Trees - for - Greece GmbH

Management for ecosystem recovery in Amorgos Island

Technical Report

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YLI - Environmental Management and Protection
Environmental Consultant

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1. INTRODUCTION - PRESENTATION OF COOPERATING PARTIES

Amorgos is one of the Aegean islands that has not experienced major interventions in the natural landscape, nor major out-of-scale projects.

The German NGO Trees-for-Greece GmbH have chosen Amorgos as first choice to implement a program of actions to upgrade the ecosystem.

Trees-for-Greece GmbH is a nonprofit organization based in Regensburg in Germany and wants to promote the idea of bilateral understanding and friendship between Germany and Greece.

The purpose of the organization is to initiate and implement projects of German-Greek cooperation for recovery of degraded ecosystem (reforestation or reclamation of derelict land) to protect against further degradation and to restore long-term historical and ecologically valuable cultural landscapes in Greece.

Through these actions, the organization expressed the intention and the hope to promote transnational understanding and strengthening of friendship between Germany and Greece, contributing in this way to overcome potential environmental crises in the current economic downturn.

The works of this cooperation should be a sign of the responsibility we all share for the next generation, but also to facilitate sustainable and environmentally friendly oriented land management for the residents of the areas where they will perform the actions that can recover natural and agricultural landscapes.

Trees-for-Greece GmbH is organizing activities with no commercial intent. The financing of actions is based solely on private or public grants and donations from people and institutions who want to support the work on protecting the environment and creating a sustainable attitude to life.

YLI are the project consultants. “YLI-Environmental Management and Protection” is a company founded in 2001 and deals with projects of forestry and environmental management. Focused firmly on projects with environmental sensitivity, with technical competence and fast adaptation to new technologies. In recent years YLI has entered into the field of Environment Consultants and Corporate Social Responsibility. YLI has acquired the quality management system ISO 9001: 2008.

2. PURPOSE OF THE PROJECT

This report deals with the recording and analysis of the ecosystem in the island of Amorgos, in order to propose appropriate management actions for recovery and improving ecosystem functions. 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”. The vegetation consists of species that can withstand high temperatures and lack of water.

This project aims to have a character of pioneer application and represent a good intervention example for all Cyclades and other Aegean islands.

Management for ecosystem recovery comes to balance past losses due to overexploitation, overgrazing and repeated fires. Any intervention should show ways to regulate the relations between the natural ecosystem and agro-pastoral activities.

The NGO Trees for Greece, the project reporting consultants and the municipal Authorities of Amorgos, nominated 3 different places of special interest where specific management measures could be applied.

Knowing the factors that affect the ecosystem, it is concluded that the key management factor is soil management. Also important is water management and the selection of suitable plant species.

The program of the organization Trees-for-Greece GmbH has the potential expansion of successful actions throughout Greece in the form of a large "mosaic" which will attempt to play the role of better prospects for people who live in degraded ecosystem, so that next generations will not be forced to immigrate.

All actions and projects to be proposed are long-term 'investment' for future generations. Trees-for-Greece GmbH encourages the integration of people in a natural and healthy environment for the care and protection of which, all participants should be equally responsible.

Trees-for-Greece GmbH plans to promote the reclamation of derelict land and reforestation of degraded areas throughout Greece.

For any action to be taken, all possible sites of the project will be subject to a thorough scientific examination by specialists to determine their suitability and to assess the prospect of success. Another activity is the extensive renovation process and public discussion with the residents of these areas. The consultations will lead to the final acceptance of the project by the majority of people, before the final plan and with the purpose of local residents to support and work for the project.

Trees-for-Greece GmbH hopes to provide support for many projects, based on the idea of offering to future generations in the context of reduction of environmental destruction and supply a new life concept to the inhabitants of various regions.

Every restoration project will be implemented with respect to nature and local identity. This means

a) that the various projects will be implemented with the possible use of local resources and the support of local residents

b) that the relevant local organizations and societies participate in these planning processes

c) that the only plants that are used for the various plantings are native plants that are adapted to local ecosystems and native plants of the same bioclimatic zone

d) the projects take into account local traditions and structures, if they do not jeopardize the target of ecological sustainability

e) build relationships and partnerships and maintain synergies with other relevant local initiatives (cultural, economic and ecological).

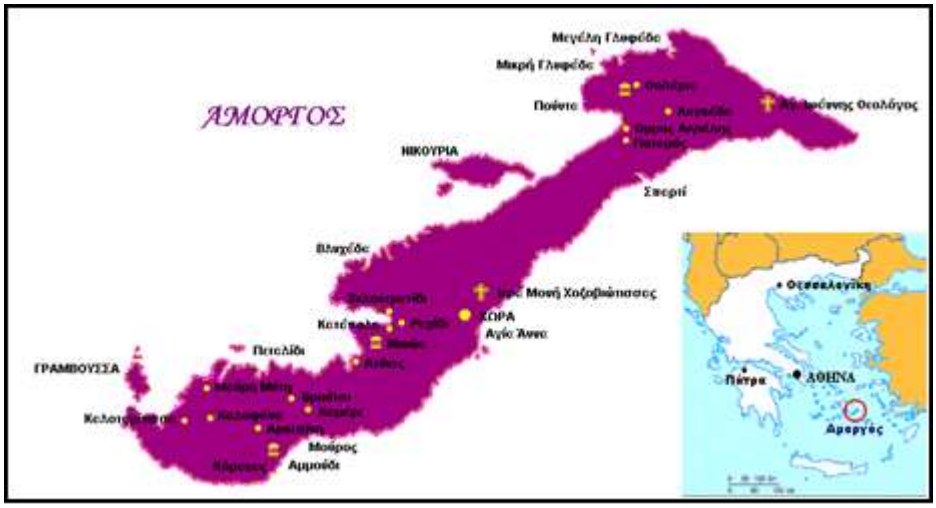
3. THE ENVIRONMENT OF THE STUDY AREA

3.1 The Island of Amorgos

The island of Amorgos belongs to Regional Section Naxos of South Aegean Region. It is the easternmost island of the county, between the Small Cyclades and Astypalaia and has a total area of 121 km2 (the 7th largest island in the Cyclades), 112 km of coastline and a population of 1866 inhabitants (2001 census). The Municipality is located in Chora, Amorgos and resulted from merging of the communities Aigialis, Amorgos, Arkesini, Vroutsi, Tholaria and Katapola.

The shape of the island is very elongated, with a length of about 32 Km and oriented NE-SW. Distance from Piraeus is 138 nautical miles. 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



3.2 Physiography

Generally, the factors that determined the current terrain of Amorgos are:

- The tectonics
- The petrographic composition
- The climate

Considering the physiographic features of the island, Amorgos is divided into three distinct geographical sections, as follows:

A) The Northeast (NE), Aigialis area

B) The center, located where the capital town and main port Katápola

C) The Southwest (SW), with the name "Kato Meria" .

From a geomorphological point of view, the island is mountainous and rocky. At the NE Krikelos massif dominates, the maximum altitude being 823 m. In the central part of the island-east of Chora- is the Prophet Elias summit at an altitude of 698 m and at the SW there is a massif called "Korakas" maximum altitude being 530 m. The entire S-SE coastline is characterized by very steep slopes, is extremely rocky and steep, while in the NW numerous small ravines are formed.

The alluvial valleys are very few in Amorgos, largest in Aigialis, where there are the most important lowland, farmland and olive groves of the island. Another, smaller valley is formed

by a stream in Xylokeratidi, Katapola. The most extensive lowland plateau is located in the SW part between Kolofana and Kalotaritissa.

