

Furnas Protected Landscape
São Miguel Island Natural Park

Furnas, Landscape Laboratory

www.furnaslandlab.azores.gov.pt



Furnas, São Miguel
2015

Title:

Furnas, Landscape Laboratory

Project for the Ecological and Landscape Restoration of Furnas Lake Watershed

Authors:

Miguel Gomes Caetano Ferreira

Malgorzata Pietrzak

Filipe Teixeira

Translated by:

Nanci L. S. Paiva

Update of Portugal's 2012 National Landscape Award application file.

Furnas Protected Landscape. São Miguel's Island Natural Park

Furnas Landscape Laboratory (Furnas LandLab)

Cover image source: Fernando Guerra Fotografia de Arquitectura; Reginaldo Andrade.

Furnas Landscape elements (pastureland and agricultural areas, forestland, architectural patrimony, lake, *Furnas LandLab* intervened areas).

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Projet Founder and Manager (2007-2015) contacts:

miguel.gc.ferreira@azores.gov.pt

Skype: miguelferreira-azorian

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CHAPTER 1. FURNAS LANDSCAPE LABORATORY- CONTEXT

Furnas Landscape Laboratory is part of Furnas Protected Landscape, at São Miguel Island Natural Park.¹

GEOGRAPHIC BACKGROUND ²



Fig. 1. São Miguel's Natural Park Map, Furnas protected Landscape. Source: São Miguel's Natural Park.

The Azores archipelago is located in the North Atlantic Ocean, limited by the parallels 36°55'43'' and 39°43'02'' N and by the meridians 24°46'15'' and 31°16'02'' W. Its oceanic location turns into the deep geographical isolation of the Region (insularity), as it is, roughly, 1500 km distant from the European Continent and over 2500 km distant from North America. The archipelago, composed by nine islands and several islets assembled in three distinct groups (Western, Central and Oriental), extends along a WNW-ESSE orientation that is due to the regional tectonic. The maximum range between the islands exceeds 340 nautical miles (630 km), the distance that separates Corvo Island from Santa Maria Island.

The Azorean area (2334 km²) represents 2,6% of the national territory (88797 km²). However, there is a significant size range between the islands: the biggest islands, São Miguel (745,8 km²), Pico (448,4 km²) and Terceira (403,4 km²), represent 70% of the total area; São Jorge (245,9 km²), Faial (173,8 km²) and Flores (141,6 km²) have an intermediate size; Santa Maria (97,1 km²), Graciosa (61,2 km²) and Corvo (17,2 km²) are the smallest ones. According to UNESCO criteria, which define "small islands" as insular surfaces with less than 1000 km² area, all the Azorean islands are included in this classification.³

Furnas Protected Landscape is situated in the municipality of Povoação at São Miguel Island. Furnas village is the urban area integrated in the landscape.

PHYSICAL CHARACTERIZATION

TOPOGRAPHY

The islands emerged abruptly from the ocean, showing a great vertical development. The mountainous interior is carved by profound ravines that tear the hills till the sea-level. The flat areas are undersized, without significant relevance in the insular territory. Furnas Protected Landscape has an accentuated and uneven topography, which is easily understood by its volcanic-geologic context.

VULCANOLOGY AND GEOLOGY

The Azores archipelago is located over the triple junction of three tectonic plates: American, Eurasian and African. The complex interaction of these plates results in the Mid-Atlantic Ridge. Several fractures or fault areas and the Azores-Gibraltar Transform Fault, originated the Azores Platform. The geotectonic complexity of the Azores Platform results in a volcanic and seismically active archipelago.

The island of São Miguel was formed by several volcanoes. Within this context, it emerged from the deep ocean over 4 million years ago⁴ in the East area, with the formation of the Nordeste Volcano,

¹ Regional Legislative Decree 19/2008/A

² Acompanhar com Anexo 1

³ Reports on the state of the Territory Management in Azores ...page 9

⁴ See table in Annex 1 source: Geographical position, area, age and elevation of the Macaronesian archipelagoes. Hughes & Malmqvist.

