaia) and caves (Korikion Andro cave, Neraidospilia cave, cave of Odysseas Androutsos, etc.) and 7. the Pan-Hellenic Sanctuary of Delphi, with the most famous oracle of ancient Greece (archaeological site - UNESCO World Heritage Site), Korikion Andron cave, etc.

The ecotourism promotion, the development and the efficient management of the trails at Mt. Parnassos, the protection and enhancement of the landscape, the natural and built environment and geo-biodiversity that surround them, need compliance to the relevant rules in to be maintained. These rules include proper signage, regular maintenance and, in some cases, monitoring and guarding as well as promotion. The appropriate signage and maintenance are prerequisites for the safe use of the trails. Consequently, the trails have to be managed systematically, namely to be maintained in a satisfactory level of cleanliness and safety conditions. This applies to the maintenance of constructions too. The proper design and construction of new trails or "improved" routes in the pre-existing trails can reduce the cost of maintenance and management while increasing the promotion of the surrounding area and the quality of information provided to the visitor. Combining the above can create favorable conditions for the attainment of the purposes the trail is created for.

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