3.3 Geological Conditions

According to the "Hydrological Cyclades Research II Amorgos" (Geological Institute 1983) the geological structure of Amorgos consists of sediments and volcanics of low metamorphosis, which are divided into four main series:

1. Lower shales and conglomerates - Triassic, which is dominated by aluminate and mica schists

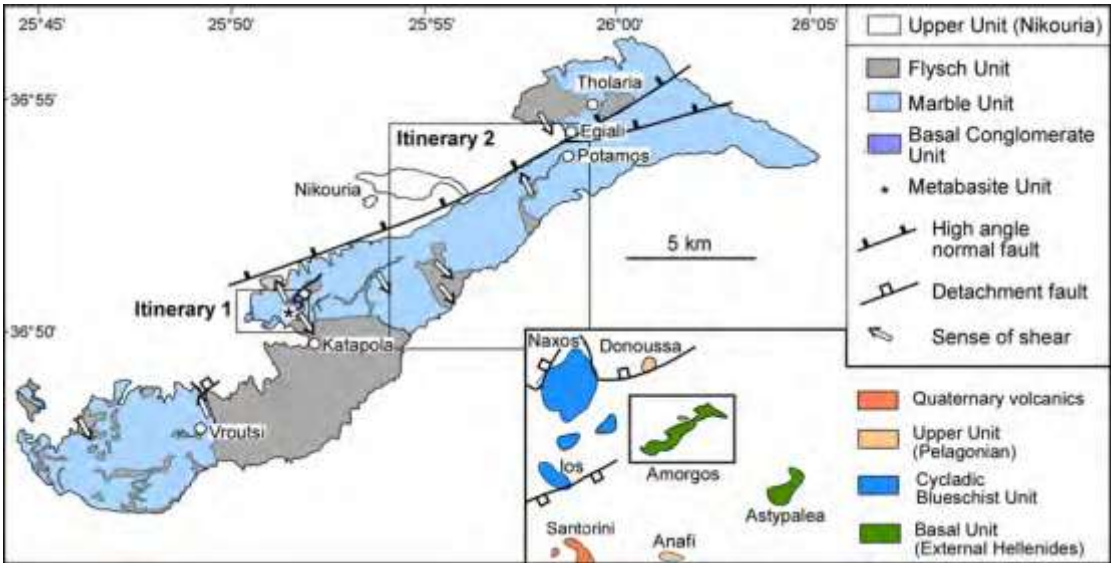
2.. Carbonate series - Triassic, Jurassic, Eocene, which is the largest part of the island and consists of alternating crystalline limestones and dolomites with mica in the lower parts and bauxite lenses at the upper parts of NE Amorgos, plate limestones and dolomites with interference by mica shales in the upper parts of the SW Amorgos.

3. Higher shale series, Flysch - Paleogene, typical flysch that consists of alternations of shales and sandstones.

4. Quaternary deposits, not extended at all but include various types of formations such as alluvial silt of torrential origin, scree cones etc.

Amorgos geotectonically is located at the edges of Attika-Cyclades mass. The Mesozoic sediments have undergone the tectonism of Alpine orogenesis which led to folding of sediments. The main faults are relatively few and are found either in the carbon series or the contact between flysch and carbonates. Flysch and especially at SW has undergone intense tectonism as a result of compression by two less flexible limestone masses. The movements that followed Alpine orogenesis caused a large number of vertical faults observed in the different geological formations of Amorgos.

Figure 2: Geological map of Amorgos (Fytrolakis & Papanikolaou 1981, IGME 1985)



The predominant geological formations of the island are limestone and shale, which plays an important role in surface water and groundwater. The arrangement of these rocks include marble formations alternating with shale formations. In the northeastern part of the island appear superior, normally aluminate and sometimes mica, schists (Tholaria), while the

mountain of Krikelos have normal body limestone / marble extending across the ridge to the upper central portion of island B to Country and Katapola (upper marbles). In this inserted middle shales (Potamos), middle blue-gray marbles of Chozoviotissa, several lower shale formations B peak of Pr. Elias (Rihtis shales) and lower marbles (Kryoneri - NW of the bay of Katapola). In the lower central part, South of Chora and Katapola, lower shales prevail. Finally, in the SW part of the island (Vourtsi - Arkesini) reappear normal limestones and marbles like those at Chozoviotissa. Conglomerate limestone rocks are found in various parts of the island, while the youngest geological formations include alluvial deposits, streams boulders and gravel (Fytrolakis & Papanikolaou 1981, IGME 1985).

3.4 Water Resources

According to the study "Hydrogeological Cycledes Research II Amorgos" (Geological Institute 1983), the hydrological conditions of Amorgos and the Eastern Cyclades are unfavorable, mainly due to annual rainfall, which usually do not exceed 400 mm. Specifically, based on climatic conditions of Amorgos, it is estimated that rainfall presents:

- Low total annual amount
- Inequality during the year
- Absence during summer months
- High intensity (usually)

The hydrographic network is dense, characterized as moderately developed, the geomorphology being the key factor in its configuration and development. Spring formation is found mostly in areas where the dominant bedrock is slate. The two most important springs of the island are found at St.George Varsamitis near Chora, and at Varma , SW of Katapola. In Amorgos there are several streams, which usually remain dry during most of the year. The longest streams are Araklou stream at Langada ending at Aigiali and Fonias stream ending at Katapola.

It is estimated that evapotranspiration levels are high, partly because of high average temperatures and sunshine, and also due to high wind speeds.

Considering the geological substrate, infiltration is minimized in formations of shale and flysch and is moderate in limestone formations. On the contrary, in the alluvial deposits, penetration of water is increased. It is concluded that the amount of infiltrating water capable of compensating aquifers is limited.

Regarding the quality of drinking water, the quality is not very good and it is considered as non-drinkable, due to the age of the network and the tanks as well as and the salinity of drilled water.

3.5 Soil

The island of Amorgos is characterized by calcareous soils with high amounts of surface rock; on the contrary, flysch soils are more fertile and can support agricultural cultivations.

Furthermore, the risk of desertification is high in the island, according to the potential desertification risk chart developed by the Agricultural University of Athens.

The calcareous soils are classified as Calcaric Leptosol: The parent material is limestone rocks of very low quality and very high sensitivity to desertification.

The depth of the soil is primary related to the nature of the soil parent material (geological texture), the presence of degradation, the extent of anthropogenic impact, mainly on vegetation and other factors such as slope grade and orientation of slopes, the climate, etc.

Rocks which disintegrate rapidly (such as flysch) give generally, deeper soils, unlike those of slow degradation which give shallow soils. The inclined areas, where the protective role of vegetation is absent for time, are characterized by considerable shallow soils, due to intensive erosion. Soil erosion, which is accelerated notably by the adverse anthropogenic intervention in the natural environment and extreme natural phenomena, leads to soil degradation, reduction of their fertile capacity and, ultimately, the loss of precious, irreplaceable and non-renewable natural resource. To conclude, it has to be mentioned that soil degradation is one of the main factors of soil desertification.

3.6 Climatic Conditions - Bioclimate

The island of Amorgos is classified, in terms of climate, as the 'temperate' type of the 'terrestrial Mediterranean'. Since there is no meteorological station on the island, the data that are used for this report, are from the meteorological station of the island of Naxos (s / N 732 station, latitude, north 37.06 degrees, longitude, east 25.23 degrees and barometer altitude 9.8 m), which is the nearest station. It is estimated that all the meteorological data of Naxos station, represent the current conditions unexceptionably, despite the fact that they refer to the period from the year 1955 until 1992. This can be confirmed by the data provided from the meteorological station of the Hellenic National Meteorological Service (HNMS) of the airport of the island of Santorini, where there are only negligible differences between the data of these two stations.

Temperature

The figures, from the archive of the HNMS, indicate that the coldest months are January and February with average monthly temperature 12.1 °C and 12.2 °C respectively, while the warmest ones are July and August with average monthly temperature 24.7 °C and 24.6 °C respectively. In particular, the lower temperature has been recorded in February, -1 °C and the highest one in July, 37.4 °C respectively. In addition, the warm season can be characterized the period between April-May and September-October with average temperature above 18 °C, which exceeds 20 °C during June-September.

Precipitation

The average annual rainfall for the period 1955-1988, is around 370 mm, the average number of rain days is 82, while it should be noted that the average rainfall during the period May-September is only 22 mm. Specifically, it should be mentioned that July is the driest month with 0.7 mm of precipitation, whereas December is the wettest with 69.8 mm. Furthermore there is a tendency of rainfall to be extreme in terms of rapidness, because it is few but downspout. This can lead to a first conclusion that the management methods of water resources may need to be oriented to the management of flood water too.

Taking into consideration what mentioned before as well as the rate of evaporation, it is clear that, during the summer months with high temperatures, the area is deficient in soil water and crop needs should be covered by continual irrigation.

