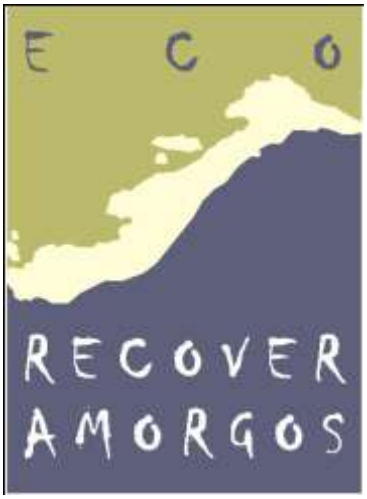
MUNICIPALITY OF AMORGOS

Management for ecosystem recovery in Amorgos Island

Location: Dokari, Lagada area



May 2014

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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 site **Dokari** in **Lagada** area of the Aigiali 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 undertakes 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 recovery 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 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.

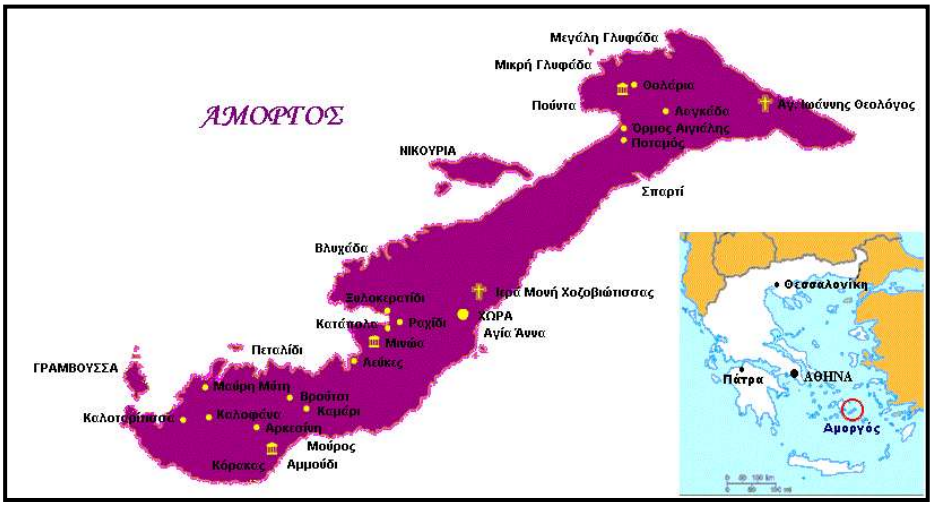
3. THE ENVIRONMENT OF AMORGOS ISLAND

3.1 Natural environment

Amorgos is the easternmost island of the Prefecture of Cyclades and has a total area of 121km^2 (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 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 of 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 Lagada, 1,300 meters west of the village and 2 kilometers from the bay of Aigiali. It has an area of 10 hectares and is surrounded by rocks. The altitude ranges from 170m to 310 meters above sea level. The slopes are quite steep and range for most of the area from 55% to 65%. However, as shown on the inclination map, there are some positions with gradients around 30-40%. The orientation is NW.

4.2. Edaphic and water conditions

The bedrock is limestone throughout the area. The soil is calcareous and very stony. Rocks surround the area from the south, east and west. The slope in conjunction with calcareous soil, have created at various points very steep slopes with stones (scree). It is worth mentioning, that falling stones on the road in the area the north is a frequent phenomenon. The erosion that has occurred is high and this marginal vegetation keeps the soil. The limestone is permeable to water and there is none aquifer close to the surface. The soil is clayey and because of the amount of infiltrating water, retains enough moisture.

4.3. Specific description of vegetation and flora

The area is overgrazed with degraded bushes and phrygana. The soil has many screes. The dominating species are the kermes oak (*Quercus coccifera*) and Tree Spurge (*Euphorbia dendroides*). Moreover, other shrubby or phrygana species in are the broom (*Genista acanthoclada*), the Jerusalem sage (*Phlomis fruticosa*), the Greek horehound (*Ballota acetabulosa)*, the Mediterranean buckthorn (*Rhamnus lycioides)*, Etruscan honeysuckle (*Lonicera etrusca)*, the Italian buckthorn (*Rhamnus alaternus)*, Greek sage (*Salvia fruticosa), Prasium majus* and rarely *Erica manipuliflora*.