where the volcanic complex of Furnas is located. It was formed by the collapsed calderas and other volcanic structures such as the trachytic domes, cinder cones or the fumarole fields, which currently characterize the Furnas volcano, until a new eruption adds another element. The composition of Furnas Volcanic Complex is essentially trachytic, with the volcanic activity responsible by its formation being predominantly of the explosive type, sometimes complemented by the installation of domes and very thick drained lava material. The top of the central volcano of Furnas is at a maximum altitude of 804 m and presents a complex of calderas, resulting from a sequence of major collapse episodes. An oldest caldera with approximately 7x5 km and walls that in some sectors go up to 290 m high, has in its interior a more recent caldera with a roughly round shape and approximate diameter of 5 km. The central volcano of Furnas started its formation around 100000 years ago and most of the outcrops occurred after a lava drain dated of 48000 ± 4000 years. In the last 5000 years at least ten explosive eruptions occurred in this volcano, two of which accompanied by the extrusion of trachytic domes. The last one occurred in 1630. Furnas volcano is considered as potentially active. There are, in its area, several geological structures namely the collapse caldera, intra-caldera volcanic cones, trachytic domes, tuff rings, pumice materials, fumaroles, thermal springs and fossil coal fields.

CLIMATE

The Azorean meteorological conditions are determined by the position, orientation, development and intensity of the Azores Anticyclone, which controls the atmospheric circulation in this region of the planet. The climate in the archipelago is characterized by high levels of humidity in the air, mild temperatures, low rates of insolation, regular and abundant rains and strong winds. The four seasons of the year are distinct, typical of temperate climates. Therefore, winters are rainy with mild temperatures and, summers do not have high temperatures but high relative humidity. The average temperatures are 13°C in the winter and 24°C in the summer. The islands benefit from the proximity of a warm current coming from the Gulf Stream that moderates the air temperature.

WATER RESOURCES AND FURNAS LAKE

Numerous thermal and mineral water springs are spread by many of the volcanic regions in the terrestrial globe. These may occur as an expression of hydrothermal systems activity or as a result of volcanic eruptions, of determined duration. The volcanic origin of the Azores explains the occurrence of several springs of mineral water, mainly carbonated and thermal, spread out through almost all the archipelago, namely in the islands of São Miguel, Terceira, São Jorge, Pico, Faial, Graciosa and Flores. São Miguel being the richest one in these waters, particularly in the Eastern part, where there's one of the biggest spring areas in Europe – The Valley of Furnas⁵. The majority of the mineral and thermal water springs in Furnas volcano is related to a tectonic alignment with a W-E orientation. Near the village, it is possible to see several springs of mineral carbonated water and thermal water, as well as hyper thermal water discharges from fumaroles. There are also a fumarole field near the North side of the Lake and another one nearby the shore of *Ribeira dos Tambores*. Furnas Lake is located in the East part of the Furnas Caldera, at an altitude of 280 meters. With 2025m maximum length and 1600m wide, this lacustrine ecosystem has an area of 1,87km² and is the shallowest body of water (15m) when compared to the other lakes of São Miguel located inside volcanic calderas (Sete Cidades and Fogo Lakes). The volume of stored water in this lake is estimated to be 14 334 408 m³ ⁶.

⁵ In the Mouth of the Volcano, guide to know Furnas Vallley...page 64

⁶ In the Mouth of the Volcano, guide to know Furnas Vallley...page 42

BIOTIC FACTORS

From a biogeographical perspective, the Azores belong to Macaronesia, the Greek designation (makarón neseu) for “fortunate islands”, given to the group of North Atlantic archipelagos with biological affinities, resultant from their colonization process. Besides the Azores, this group includes the archipelagos of Madeira, Cape Verde and Canary Islands (28 islands in total), comprised between the latitudes 15° and 40° N and the longitudes 13° and 31° W. The climatic, geographical and geological conditions provide a large variety of biotopes, ecosystems and landscapes, granting a high number of habitats as well as a high terrestrial and marine biodiversity. Together, these two environments present about 450 endemic taxa⁷.

FAUNA⁸

The geographical position and insular nature provide the Azores with a great richness of marine fauna. In fact, the Azorean sea shelters more than 500 fish species⁹, representing not only an ecological but also economical richness. The island factor endorsed the appearance and development of new inland species (through natural evolution). In some cases, due to anthropic pressure (especially during the last century) some of these species were almost lost, decreasing its biogeographical distribution, like Priolo (*Pyrrhula murina*).

