

Management of the Natural Environment of Nisyros Volcano Towards Sustainable Development

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Abstract: - Nisyros represents the ideal candidate of a Mediterranean volcano for a pilot study in sustainable development: it is a geotope with rare fauna and flora, as well as, rock exposures that illustrate a host of volcanic phenomena taking place during the evolution of a subduction related-stratovolcano. Nisyros with a population of 916 permanent habitants survives due to its quarrying of pumice and perlite stone from the nearby island of Yali and to transit tourism from the island of Kos. Fresh water is a rare commodity on Nisyros. However, the island contains all the solutions that will set it in a sustainable orbit: (i) Inexpensive wind and solar energy and a high enthalpy geothermal field that could provide electricity and also power a much needed second desalination plant to revive the southern part of the island. (ii) It was a renown Loutropolis in the past and its baths, for medicinal purposes, they can be developed into Spa-Centers. (iii) It has an important geopolitical position lying 16.7km off the coast of Asian Minor. Due to its rich cultural and physical heritage we propose here the sustainable development of Nisyros into a National Park. The island will act as a pole of attraction for alternative tourism and ecotourism. Five “nature itineraries” with the purpose to expose and educate visitors to the stunning workings of an active volcano and to rare species of fauna and indigenous flora, are presented here. The National Park of Nisyros will co-host a Volcano Observatory and a Cultural and Natural Museum.

Key-Words: - Nisyros, geotope, sustainable development, volcanology, fauna, flora, national - park

1 Introduction

The geotopes of the Aegean, the fauna and flora, are characterized by striking variability. These geotopes also provided the natural resources for the flourishing of the Aegeopelagic civilization. The physical characteristics of the Aegean Archipelago are unique, since it represents one of the most active parts of the earth's crust. It is unique in hosting 8000 small and large islands which represent the relics of the Aegean microcontinent (Fig.1). One of these is the round island of Nisyros with a 42km² extent of entirely volcanic fertile land, the largest of four other volcanic islets outcropping in the Kos Caldera area, such as Pachia, Perigussa, Yali and Strongyli (Fig. 2).

Nisyros, with a permanent population of 916 inhabitants (latitude 36° 35', longitude 27° 10') lies 16.7km westerly from the coast of Asia Minor occupying one of the extremities of the 'unfrequented ship line' of the Dodecanese Island Complex, in stark contrast with the overpopulated resorts of Kos, Kalymnos or Rhodes.

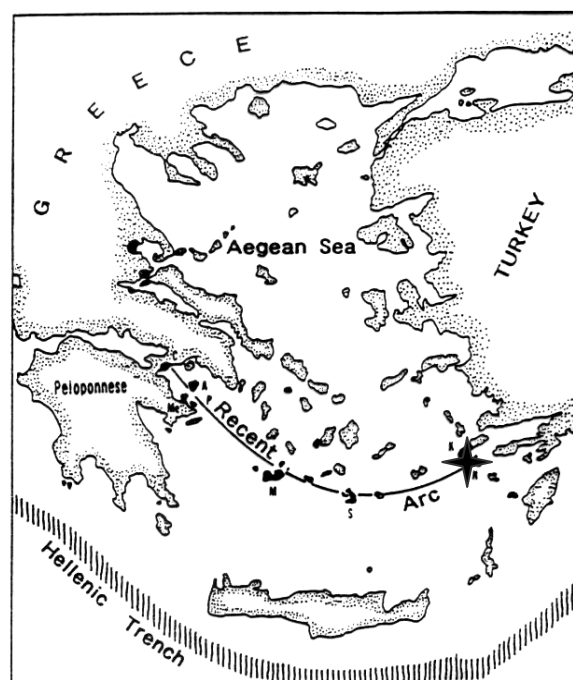


Fig. 1: Aegean volcanic arc and volcanic centres (black colour). Nisyros is indicated with a black star.

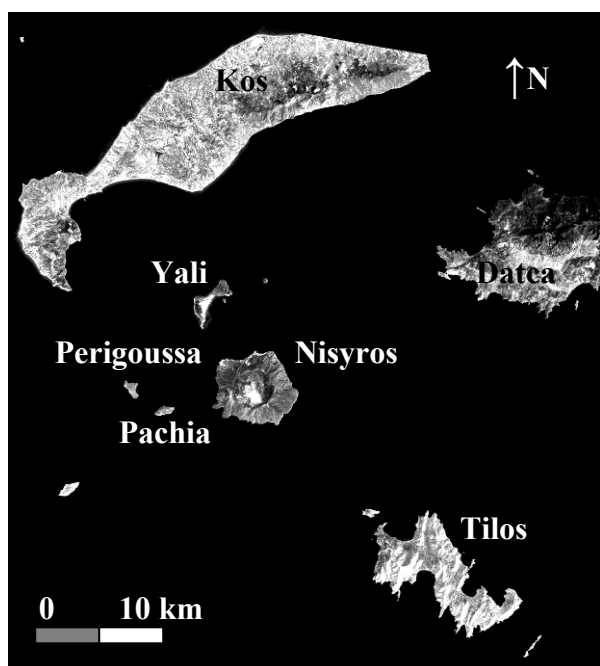


Fig. 2: Landsat Satellite image of Nisyros volcano, adjacent islands and Asian Minor (Datca Peninsula).