Perimetrically the rocks are an important habitat with interesting plant species, which include, *Centaurea redempta, Symphytum davisii, Cymbalaria microcalyx* ssp*.dodecanesi, Campanula laciniata, Origanum calcaratum, Muscari macrocarpum*. Apart from these important plants, few other species grow in the rocky ecosystems such as *Euphorbia dendroides, Ptilostemon chamaepeuce, Aurinia saxatilis, Micromeria juliana, Phagnalon graecum, Brassica cretica* ssp*.aegaea, Ceterach officinarum.*

In addition, the following herbaceous species were found in the study area during the sampling of April 2014:

Sarcopoterium spinosum, Urginea maritima, Origanum onites, Silene colorata, Dracunculus vulgaris, Centaurea raphanina ssp.mixta, Allium subhirsutum, Centranthus calcitrapa, Anthemis chia, Vicia villosa, Lagurus ovatus, Geranium robertianum, Muscari comosum, Asphodelus ramosus, Clematis cirrhosa, Stellaria cupaniana, Erysimum handelii, Trifolium stellatum, Hypochoeris achyrophorus, Trifolium campestre, Hedypnois ragadioloides, Euphorbia peplus, Convolvulus althaeoides, Scandix pecten-veneris, Rumex sp., Anthyllis vulneraria, Trifolium grandiflorum, Rumex tuberosus, Trigonella spicata, Papaver purpureromarginatum, Valantia hispida.

In the sampling that took place in the beginning of November 2013 found the autumn crocus (*Colchicum cupanii*), the autumn daffodil (*Sternbergia lutea*), and a Greek endemic crocus species (*Crocus laevigatus*).

Below is the form of sampling in April 2014.

SAMPLING			
PROJECT :Management for ecosystem recovery in Amorgos Island			
TEAMWORK: YLI		GPS:	
SAMPLING DATE: 13/4/2014		SAMPLE NUMBER: 1	
PLACE: AMORGOS		SITE: Lagada	
VEGETATION UNIT: Kermes oak-Phrygana		SAMPLING AREA: Flora Transect	
PHYSIOGRAPHY:			
ELEVATION: 180-200	ASPECT: NW	SLOPE: 50-60%	
GEOLOGY SUBSTRATE: Limestones		STONES & GRAVEL: -	
TOTAL PLANT COVER:		LEAF LITTER:	
BARREN LAND COVER: 10-20%		SURFACE ROCK COVER:	
TREE COVER: 0%		MAX. HT:	AVERAGE HT: -
SHRUB COVER: 60%		MAX.HT: 1.5 m	AVERAGE HT: -
PHRYGANA/HERBACEOUS COVER: 40%		MAX. HT:	AVERAGE HT: -

ECOLOGICAL CONSERVATION STATUS - OBSERVATIONS: Area overgrazed, with degraded shrubs. Small screes. The surrounding rocks are an interesting habitat of important plant species: Euphorbia dendroides, Centaurea redempta, Ptilostemon chamaepeuce, Aurinia saxatilis, Micromeria juliana, Phagnalon graecum, Brassica cretica ssp.aegaea, Ceterach officinarum, Symphytum davisii, Cymbalaria microcalyx ssp.dodecanesi, Campanula laciniata, Origanum calcaratum, Muscari macrocarpum. Grazing animals enter from SW. Grazing is practiced with the shepherds absence, while been banned. The road Aigiali-Chora passes through from the north side.

