

Lesvos Petrified Forest Geopark, Greece: Geoconservation, Geotourism, and Local Development

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Guest editors' note: Lesvos Petrified Forest Geopark in Greece, one of the first geoparks in the world, already has one decade of successful operation. Lesvos Geopark operates according to a management plan that is aimed at improving the site's infrastructure, services, education, and promotional activities. The results of the implementation of the management plan have been a significant increase in the number of visitors, enrichment of program offerings and tourism services, and improvement of its operations. In addition, Lesvos Geopark contributes significantly to the local economy by creating new jobs and establishing close collaborations with local tourism enterprises.

Introduction

THE ISLAND OF LESVOS, situated in the northeast Aegean Sea, is the third largest island in Greece at 1,630 sq km. On its western side that one can find the Lesvos Petrified Forest Geopark, the very first Greek geopark, comprising large accumulations of exposed fossilized tree trunks. A protected natural monument, the Lesvos Petrified Forest consists of four major terrestrial and marine fossil sites lying on an area of 15,000 hectares with a buffer zone of 20,000 hectares. The formation of the petrified forest is directly related to the intense volcanic activity in Lesvos during early Miocene times.

The Natural History Museum of the Lesvos Petrified Forest was founded as a non-profit organization in 1994 to protect and efficiently manage the petrified forest. Systematic scientific research and excavations have been carried out over the last decade by the Natural History Museum in order to gain a better understanding of the geological evolution of the island and the origin of the petrified forest.

The main components of the operation of the geopark include scientific research; creation of a geosite inventory; protection, interpretation, and promotion of geosites; conservation of fossils; creation of visitor parks; establishment of a network of walking trails linking sites of interest with ecotourism infrastructures; development of environmental education programs on geosites; organization of scientific and cultural events; and promotion of geosites monuments.

The Lesvos Petrified Forest Geopark is a founding member of the European Geoparks Network (EGN) and one of the initial members of the Global Geoparks Network. Lesvos

Geopark has benefited from international collaboration and developed an infrastructure that is highly appreciated and valued by the local population, visitors, and politicians alike.

According to its latest evaluation carried out by international experts during the summer of 2007, "the European Geopark Lesvos Petrified Forest is a best practise example within the European Geoparks Network and [it] plays an important role in the sustainable economic development of the island, especially for the rural area of Western Lesvos."

Lesvos Geopark management plan

The management plan is the main tool for the operation of the geopark and links geoconservation and promotion of natural and cultural heritage with the development of geotourism. During the last seven years the geopark has been following the provisions of its management plan and has implemented a range of activities aimed at the further improvement of its infrastructure, services, activities, and promotion. The results of the implementation of the management plan have been a significant increase in the number of visitors, the enrichment of its offerings and services to visitors, and improvement of its operations. The main activities implemented during this period are presented below.

Geosite identification and assessment A research study and field survey on Lesvos, carried out by the Natural History Museum of the Lesvos Petrified Forest and the Department of Geography of the University of the Aegean, has resulted in a better understanding of the geological evolution of the island and the origin of the petrified forest. Several geosites were identified, mapped, and assessed (Zouros 2005, 2007) using the following criteria: (1) scientific and educational value (integrity, rarity, representativeness, and exemplarity); (2) natural beauty and aesthetic value; (3) cultural interest; (4) geodiversity; (5) potential threats and protection needs (vulnerability and legal protection.); and (6) potential for use (recognizability, geographical distribution, accessibility, and potential for generating economic activities).

The results were published as a new geosite map of Lesvos Geopark. Apart from the fossil sites, geosites within the volcanic terrains of the geopark include the volcanic calderas, columnar lavas, the Petra volcanic necks, veins, domes, laccoliths, and impressive volcanic landscapes. Other geosites represent active and evolving geomorphologic landforms, including tectonically active fault scarps, geothermal fields, karst and caves, and coastal and fluvial landforms.

Enhancing the natural and cultural heritage A second component of the geopark's management plan is the identification of the different natural and cultural resources of Lesvos Geopark, including flora and fauna (especially birds), wetlands, archaeological monuments, Early Christian basilicas, Byzantine monasteries, Venetian castles, picturesque villages and rural architecture, drystone constructions, and impressive landscapes (Figures 1 and 2). All these elements of interest were linked to geopark presentation and benefit from a unified system for protection and promotion.