The island is a rare natural monument of extreme beauty at the stage of neglect, which would have been severe in the absence of daily tourists from Kos and the internationally renewed scientific interest [1, 2, 3, 4, 5] in the area.

The present work is a preliminary proposal for restoring and promoting the natural environment of the volcano of Nisyros such as the fauna, flora and mainly the volcanic structures with the aim to establish Nisyros to the status of a National Park for educating the public and creating a major attraction pole for alternative tourism. One would inquire primarily, if the proposal responds to a high priority social need and secondly question the reasons for choosing this particular volcano. Hellas is a locus of earthquakes and volcanoes. However, since there is a marked discrepancy in the frequency of earthquake and volcanic activity the general public of this country is uneducated with respect to the volcanoes and unaware of the mixed blessing of advantage and hazard they represent. Nisyros offers the best choice for a National Volcanological Park: the volcano is active and compact, in the sense that has every volcanic feature displayed by calcalkaline volcanoes [6], including an impressive caldera, within small distance. Nisyros does not require expensive boat trips to see the volcanology. The diversity of volcanic features, structures and evolution of Nisyros can be seen generally on one day trip by car and in detail in a five day visit by car, on foot and short boat trip to Yali. Nisyros can show an active

hydrothermal field with phreatic craters marking its caldera floor, drillholes for geothermal energy-and who knows- tomorrow a geothermal plant. Nisyros can show how hot springs can be developed into Spas. The civilization, mythology and history of Nisyros (wars, economy, art, etc) are related directly to the volcanic environment, via mining pumice, perlite stone and sulphur, the exploitation of hot waters and the effects of volcanic earthquakes. We propose six itineraries for the new National Park.

2 Problem Formulation

Nisyros presents a unique challenge in the newly found human interest in applying knowledge from science and technology for the sustainable development of the environment. It is not that Nisyros is another number in the statistics from National Statistical Service of Hellas for the period of 1999-2004 showing a decrease in the number of visitors (Table 1) [7].

| Year | Arrivals | Overnight stays | Beds |
|------|----------|-----------------|------|
| 2004 | 1297 | 5288 | 677 |
| 2003 | 1329 | 6929 | 729 |
| 2002 | 4880 | 47385 | 2430 |
| 2001 | 4418 | 44303 | 2139 |
| 2000 | 2174 | 14516 | 1307 |
| 1999 | 2150 | 12007 | 1081 |

Table 1: Statistical data obtained from N.S.S.H. of arrivals, overnight stays and beds in Nisyros island for the period 1999-2004.

Nisyros presents a host of compelling reasons to invite a full scale experiment on sustainable development:

- (1) Geopolitical position: Nisyros lies 16.7 km off the coast of Turkey. The image of a bustling Hellenic Loutropolis (Fig. 3) imprinted in the minds of European visitors will contribute a great deal towards warding-off any plans for division of the Aegean Sea.
- (2) Nisyros has a long cultural history and heritage. Remnants from ancient and medieval times. These they should be preserved, rebuilt and exposed in a local Cultural Museum (which can be hosted in the same building with the Volcanological Museum).
- (3) Nisyros is another Mediterranean Island which shrinks to death due to lack of fresh water (Fig. 4). It invites application of new technologies for desalination powered by sustainable energy sources [6].



Fig. 3: View of the building of the *baths* in Pali village.

(4) Finally and most importantly Nisyros is a volcano. We have been accustomed to perceive Hellas as the land of the earthquakes. However, this is a very active tectonically region that hosts many volcanoes. This is a natural heritage that we have to promote to the status of a National Park. Nisyros offers the ideal package for a National Park since it is a small, compact volcano with all the volcanic features that can educate and impress the visitors [6] such as caldera, fumaroles, pillowed-lavas, pumice deposits, lava domes, phreatic craters and numerous hot-springs all within small distance and easily accessible together with the unique flora and fauna.



Fig. 4: Abandoned water reservoir of municipality of Nisyros in the vicinity of Hellinika near Katsouni Cape.