OBSERVED SPECIES

	SPECIES NAME	COVER-ABUNDANCE	MAX.HEIGHT	
Tree Layer				
1				
Shrub Layer				
1	*Quercus coccifera*	**3**	**1.5**	
2	*Euphorbia dendroides*	**2a**		
3	*Prasium majus*	**+**		
4	*Phlomis fruticosa*	**+**		
5	*Ballota acetabulosa*	**2a**		
6	*Rhamnus lycioides*	**+**		
7	*Lonicera etrusca*	**r**		
8	*Rhamnus alaternus*	**r**		
9	*Salvia fruticosa*	**+**		
10	*Erica manipuliflora*	**r**		
Herbaceous Layer				
1	*Sarcopoterium spinosum*	**2b**		
2	*Urginea maritima*	**1**		
3	*Origanum onites*	**+**		
4	*Silene colorata*	**1**		
5	*Dracunculus vulgaris*	**+**		
6	*Centaurea raphanina ssp.mixta*	**+**		
7	*Allium subhirsutum*	**+**		
8	*Centranthus calcitrapa*	**+**		
9	*Anthemis chia*	**+**		
10	*Vicia villosa*	**+**		
11	*Lagurus ovatus*	**+**		
12	*Geranium robertianum*	**+**		
13	*Muscari comosum*	**1**		
14	*Asphodelus ramosus*	**1**		
15	*Clematis cirrhosa*	**r**		
16	*Stellaria cupaniana*	**+**		
17	*Erysimum handelii*	**r**		
18	*Trifolium stellatum*	**+**		
19	*Hypochoeris achyrophorus*	**+**		
20	*Trifolium campestre*	**1**		
21	*Hedypnois ragadioloides*	**+**		
22	*Euphorbia peplus*	**+**		
23	*Convolvulus althaeoides*	**+**		
24	*Scandix pecten-veneris*	**+**		
25	*Rumex*	**+**		
26	*Anthyllis vulneraria*	**+**		
27	*Trifolium grandiflorum*	**+**		
28	*Rumex tuberosus*	**+**		
29	*Trigonella spicata*	**+**		
30	*Papaver purpureromarginatum*	**+**		
31	*Valantia hispida*	**+**		

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

From the rocks in the SW of the study area there is a path that is used from the grazing animals. At that location and out of the site, there are two fenced areas at the side of the village Potami. Goat grazing is taking place without shepherds, whereas it has been officially banned. The road Aigiali-Chora passes from the north side of the study area.

Within the area there are crossing paths particularly in the western side. Moreover there are few and of short length stone walls in the area. They are found mainly on the west side and one of them located on the eastern edge.

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 that of a sparse and low shrub land with a strong presence of phrygana, like the one 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. As plant community climax, should be considered the high kermes oak (*Quercus coccifera*) shrub land.

Therefore, if the ecosystem is left undisturbed and there be a management towards soil and water conservation, then the ecosystem could reach the form of high shrubland with *Quercus coccifera, Rhamnus alaternus, Pistacia terebinthus, Euphorbia dendroides*, and even *Ceratonia siliqua, Quercus ilex and* perhaps *Quercus ithaburtensis* ssp.*macrolepis.*

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

The advantages concern the existence of a road in one side of the site, the physical surrounding with rocks from three sides, the presence of interesting flora on the rocks, the existence of know-how to build terraces, the legal rights regarding grazing, the presence of shrubs with a sufficient height (up to 1.5m).

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 the location, their use is indicated for the prevention of corrosion and not for zero gradient, which would require the transport of soil.

For this purpose, two long terraces will be built, one in the middle of the site, approximately along the contour 240 and another one on the crest of the road slope on the north side. These terraces will have a width of 0.40m and a height of 0.60m out of which 0.15m is the foundation.

Moreover, there will be built similar small-length terraces, locally in places with milder slopes where new plants will be installed. It recovered and existing grades.

More details are shown on the project map and on a map with detailed project sections.

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. Any attempt for ecosystem management involves a way of collection and storage of water, which can then be used for irrigation of new plants in the first years of their lives.

However, waters supply of the countryside will be in such size range that it respects the natural landscape and environment and the sustainability of the water.