FLORA

“The paradise island concept exists for a long time in the imagination of the European Man. Eventually it is due to the sensation of isolation and security offered by islands geographical dimension, to be far from everything, including tensions and concerns. The luxurious and exotic vegetation that they usually possess¹⁰ is also included in this conceptual myth. The ecological concept of an island is naturally applied. In a pre-glacier age, the islands’ original flora shared a large number of species with the European Continent which have reached the archipelago by air or through seed transport agents by stages, from island to island that once proliferated in the North Atlantic. After the Würm last glacier age, the Azores archipelago lost this connection with the European Continent. Because of the islands existing flora wasn’t affected by the glaciation, it allowed the existence of nowadays real living fossils, revealing the great importance of the botanic heritage. Thus, at the time of its discovery by the Portuguese navigators, the archipelago had high levels of endemism and native species shared with the other islands of Macaronesia. Due to economic and cultural factors, these species lost their extension area because of over exploration, and they were gradually replaced by imported vegetation. Some of the new exotic species became invasive.

⁷ Guia parque natural de S. Miguel...page 31

⁸ Vêr anexo Fauna e Flora

⁹ Guia parque natural de S. Miguel...page 37

¹⁰ DIAS, Eduardo – Açores. In SILVA, Joaquim Sande – Árvores e Florestas de Portugal: Açores e Madeira, a Floresta das ilhas...page 31

HUMAN FACTORS

HISTORY AND CULTURE

Discovered in 1427 by Diogo Silves, the archipelago of Azores presented islands full of birds and dense vegetation, to the view of the mainlanders. It was the beginning of a gradual discovery of the nine islands of the archipelago and its occupation and settlement, carried out by Europeans in the 15th century. The settlement in Furnas Valley started in 1637, near the current village center, upon the Jesuits arrival, which started the agricultural transformation of the land with the support of colonists. Formally classified as parish in 1791, Furnas has currently 1800 inhabitants, a number that doubles in the summer. The main economic activities include dairy and beef farming, fruit production and forestry, owing this to its microclimate, fertile soil and humidity, along with tourism, hotels and restaurants. With a unique blend of natural and cultural values, Furnas appraisal as a holiday resort dates back to the 18th century, visited by locals and foreigners, attracted by the magnificent landscapes, the diversity and richness of vegetation, the variety of thermal and mineral springs, the geothermal fumaroles, as well as the gastronomy¹¹.

MATERIAL AND IMATERIAL HERITAGE

Furnas Valley shows evidence of significant cultural values, not only from the material records perspective but also for its traditions. Standing out, the architectural and landscape pieces from the economic era of the orange production, as well as the erudite contribution of 19th century's personalities such as the Canto family¹², with the Garden-woodland in the Lake Margins and the Chapel of N^a S^a das Vitórias. The Terra Nostra and D. Beatriz do Canto Parks are also records with high landscape quality. The religious traditions are important records of this community heritage, with the patron saint and the Holy Ghost celebrations, always associated to thanksgiving for the numerous natural calamities that the population suffered throughout the centuries. The gastronomy is a world reference and an example of the practical sense of the Azorean people that seizes what Nature offers for free, standing out the Stew – *Cozido das Furnas* – cooked in the calderas.

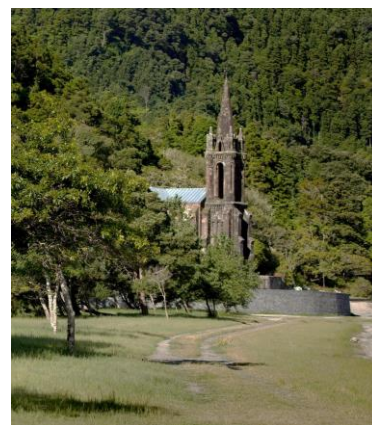


Fig. 2. Nª Sª das Vitórias Chapel by Furnas Lake Margins.

Source: Fernando Guerra fotografia de arquitectura.

ECONOMIC ACTIVITIES AND LAND USE

The Azorean economic history is described by the phenomenon of “colonial monoculture for export purposes”. Since the beginning of the settlement, the cycles of agriculture specialism (grains, woad, orange and mixed farming) have been succeeded by intermediate periods of crisis and socioeconomic disrupts resulting from the soil exhaustion, plagues and other causes such as commercial transformations. The exploration cycles left profound marks in the islands landscape and have dictated an abusive use of natural resources. The intensive cattle farming activity had its development after the Second World War, and it's currently the leading economic activity and the sustenance of the regional economy. The increase of intensive pastures, the large increase of cattle heads and industrial factories for milk transformation, took the place of other agricultural productions (horticulture and fruticulture), leading this activity to a monoculture with all the inherent consequences of depending on one industry alone. With the growth of tourism, a new diversification of the economic basis is expected, making use of all the intrinsic potential of a Region where nature is still preserved., when compared to other places where the burden over the environment is higher. This is the framework in which Furnas Protected Landscape lies. This is an area with a great

