



MUNICIPALITY OF AMORGOS

Management
for ecosystem recovery
in Amorgos Island

Location: Kato Kampos



May 2014



YLI - Environmental Management and Protection
Environmental Consultant
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1. INTRODUCTION

Amorgos is one of the Aegean Sea islands that maintains its naturality, while having a natural and cultural environment that assign a special identity and value.

The Municipality of Amorgos decided to interfere in the field of ecosystem recovery. For this reason the Municipality elaborated management projects for ecosystem recovery in three specific locations which are its property. These projects are sequel of an initial project under the title "Management for ecosystem recovery in Amorgos Island" done in January 2014 which investigated the potential interventions within the ecosystem.

In these areas, management measures are specialized. In this way, it is attempted to manage the region of the Cycladic islands towards rehabilitation of the natural ecosystem. This study refers to one of the three selected locations, the one in the location of **Kato Kampos** in the Arkesini community.

The NGO "Trees for Greece gGmbI" and the organization Velanidia Foundation for Amorgos contributed to the implementation of the study.

The project as well as the initial study, is implemented by the company "YLI"-Environmental Management and Protection - Environmental Consultant", which conducts studies regarding management and protection of the natural environment.

2. PURPOSE OF THE PROJECT

This report deals with the recording and analysis of the ecosystem in this particular location on the island of Amorgos, and **suggests appropriate management actions for the upgrade and improvement of ecosystem functions.**

The fundamental ecosystem elements are soil (especially the fertile one) and water in terms of soil humidity that can be conserved. The purpose of the project is to manage soil and water in such a way that the natural vegetation is rectified and the functions of soil and water conservation are improved. Amorgos, like other nearby islands, is covered primarily by shrubs and low bushes called "Phrygana", which are degraded by the bioclimate restrictions, grazing and repeated wild fires. The vegetation consists of species that can withstand the xerothermic conditions, so as high temperatures and lack of water.

This project aspires to have a character of pioneer application and represent a good intervention example for all Cyclades and other Aegean islands that are characterized by similar conditions.

Considering the knowledge of the project area and the study of factors that affect the ecosystem, it is concluded that the key management element is **the management of the soil**. In addition, it emerges the parameter of **water management** through its storage and through the **proper selection of plant species** to be used. Management for ecosystem recovery should repair past damages due to over-logging, overgrazing, and repeated fires. Any intervention for ecosystem recovery should also regulate the relation between the natural ecosystem and agro-pastoral activities.

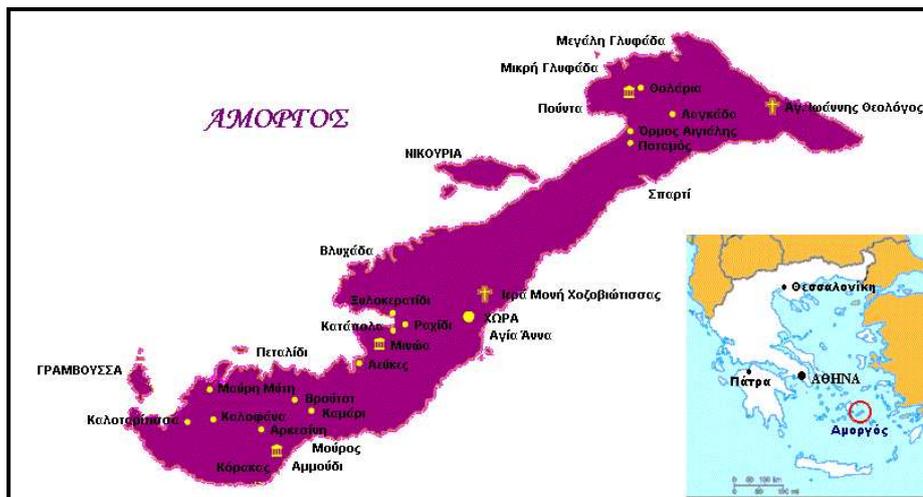
3. THE ENVIRONMENT OF AMORGOS ISLAND

3.1 Natural environment

Amorgos is the easternmost island of the Prefecture of Cyclades and has a total area of 121km² (the 7th largest island in the Cyclades) and 112km of coastline. The shape of the island is very elongated, with a length of about 32Km and oriented NE-SW. The shape and the geographical position of the island, is presented in the following geographic orientation map