For the irrigation of the plants that will be planted, there will be used 2 plastic cylindrical 5m³ water tanks. The placement will be done in appropriate places shown on the intervention map. The plants will be supplied with water from a suitable point on the road Aigiali-Chora, with a tanker pump. In order the two tanks to be placed, the soil will be configured a bit and if they are visible from the street, there will be built a dry wall on the downstream side of them. The transfer to the placement position will be done manually with the use of wooden drivers with pulley. At the placement position a pulley will be mounted on a metal pole. The tank will be tied with rope while alongside a 'worker' wraps the rope so that the pulley drives the reservoir upstream. To climb the slope there will be used planks placed as guides to give track and which manually move upwards along with the movement of the tank.

5.4 Grazing management

Regarding grazing management, fencing will be practiced and it will prevent grazing animals to enter. The fence is made of a galvanized mesh, with hole 6x10cm, diameter 2.7mm and height 1.5m. For mounting there will be used galvanized poles 1.5mm Φ42 1.5m high, which will be placed every 2m.

The length of the fence will be along the road on the edge of the crest (550m), on the east side (150m) and on the west side (200m).

5.5 Installation of new plants

5.5.1. Species selection

In cases the ecosystem has suffered a significant degradation as in Amorgos, it will need some kind of plant material introduced in order to help in ecosystem recovery. Introduction can be done either by seeding or by plantings. The selection of proposed plant species should meet the following requirements:

- to be species of native flora.
- to be adapted to local bioclimatic conditions and resistant to the specific conditions of the project (drought, winds, poor soils).
- to have low requirements of water and nutrients.
- to be species present in nurseries, to be able to order it in relation to the quantities and sizes needed.
- Not to be easily affected by pests and diseases.

For the above reasons species that can be selected are:

1. the Valonian Oak (*Quercus ithaburensis ssp. macrolepis*),
2. the Holm Oak (*Quercus ilex*),
3. the Mediterranean buckthorn (*Rhamnus alaternus*),
4. the carob (*Ceratonia siliqua*),
5. the terebinth (*Pistacia terebinthus*),

The **Valonian Oak** (*Quercus ithaburensis ssp. macrolepis*) is semi-evergreen tree up to

15m. Its crown is very wide and has large cups and acorns. It is a thermophilic species, resistant to dry, calcareous soils and winds. It is a native species in the Cyclades and Amorgos.

The **Holm Oak** (*Quercus ilex*) is an evergreen sclerophyllous tree. The fruit is acorn. It is resistant to poor soils, drought and winds. Moreover, it is planted in cities, as an ornamental tree. Native to Amorgos.

The **carob** (*Ceratonia siliqua*) is an evergreen tree 10-12m high with relatively spherical crown. It has leathery leaves, oval, dark green, whereas it produces a hard, brownish fruit with many uses. It is resistant to drought and air pollution. It withstands poor soils. It is also present in cities, where it is planted as an ornamental species.

The **Mediterranean buckthorn** (*Rhamnus alaternus*) is an evergreen shrub usually 2 to 3m high, with hard glossy leaves. It has small round berries that become black when ripe. Its wood is yellow inside. Native to Amorgos.

The **terebinth** (*Pistacia terebinthus*) is a deciduous shrub, used as rootstock for grafting of edible Pistachio tree. It has small red berries and ornamental foliage in autumn. Native to Amorgos.

5.5.2. Installation method

For plantings there will be used small plants in pots. The pit of the planting is small (hole) and will be made only in favorable microenvironments. The seeding has been used experimentally for the Valonian oak to Amorgos from Velanidia Foundation. For the three of these species can be used seeding: Valonian oak, Holm oak and carob.

Planting locations

Based on the inclination map, four positions are determined approximately with slope less than the general one. The surface of each one of the four areas is approximately 400m². In these locations dry walls will be built downstream. The locations are shown on the map of interventions.

Planting distances

The distance is not precisely defined, since the precise planting location is determined by the microenvironment. However, the distance should not be smaller nor larger than 3-4m.

Seedlings' origin

Seedlings will come either from the nursery that will be established by the Municipality of Amorgos, either from the existing nursery on the island. In any other case, the seedlings should be transferred from a nursery of an adjacent island (eg Naxos). The nurseries should operate in accordance with the provisions of Law 1564/85.