¹¹ Proposal for Classification of Protected Landscape of Furnas...page 23

¹² See: *O desenho do território e a construção da paisagem na ilha de S. Miguel, Açores, na segunda metade do século XIX, através de um dos seus protagonistas*

potential for tourism, where the combination of human factors, such as history, culture and heritage, with the physical factors (like geological and volcanic legacy), become an added value to build sustainable and nature tourism models. In Furnas, some of the former economic cycles landscape heritage, such as the orange cycle, has been lost and, nowadays, orange groves are a rarity. Also the beautiful mosaic of apple orchards in Furnas Valley, with dozens of varieties, has lost its preponderance to pastureland and production forest stands (mainly *Cryptomeria*) or even to invasive vegetation woods.

ROAD NETWORK ¹³

Furnas Landscape Laboratory (*Furnas LandLab*) is located at Povoação, and it's served by the main and secondary road networks of São Miguel Island and by the Furnas LandLab's accessibility network that connects it with the island roads and it's a structural element of internal communication. Therefore, the *LandLab* connects to Furnas parish through the Regional Road 1-1, which also connects it directly to the center of the municipality. The same roadway links with the neighbor municipality of Vila Franca do Campo, which allows the access to the south freeway, the structural roadway to the city of Ponta Delgada, the main urban center of the island. The access to the north side of the island and to the north freeway is made by the Regional Road 1-2, going through Achada das Furnas

LANDSCAPE CHARACTER

The Azorean Landscape is the result of a five century dynamic relation between human activity and natural environment. The volcanic activity, whose periodic events cause profound personal drama to the habitants, was the core element in the landscapes definition and its rich geological legacy. The human intervention in the Azorean landscape has been determined by historical events where the insularity factor delayed the technological and cultural evolution in some periods and, in other periods, brought cosmopolitanism.¹⁴ Throughout the centuries, the major changes were based on long economic cycles with prevailing cultures such as grain, woad, vineyard, tea, pineapple, *Cryptomeria japonica* or pastures¹⁵. More recently, fast and intense transformations such as the infrastructure improvement and the urban sprawl of the main centers, as well as the strong investment in the promotion and advertisement of the archipelago and the increase of tourism as an economic activity, changed the social, cultural and economic dynamics, which interact directly or indirectly with the landscape, arising problems such as the loss of population in some of the islands and, in consequence, the abandonment of agricultural areas. Furnas Protected Landscape area is not apart from these new realities, an issue that will be discussed further on.

The morphology of São Miguel island landscape, determined by its volcanic character and conditioned by the action of natural elements, finds in its topography the most characteristic shapes and the main factor of diversity and complexity. Old collapsed craters that transformed into numerous lakes such as Sete Cidades, Fogo or Furnas, or opened to the sea, as happened in the Islet of Vila Franca do Campo and in the large declivity of Povoação (as a result of the old caldera degradation)¹⁶. Furnas Landscape Laboratory is placed in a landscape with a blend of natural and cultural features that distinguish it from the other regional landscapes and define its uniqueness at national and international level.¹⁷

¹³ Ver anexo 1 mapa

¹⁴ See: MONICA, Maria Filomena – Os Cantos...

¹⁵ Livro das Paisagens...page 31

¹⁶ SIARAM

¹⁷ Proposal for Classification of Protected Landscape of Furnas...page 19

LANDSCAPE UNITS

At Furnas Protected Landscape 3 Landscape units¹⁸ have been identified:

1st Landscape Unit of Furnas Lake:

The wide water extension complemented by the calderas and fumaroles to the North, which centralize this landscape composition and shapes its high potential for recreation and leisure. Along the Lake shores, the human activities of manufacture and leisure occupy a narrow strip between the lake and the abrupt hillsides that limit it. Here one can find important cultural values that point out this landscapes evolution and represent important assets of the 19th century landscape art heritage: the woods of José do Canto and Grená. Posteriorly, the construction of summer residences with gardens took place at these shores. This unit includes the highlands of *Achada das Furnas*.