(Figure 1):

Figure 1: Geographical position of Amorgos



The thermo-mediterranean bioclimate of the island, as well as the long term human intervention, have created in Amorgos, restricted growth conditions of shrub vegetation. The trees are very rare due to logging, grazing, erosion and wind. Strong winds contribute to dryness of the atmosphere and thus to reduce the moisture available for the plants. The island is within high risk of desertification according to the desertification hazard map developed by the Agricultural University of Athens (AUA). In contrast with the trees and shrubs, the herbaceous flora is of great interest as many rare and steno-endemic species of flora of the Aegean region grow on the rocks.

According to measurements of residents of the island, in recent years, the average rainfall is in the 400-450mm, but last year was 350mm while the maximum was recorded at 600mm.

The soils of Amorgos mounted on the main geological substrates such as limestone and flysch. The limestone soils are classified in the Calcaric Leptosol and are of very low quality and very high sensitivity to desertification.

The depth of soil is directly related to the nature of the soil parent material (geology composition), the erosion, the extent of anthropogenic impact, mainly on vegetation and other factors such as inclination and orientation of slopes, the climate. The rocks which disintegrate rapidly (flysch) give, generally, deeper soils, unlike those which disintegrate with difficulty. Inclined areas where protective vegetation has been destroyed for a

considerable time have shallow soils due to intensive erosion they have suffered. Soil erosion, accelerated notably by adverse human interventions in the natural environment and extreme natural phenomena, leads to degradation of soils, reduction of their productive capacity and ultimately loss of precious, irreplaceable and non-renewable natural resource. This soil deterioration is also one of the dominant factors of desertification.

The physical space of the island is used for goat and sheep grazing. In the surrounding region, there are cultivated lands and abandoned terraces, mainly on the flysch which is more fertile from the limestone and mainly retain moisture.

The NW side of Krikelos mountain (823m) was full with oaks (*Quercus ithaburensis ssp. macrolepis*), kermes oaks (*Quercus coccifera*) and Phoenician junipers (*Juniperus phoenicea*) (Miliarakis 1884). In the inaccessible location "Pappas" of Krikelos mountain even nowadays there are remnants of the former extensive forest, which was burned in the great fire of 1835 which lasted twenty days and eliminated it almost completely. Today there are only 15 individuals on the island, mainly in the northern part of the island, in the region of Lagada. Some of them have very large acorns. The Velanidia Foundation for Amorgos implements collection and planting of oak seeds in order to spread the species presence, without any evaluation of the method yet.

Other trees that were found on the island and took part in the ecosystem is the holm or holly oak (*Quercus ilex*) found in Profitis Ilias (702m), the carob tree (*Ceratonia siliqua*), few scattered individuals of which were found in Lagada and terebinth (*Pistacia terebinthus*) also with scattered individuals, mainly found in the northern part of the island. In coastal locations there are tamarisk trees (*Tamarix smyrnensis*) and in few locations with high level of aquiferous horizon, the plane tree (*Platanus orientalis*) and white poplar (*Populus alba*). Furthermore, there are recorded the almond-leaved pear (*Pyrus amygdaliformis*), the bitter almond (*Prunus webbii*) and laurel (*Laurus nobilis*).

Regarding planted tree species, they include figs (*Ficus carica*), cypress (*Cupressus sempervirens*) and the alien cypress species (*Cupressus arizonica*), the Turkish pine (*Pinus brutia*) and the Aleppo pine (*Pinus halepensis*), and few individuals of the stone pine (*Pinus pinea*).

Where the soil has been managed with stone benches and terraces, hydrological conditions are better. The terraces can be found in a great extent in the island.

The main ecosystem types of Amorgos are:

- 1) The evergreen kermes oak shrublands with great presence of phrygana species,
- 2) The shrubby areas dominated by Phoenician junipers and mastic trees and
- 3) The rocks which host significant flora with endemic and rare plant species.