Seeding

For the seeding, four locations have been chosen at a higher altitude than the positions of the seedlings. These locations are also shown on the map of interventions. The seeds will be collected in Amorgos by the existing Valonian oak, holm oak and carob individuals and will be sown immediately after their collection in autumn, 2-3 seeds per point at various points in the chosen position within 3m from one another.

5.5.3. Material and task prescription

All seedlings must be representative of the species which has been chosen and have normal branches or stems and fairly well developed, as and healthy root systems. Plants should be hardy, without phytopathological or pest abuses, unsightly knots, bark abrasions, injuries from wind and other deformities. Their appearance should be indicative of good health and vitality and to be clear that the pruning of the vertices and the cleanup of the roots has been done correctly.

If plants are grown in plastic polyethylene bags or pot, they must be fill with suitable growth subbase.

The trees should have straight trunks with proper configuration of branches, symmetrical peak and untouched central trunk. They should not have sections of the strands with diameter greater than 20mm, which have not healed completely. The height of the trees, which identify the required features, will be measured over the root node (the neck of the root). The dimensions of the overground and underground part of the plant should be in proportion. Otherwise, either roots are cut or the overground part is pruned.

Generally, the trees will be planted, will be small. The height will range from 0,20m to 1m, whereas the trunk circumference up to 8cm and the soil ball no more than 7 liters.

The planting process helps the plant to adapt to the natural environment in which it will be placed. The first time after planting the plant must harden. The goal is physical and smooth integration of the new site and new conditions which are less favorable than those of the nursery. The period during which the planting should take place is either October-November or February-April. Before planting, the surface should be cleaned from aggregates and greens. It is explicitly indicated that there will not be a general leveling of soil or treatment with machinery.

The planting procedure is as follows:

Opening up of planting pit

The planting pit is opened with digging tool or machine and is usually shaped like a truncated cone. Its dimensions are proportional to the size of the plant and particularly relative to the size of the ball of soil surrounding the roots. The depth of the hole should be approximately equal to the diameter at the level of the natural ground. The minimum depth of the planting pit should be as the height of the soil ball, higher by 10 centimeters. The aim is to ensure space for the plant so it can grow. A typical planting pit of a small tree has depth of 40cm and of diameter on the surface of the natural ground 30cm.

Plant preparation

During preparation for planting the young plants which are grown in plastic bags with soil balls, the pouch that protects the soil ball is carefully remove. The pouch is cut with a sharp knife around and then is removed the bottom. Following is a vertical cut on the side of the bag and removed without breaking the soil ball.

Plant placement

The placement of the plant in the pit is made with attention not to spoil the soil ball. The plant is placed in the upright position, holding it with one hand from the part between the roots and foliar (neck), and with the other hand holding the base of the soil ball. It has previously been placed at the base of the pit a layer of loose soil material (10cm). This layer helps root growth during the first stage adaptation of the plant.

Filling with soil & irrigation basin configuration

After placing the plant, the gaps are covered in the pit by soil. The added soil material must be up to 10cm below the natural ground line to form irrigation pit. The soil to be used may be the same as that which was removed during the opening of the pit after the stones have been removed. Around each plant an irrigation basin is shaped, with diameter of about 60cm for a 30cm pit. Within the irrigation basin sawdust will be added. Sawdust will retain moisture after first watering and will prevent germination of weeds around the plant.

Irrigation

After planting the first watering follows in order to eliminate the gaps and achieve the integration of the ball of soil in natural terrain. Then the pit is filled with soil if needed.

5.5.4. Irrigation and maintenance of the plantings

The seedlings are watered the dry season (June-September) for two years after planting. There will be 10 waterings in the xerothermic season. This number may change depending on the prevailing weather conditions. The water will be pumped from the tanks that have been proposed for the site of intervention. The tanks will have automatic irrigation solenoids.