Winds

The 77% of annual winds fall into the category of small and medium Intensity, 1-5 in the Baufort range. According to the statistics of the meteorological station of the Naxos Island, the predominant winds in the region is, with declining incidence respectively: the N ones up to 11 Beaufort, the S ones up to 10 Beaufort, NE ones up to 10 Beaufort, the SE ones up to 11 Beaufort. The prevailing winds are the N-NE ones with total annual incidence of 50.75%.

Furthermore, the maximum wind intensity for the northern part, according to the existing data does not exceed 9 Beaufort. However, very strong winds do occur up to 10 Beaufort but with short duration. During the winter months the presence of southerly winds reduces significantly, whereas the presence of northern ones remains steady, while the presence of the western and northeastern winds increases everywhere. The percentage of lull is very low, something which is normal for an Island of the Cyclades, such as Amorgos. In addition, it should be mentioned that from July to September, an annual wind blows in the Aegean Sea, called Etisies or Meltemia in vulgar tongue. Other extreme weather phenomena, such as snow, hail, frost, fog etc., are rarely observed.

3.7 Anthropogenic environment

3.7.1 Primary Sector

Agriculture

As regards agriculture, Amorgos Island follows the same path of development with most Cycladic Islands. The technological infrastructure is limited in agriculture and cultivation techniques are generally suited to arable crops.

There are four agricultural corporations on the island, namely, in Chora, Aegiali, Arkesini and Katapola. The provision of agricultural supplies comes from Naxos Island, whereas the products produced on the island, are not sufficient to meet the needs of the local market.

The main agricultural activities are viticulture (wine-raki) and olive cultivation. The table below shows the main agricultural production per local community, in order of priority of economic importance to the Island, using a scale from 1 to 7. The "1" corresponds to a product of great economic importance, while "7" denotes a product of less economic importance to the Island.

Table 3.7.1-1: Economic importance of agricultural products of Amorgos per local community

Local Community	Olives/Olive oil	Wine	Vinelike	Citrus fruits	Vegetables	Agricultural	Fruit trees	Cereals	Livestock	Legumes
Amorgos/Chora	1	3	5	-	-	4	-	6	2	7
Aegiali	2	3	-	6	-	4	-	5	1	-
Arkesini	4	5	6	-	-	2	-	3	1	7
Vrousti	4	5	6	-	-	2	-	3	1	7
Tholaria	1	3	4	-	6	5	-	-	2	7
Katapola	1	4	-	3	1	7	2	6	5	-

Source: Development Agency of Cyclades SA, Questionnaire for the establishment of the Municipal Corporation for Tourism Promotion - Development in the Municipality of Amorgos.

The table above shows that the primary production of the livestock sector and olive groves are the most important economic resources in Amorgos.

The expansion of agricultural crops and general the systematization of primary sector activities are quite difficult, due to climatic conditions and especially because of the low amount of rainfall observed in recent years.

Livestock

Livestock activity includes mainly sheep and goat farming and in a very small scale poultry. The total estimated number of livestock of sheep and goats stands at 19,100, as well as 154 cattle that have been measured, while there are no data for pigs and poultry.

Regarding the number of sheep and goats and the overall management, from the environmental and economic point of view, it has been found that although the grazing carrying capacity of the island is boundary, the exploitation of the production of meat, milk, or dairy products it is not relative to the grazing extent on the island. This is due to the subsidy system which has been established the recent years by the European Union.

In conclusion, from the livestock operation on the island of Amorgos derives a significant amount of traditional dairy products, most of which are used for own consumption and the rest production is consumed by the local market.

Fishing

The island of Amorgos, the easternmost island of the Cyclades, has tradition in fishing since many years. There are two main ports, with mixed use, the first one in Aegiali, in the northeastern (NE) part of the island and the second one in Katápola in the middle of the north part. However, apart from these two ports, in various parts of the Island, there are smaller fishing ports in the bay of Agios Pavlos, in the bay of Kalotarissa, in Kato Kampos and some other smaller ports in the south side of the Island.

The main port of the island is the one in Katapola, whereas the other neighboring ports with the same fishing activity have the following distances from Katapola (in nautical miles), Aegiali 9, Koufonisi Island 14, Donusa Island 18, Schinousa Island 20, Heraklia Island 22, Naxos Island 46 and Mykonos Island 58 respectively.

The fishing activity is quite significant, as shown by the considerable number of the fishing vessels. It has been estimated that the annual amount of fish is about 200 tons, while the annual amount of fish transported to markets outside Amorgos, estimated at About 150 tons.

Worth mentioning is the fact that many fishing vessels were sunk in recent years because of extreme weather phenomena. Some of these vessels were refloated with machinery (agricultural, earthmoving etc). However, most of them, the larger ones, remained shipwrecks on the seabed, because of lack of suitable machinery, such as cranes.

3.7.2 Secondary Sector

Approximately 40 people are employed in the secondary sector in Amorgos. The existing secondary production units include 10 carpentry workshops and 2 oil mills. In addition, there are few small family craft enterprises engaged in manufacturing clay products, folk art and embroidered headscarves and standardization of agricultural products. In terms of building construction activity in Amorgos Island, there is an increase due to the tourist development on the Island.

3.7.3 Tourism

The island of Amorgos is considered a popular holiday destination and the average stay on the island during summer peak season is between 5 to 7 days. Although there is no further information on the visitors' spatial distribution on the island, it is sure that the most tourist areas of the island are Chora, Katapola and the surrounding area of Aegiali where most of the tourist accommodation is.

Regarding the visiting season distribution of the island it is closely followed the classical model, according to which there is a gradual increase in arrivals of visitors from Easter onwards, whereas the greatest number of visitors is observed during the summer, especially in August, and a gradual decline after September which becomes final at the end of October. As regards alternative tourism, it includes mostly hiking tourism, which is higher during late spring to early summer and early to mid-autumn.

An additional excellent perspective concerns diving tourism, which due to the french film "The Big Blue"; Amorgos became famous around the world for the pure deep sea. Currently diving perspective remains untapped in the island. As it can be observed in almost all around the island, there is a natural background for diving activities. Currently this natural background is exploited individually only for underwater fishing but not for observation and study reasons. However, it is recommended that the right utilization of the diving perspectives, should be ensured, organized and controlled by the local authorities and their associations, in order to avoid possible adverse environmental effects due to the massive diving activity, especially in sensitive areas such as the NATURA zones.

Another kind of alternative tourism which increases the recent years is climbing tourism in combination with trekking. Particularly in Lagada, an area in Aegiali, a climbing center has been created with 36 climbing routes of various difficulty from 5a to 8b covering the preferences of every climber of any level, as well as providing the possibility of free climbing on virgin places.

Furthermore, the religious tourism, with reference to the Monastery of Our Lady of Chozoviotissa, and countless byzantine churches, is on the increase with a growing number of people visiting religious places.

3.8 Road Network - Infrastructure

The total length of the main road network on the island is about 50 Km, while 10 km is the total length of the rural roads. The asphalt road network is relatively small, and extends from Aegiali (and the nearby villages) to Chora, Katapola and Kato Meria, and near the Monastery of Chozoviotissa. The rest island is covered by a dirt road network of different types.

As regards maritime and air transport, the island is served by both passenger ferries and speed ferries. However during winter the island is served only by the passenger ferry on a daily basis since winter 2008. More specifically, the Island is connected to the port of Piraeus, via Naxos and Paros with the Dodecanese sea line and via Ios, Naxos, Paros, Santorini, Syros, Astypalea and Crete with the Cyclades-Crete sea line. Moreover the island is connected to the port of Rafina in Attica, via Mykonos, Naxos and Paros. There is also the Aegean sea line, connecting, even in winter, to Naxos, Paros, Syros, Folegandros, Koufonisia, Schinousa and Donousa. Speed ferries connect the island of Amorgos to Rafina and Andros, Syros, Mykonos, Tinos, Ios, Paros, Naxos, Santorini and Donousa.

Air transport does not exist, except for transport of emergency health incident by a helicopter.