3 Problem Solution

Nisyros offers an attractive challenge for sustainable development because at the same time contains all the solutions to launch her into a sustainable orbit. We feel that a second desalination unit near the village of Nikia is absolutely necessary for reviving

the dying south part of the island, as well as, the upgrading of the existing desalination unit (Fig. 5).

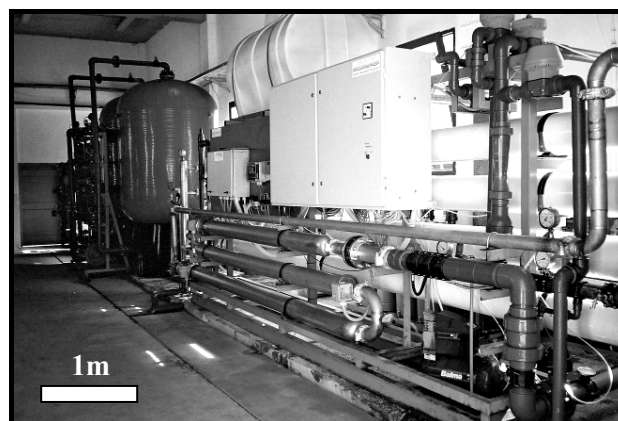


Fig. 5: *Desalination unit* situated in the vicinity of Loutra. The picture shows the sea water filters in the back and the tubes of high pressure for cleansing the filtered water in the right part of the picture.

The sustainable energy source for these units is provided by ample reserves of solar, wind and geothermal energy that the island has at its disposition. However, in the present work we would like to concentrate in the aspect of sustainable development of Nisyros that addresses its appointment to the status of a National Park and a Spa Center (Loutropolis). Some background literature to educate the visitor in the physical wonders of Nisyros exists in the booklet by volcanologist G. Vougioukalakis: “In the Blue Volcanoes: Nisyros” [8] and A. Nikolopoulou: “Sustainable Development of Nisyros Island” [9]. However, here we would like to present the detailed itineraries that will lead the visitor of the Nisyros National Park to observe and be explained with an easy access, most of the rocks that illustrate volcanological phenomena, as well as, visit the baths and take a glimpse of the rare fauna and flora of the island.

The first hike would present the visitor with volcanic features, social elements and fauna species (Fig. 6). The starting point for this hike is the Chochlaki beach near Mandraki where visitors can witness, by an accident of nature, the submarine products which essentially build the volcano such as pillow lavas and lava tubes and the overlying andesite lava flows of the first subaerial volcanic edifice with their feeder dykes (Fig. 7).

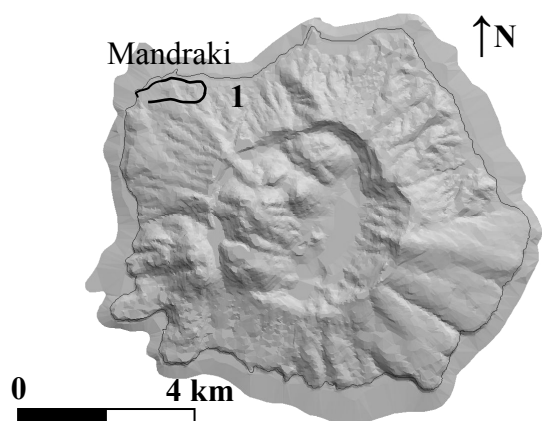


Fig. 6: First (1) itinerary (black line) from Chochlaki beach, through Mandraki to the castle of Nisyros (Kastro).



Fig. 7: Unique exposures of basaltic andesite with pillows, tubes and pillow breccias (‘‘potatoe-sack’’) morphologies can be found at Chochlaki beach near Mandraki village. Lavas with pillow structures are emplaced under sea water but they are accidentally exposed due to rotation of a fault plane.

The Chochlaki beach is the shelter for rare fauna species such as the seal *Monachus monachus*. On the way to Mandraki, a rockfall formed by an earthquake reminds the visitors of volcanic hazard and a walk through Mandraki of the adaptation of a community to a volcanic environment. This hike will end in the ancient Castle of Nisyros (Kastro) overseeing the village. The castle was built with oversized blocks quarried and masoned from local andesite stone. The visitors would have the opportunity to walk through reworked volcanic features and rich flora on the way to Kastro and enjoy the view while ascending at an elevation of almost 100m and return on foot to Mandraki.

The destination point of the second day car trip is the St. Evangelistria church near the caldera rim

(Fig. 8). Visitors can enjoy the view of the north side of Nisyros and the pumice and perlite quarries of Yali with Strongyli and Kos in the background.