The presence of extensive cliffs favors the development and maintenance of many chasmophytes, including several stenotopic species, Cycladic or Aegean endemic taxa. Moreover, in Amorgos exclusively exists the plant taxa *Symphytum davisii ssp. davisii*, *Campanula amorgina*, *Erysimum senoneri ssp. amorginum*. The rock flora of the island includes also the species *Helichrysum amorginum*, known only from Amorgos and

Anydros islet in the SW, and *Eryngium amorginum*, which outside Amorgos inhabits Sikinos, Astypalea and Crete as well.

In the island, there have been declared protected areas of Natura 2000 network 2 areas which overlap with one another and almost entirely cover the northeastern part of the island that includes Mount Krikellos.

1. Special Protection Area for birds GR4220024 entitled " AMORGOS ISLAND (NE PART) AND ISLETS: PSALIDA, GRAMVOUSSA, NIKOURIA, MIKRO and MEGALO VIOKASTRO, KRAMVONISI, PETALIDI" area 3,038.4 ha including marine parts
2. Site of Community Importance GR4220012 entitled "NORTH AMORGOS AND KINAROS, LEVITHA, MAVRA, GLAROS and marine zone" area of 6,062.5 hectares including marine parts

3.2 Anthropogenic environment

Amorgos Island belongs to the Regional Section of Naxos of South Aegean Prefecture. The population of the island is 1,973 inhabitants (2011 census). The Municipality is located in Chora, Amorgos and resulted from merging of the communities Aigiali, Amorgos, Arkesini, Vroutsi, Tholaria and Katapola.

The basic economic and social activities on the island, especially the last decades, are tourism and services as well. However, the primary sector (agriculture, livestock and fisheries) remains very important for the island.

The rural areas are located throughout the island, where there are gentle slopes and either being currently cultivated or have been cultured in the recent past. Generally, the rural areas of Amorgos are located in shale background. The soil in such backgrounds is better than the limestone soil, because it retains water and is deeper. These areas have an extensive network of stone benches and terraces, which are used in order to avoid soil erosion and thus many cultivations were supported or being supported such as cereals, olives, figs, pomegranates, vineyards.

The main cultivations are those of grapes, production of wine and raki and olive groves. In addition, livestock production is a very important activity for the island. The total estimated number of sheep and goats stands at 19,100 animals. Fishing activity is quite significant as well, as shown by the number of fishing vessels.

The secondary sector, in the island, is considered low, since only 40 people have been reported that are employed in small units of the island (carpenters, olive mills, construction of clay items, standardization of agricultural products).

Furthermore Amorgos is considered a popular holiday destination with a gradual increase in arrivals from Easter time onwards, with the peak of the number of visitors during the summer (especially in August) and gradual decline since September.

Regarding alternative tourism, it includes the following types:

- Trekking tourism, which is higher during the late spring - early summer and early to mid-autumn.
- Diving tourism, who emerged and developed after the movie "The Big Blue", since Amorgos gained worldwide reputation for clean and deep sea.

- Climbing tourism combined with hiking, especially in the area of Lagada where it has been created climbing center.
- Religious tourism, with reference to the Monastery of Chozoviotissa, and countless byzantine churches.

4. INTERVENTION AREA

4.1. Physiography-Terrain

The study area is located in the southern part of the island in Kato Kampos, two kilometers north of the village Kalofana following the road and 4.5km NW of the village Arkesini also on the road network. The site has an area of 28.3 hectares and is a peninsula on the edge of a small valley named Kato Kampos. It is surrounded by the sea from three sides. The altitude ranges from 0m to 92m. The slopes vary from very rocky and steep to the west, mild (5-20%) at the ridge and quite steep in the east (45-55%). The orientation also varies and is E-SE in the bigger part of the area, NW in the north of the peninsula, and W at the rocks.

4.2. Edaphic and water conditions

The bedrock is limestone with presence of conglomerates in the eastern part. The soil is erodible in the east. In the ridge is rocky with amount of surface rock raised to 30%. The shrub vegetation coverage is significant (40-70%) and protects the soil from erosion, despite intense grazing that exists in this area. The area is fenced in the south side, the only land side. There is no aquifer near the surface, whereas the soil is poor in nutrients.