With respect to rural construction, there is a wide range of old terraces and drystone wall. There is no spot in Amorgos, where the visitor cannot see any stone construction. The use of terraces was extensive in the past, when cultivation techniques were not developed, so the stone constructions provided protection from strong winds. Today, the terraces are almost complete abandoned, and gradually are overlapped by the natural element, whereas

their functional use is extremely limited. Amorgos is literally full of untapped terraces, which are in good condition, and the prospect of their partial use is worthy of investigation.
In the matter of the tourist infrastructure, they are classified into the following categories:
a) Midsize hotels with basic luxury amenities
b) Rental rooms
c) Camping
There are 45 restaurants on the island, 9 of which remain open during winter, 21 bars (6 in winter), 21 coffee shops (12 in winter), 23 food stores (20 in winter), 27 stores (15 in winter) 2 banks, a post office, 2 pharmacies, 2 fuel stations, 5 car rentals, 5 travel agencies, and a diving center.
The Municipality of Amorgos is watered by groundwater through drillings and water transfer by boat from the port of Lavrio in Attica. There are no desalination plants on the island. The island is facing severe problems in water supply since the water from drillings is brackish in the region of Katapola, Chora, and Aegiali and the available water storage tanks, from aquifers, are inadequate during the summer season.
The supply of water on the island comes primarily from the basin of Katapola, where the settlements of Chora and Katapola take water from. There are 4 water drillings and 3 wells, the distance of which from the sea is between 600 and 2,000 meters. There is also a spring at the location “Kaminia” and a well at “Agios George Valsamitis” which supply water in the Chora in a distance of 1500 meters from the sea. In addition, in the region of Kato Meria there is a spring at “Kamari” and 3 drillings at "Agios Vasilios", "Malia" and "Stavros" that supply the settlements of Vroutsi, Kamari and Arkesini. There is also a drilling at the location “Kato Kampos” in the region of Kolofana.
Overall during the summer months water is not sufficient in the region of Kato Meria, so the water is transferred by tank. In the region of Aegiali there is the drilling of “Potamos” (about 1 km from the sea) whereas for the regions of Ormos, Potamos and Lagada there is a drilling at Lagada (4km from the sea). The settlement of Tholaria covers the needs in water by two drillings (3km from the sea). In Aegiali there is great lack of water, which increases during the summer months because of the high number of visitors. The needs in water are covered by transfer with sea tankers.
As regards the existing water tanks on the island, there are two reservoirs in Chora, one of 500 m^3 and a smaller one of 50 m^3. There is also a tank of 100 m^3 in Kastellopetra and in Katapola there is a 500 m^3 tank and a metal one of 100 m^3. The region of Ormos in Aegiali covers the needs in water with 3 reservoirs, one of 1000 m^3, one of 600 m^3 and one of 400 m^3. Moreover there are two reservoirs of 60 m^3 and 50 m^3 respectively in Potamos and in the region of Lagada in Aegiali a small tank of 60 m^3. Also Tholaria have two tanks of 300 m^3 and 100 m^3 respectively, whereas in Kolofana there are two tanks of 200 m^3 each, whereas two tanks of total capacity of 2,000 m^3 have been established in Katapola. Finally two tanks of 500 m^3 are allocated one Tholaria and One in Lagada.
Generally, it should be mentioned that the water supply network and the sewerage system of the island, is old with additions at various times.
The most common way of managing wastewater, on the Island of Amorgos, is the sewer systems, however since recently there were only two sewerage systems in Tholaria and Potamos, but none of them ends up in biological wastewater treatment plant. So far, the construction of the sewerage system has been completed in the area of Katapola as well as the construction of biological wastewater treatment plant, covering the needs of the region

of Katapola and Chora. The biological wastewater treatment plant has been established at "Aspes" in the bay of Katapola, southwest of the port, in an Area of 3,000 m^2. The processed sewage water ends up in the seaside of Kato Akrotiri with undersea pipeline of length 70 m and the diffuser at a depth of 20 m. At the same time, the construction of sewerage system and water supply network of the town of Amorgos has been completed.

4. SPECIFIC DESCRIPTION OF ECOSYSTEMS

4.1 Vegetation - Habitat Types

4.1.1. Classification

Amorgos is an island dominated by "phrygana", sparse shrubs and only very few remains of older sclerophyllous forests. According to Dafis (1986) vegetation classification Amorgos belongs to the thermo-mediterranean class (Oleo-*ceratonion*).

The dominant low- shrub or phrygana vegetation consists of Juniperus phoenicea, Quercus coccifera, Erica manipuliflora, Pistacia lentiscus, Rhamnus lycioides ssp.oleoides, Sarcopoterium spinosum, Balota acetabulosa, Coridothymus capitatus, Prasium majus, Salvia fruticosa, Satureja thymbra, Euphorbia dendroides, E. acanthothamnos, Anthyllis hermanniae, Genista acanthoclada, Calicotome villosa, Rhamnus alaternus, Cistus creticus, and C. salvifolius.

The almost total absence of running water has resulted in the absence of wetlands and hydrophilous trees, such as the plane tree. In few streams, like the Varmas one, the hydrophilous shrub oleander (Nerium oleander) is present.

In an inaccessible site of Mount Krikello, remnants of an old sclerophyllus forest occur. It was burnt in the great Fire of 1835 which lasted twenty days and eliminated almost completely the old-growth forest. It is referenced that before that disaster, the old-growth forest consisted of Valonia oak (Q. ithaburensis ssp. macrolepis), holm oak (Q. Ilex) and Phoenicean junipers (Juniperus phoenicea) which are still present in various places of the island. Today there are 15 trees of Valonia Oak, mainly in the Northern Part, at Langada area. Some of them have very large cups and large acorns. Velanidia Foundation for Amorgos performs collection and Valonia Oak seeding in order to spread its presence, the method not being evaluated yet.

Other trees found on the island and took part in the old ecosystem is the Holm oak (Quercus ilex) found in Pr.Ilias (702m), the Carob tree (Ceratonia siliqua) few individuals which were found in Lagada and Kokorevythia (Pistacia terebinthus) with also a few scattered individuals mainly in the northern part of the island.

Planted Tree Species include Fig Trees (Ficus carica), cypress (Cupressus sempervirens) and the alien C.arizonica, Calabrian and Aleppo Pine (Pinus brutia, P, halepensis), few individuals of Stone pine (Pinus pinea). In coastal locations there are tamarisk trees (Tamarix smyrnensis).

Classifying the different types of ecosystems or habitats on the island, the following categories are meaninfull:

- Phrygana ecosystems
- Evergreen shrub with kermes oak (Quercus coccifera) and Phoenicean juniper (Juniperus phoenicea)
- Rocky ecosystems
- Rural areas

More details on these types are presented below.

4.1.2 Phrygana Ecosystems

Phrygana ecosystems appear after disturbances of the forest ecosystem. Fire, continuous logging and overgrazing degrade shrubs and trees and make phrygana dominate. In Amorgos the main phrygana species are astoivi (Sarcopoterium spinosum), luminia (Balota acetabulosa), thyme (Coridothymus capitatus), sage (Salvia fruticosa), savory (Satureja

Thymbra), afana (E. acanthothamnos), alogothymaro (Anthyllis hermanniae), genista (Genista acanthoclada), rock-roses (Cistus creticus and C. salvifolius). Shrub species (kermes oak, buckthorn) are present but very sparse and degraded. Besides the above species, kremmyda (Urginea maritima), oregano (Origanum onites), wild sparagus (Asparagus acutifolius) and bulbous plants like cyclamen (Cyclamen graecum), saffron (Crocus laevigatus), colchicum (Colchicum cupanii), sternbergia (Sternbergia lutea) are frequently found.
Located in the northern and central part of the island, both over limestones as well as shales.

4.1.3 Evergreen shrub with Kermes oak (*Quercus coccifera*) and Phoenician juniper (*Juniperus phoenicea*)

When disturbances are in recession, shrubs are denser and more robust. This happens in cases where it has been a long time since the last fire or since grazing retreated, thus the soil is capable of supporting shrubs. Species of the dominant evergreen shrubs are kermes oak (Quercus coccifera) in the north and Center of the Island and Phoenician juniper (Juniperus phoenicea) in the south around Mount Korakas. The Phoenician juniper appears along with the Mastic Tree (Pistacia lentiscus). These two species create a satisfactory vegetation cover in the southern part of the island, over limestone.
The herbaceous species present are the same as those of phryganic ecosystems, as phrygana are just the degraded succession of evergreen shrub.
In areas of kermes oak other species include Genista acanthoclada, dendrogalatsida (Euphorbia dendroides), buckthorn (Rhamnus lycioides ssp.oleoides), Sarcopoterium spinosum, Balota acetabulosa, Coridothymus capitatus, Prasium majus, Salvia fruticosa, Satureja thymbra, Anthyllis hermanniae, ‘aspalathos’ (Calicotome villosa) yellow wood (Rhamnus alaternus), low heath (Erica manipuliflora).