One 40mm polyethylene pipe carries water with a pump to the two tanks. From the tank Δ1 at the altitude of 220m, a Φ32 pipe leads the water to the planting location Φ2, where 16mm pipes irrigate the planting locations Φ1 and Φ2. From the planting location Δ2, at the altitude of 258m two Φ32 pipes descend to the planting locations Φ3 and Φ4 where the respective Φ16 pipes irrigate them. Finally, in the tanks it will be installed a battery programmer.

Digging

Digging is necessary because it improves the soil around the roots and gives better growth to the plant. It should be done in spring after the last rains (one time in total). Moreover, because of the fact that the plants will be watered during the summer period, the pits must be shaped properly.

Weeding

After planting, weeding along with digging is applied in order to create good conditions for plant growth. The task of weeding refers to the removal of weeds that grow around the plant. The weeds cut out the necessary ventilation from the plant, limit the growth space and consume soil minerals and water that are essential for the plant.

5.6. Other management interventions

1. Recovery of Kermes oak

In the study area, there are Kermes oak individuals with height up to 1-1.5m and even to 2m, with obvious signs of grazing. They usually branch from low height and spread in width without central trunk. During the project these individuals will be pruned in order to get a central trunk. The work will be implemented in 2.5 hectares, which is the area that the species it is estimated that occupies.

2. Paths cleaning

The existing trails of the study area will be cleared of shrubs, grasses, stones that prevent the passage

3. Paths opening up

New trails will be opened up for hiking in the area. The routes are shown on the map of interventions.

4. Emergence of rare flora of the rocky ecosystems

The significant flora of the surrounding rocks will be highlighted, with photographic documentation for inclusion in a future ecotourism guide of Amorgos.

5.7. 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	Fencing					
2	Terrace					
3	Paths (cleaning & opening up)					
4	Kermes oak height recovery					
5	Tanks & irrigation network establishment					
6	Sowing					
7	Planting					
8	Irrigation network function					
9	Maintenance					

The process will be monitored and the results will be evaluated. After 7 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 tasks

6.1.1. Bill of quantities table of planting sites

s/n	Site	Surface (m^2)
1	Φ1	400
2	Φ2	400
3	Φ3	400
4	Φ4	400

6.1.2. Bill of quantities of plant species

s/n	Species	Quantity
1	Holm oak	10
2	Terebinth	20
3	Valonian oak	30
4	Mediterranean buckthorn	40
5	Carob	20
	Sum	100

The species 1, 3 and 5 are tree species whereas the species 2 and 4 are shrubs.

6.1.3. Summary table of bill of quantities

No	Tasks	Unit	Quantity	Article
1	Stone terracing with elaborate surface	m^3	292.80	Β.9-ΟΔΟ
2	Tree supply	item	60.00	Δ1.1.
3	Shrub supply	item	40.00	Δ2.1.
4	Pits drilling with hand tools of dimensions 0.3x0.3x0.3m	item	100.00	Ε1.1.
5	Planting with soil ball 2-4lt	item	100.00	Ε9.4
6	Formation of basins with diameter up to 0.60m	item	100.00	ΣΤ1.1.
7	Shrubs' pruning	ha	25.00	ΣΤ4.5.1
8	Tank $5m^3$ made of polyethylene	item	2.00	NEW
9	Polyethylene tube Φ16/6Atm	m	365.00	Η1.1.1
10	Polyethylene tube Φ40/6 Atm	m	450.00	Η1.1.5
11	Polyethylene tube Φ32/6 Atm	m	425.00	Η1.1.4
12	Self-regulating dripper, visitable	item	100.00	Η8.1.1
13	Simple type irrigation battery programmer	item	2.00	Η9.2.2.1.
14	Fencing mesh	m	900.00	Ε5-ΟΔΟ
15	Existing path elaboration	m	780.00	ΠΡΣ 5390.1
16	New path opening up	m	765.00	20.01.01 ΟΙΚ.

The terraces are applied in a total length of 1,220m with a width of 0.40m and a height of 0.60m.