Several ecological or cultural aspects of the petrified forest protected area were identified and studied in collaboration with the University of the Aegean, research institutes, and other scientists (e.g., birds, plants, wetlands, coastal and marine ecosystems, drystone constructions, and agricultural landscapes). The results of this research have been used for man-



Figure 1. Tours of historic buildings are a geopark highlight. Visitors discover the role of geology in preserving the history of a place. Photo by Heidi Bailey.

agement, educational, and promotional purposes.

Geosite protection and geoconservation Lesvos Petrified Forest Geopark applies certain management measures for the protection and conservation of the inventory of geosites present in the territory. These measures comprise: (1) regular maintenance (fencing, cleaning) and custodial services to protect geosites from abuse and vandalism; (2) geosite monitoring with necessary measures and protective installations against weathering and erosion; and (3) treatment of vulnerable geosites with annual conservation and protective measures (preparation, sealing).

A conservation team was formed and a laboratory for fossil conservation organized and equipped. Conservators treat dozens of petrified trees through the use of innovative techniques in an effort to face several challenges such as weather conditions (unstable temperatures and relative humidity can deteriorate the fossils exposed to the open air), as well as the actions of unaware visitors.

The most fragile fossils are covered by shelters that protect them from the rain. Stone walls also protect the fossils from water runoff while the fossil sites themselves are angled for proper drainage. In some cases, stone walls have been constructed to stabilize the ground and prevent natural erosion. These walls, along with wooden fences, also serve to protect the fossils from visitors.

Geosite interpretation panels provide information to geopark visitors on the importance of the geological and geomorphologic processes on the evolution of the region. Thus local people can also learn that certain “rocks” represent remnants of outstanding phenomena and



Figure 2. Villagers living within the Lesvos Petrified Forest Geopark in Greece. The European geoparks focus on the inclusion of local people and the celebration of diverse cultures. Photo by Heidi Bailey.

processes that demonstrate the geological history of their own terrain. In this way particular rock formations gain a new identity for the people and at the same time become objects to be respected and protected.

Geopark infrastructure and land management Lesvos Petrified Forest Geopark has developed a range of tourist facilities to serve its visitors. The Natural History Museum of the Lesvos Petrified Forest in Sigrí village is at the core of this infrastructure. This state-of-the-art museum has become a key factor in attracting visitors to this part of the island.

Museum exhibitions present the evolution of plant life on earth, the flora of the petrified forest with fossil remains of over 40 different species found and identified in the broader area

of western Lesvos, and the volcanic activity related to the formation of the petrified forest and the evolution of the Aegean area.

Within the petrified forest's protected area, the main fossil sites are fenced and safeguarded, and five visitor parks have been established, attracting thousands of visitors each year: Petrified Forest, Sigri, Plaka, Nisiopi, and Skamiouda parks. Several other areas will become visitor parks during the next years, as the museum has already begun the necessary procedures.

Another main part of the infrastructure is the "Lava Paths" that lead visitors down the ancient paths of the pyroclastic flows from the main volcanoes to the petrified forest. Equipped with information panels that explain the various geosites, these footpaths link the existing visitor parks, wetlands, and sites of natural beauty and ecological value, as well as cultural monuments, picturesque villages, and other sites of interest throughout the geopark. Along the main roads crossing the Lesvos Geopark area, information panels and road signs direct visitors towards the petrified forest and demarcate the borders of the protected area. Walking trails start from different points along the main road.

The geopark has also established two information centers to inform visitors about the geotourism and educational activities in Lesvos. The first, in Mytilene, the capital of the island, includes a small exhibit. The second operates in the village of Eressos during the summer. There is also an information point in the Odysseas Elytis Airport of Mytilene.

Geotourism and promotional activities A broad range of activities accomplishes the task of attracting and informing visitors. Lectures and multimedia presentations at the museum are used to familiarize visitors with the geological processes related to the creation of the petrified forest, the diversity of fossil plants, and the geological evolution and natural heritage of the Aegean. Guided tours in the petrified forest's visitor parks, thematic guided walks, trekking, and various other recreational activities in the vicinity of geosites help raise public awareness about their value.

Furthermore, a series of scientific and cultural events is organized and hosted every year in the petrified forest to attract the attention of the broader public to this unique natural monument. The range of events includes scientific lectures, slide shows, documentary films, natural science-oriented temporary exhibitions, book presentations, art exhibits, music and dance events, and theatrical plays. Through these events, the geopark draws large audiences of people who may have little or no interest in natural heritage, thus creating new opportunities for sensitizing the public.