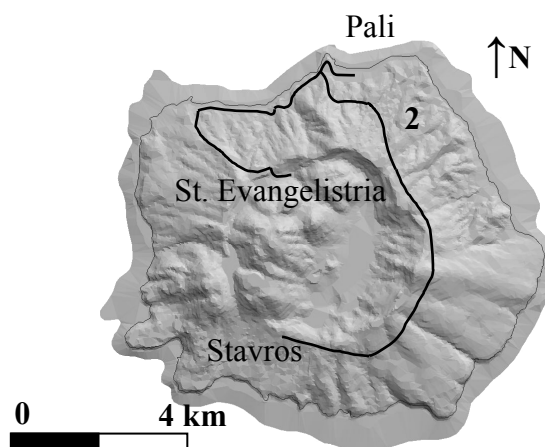


Fig. 8: The second itinerary (black line) starts from St. Evangelistria, passes through the village of Nikia and has a final destination the village of Pali.

In the vicinity of St. Evangelistria, they can see features such as the present caldera rim and the post-caldera domes. Remnants of a medieval stone-paved trail lead into a topographic low with field evidence of a proto-caldera and a feeder neck of the first subaerial volcanic edifice. On the caldera wall, man-made terraces (tavles) retain soil and rainfall waters (Fig. 9).

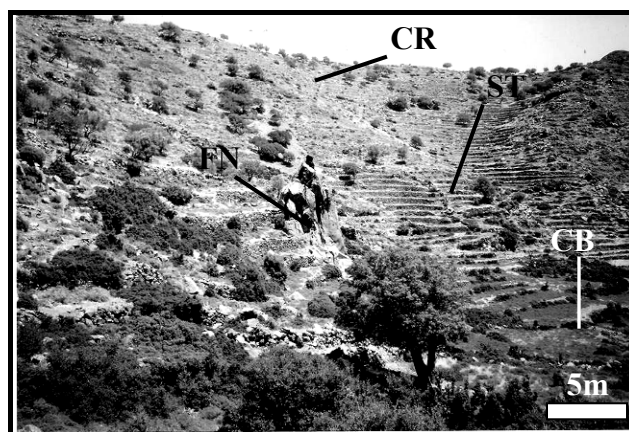


Fig. 9: A series of steps (ST) from the caldera bottom (CB) to the caldera rim (CR) were constructed in the past to increase the ground surface and retain rainfall and soil for agricultural purposes. A feeder neck of andesitic lava (FN) is shown in the middle of the picture.

A car trip leading to the Monastery of Stavros would provide a general view of the northern and western part of the volcano and a panorama of the Cretan Archipelago.



Fig. 10: View of the caldera floor of Nisyros volcano where phreatic craters, *Stefanos* (S) and *Polyvotis* (P) and post-caldera domes (PC) are situated.

Visitors can be informed about the culture of Nisyrians, their festivals and customs. Moving to the west and along the caldera rim visitors can admire a unique caldera view, the post-caldera domes and phreatic craters occupying the caldera floor, the Avlaki lava flows and the feeder neck which lies on the inner part of the southern caldera wall (Fig. 10). This trip will end in the scenic Pali.

The second and third day trips unfold the evolution of the volcanic edifice. On the third day visitors would be transported to Emborios with its great view of the caldera and its very interesting history and the natural hamam (cave of hot steam) (Fig. 11).

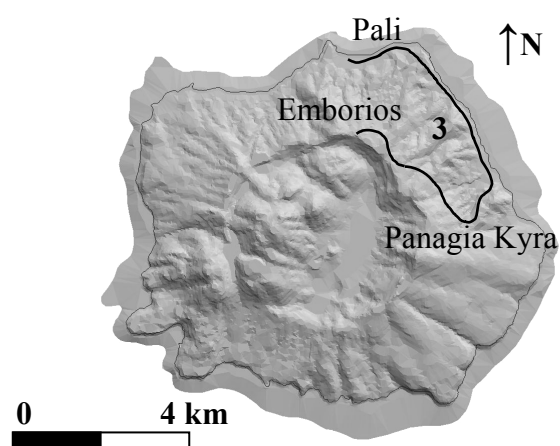


Fig. 11: The third itinerary (black line) descends from Emborios village through Panagia Kyra to Pali village.

Nearby, people will witness an inclusion-ridden lava flow and see imposing feeder necks and dykes marking the caldera wall. A hike to the Monastery of Panagia Kyra will present the visitors with outstanding exposures of airfall, surge and

pyroclastic fall deposits and educate them into the intricacies of fierce pyroclastic explosions, occurring when water gains access to the magma reservoir (Fig. 12).