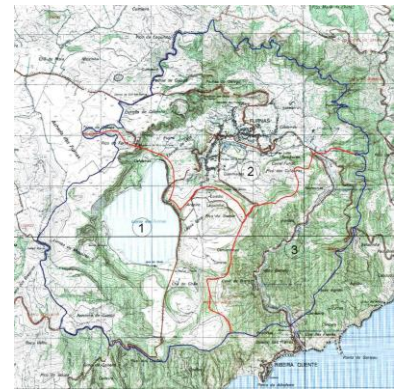


Fig. 3. Landscape Units. Source: Proposta de Paisagem Protegida

2nd Landscape Unit of Furnas Village: The deep valley of fertile and sheltered lands, along with the assortment of fumaroles, calderas, springs and streams, were the initial pull factor, enhancing the currently coexisting usages and activities. This subunit is characterized by a main nucleus composed by the linear settlement, the agricultural irrigated areas and orchards, the parks and gardens and also the thermal area. It is possible to understand the Furnas Landscape' evolution through the settlement, since the colonists and Jesuits' agricultural activities, followed by the private owners' orchards and forests and, finally, the leisure landscape related to private residences, gardens and gardened woodlands, illustrative of the 19th century landscape art. The different usages in this central core allow the delimitation of homogeneous areas, whose interrelation and articulation provide a unique landscape diversity, unmatched at the Island of S. Miguel. The parks and gardens intercross with yam cultivation and hedged partitioning, along the streams and occupying cells bounded by the typical linear settlement of this locality. In addition to this central diversity, there's the thermal landscape characterized by fumaroles and calderas, some buildings for private and public baths and their respective gardens.

3rd Landscape Unit of Ribeira Quente Valley: This unit is characterized by its highly irregular topography, with practically no human population or agricultural occupation. With a heavily conditioned accessibility, this area is mainly occupied by forest production species and traces of endemic vegetation. However, it has a high landscape and environmental interest, owing to the possibility to establish ecological corridors with the hillsides of the Lake and Furnas Village as well as for their high aesthetical interest. The road along the valley of Ribeira Quente stands out as its lush vegetation and waterfalls symbolize important and valuable landscape elements.

With 3150 ha, Furnas Protected Landscape area is located inside a caldera resultant from the structural collapse of one of the most active volcanoes in São Miguel, the Furnas volcano. This caldera singular geomorphology and hydrology led to the classification of this area as protected landscape. Furnas Lake and secondary volcanism phenomena, such as steaming fumarole fields and thermal water springs, stand out of this landscape.

¹⁸ Annex 4. map

LANDSCAPE PROBLEMS: DEGRADATION

The aesthetical degradation of Furnas Protected Landscape was mainly caused by the intensive economic practices, sustained in the monoculture production system, leading to the proliferation of pastures plus the intensive use of *Cryptomeria japonica*. At the ecological level, the degradation can be seen through the loss of habitats for Macaronesia native vegetation and Azorean endemism caused by the pressure of imported exotic vegetation, especially the invasive one.

Dairy and beef farms - Furnas Lake Eutrophication

The change of paradigm for agricultural practices with the promotion of the cattle monoculture had a negative impact in the landscape as the intensive pastures were established through the devastation of native forests and the replacement of fruit orchards. By changing the landscape and its topography, the promoters of cattle farming (mostly dairy) undertook a damaging process for the water quality, due to the excessive use of chemical fertilizers that drained to the lakes, contributing to the beginning of the unnatural eutrophication process.¹⁹ Livestock excess in these areas caused an extreme pressure to the soil and, in general, the bad agricultural practices were common. These unfavorable attitudes towards the environment, led manure discharges into the lake tributaries. Nevertheless, the lake and its water tributaries weren't the only affected by this semi-intensive farming practice. The need to create adequate conditions for cattle farming has demanded the natural topography transformation through the intensive soil leveling and plowing, which caused a severe problem of soil erosion. Eroded soil was washed away and sediment in the lake, significantly reducing its depth.

From Gardens to Nature – Exotic Flora species became invasive

The process of invasion varies according to several factors, namely the invasive species biology and invaded ecosystem features, as well as the interactions with the native species. Most of the invasions occur in habitats with human intervention; particularly those subjected to profound disruptions, but this may only reflect an easier transport of species to these places²⁰. As for Furnas, the proliferation of private gardens and importation of exotic species during a period of economic prosperity, were the main cause for the spread of some of the imported species that became invasive in the landscape.

Forest production and the biodiversity adverse monoculture

Forestry production with the vast *Cryptomeria japonica* stands, led to the diminishment of the Azorean forests richness, as it is evident at Furnas Landscape. This is a huge loss, at the aesthetical, but also economic level, by limiting business opportunities to forestry producers. From an ecological perspective, the proliferation of these production woods, along with the forest areas dominated by exotic invasive species, contribute to an enormous downfall of native and endemic species, which don't have a place in these areas. However, the endemic and native species could play an important role in the relation between economy (production) and ecology (protection), as well as for the development of areas for species association that would promote flora and fauna biodiversity.