4.3. Specific description of vegetation and flora

It is a grazed area with Phoenician juniper (*Juniperus phoenicea*) and mastic tree (*Pistacia lentiscus*) and phrygana species as well. The bushy individuals reach are up to 2m tall and have good vegetation coverage of the area. Moreover, there are other shrubs, such as the mediterranean buckthorn (*Rhamnus lycioides*) and the Jerusalem sage (*Phlomis fruticosa*).

The following phryganic and herbaceous species were found in the study area during the sampling of April 2014:

Thyme-Coridothymus capitatus, *Urginea maritima*, *Sarcopoterium spinosum*, *Ballota acetabulosa*, *Teucrium brevifolium*, *Euphorbia acanthothamnus*, *Asphodelus ramosus*, *Prasium majus*, *Mercurialis annua*, *Plantago bellardii*, *Plantago coronopus*, *Lamarckia aurea*, *Valantia hispida*, *Crepis hellenica*, *Anagallis arvensis*, *Linum strictum*, *Erodium malacoides*, *Trifolium campestre*, *Urospermum picroides*, *Senecio vulgaris*, *Pallenis spinosa*, *Trigonella spicata*, *Malva aegyptica*, *Trifolium stellatum*, *Lagoecia cuminoides*, *Mandragora officinarum*, *Phagnalon graecum*, *Onosma graeca*, *Malcolmia flexuosa*, *Trifolium uniflorum*, *Limonium sp.*, *Papaver purpureomarginatum*.

In another sampling, in the beginning of November found the *Narcissus serotinus*.

Below is the form of sampling in April 2014.

SAMPLING			
PROJECT :Management for ecosystem recovery in Amorgos Island			
TEAMWORK: YLI		GPS:	
SAMPLING DATE: 12/4/2014		SAMPLE NUMBER: 3	
PLACE: AMORGOS		SITE: Kato Kampos	
VEGETATION UNIT: Juniperus-Lentisk		SAMPLING AREA: Flora Transect	
PHYSIOGRAPHY:			
ELEVATION: 0-92	ASPECT: E, NW	SLOPE: 20-60%	
GEOLOGY SUBSTRATE: Limestones		STONES & GRAVEL: 20%	
TOTAL PLANT COVER:		LEAF LITTER:	
BARREN LAND COVER: 10%		SURFACE ROCK COVER: 20-35%	
TREE COVER: 0%	MAX. HT:	AVERAGE HT: -	
SHRUB COVER: 50%	MAX.HT: 2.5 m	AVERAGE HT: -	
PHRYGANA/HERBACEOUS COVER: 40%	MAX. HT:	AVERAGE HT: -	
ECOLOGICAL CONSERVATION STATUS - OBSERVATIONS: In the upper part the habitat is better, as slopes are mild, compared to the north and the two sides. On the west, rocks are vertical, whereas on the east slopes are up to 60%. Better conditions allow the juniper-lentisk shrubland to be in a satisfactory conservation status.			
OBSERVED SPECIES			
SPECIES NAME		COVER-ABUNDANCE	MAX.HEIGHT
Tree Layer			
1			
Shrub Layer			
1	<i>Juniperus phoenicea</i>	2b	2.5
2	<i>Pistacia lentiscus</i>	2b	1
3	<i>Rhamnus lycioides</i>	+	
4	<i>Phlomis fruticosa</i>	+	
Herbaceous Layer			
1	<i>Genista acanthoclada</i>	2a	
2	<i>Coridothymus capitatus</i>	+	
3	<i>Urginea maritima</i>	+	
4	<i>Sarcopoterium spinosum</i>	+	
5	<i>Ballota acetabulosa</i>	+	
6	<i>Teucrium brevifolium</i>	+	
7	<i>Euphorbia acanthothamnus</i>	+	
8	<i>Asphodelus ramosus</i>	+	
9	<i>Prasium majus</i>	+	
10	<i>Mercurialis annua</i>	+	
11	<i>Plantago bellardii</i>	+	
12	<i>Plantago coronopus</i>	+	
13	<i>Lamarckia aurea</i>	+	
14	<i>Valantia hispida</i>	+	
15	<i>Crepis hellenica</i>	+	
16	<i>Anagallis arvensis</i>	+	
17	<i>Linum strictum</i>	r	
18	<i>Erodium malacoides</i>	+	
19	<i>Trifolium campestre</i>	+	
20	<i>Urospermum picroides</i>	r	
21	<i>Senecio vulgaris</i>	+	
22	<i>Pallenis spinosa</i>	r	
23	<i>Trigonella spicata</i>	+	
24	<i>Malva aegyptica</i>	+	
25	<i>Trifolium stellatum</i>	+	
26	<i>Lagoecia cuminoides</i>	+	
27	<i>Mandragora officinarum</i>	+	
28	<i>Phagnalon graecum</i>	+	
29	<i>Onosma graeca</i>	r	
30	<i>Malcolmia flexuosa</i>	+	
31	<i>Trifolium uniflorum</i>	+	
32	<i>Limonium sp.</i>	+	
33	<i>Papaver purpureomarginatum</i>	+	
r: very rare, too small area		+ : very few individuals, small cover	
1 : many, cover 1-5%		3 : any individuals, cover 25 - 50%	
2m : too many (>100), cover < 5%		4 : any individuals, cover 50 - 75%	
2a : any individuals, cover 5 - 12,5%		5 : any individuals, cover 75 - 100%	
2b : any individuals, cover 12,5 - 25%			