Fig. 12: Exposures of airfall, surge and pyroclastic deposits in *Panagia Kyra* formation.

This hike will effortlessly lead to an easy downslope trail to the Lyes beach where observation of pyroclastic deposits will be combined with sightings of rare flora and fauna. Before Pali village visitors can inspect scoria cones and volcanic agglomerates.

Near Katsouni Cape, unique seaside cross-sections of pyroclastic formations of Panagia Kyra overlain by Lower and Upper Pumice Units can be visited in the fourth day (Fig. 13).

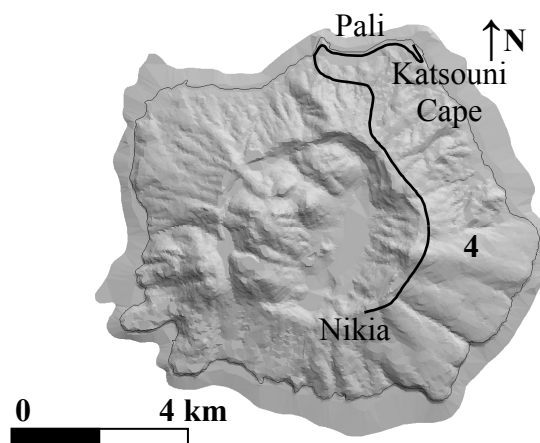


Fig. 13: the fourth itinerary starts from Katsouni Cape, passes through Pali village to end Nikia village.

Each formation is divided by a paleosol horizon indicating waning stages in the volcanic activity. Visitors could admire enormous dunes of pumice surge deposits and be informed about their catastrophic effects. A hike from Katsouni Cape towards Pali village will provide an overview of the pyroclastic formations occupying most of the northern shores of Nisyros. In Pali, existing incomplete bath facilities (Loutra; Fig. 3) should be

developed into Spa Centers due to the exceptional medicinal benefits of Nisyros thermal waters which in the past have raised the island to the status of a renown Loutropolis. The traditional village of Nikia offers the best view of the Nisyros caldera filled with post-caldera domes, phreatic craters and steaming solfataras on the caldera floor.

Nikia is built on the rhyodacitic lava flow of Agios Ioannis and between the houses one can observe feeder necks, lava spines and other volcano-geomorphological features. This day trip ends in the village of Nikia where the future Nisyros Volcanological Observatory should be hosted.

The fifth day trip is planned for the 'aficionados' of volcanoes (Fig. 14). The meeting point would be the St. Evangelistria church and from there the visitors will follow the remnants of a medieval stone-paved trail ascending between Boriatiko and Nifios post-caldera domes and descending to the caldera floor. During this hike, fauna, flora and volcanological information of the younger activity of the volcano will be presented. When inside the caldera visitors could observe numerous solfataras with deposition of sulphur 'flowers', the old sulphur quarry and the phreatic craters of Stefanos and Polyvotis. In the refreshment center and the small theatre in the caldera a recapitulation of the volcanic evolution of Nisyros will be presented.

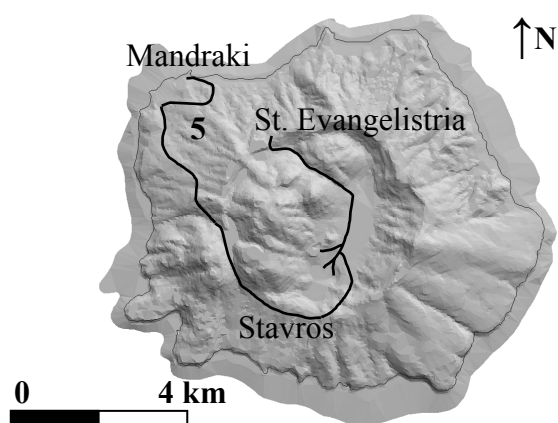


Fig. 14: The fifth itinerary (black line) starts from St. Evangelistria, ascends through the post caldera domes, descends on the caldera floor, passes near Stavros Monastery and continuous through the post-caldera domes, to end up in the Mandraki village.

This ~20km hike ends at Mandraki on a round trip of the island from the caldera to the Stavros Monastery and through the post-caldera domes of Karaviotis and Trapezina.

4 Conclusion

These itineraries revised, enriched and illustrated can be advertised in the web and advertising brochures can be sent to schools, high-schools and universities locally and abroad. European universities should be presented with the opportunity to carry-on organized field trips, especially for their Earth Science and Biology departments on Nisyros. The ascendance of Nisyros island to the status of a National Park for ecotourism and a Loutropolis will provide its take-off point to an orbit of sustainable development.

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