4.1.4 Rocky ecosystems

Located in the South and all NE part, including Mount Krilellos. Also, at the steep southern slopes of Pr.Elias and the southern slopes of Mount Korakas. Characterized by the very large cover of limestone surface rocks and the very few pockets of soil. Trees and shrubs sparsely can live under these circumstances and only rock-loving lower plants occur.
It is the type of ecosystem where the Rare, Threatened and generally interesting Flora of Amorgos is present. At the Rocks of Pr.Elias few individuals of holm oak (Quercus ilex) were found.
The presence of extensive cliffs favored the existence of many chasmophytes, including several endemic taxa. Exclusive Amorgos plants include Symphytum davisii ssp. davisii, Campanula amorgina, Erysimum senoneri ssp.amorginum. The chasmophytic flora consists also of Helichrysum amorginum, a species, Known only from Amorgos and the islet Anhydros and Eryngium amorginum, which outside Amorgos is also found in Sikinos, Astypalaia and Crete. Both these last two species are listed in the "Red Data Book of Greece" (Phitos & al. 1995).

4.1.5 Rural areas

These are the areas under cultivation or that have been cultivated in the recent past. Generally, these areas are over slate substrate, where soil conditions (moisture retention and soil depth) are better than those of limestone.
An extended network of terraces supports the cultivation of cereals, olives, figs, pomegranates, grapes. Valonia oak and carob individuals occur at rural areas.

4.2 Current Management

Livestock production is the main land use on the Island where, according to the National Survey Service 19.000 livestock (Goats, Sheep, cows) live. Especially the goats and sheep are the main use in the natural ecosystem areas.
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 3038,4 ha including marine parts
2. Site of Community Importance GR4220012 entitled "NORTH AMORGOS AND KINAROS, LEVITHA, MAVRA, GLAROS and marine zone" area of 6062,5 hectares including marine parts

4.3 Management in the past

As part of this Technical Report, the Project Consultants mapped ecosystems of Amorgos, both today and by the year 1945.
Mapping by the year 1945 showed that a High Forest was absent. The shrubland was even less extended than today. It is certain that grazing was even more intense.
Comparing 1945 coverage with the current one, there is a loss (37.47%) in Rural areas, which apparently closed with phrygana and shrubs, as shown in the Table below. Settlements increased considerably as a result of Touristic development. Shrubland increased as grazing pressure reduced, like any other use of shrubs reduced (burning, pruning for livestock feed etc).

	TODAY	**YEAR 1945**	**Difference**	**CHANGE**
VEGETATION CATEGORIES	**LAND AREA (ha)**			
ROCKY AREAS	11,061	70,601	- 11,476	- 16.25%
PHRYGANA	48,064			
SHRUBLAND	43,005	25,115	17,890	71.23%
SETTLEMENTS	3,993	407	3,587	881.33%
RURAL AREAS	16,824	26,906	-10,082	-37.47%
HOLM OAK	2			
RELIC OF OLD-GROWTH FOREST	79			
SUM	123,028	123,028		

In general, changes in relation to the past are small, confirming what is observed today: Amorgos is characterized by very good preservation of both natural landscape and the traditional buildings, monuments and trails, so it could really become a model for the management of such areas in the Cyclades.

4.4 Flora. Endangered, Rare and Interesting Species

Amorgos is an important island for its biodiversity and rarity of herbaceous flora, mainly on the rocks of Krikellos of Pr.Elias and Chozoviotissa Monastery.

Endemic, rare and endangered species of flora include:

Plants referred in Snogerup S. & W. Greuter (Eds.): The Red Data Book of Rare and Threatened Plants of Greece, Athens: WWF.

1. Eryngium amorginum Rech. Fil.,
2. Erysimum senoneri (Reuter) Wettst. subsp. amorginum Snogerup,
3. Helichrysum amorginum Boiss. & orph.,
4. Anthyllis splendens
5. Medicago heyniana

Eryngium amorginum is a herbaceous perennial, spiny plant with strong roots, erect stems 60-100 cm high and white flowers. A chasmophyte with a clear preference to coastal limestone rocks, where it grows in shady positions facing north. E. amorginum is endemic to the Cyclades and Crete. The distribution includes Amorgos, Anhydros, Islets among Folegandros and Sikinos, Astypalaia, two islets W of Astypalaia and two sites in Eastern Crete.

Erysimum senoneri is endemic in Greece and includes three subspecies. E. senoneri subsp. amorginum is a small shrub native to Amorgos, with a height of 15-45 (-100) cm and light yellow flowers. Unlike the other Two kinds of subspecies, which are exclusive chasmophytes, the E. senoneri subsp.amorginum prefers dry places with phrygana, at altitudes between 150 and 750m.

Helichrysum amorginum is a perennial plant, branching from the base in numerous shoots 12-30 cm high, with hemispherical heads with white or pale rose bracts. This is a very rare species, endemic to the Cyclades, known from a few sites in Amorgos, Keros and Anhydros. H.amorginum is an obligatory chasmophyte. The kind that grows in crevices of S-facing limestone Rocks.

Anthyllis splendens is a flowering shrub with stems 5 to 20 cm, leaves pinnate with 6 to 12 pairs of leaflets and white flowers in dense, spherical inflorescences. A chasmophyte that grows in crevices of calcareous rocks from sea Level up to 600 m. Its distribution includes few sites in the Cyclades (Amorgos, Anafi, Kythnos) and E. Crete, whereas its presence in Folegandros has not been confirmed.

Medicago heyniana is a herbaceous, annual, with slender stems, compound leaves with three leaflets and small yellow flowers. Its distribution includes Amorgos, Rhodes, Tilos, Karpathos and SW Turkey. M. It grows on rocky limestone places in phrygana and among cultivated land, at altitudes between 700 and 900 m.

Also, important flora of Amorgos includes:

- *Allium luteolum* (endemic Cyclades)
- *Asperula abbreviata* (endemic Amorgos, Naxos, Evia)
- *Astragalus spruneri*
- *Campanula amorgina* (endemic Amorgos, Sikinos)

- *Centaurea atropurpurea*
- *Cephalaria squamiflora* subsp. *squamiflora* (endemic Amorgos, Crete, Ikaria and Karpathos)
- *Dianthus fruticosus* subsp. *amorginus* (endemic Cyclades, Crete NE)
- *Eryngium amorginum* (Endemic Cyclades and Crete)
- *Erysimum senoneri* subsp. *amorginum* (endemic Amorgos)
- *Galium amorginum* (endemic Amorgos, Folegandros, Karpathos and Keros)
- *Helichrysum amorginum* (endemic Amorgos, and ros and Keros)
- *Jacobaea maritima* subsp. *bicolor* (*Senecio bicolor)*
- *Origanum calcaratum* (endemic Cyclades, Crete and A Halki)
- *Symphytum davisii* (endemic Amorgos)
- *Seseli gummiferum subsp. rithmifolium ,*
- *Verbascum adeliae* (endemic Amorgos and Naxos).
- *Muscari macrocarpum (A Crete, Amorgos, W Turkey)*
- *Ophrys Aeoli (Amorgos and Astypalea)*
- *Crocus laevigatus (endemic S.Greece)*

In special sites 2 and 3 (Chora and Langada) the Autumn Crocus ('Goula') was found (Crocus laevigatus) which is a Greek endemic (Southern Greece, Aegean Islands and E.Crete).

4.5 Fauna

Fauna of reptiles and amphibians is particularly important. In Amorgos four subspecies endemic reptiles live, the Elaphe quatorlineata rechingeri (four-lined Snake) and Three subspecies of the Lizard Podarcis erhardii (amorgensis, kinarensis, levithensis). Species like Cyrtodactylus kotschyi, Podarcis erhardii and Rana ridibunda are protected by the Greek Law (Presidential Decree 67/81) and the Bern Convention (Annex II). Eryx jaculus is protected by the same Treaty. The species Podarcis erhardii and Rana ridibunda are listed in Annex IV of DIRECTIVE 92/43/EU. Another important species is the river chelona Mauremys caspica rivulata .