4.4 Existing management

Inside the area there are goats which graze and do not go out as the area is fenced.

4.5. Evolution and natural vegetation succession

Generally, after an intense disturbance, the ecosystem loses a significant part of the biomass and according to the ecosystem terminology, it follows regressive succession. The main aspect of the ecosystem today in Amorgos is the one of sparse and low shrub land with a strong presence of phrygana like that in the study area. The disturbances that bring immediate regressive succession are fire and land clearing to create arable land. By grazing on current conditions there is no regressive succession but maintaining the same degraded form.

The normal undisturbed evolution is the gradual succession to a higher and denser shrub land with the existing species *Juniperus phoenicea* and *Pistacia lentiscus*, which are considered to represent the phyto-society sub-climax. If ecosystem is left undisturbed and there is an auxiliary management of the ecotope (land and water), then it will have the conditions to be found in the form of even higher and denser shrub land.

5. MANAGEMENT INTERVENTIONS

5.1 Purpose of interventions

The **interventions for upgrading and improvement of ecosystem functions**, include projects that will help to **gradually rectify vegetation** and **improve the conservation functions of the soil and utilization of water**, in an **ecosystem which is degraded** by grazing and past fires and bound by the **limitations of the bioclimate**.

The goal is that all interventions for ecosystem restoration to be implemented with respect to nature and local identity. The proposals for the various interventions reflect a conception of respect to the place so refer to projects adapted to the region, site, society, tradition (no grand interventions, no planting of alien species). These measures take into account local traditions and structures, if they do not put at risk the real goal of **ecological sustainability**.

Moreover, a second goal is the proposed projects to be implemented with the best possible use of **local resources** and the **consent and support of the local community** and the productive forces of the island (e.g. livestock farmers, farmers and other land owners). It will seek to ensure that all interventions and initiatives will be framed by the local organizations and collectives who should be involved, to some extent, in the respective planning processes.

Finally, the aim of the proposals is to build relationships and partnerships and create **synergies with other relevant local initiatives** from the cultural, economic and ecological point of view.

5.2 Capabilities and limitations

The restrictions are strong and derive from steep slopes, dry soil, xerothermic bioclimate and grazing, associated with socio-economic conditions.

The access to people who want to hike to the site is simple through the dirt road Kalofana-Kato Kampos. After the end of the dirt road, the entrance to the site is 180 meters. The planting of new plants is not considered as a possibility.

The capabilities are related to both mitigate the constraints and the existence of advantages.

As an advantage of this location is considered the beauty of the landscape and the know-how to build terraces for the residents.

5.3 Soil and water management

5.3.1 Terraces

Terraces are stone walls (masonry without mortar), that aim to prevent soil erosion and improve soil moisture, by reducing slope. They are constructed by stones without binder, as a common agricultural technique to create or expand arable land, globally applicable, in particular, widespread in the Mediterranean Basin and the Aegean islands. Stone terrace is a dominant traditional element of Greek natural environment and landscape, particularly found at the islands of the Cyclades.