The geopark also organizes several thematic events to celebrate special events or international days (i.e., Museums International Day, Day of Monuments, Earth Day, Day of the Environment, European Heritage days, European Geoparks Week, and Earth Fest). Temporary exhibitions on the Lesvos petrified forest circulating through the larger cities and museums in Greece and abroad contribute significantly to the promotional work of Lesvos Petrified Forest Geopark.

International and national scientific conferences and meetings are also hosted in the museum's conference center. Such events bring scientists from all over the world to the geopark, helping to raise the petrified forest's profile in the academic community and to promote the use of its infrastructure for the hosting of other academic and educational activities (e.g.,

research groups, educational visits, student fieldwork). As a result, several universities have started to organize student visits and fieldwork in the geopark.

The promotion of the petrified forest occurs through print and television media. New excavation findings have attracted the attention of local and national media to this exceptional natural monument. A number of articles in national newspapers and magazines as well as radio and TV programs have referred to the petrified forest, the new excavation findings, and the importance of the monument. Research results have been presented in numerous scientific meetings in Greece and abroad, and several multimedia presentations on the Lesvos Petrified Forest have been organized in Athens, Thessaloniki, Crete, and in the main towns of Lesvos. The geopark has also produced a series of scientific and popular publications for visitors such as coffee-table books, field guides, magazines, conference proceedings, brochures, leaflets, and posters.

Educational activities and tools Educational activities lie at the core of the geopark's operations. Environmental education programs organized for elementary and high school students at the petrified forest cover a broad range of activities such as geosite recognition, fossil excavation and conservation, nature observation, and bird watching. School visits are organized during spring and autumn, outside the main tourist period, thus contributing to the local economy through the development of educational geotourism.

Educational activities for local schools help raise the awareness of the local inhabitants as to the importance of our natural monuments and the conservation of the earth's heritage. Extended educational programs, with school groups coming from other parts of Greece and abroad, introduce young students to the "secrets" of scientific research and geoconservation.

A variety of educational tools have been created for the needs of the environmental education programs (such as museum kits, an educational CD, booklets, student booklets) for all levels of education. The two museum kits focus on plant fossils and volcanic rocks. The geopark also supports university field camps dedicated to various scientific disciplines (geomorphology, geology, paleontology, geography, vulcanology, environmental science, museology, conservation, etc.). Several universities from various European countries and the USA have organized visits and educational activities using the geopark.

In 2000, the Vocational Training Center of the Natural History Museum of the Lesvos Petrified Forest was founded to train young unemployed people in the techniques of conservation, excavation, and preservation of fossils, as well as in visitor reception and geopark promotion. By 2007 five courses had been delivered and 108 young people living in the area of the geopark were trained. Thirty-four of these trainees found employment in the geopark. During the spring of 2007 a three-month course entitled "Techniques of Protection and Conservation of Fossils" was delivered in collaboration with Bergstraße-Odenwald, a European and global geopark.

Supporting local business, sustaining local communities An important component of the Lesvos Geopark management plan is the support of the local economy. The geopark has created links with local tourist enterprises, restaurants, and small hotels in order to provide the necessary infrastructure to meet the needs of the increasing number of park visitors. The majority of visits to the geopark occur during the summer (July–September), but the aim is to extend the visiting period to the spring and autumn.

In the village of Sigri, the number of bed and breakfast accommodations has doubled over the last few years in order to meet the increasing demand. More importantly, visitors have increased the duration of their visits to the geopark area. As a result, the majority of the new enterprises established in Western Lesvos are connected with the activities of Lesvos Geopark.

The geopark also supports the making of local handicrafts such as the production of fossil casts and souvenirs by local enterprises. These items are on sale in the museum shop along with a variety of other locally made products (Figure 3). Lesvos has a long tradition in pottery and woodcarving and the geopark promotes these products to its visitors.

Lesvos Geopark also collaborates closely with women's agrotourism cooperatives and local organic food producers to offer its visitors the opportunity to taste and buy local food products (e.g., pasta, organic olive oil, wine, ouzo, liquors, traditional sweets, and marmalades; Figure 4). The catering for all geopark events (conferences, meetings) is supplied by the women's cooperatives using the local traditional recipes. Their products are also sold in the museum snack bar.

Every summer the geopark organizes an agrotourism festival (attended by 28,000 visitors in 2007), which promotes high-quality local products, food, and drinks prepared by the women's cooperatives. The agrotourism festival includes a variety of presentations, events, and happenings as well as an exhibition of local products. The event brings local producers

Figure 3. Visitor centers and museums within a geopark sell local products to tourists. These products play an important role in sharing the story of a place. Photo by Heidi Bailey.