It has been recorded the appearance of the monk seal (Monachus monachus) as well as the ferret.

Among bird fauna bird, Amorgos is important for Breeding and Migratory Raptors, and species of scrub and cliffs. The Most important species are Larus audouinii (Gull), Hieraaetus fasciatus (Bonelli), Falco eleonorae (Falcon). Larus audouinii is considered as a globally Threatened Species. The Other Two of the aforementioned species are of an unfavorable conservation status in Europe. Other observed bird species are the Herring Gull (Larus michahelis), Blue Rock Thrush (Monticola solitarius), Karvouniaris (Phoenicuros ochruros), the Fieldfare (Turdus Pilaris), The Lark (Galerida cristata), the Sardinian Warbler (Sylvia melanocephala).

5. ECOSYSTEM ASSESSMENT

5.1 Status of Natural Ecosystems

The Thermo-Mediterranean bioclimate of the Island, and the long human intervention have created marginal conditions for tree and shrub growth. Trees are very rare due to logging, grazing, erosion and wind. Strong winds contribute to the dryness of the atmosphere and therefore to reduce the moisture available to the plants. The Island has undergone significant erosion and desertification remains at a high risk. In contrast with trees and shrubs, herbaceous flora is highly interesting as on the rocks, several rare and narrow Aegean endemics live.

According to measurements of local residents in recent years, the average rainfall is at 400-450 mm, the last year recording a minimum of 350 mm whereas in the past a maximum of 600 mm has been recorded.

The soils are classified as soils Calcaric Leptosol: The parent material is limestone of low quality and very high sensitivity to desertification.

Soil depth is directly related to the nature of parent material, to the erosion to anthropogenic influence, to vegetation cover and other factors such as slope, orientation, the climate, etc. The substrate that disintegrates quickly (flysch) generally gives deeper soils, unlike the limestones. Inclined areas where protective vegetation has been destroyed, have considerably shallower soils due to erosion. Soil erosion is accelerated by human interventions and extreme climatic phenomena and leads to soil degradation, of reduced productive capacity.

The main land use in natural ecosystems is goat and sheep grazing. Surrounding areas are cultivated with olives and terraces, mainly on flysch which is a more fertile substrate than limestone.

The old-growth forest disappeared. Today very few scattered trees occur and shrubland is degraded as well.

Where the soil has been stone-terraced, soil has been conserved and better hydrological conditions occur. The terraces are extended in Amorgos.

The relative absence of vehicular roads, combined with the well-maintained network of traditional paths, make the island of Amorgos, a traditional landscape and an ideal place for hiking and nature tourism.

5.2 Disturbances

The ecosystem has suffered serious disturbances by fire and overgrazing. Disturbances have influenced synergistically resulting in the degradation of vegetation. They resulted in the reduction of shrub height and the rarity of trees.

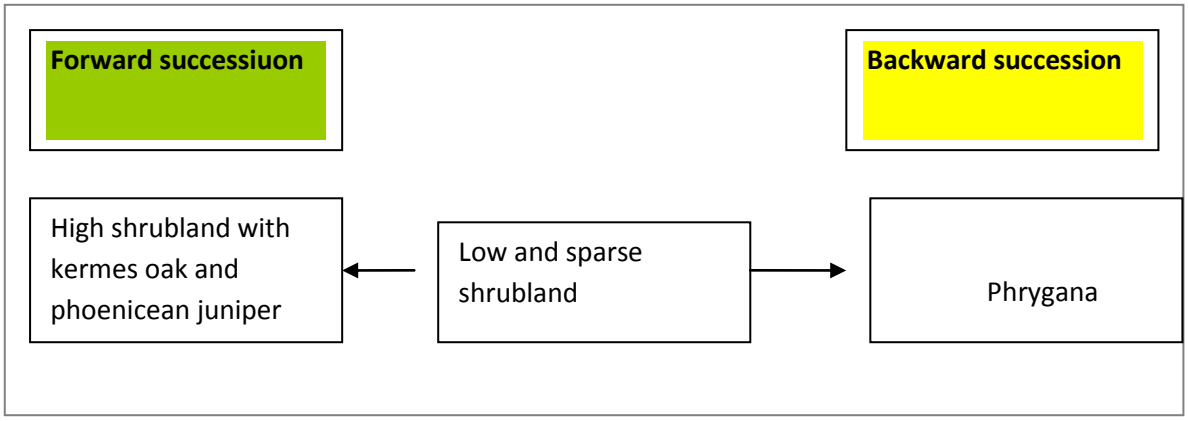
The fire of 1835 was recorded as the most serious disturbance. At that time, almost alla stands of trees and shrubs have been burnt. Since then, other smaller fires have also occurred. Sometimes farmers use fire as a management tool for re-vegetation of shrubs, the new growth of which is desirable by grazing livestock.

Grazing can be very intense and leads to overgrazing that takes place when the stocking rate (the pressure of grazing animals) is greater than the carrying capacity of the ecosystem. Goats feed on leaves and stems of woody plant species. They cannot eat the buckthorn (Rhamnus lycioides ssp. Oleoides) and other thorny plants like Calicotome villosa, Genista acanthoclada, Sarcopoterium spinosum, Euphorbia acanthothamnos. They also avoid spurge (Euphorbia dendroides), the mastic tree (Pistacia lentiscus) and the Phoenicean

juniper (Juniperus phoenicea) . The shrubby vegetation of kermes oak is highly degraded at places and the plant height does not exceed 0.50m. On the contrary, areas with the Phoenician juniper have a satisfactory plant cover.
The combination of fire and overgrazing leads to intense erosion and soil loss. This has happened to all limestone soils in Amorgos.

5.3 Natural Vegetation Succession

After an intense disturbance, the ecosystem loses significant part of its biomass and follows the backward succession. Today, the average facies of Amorgos ecosystem is the one of low and sparse shrubland with a strong presence of phrygana. Disturbances that bring immediate backward succession are Fire and Land Clearing. Grazing keeps current degraded conditions. The natural undisturbed process is the forward succession to a higher and more dense shrubland. In Amorgos, the Climax plant community should be considered the arborescent matorral (high shrubland) of Quercus coccifera and in some areas of Juniperus phoenicea and Pistacia lentiscus. The Phoenician juniper is considered subclimax where Aleppo Pine is disappeared and has no prospects for recovery.
If left undisturbed and there will be a little boost through habitat management (soil and water conservation) then the ecosystem will be capable of supporting the form of high shrub with Quercus coccifera, Rhamnus alaternus, Pistacia terebinthus, Euphorbia dendroides and specimens of Ceratonia siliqua and Quercus ithaburtensis ssp.macrolepis. The high shrub ecosystem in the southern part of the island will be composed of dense stands of Juniperus phoenicea and Pistacia lentiscus.



5.4. Analysis of Special Interest Places

The three specific sites of interest summarized in the table below, the area, slope, orientation and maximum elevation.

A / A	SPACE	Area (ha)	SLOPE	Orientation	Max. Elevation
1	Kato KamposKAMPOS	280	10-45%	SE-NW	92
2	Chora	32	30-35%	NW	484
3	Langada	99	50-55%	NW	260

More specifically, for each of them:

Area 1: **Kato Kampos**

Sample surfaces 6 and 7 were obtained. It is an overgrazed shrubland in an extended hill-peninsula. Main species of the shrubland are Juniperus phoenicea and Pistacia lentiscus. It is fenced and apparently used by a shepherd. The sea is very close. In its northern part slopes are milder and conditions a lttle better. The Phoenicean juniper then reaches 2.5 m high. Other Species are phrygana thyme, astoivi and afana. The Autumn narcissus Narcissus serotinus was found.

Area 2: **Chora**

Sample surfaces 4 and 5 were obtained. This is a small overgrazed area. Shrubs are not even exceeding 20cm high. The soil is rocky. The road Chora-Aigialis passes through the northern side. At the western edge there is an open excavation, used for various deposits, mainly construction debris. The main species are the kermes oak, buckthorn and various phrygana like afana, luminia and astoivi. The bulbous Crocus laevigatus (Greek endemic), was found as well as Sternbergia lutea.