The Kermes oak individuals are estimated to be 80 per $1000m^2$ for the area that will be applied pruning (2.5 hectares). The bill of quantities of the irrigation pipes and the trails were based on the map of interventions.

6.2. Unit prices

No	Tasks	Unit	Price (€)	Article
1	Stone terracing with elaborate surface	m^3	43.80	B.9-ΟΔΟ
2	Tree supply	item	3.50	Δ1.1.
3	Shrub supply	item	2.30	Δ2.1.
4	Pits drilling with hand tools of dimensions 0.3x0.3x0.3m	item	0.65	Ε1.1.
5	Planting with soil ball 2-4lt	item	1.10	Ε9.4
6	Formation of basins with diameter up to 0.60m	item	0.40	ΣΤ1.1.
7	Shrubs' pruning	ha	96.00	ΣΤ4.5.1
8	Tank $5m^3$ made of polyethylene	item	1,000.00	NEW
9	Polyethylene tube Φ16/6Atm	m	0.30	Η1.1.1
10	Polyethylene tube Φ40/6 Atm	m	0.85	Η1.1.5
11	Polyethylene tube Φ32/6 Atm	m	0.65	Η1.1.4
12	Self-regulating dripper, visitable	item	0.22	Η8.1.1
13	Simple type irrigation battery programmer	item	100.00	Η9.2.2.1.
14	Fencing mesh	m	4.00	Ε5-ΟΔΟ
15	Existing path elaboration	m	3.00	ΠΡΣ 5390.1
16	New path opening up	m	6.75	20.01.01 ΟΙΚ.

Prices are derived from the Single Tariffs Government Gazette B363/19-2-2013.

6.3. Budget

Project budget (Prices of Single Tariffs Government Gazette B363/19-2-2013)						
No	**Tasks**	**Unit**	**Article**	**Price (€)**	**Quantity**	**Cost (€)**
1	Stone terracing with elaborate surface	m^3	B.9-ΟΔΟ	43.80	292.80	12,824.64
2	Tree supply	item	Δ1.1.	3.50	60.00	210.00
3	Shrub supply	item	Δ2.1.	2.30	40.00	92.00
4	Pits drilling with hand tools of dimensions 0.3x0.3x0.3m	item	E1.1.	0.65	100.00	65.00
5	Planting with soil ball 2-4lt	item	E9.4	1.10	100.00	110.00
6	Formation of basins with diameter up to 0,60m	item	ΣΤ1.1.	0.40	100.00	40.00
7	Shrubs' pruning	ha	ΣΤ4.5.1	96.00	25.00	2,400.00
8	Tank $5m^3$ made of polyethylene	item	NEW	1,000.00	2.00	2,000.00
9	Polyethylene tube Φ16/6Atm	m	Η1.1.1	0.30	365.00	109.50
10	Polyethylene tube Φ40/6 Atm	m	Η1.1.5	0.85	450.00	382.50
11	Polyethylene tube Φ32/6 Atm	m	Η1.1.4	0.65	425.00	276.25
12	Self-regulating dripper, visitable	item	Η8.1.1	0.22	100.00	22.00
13	Simple type irrigation battery programmer	item	Η9.2.2.1.	100,00	2.00	200.00
14	Fencing mesh	m	Ε5-ΟΔΟ	4.00	900.00	3,600.00
15	Existing path elaboration	m	ΠΡΣ 5390.1	3.00	780.00	2,340.00
16	New path opening up	m	20.01.01 ΟΙΚ.	6.75	765.00	5,163.75
Total task cost						**17,011.00**
Contingencies 15%						2,551.65
Final project values						**19,562.65**

7. PHOTOS

Photo1.The rocks surrounding the area, host rare and endemic plant species.

Photo2.The site Dokari in Lagada, extending to the rocks that appear in the background.

Photo3. The location where the tank Δ2 will be placed.

Photo4. Phrygana and mosses compose the vegetation in the upper side of the location.

Photo5.The site Dokari in Lagada, from the center to the east.

Photo6.The site Dokari in Lagada, downslope and west, overlooking the bay of Aigiali.

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