¹⁹ When the lakes are disturbed by the anthropogenic action, the biological production of these systems is normally altered, tending towards a state named as eutrophic. The eutrophication of a lake is a process that can occur naturally by the accumulation of organic matter in the bottom and consequent decrease of water volume, a process that occurs during a long period of time and can be measured at the geological scale. However, Man has been strongly accelerating this process through the artificial nutrient enrichment in these reservoirs or also by adding organic material. These systems eutrophication results in larger biological productivity of the lakes that, in general, translates in larger algae production and consequent increase of organic matter in the bottom of the lake.

In *In the mouth of the volcano...* page 41

²⁰ SILVA, Luís – Flora e Fauna Terrestre Invasora na Macaronésia...page 31

For some years now, the Azores Autonomous Region has made efforts to create territorial management instruments in the context of the National Policies for the Territorial Management²¹. The demarcation of the Regional Network of Protected Areas²² states the establishment of the Islands Natural Parks and the Protected Landscape Areas, including Furnas Landscape Laboratory which is supported by the Furnas Lake Watershed Management Plan²³. The quality of Furnas Landscape is defined through these legal instruments, allowing to protect and manage this rich landscape mosaic shaped by the relation between Man and Nature, both contributing for the creation of this Cultural Landscape. The Furnas Lake Watershed Management Plan is the territorial management mechanism that specifies the strategies, discussed in Chapter II, to find solutions for the landscape problems mentioned above. The actions for the landscape Protection and Management are discussed in Chapter 3.

²¹ *O Ordenamento do Território nos Açores: Políticas e Instrumentos...*

²² Regional Legislative Decree 15/2007/A

²³ Regional Regulatory Decree 2/2005/A

CHAPTER 2 SOLUTIONS FOR THE RESTORATION OF A DEGRADED LANDSCAPE. CONCEPTS AND OBJECTIVES

FURNAS LAKE WATERSHED MANAGEMENT PLAN (POBHLF)

The increasing ecological awareness and visible landscape degradation, both aesthetical and ecological, in the lake's water and surrounding areas of such an emblematic and touristic place, was the motor for the establishment of strict legislation. The main goal for Furnas Lake Watershed Management Plan is to restore the lake's water quality, complying with the European Water Framework Directive.

The Management Plan is a crucial instrument for the sustainable development at all levels: environmental, economic, social, cultural and aesthetic, with regard to the definition of rules and usage measures, soil occupation and transformation as well as the management of the geographical area, in a dynamic and integrated approach.

The Management Plan came into force in 2005, through the publication of the Regional Regulatory Decree number 2/2005/A of February 15th, and its formulation involved several entities: Regional Directorate for Territory Planning and Water Resources, Regional Secretariat for the Environment, the Water Institute and it also engaged a wide number of participants during the public discussion.

Throughout its implementation, several open days were organized to explain the project as well as the planned and ongoing actions, with explanatory guided tours through the restoring landscape, in order to inform and involve the local population. The publication of several articles and interviews to the media also aimed to disseminate the progress of the intervention. The involvement and awareness of local communities are a relevant issue, as established in the Decree of the European Landscape Convention, article 6, paragraph a) and article 5, paragraph c).

The Management Plan implementation has been materialized, since its publication, in a series of corrective and preventive actions that allow the compatibility of usages and activities such as environmental protection and promotion. The six main guidelines of the Management Plan²⁴ for all actions were:

- **Reduce the inflow of nutrients to the lake:** Fertilizers and manure from dairy and beef farms, as well as the eroded soil which accumulated in the lake's bottom were the most direct causes for Furnas Lake eutrophication.
- **Increase Biodiversity:** Monocultures on wide areas of semi-intensive pastureland and *Cryptomeria japonica* mono specific forests reflected the monotony and scarce diversity, not only in landscape terms but also at the ecological level, with low numbers of indigenous flora and fauna taxon.
- **Safeguard income sustainability:** The fragile local economy has been dependent on monocultures. The land acquisition and subsequent removal of cows and fertilizers from Furnas Lake Watershed, represents an opportunity as a showground to demonstrate sustainable alternative crops and activities for farmers' incomes.
- **Local Economy Diversification and Strengthening:** Furnas is a very rich area regarding its landscape, geology, tourism, gastronomy, history and culture. This richness provides a huge potential for its sustainable development and economic diversification, particularly in the tourism sector.