Area 3: **Langada**

Sample surfaces 1,2 and 3 were obtained. A long overgrazed sparse shrubland with phrygana. Site with small screes. There is a path traversing along the contour lines. The road Chora-Aigialis passes through the northern side. The main species are the kermes oak and Euphorbia dendroides. Also, astoivi, sage, oregano, colchicum, sternbergia and the Greek endemic Crocus laevigatus.

All areas are over limestone substrate.

6. MANAGEMENT PROPOSALS

6.1 Objectives of the proposals

The **upgrading and improvement interventions of ecosystem functions** , include projects that will help **to the gradual rectification process of vegetation** and improve the **functions of soil conservation and utilization of water,** in an **ecosystem degraded** by grazing and fires and **the restrictions of bioclimate** .

Ecosystem management goals are more likely to be achieved if all interventions for ecosystem restoration are implemented with respect to nature and local identity. The proposals for various interventions reflect a conception of respect to the local ecosystem, thus projects are suited to space, place, society and tradition, (not major interventions, not planting invasive species, or even foreign to the ecosystem). These measures take into account local traditions and structures, therefore they do not jeopardize the real goal of **ecological sustainability.**

In particular, the proposed projects will target on the best possible **use of local resources,** taking into account the **consent and support of the local community,** plus the dynamic of primary sector production (agriculture). Through the management proposals, it will be ensured that relevant local organizations will participate, to some extent, in the planning processes.

Further aim of the proposals is to build effective **partnership relationships** and generate **synergies with other relevant local initiatives** (cultural, economic and ecological).

6.2 Intervention Capabilities

From the analysis of various aspects of the region, come out the advantages and drawbacks of the interventions, concerning the existing ecological balance . Proposed interventions will be implemented in areas with **Limestone** , usually **rocky** substrate. On the other hand, most of **Slate** substrate lands are privately owned and the potential of such areas is fulfilled by cultivation.

Also, for the investigation of potential intervention should be taken into account **physical limitations** and even some **social - economic constraints** .

The basic approach to the conservation of the landscape can be considered as an advantage of intervention strategy, since the landscape is not 'damaged', so it may gradually "recover." Road structure is compatible with the landscape and technical elements are indicated in minimum scale.

Agricultural activities are implemented with traditional practices, for instance old paths and animals are used for the transport of products.

A crucial clue for the development of the proposed projects are the small groups of shrubs, scattered around the island. It is estimated that these groups should be protected, therefore they are indicated as "spotlight sites" for intervention. As a result, protection of groups of scrubs is a beneficial impact of the proposed strategy.

Another important element that inextricably linked with the proposed procedures is the possibility of recovery and reconstruction of old terraces, utilizing the relevant experience and expertise of residents.

Based on the same logic, the use of existing underground - collector - water tanks, after reconstruction, would be beneficial, thus these constructions are perfectly adapted to the environment and can facilitate the watering of plants. In addition, due to the proximity, the

use of existing underground - collector - water tanks minimizes the transportation costs of the project.

6.3 Soil and water management

6.3.1 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. Stone terraces mainly occur in areas with intense summer drought problems, in corroded and unsuitable for cultivation lands, and also in deep sloping lands with acute problems and grooved surface erosions. Often stone terraces were the boundaries of land ownership. In the frame of desertification and rural land abandonment stone terraces have been neglected and slowly destroyed. Their preservation as cultural piece of art and also as a result of human endeavor for effective use of inaccessible and uncultivated fields, allowed the inhabitants of mountainous and island countryside to live and thrive in their place. Consequently, preservation of stone terraces is crucial, as they are regarded not only part of tradition and cultural heritage, but **maximum expression of culture** .

The conversion of corroded and sloping surfaces into cultivated terraces, or creation of territories suitable for upgrading vegetation, includes the following tasks:

1.Definition of the construction terrace line, avoiding existing plants,

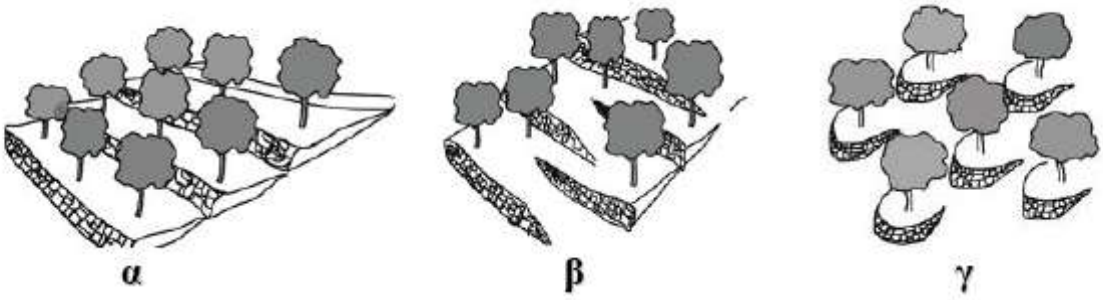
2. Cleaning of stones,

3. Construction of stone terrace and

4.Enrichment with soil behind the formed terrace.

The manufacturing of terrains usually occurs in winter, whereas the soil is soft. The choice of site development and configuration of stone terraces , that aim for creating ground levels of cultivation, is based on the intensity and the erosive force of rainfall, the suitability of spatial position for certain cultivation crops, slopes and finally, the need for safe drainage of rainwater, in order to prevent fluids. If direct draining to the nearest stream is not possible, stone grooves are created, following crossed direction, at the overall surface of the terraces, without destroying crops, until a proper way is found that leads water to a stream. Then, with appropriate signs on the ground (e.g upright poles height 0,60 - 0,70 m, straightened) the surface becomes flat.

The basic types of terraces: a) parallels b) successive c) pockets



The excavation of the foundation is usually done by digging with hoeing tools. Throughout the excavation uniform layers emerge called "shirts". Soils with strong inclination require

many "shirts" to be exported. Excavation must reach the solid ground, rocky usually, which is often difficult. If the excavation is not applied elaborately, the whole structure is in danger, because the soil must receive the weight of the stone terraces. Imperfections have adverse impacts, associated with erosion and moisture, hence the stability of the stone terraces. The base of a stone terrace is formed flat with **slight inclination 3-7%,** due slope of the upstream terrace. The thickness of base is usually 0,60 - 0,80 m, which allows the use of larger stones, without breaking them further.

The task begins from the base of the slopes, with the construction of the first collector groove and at its end point the first stone is founded. After that, far apart one meter from the second stone, the next collector groove is created, which receives the outflow of water. These collector grooves, with a system of stone channels, lead the outflow of water into adjacent streams, where small stone - clay dams placed in succession, prevent floods.

These projects are very crucial for Greek warm and dry places, but unfortunately are not often implemented, only occasionally. Practically, stone terraces is a human intervention that perpetuate water recycling and maximize water utilization, compatible with natural processes.

In selected sites, where stone terraces are bound to be created, can be added an amount of soil, transferred from another nearby location.

6.3.2 Water collection and storage

Water management has always been the major issue in the Cyclades, where a water shortage occurs, because of insufficiency of aquifers, salinization, low rainfall and bad management practices, particularly in recent years.

A drinkable water network has been constructed just 30 years ago, in Amorgos. In Katapola, after the construction of two new wells in the 90s and despite the construction of an aquifer enrichment dam, the pumpings are more than the compensation ability of the aquifers. This fact results to a gradual salinization, the danger of being permanent not excluded. The dam was constructed in 2001, at the location “Andiadenes’. Its capacity of 110.000 cubic meters does not cover irrigation and drinking needs but only aquifer enrichment.

The traditional way of rainfall collecting still remains the collection in rainfall reservoirs. Even in sites of steep inclination, like the Mount Pr.Elias, small underground cisterns covered by large stones have been observed. Another way of water management is to build small stone dams along some major streams in order to enrich aquifers.

Any attempt for ecosystem management should include a way to collect and store water, which will partly be used for plantings irrigation. In addition, the collected water can be used for livestock drinking.