Figure 4. At a winery located inside the Lesvos Petrified Forest Geopark in Greece, the owner explains to visitors how minerals like gypsum influence the flavor of wine. Photo by Katarzyna Kozina.

and potential customers together. In this way, geopark visitors experience not only the rich natural heritage of the area and sites of high ecological and aesthetic value, but also the culture, tradition, and local production of the region. The women of the agrotourism cooperative found that this festival provided them with an excellent opportunity to promote their products, and their success led to the creation of similar cooperatives in other villages.

Lesvos Geopark contributes significantly to territorial development by directly and indirectly creating new jobs. Since 1995, people have been finding employment within its activities, such as the twenty-five seasonal positions (eight months per year) and eight permanent positions. This is in addition to the five existing positions in the Petrified Forest Park. But what is even more important for the employment in the area is the number of other opportunities that have been created in tourist enterprises, small hotels, guest houses, restaurants, and other enterprises connected with the increase of tourism to the geopark area. Several other local artisans, such as makers of handicrafts and ceramic fossil casts, carpenters, and blacksmiths, are permanent collaborators with the geopark.

Implementation, monitoring, and review To protect vulnerable geosites, Lesvos Geopark has developed a geosite monitoring system that includes custodial services to prevent abuse and vandalism, and intermittent monitoring that provides all the necessary measures and protective installations against weathering and erosion.

The monitoring system is based on the creation of a sophisticated geosite database that

contains a complete descriptive record of each geosite and all conservation measures currently being taken. The basic elements of this database are geosite location, identification, classification, description, age, land ownership, and cleaning and conservation measures.

Monitoring and review of geopark operations and services takes place regularly while an evaluation process established by the EGN and the Global Geoparks Network is done every four years. This procedure is carried out by independent auditors and takes into account geopark management with a focus on geotourism, educational and promotional activities, and improvements to infrastructure and services.

Conclusion

Geoparks address the strong need for effective management of important geosites and sustainable development of rural areas through the development of geotourism, which enhances the value of the earth heritage, its landscapes and geological formations—key witnesses to the history of life. The geoparks initiative adds a new dimension to the 1972 World Heritage Convention by highlighting the potential for interaction between socioeconomic and cultural development and conservation of the natural environment.

Lesvos Petrified Forest Geopark integrates the range of resources found in its broader region, including the existing geological tourist attractions (Petrified Forest Park, the museum, Sigri Park, and Plaka Park), the various interpreted geosites, unique landscapes, wetlands, sites of natural beauty and ecological value, as well as cultural monuments, picturesque villages, traditional gastronomy, and local products.

A broad range of activities combine the main components for the operation of Lesvos Geopark, including scientific research; creation of the geosite inventory and map; protection, interpretation, and promotion of geosites; conservation of fossils; creation of visitor parks; establishment of a network of walking trails linking geosites to ecotourism facilities; development of environmental education programs on geosites; organization of scientific and cultural events; and promotion of geosite monuments.

The results achieved by Lesvos Geopark demonstrates the potential of all geoparks across Europe to be powerful new tools for holistic nature conservation and sustainable rural development through geotourism.

References

- Eder, W., and M. Patzak. 2004. Geoparks—geological attractions: A tool for public education, recreation and sustainable economic development. *Episodes* 27:3, 162–164.
- Gray, M. 2004. *Geodiversity: Valuing and Conserving Abiotic Nature*. Chichester, U.K.: J. Wiley & Sons.
- Martini, G., ed. 1993. *Actes du Premier Symposium International sur la Protection au Patrimoine Géologique* [Proceedings of the First Symposium on Earth Heritage Conservation], Digne, France, 11–16 June 1991. *Mémoires de la Société Géologique de France, numéro spécial* 165.
- Reynard, E., and M. Panizza. 2005. Geomorphosites: Définition, évaluation, et cartographie. Une introduction. *Géomorphologie: Relief, Processus, Environnement* 3, 177–180.

- Zouros, N. 2004 The European Geoparks Network: Geological heritage protection and local development. *Episodes* 27:3, 165–171.
- . 2005. Assessment, protection and promotion of geomorphological and geological sites in the Aegean area, Greece. *Géomorphologie: Relief, Processus, Environnement* 3, 227–234.
- . 2007. Geomorphosite assessment and management in protected areas of Greece. Case study of the Lesvos island coastal geomorphosites. *Geographica Helvetica* 62:3, 169–180.
- Zouros, N., G. Martini, M.L. Frey, eds. 2003. *Proceedings of the 2nd European Geoparks Network Meeting*, Lesvos 3–7 October 2001.

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