In Amorgos Island they were used widely, whereas in the study location, their use is indicated for the prevention of erosion and not for creating zero gradient, which would require the transport of soil.

For this purpose, four long terraces will be built in the eastern side along the contours of 40, 48, 56 and 64m. These terraces will have a width of 0.40m and a height of 0.60m out of which 0.15m is the foundation.

In addition, other 2 terraces will cover the north side of the site to the elevations 48m and 64m as sequels of the foregoing. Details are shown in the map of the interventions and the map with the sections as well.

5.3.2. Terrain interventions

There will be no change in terrain and the terraces will be constructed so as not to cause interference on the terrain.

5.3.3 Water management

The water and especially its shortage is one of the limiting factors for the improvement of the ecosystem. As there will be no plantings, there is no need to find a way to collect and store water.

However, as measure for water management, are considered the terraces that will be built on this location and therefore they will also help the water conservation.

5.4 Grazing management

There is fencing already in the site. The grazing animals should be transported off-site in an area designated by the Municipality of Amorgos to the shepherd who uses the site.

5.5. Other management interventions

1. Recovery of shrubs

In this particular location there are Phoenician juniper individuals with a height up to 2m and mastic trees with height around 1.5m. Both species are usually branched from low height and spreading in width. According to the project there will be pruning of the lower branches with for their height recovery. This work will not involve individuals who "lean" on the ground and protect it. It is estimated that pruning will be applied to 200 individuals.

2. Paths opening up

It will be opened up a new circular path using those points already exist tracts of grazing animals. This creates the possibility that can be a hiking visit in the site. The route is shown on the map of interventions.

5.6. Task timetable

s/n	Intervention	MAY.14- SEPT.14	OCT.14- APR.15	MAY.15- SEPT.15	OCT.15- APR.16	MAY.16- SEPT.16
1	Terrace					
2	Grazing animal transport					
3	Shrub height recovery					
4	Paths					

The process will be monitored and the results will be evaluated. After 5 years a new study will take place, the role of which will be to identify actions that will have to be applied to fences, irrigation networks and other interventions.

6. BILL OF QUANTITIES-BUDGET

6.1. Bill of quantities of works and operations

6.1.1. Summary table of bill of quantities

No	Tasks	Unit	Quantity	Article
1	Stone terracing with elaborate surface	m ³	732.00	B.9-ΟΔΟ
2	Old shrub pruning (height over 1.70 m)	item	200.00	ΣΤ4.5.3

3	New path opening up	m	1,725.00	20.01.01 OIK.
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The terraces are applied in a total length of 3,050m with 0.40m in width and 0.60m in height.

6.2. Unit prices

No	Tasks	Unit	Price (€)	Article
1	Stone terracing with elaborate surface	m ³	43.80	B.9-ΟΔΟ
2	Old shrub pruning (height over 1.70 m)	item	3.00	ΣΤ4.5.3
3	New path opening up	m	6.75	20.01.01 OIK.

6.3. Budget

Project budget (Prices of Single Tariffs Government Gazette B363/19-2-2013)						
No	Tasks	Unit	Price (€)	Quantity	Article	Cost (€)
1	Stone terracing with elaborate surface	m ³	43.80	732.00	B.9-ΟΔΟ	32,061.60
2	Crown configuration of old grown shrubs, with height over 1.70m	item	3.00	200.00	ΣΤ4.5.3	600.00
3	New path opening up	m	6.75	1,725.00	20.01.01 OIK.	11,643.75
Total tasks cost						44.305,35
Contingencies 15%						6.645,80
Final Project value						50.951,15

7. PHOTOS



Photo1. The location Kato Kampos with the shrub species *Juniperus phoenicea* and *Pistacia lentiscus* along with phrygana.



Photo2. Rocky ground in the eastern side of the peninsula.



Photo3. In the ridge there are gentle slopes and denser shrub vegetation coverage. View to Keros and Naxos islands.



Photo4. Stone hut on the ridge, at the northern part.



Photo5. Close to the southern end of the site, where it is projected to be the starting point of the terraces.



Photo6. At the northern end, strong wind creates adverse conditions for shrubs. View to the Petalidi islet.

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