The ways of water collection and storage could be:

- Tanks that collect and store water from springs or seasonal streams
- Open built pits
- Closed pits
- Well-cisterns
- Cisterns

Tanks are usually rectangular constructions coated with plaster. The Open pits are built by stones in places where springs occur and the substrate is relatively sealed, for example in the site ‘Terlaki’. The closed pits are like the former ones, but with a dome roof made by

stones or concrete. In Amorgos examples of such practices are found in Kato Lakos, Chora in 'Arkesini' and in the Milies path.
The well-cisterns are pear-shaped wells. They are constructed partially over bedrock and collect both rainfall and high groundwater. In Amorgos examples of such practices are found in 'Distrata' and 'Asfontylitis'. The cisterns are similar structures, rectangular, domed and with one or more intakes. Characterized by stone-paved surrounding. Examples are found in Pigadia, Chora and at 'Ano Potamos'.

6.4 Management measures

6.4.1 Grazing

Grazing is a basic land use in Amorgos. At the same time, overgrazing is a factor degrading the ecosystem. Grazing animals eat the green shoots and leaves, therefore inhibiting vegetation growth.
One grazing management system that could be applied, is the rotational grazing of selected areas. This system can help in ecosystem recovery, without income losses for shepherds.
For this reason, a campaign is necessary to contact and inform the local population about the Project. The aim is for them to participate as this Project directly affects them. The Project would be declared to recover ecosystem and that regulated grazing will come back in these areas.

6.4.2 Fencing

The areas managed for ecosystem recovery should be fenced to prevent grazing animals and humans to enter. The fencing types can be:

- A simple iron mesh 10x10 cm.
- Iron mesh with iron rods
- Traditional fence with stones (stone wall) with mounting and fixing spiny brushwood on top.

6.4.3. Seeding or planting new plants

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:

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

For the above reasons species that can be selected are:

1. the Valonia Oak (Quercus ithaburensis ssp. macrolepis),
2. the Holm Oak (Quercus ilex),
3. the cypress (Cupressus sempervirens horizontalis),
4. the carob (Ceratonia siliqua),
5. the Kermes Oak (Quercus coccifera),

6. the yellow-wood (Rhamnus alaternus),
7. the 'kokorevythia' (Pistacia terebinthus),
8. the mastic tree (Pistacia lentiscus) and
9. the Phoenicean juniper (Juniperus phoenicea).

The species are presented below. Species 1 to 4 are trees, whereas the rest 5 to 9 are shrubs.

The cypress should be used as little as possible in order not to alter the natural landscape. The carob, mastic tree and phoenicean juniper are suitable for the Southern Part of the Island and Low altitudes. The Kermes oak, the Holm Oak, the yellow-wood, the 'kokorevythia' are suitable for the Northern and Central Part and higher altitudes. The Valonia Oak can be used in shale and the best micro-locations.

SPECIES PRESENTATION

The **Valonian Oak** (Quercus ithaburensis ssp. macrolepis) is semi-evergreen tree up to 15m. Very Wide crown and large cups and acorns. Thermophilic species. Resistant to dry, calcareous soils and winds. It is a native Species in the Cyclades and Amorgos.

The **cypress** (Cupressus sempervirens horizontalis) is a conifer tree, evergreen, pyramidal spreaded crown. Develops an impressive form with dark green foliage. Resistant to heat, drought and poor soils. Planted in Amorgos with very good results.

The **Holm Oak** (Quercus ilex) is an evergreen sclerophyllus tree sclerophyllic. The fruit is acorn. Resistant to poor Soils, drought and winds. Planted in cities. Native to Amorgos.

The **carob** (Ceratonia siliqua) is an evergreen tree 10-12m high with relatively spherical crown. Leaves leathery, oval, dark green. Produces a hard, brownish fruit with many uses. Resistant to drought and air pollution. It withstands poor soils.

The **Kermes Oak** (Quercus coccifera) is an evergreen shrub usually up to 6m. Sometimes can grow up and become a tree. Leaves hard, small, leathery, spiny. Fruit an acorn. Resistant to all adverse conditions. Native throughout Greece, as well as in Amorgos.

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

The **kokorevythia** (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.

The **mastic Tree** (Pistacia lentiscus) is an evergreen shrub with characteristic resin odor. Native to S. Amorgos, resistant to adverse climatic conditions. Does not produce mastic. This only occurs for a variety cultivated in Chios Island.

The **Phoenicean juniper** (Juniperus phoenicea) is an evergreen coniferous shrub. The foliage resembles cypress. Fruit reddish brown resinous. Native to Amorgos.

Plantings can be done using pot plants. The planting pit is small (a hole) and will be done only in favourable micro-conditions. In terraced beds, soil is going to be added and then the seedlings are going to be planted. Seeding has been done experimentaly for Valonia oak and carob. This method is not excluded in the case of Amorgos.

6.4.4. Water use

The use of water refers to the drip irrigation of new plants, for a period of 2-3 years after planting. The water will come from areas of collection and storage.
Plants should be watered during the dry season (June-September) for two years since planting. The number of irrigations (about 10) may change depending on climatic conditions. 63mm polyethylene pipes will carry water from the source. The latter will deliver to 40mm pipes vertical to contour lines, every 200m. These will deliver to 16mm pipes, 100m. long. Opening the watering valves will be done manually.

6.4.5. Other Management Actions

The management for ecosystem recovery should include other necessary actions:
1. Protecting against fire
2. Follow up (monitoring)
3. Pruning and highering some of the existing kernel oaks
4. Establishment of nursery

Fire protection will be a task performed by the residents and the Authorities of the Island. In the framework of this project, anti-fire hydrants could be constructed and Reservoirs supplied with the appropriate link for the corresponding firefighting vehicles.
Monitoring of the course of project activities is needed to be done. Also, a review and evaluation of measures, the take of correction actions and obtain statistical data for future use. Monitoring can be covered by the Project Consultants.
Actions for shrub highering include pruning individuals at lower branches so that clear stems are obvious and branches are high enough to avoid grazing. This creates a better soil microclimate and favourable conditions around the shrub.
If necessary, a Nursery may be constructed in order to produce the seedlings in Amorgos. The Nursery requires the existence of a flat area with available water.

7. COST FACTORS

The economic approach of the proposed interventions is associated with the 'scenarios', the solutions that will be chosen for the implementation of the proposals as appropriate, ie in each selected area.
However, the factors of cost of operations can be analyzed as follows:

1. **Supply and transport of plants from other regions or from local producers**
   The cost of planting material depends on where you will be supplying plant and expenditure on transport.
2. **Creating infrastructure for planting**
   The surface on which plantings will be done and how to become more suitable for the support and development of plants (soil moving, boring pits etc)
3. **Planting, plant maintenance (planting, weeding, forming pits, watering)**
   The classic maintenance of plants bear the cost of watering because of the necessity of water supply, availability of in situ project and how watering during the long summer season.
4. **Construction / reconstruction of terraces**
   Planting in selected terraces will demand terraces to be built from scratch or reconstructed if there are abandoned.

5. Construction/repair/improvement of roads, access paths

For all works, access is necessary for materials and Project staff. Costs will exist depending on the use of vehicles or animals and depending on the existence of roads or not.

6. Construction of underground reservoirs

To ensure water availability the project needs to adapt to the traditional sustainable practices of water collection and storage. Any existing underground reservoir can be used and even new ones will need to be built. Relatively expensive to build new ones, but this ensures the relative self-sufficiency of maintenance.

7. Construction of irrigation channels

In places where topographic conditions occur, a network of irrigation channels could be constructed that will create water ways towards or from water tanks.

8. Fencing construction

The fencing of intervention areas will be essential for protecting plantings from grazing. Besides the significant cost of initial construction, there is also the cost of maintenance.

8. PHOTOS

1. The site of specific interest in Langada.

2. The same site where shallow soil and low shrub cover is shown.

3. Stone terracing

4. Leaf and fruit of Amorgos Valonia oak.

5. Underground water reservoir getting water from the spring ‘Drys’ near Langada

6. Carob and kokorevythia

7. Depositing debris in the site of special interest Chora.

8. Holm oakliving among the rocks near the summit Pr.Elias

9. The site of special interest at Kato Kampos, with vegetation consisting of Phoenicean juniper (Juniperus phoenicea) and mastic tree (Pistacia lentiscus).

9. Sampling spreadsheets

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