²⁴ Regional Regulatory Decree 2/2005/A

- **Promote the local values:** The numerous values of Furnas in environmental, ecological, social and cultural domains have been forgotten or neglected.
- **Minimize Geotechnical risks:** There have been problems in Furnas with unstable soils and heavy rainfalls, as well as its inherent seismic and volcanic activities.

FURNAS PROTECTED LANDSCAPE

Furnas Lake Watershed represents a significant part of the Protected Landscape Area included in São Miguel's Natural Park, which means that, in addition to the Management Plan, it is also covered by the Regional Legislative Decretal number 19/2008/A of July 8th. The legal regulation of Furnas Protected Landscape, such as the previous Management Plan, complies with the established in article 5, paragraph a) of the European Landscape Convention.

The project implemented in Furnas Lake Watershed has been accomplishing the management goals established by Furnas Protected Landscape legislation, namely through:

- Endorse a natural and cultural harmonious interaction, by protecting the landscape, traditional usages, construction practices as well as social and cultural events;
- Support the development of economic activities and living standards in harmony with nature and the preservation of local community traditions;
- Maintain and preserve the landscape diversity, as well as the flora and fauna species, habitats and ecosystems;
- Regulate usages and activities in order to minimize threats to the landscape stability;
- Encourage touristic and leisure activities in accordance with typologies and proportions that suit the biophysical features of the area;
- Promote scientific and educational activities that contribute for the population's well-being and develop a public support for environmental protection;
- Contribute to the local community development through the benefits generated by providing services and selling natural products.

LANDSCAPE LABORATORY

The first substantial step in the process of restoring the water quality, through the Management Plan implementation, was to acquire private land in the watershed with the purpose of converting the soil usage. Considering the advanced Lake eutrophication, about 300 hectares of agricultural and forest lands were purchased since 2007. These were the areas which by their location and dimensions constituted a larger risk of nutrient drainage to Furnas Lake, due to fertilizers and animal excrements misuse, the two major causes for the deterioration of the water quality. The negotiations for the land acquisition were conducted without any governmental expropriation or lawsuits, neither with the land owners or the renters. As a result, there has been a removal of about 500 cattle heads and a decrease of over 50% of the polluting pastureland.

Since the majority of the watershed lands are still private property, there have been fruitful conversations with the landowners to



Fig. 4. Map showing Furnas LandLab pastureland area, 2012.
Source: Furnas LandLab photo archive.

convert their intensive pastures into sustainable production and protection forests, including a considerable amount of native and broadleaf trees.

The establishment of the Management Plan and the availability of public lands (acquired in 2007) enabled the implementation of the landscape restoration project that took the course of, not only a project for the restoration of the water quality, but became a multifunctional and multi-sectorial project of landscape transformation and stimulation, involving people at the local, regional, national and international level.

Thereby, Furnas Landscape Laboratory (*Furnas LandLab*) was materialized, following the guidelines established by the Watershed Management Plan and by Furnas Protected Landscape Area. The quality of the landscape and sustainability in all its assumptions – ecological, economic, social, cultural and aesthetical – is the guiding paradigm.

A *LandLab* is the equivalent to technological parks, but devoted to Natural Sciences. Instead of laboratories inside a building, there are experimental plots along the landscape. The studies and experiments conducted outdoors include topics such as Silviculture, Agronomy, Fruit and horticulture production, Biology, Ecology, Bioengineering, Biotechnology, Environmental Psychology, Landscaping, Land Art and Tourism. The Landscape Laboratory concept is not new, there are already several examples of Landscape Laboratories functioning and generating knowledge in countries like Denmark (Sletten) or Sweden (Snogeholm and Alnarp), and others planned for Iceland, Norway and Germany.

Establishing *Furnas LandLab* allowed benefiting from the unique availability of such a wide contiguous area. The experiments that have been taking place in it enable the testing of sustainable activities, complementary or alternative to the current monocultures, helping to diversify the local or even regional economy, as the field trials allow the most skeptical people to see and believe in new solutions.

Furnas LandLab has been open to other institutions, public and private, to develop their experiments, in partnership. This drive for collaboration can be seen taking place in the numerous trials, degree thesis, research projects and partner plots, not only at the environmental level but also social and cultural (as discussed in the following chapter), as a result of a multitude of partnerships with public and private institutions, such as associations, universities and research centers, among others.

With the opening of new facilities of Furnas Monitoring and Research Centre (CMIF), the project for the Ecological and Landscape Restoration of Furnas Lake Watershed gained visibility and leveraged its power to disseminate and exchange information on the actions that have been carried out. Since its inauguration, on July 2011, the Centre has been playing an important role in translating scientific language to other forms of knowledge dissemination that captivate visitors to understand nature, through recreational and ecological restoration activities, in a continuously transforming landscape. CMIF shelters not only the management Centre and the project coordination team, but it is also the head office of São Miguel Island Natural Park.

CHAPTER 3. FROM PAPER TO ACTION

Regarding the landscape restoration and the implementation of *Furnas LandLab*, which aim to create a multifunctional forest landscape, numerous actions have been carried out:

LANDSCAPE DEPOLLUTION



Fig. 5 Examples of residues removed from the acquired pastureland. Source: Furnas LandLab photo archive.

The removal of numerous polluting waste was one of the first steps that were taken in the field. Tons of several kinds of waste have been removed, from the purchased farmlands, including abundant silage plastics and packages of pesticides, oils and chemical products, barbed wire and old scrap. The ecological and aesthetic degradation have reached such a state that dozens of tires or even whole vehicles were found inside the streams. The collected waste was segregated, according to different toxicity categories, and posteriorly sent to the appropriate waste treatment facilities.

INVASIVE FLORA CONTROL

The battle against invasive flora species is one of the key actions for a full landscape recovery. In the Azores, the native flora is now a small percentage of the existing flora diversity. The fact is that many of these species coexist harmoniously with man and landscape; however some have a strong invasive nature and end up dominating and degrading ecosystems and entire landscapes. Until a few years ago, some of these species were seen as the ex-libris of Azorean landscape, such as the hydrangea, that are able to spread from confined areas to occupy wide areas of abandoned pastureland and even native habitats.

At the Furnas Lake Watershed, the invasive flora was predominant in abandoned pastures, streams and erosion gullies. The most common being *Hedychium gardnerianum*, *Rubus ulmifolius*, *Leycesteria formosa*, *Gunnera tinctoria*, along with the arboreal species *Solanum mauritanium*, *Clethra arborea*, *Pittosporum undulatum* and *Acacia melanoxylon*.



Fig. 6. Erosion gorge, invaded by exotic species, before the restoration works. Abundant natural regeneration of *Gunnera tinctoria*, which was successfully removed and the area replanted with native flora.

Source: Furnas LandLab photo archive.

Since the beginning of the project, 146 ha of degraded pastures and woodlands have been submitted to invasive flora control. The eradication of invasive plants has been a time consuming process that requires repeated treatments, due to the abundant seedbank in the soil and its high dispersion rate caused by birds. Without this intervention, the invasive species would continue to thrive and subjugate other species, considerably reducing biodiversity by forming dense mono-specific stands.

PREVENTING SILTATION

The work presented below has been developed to prevent Lake siltation, one of the main causes for the lake eutrophication, that was aggravated in the last four to five decades, due to the farming mechanization.

EROSION GULLIES

The large erosion gullies at highlands are a result of the agricultural intensification, which triggered major clear-cuts of natural forest, land flattening and draining to create pastures. In Furnas, most of the land transformed into pastures used to have a natural hilly topography, which allowed the dispersion and accumulation of water through several depressions. Over the years, after the land leveling, and only with the often cattle trampled herbaceous cover, the water tended to concentrate in isolated least elevated paths. As a result, the herbaceous strata became eroded, forming the erosion gullies that reached hundreds of meters long by twenty meters wide and six meters deep.

Throughout the project, eight erosion gullies were intervened and restored, in an area over two hectares, where the erosion process has been ceased.



Fig. 7. Restoration of erosion gullies. During the early restoration works, where an endemic Azorean laurel (*Laurus azorica*) was covered with bramble bush (*Rubus ulmifolius*) and after the intervention works, with native shrubs planted. At the second example *Gunnera tinctoria* was removed allowing the planted and natural regenerated native species to thrive.

Source: Furnas LandLab photo archive.

NATURAL ENGINEERING

By using the trunks of cut down invasive trees (ex: *Pittosporum undulatum*), **water energy sinks** were built to reduce the water velocity inside the erosion gullies. The main purpose was to create a small dimension permeable barrier where the water percolates through, reducing its velocity and, therefore, diminishing its erosion power, without the risk of creating a dam effect. Upstream the erosion gullies, there were also installed, V-shape wooden structures that allow to diverge the water away from its accumulating spots.



Fig.8. Hydric energy sinks. Source: Furnas LandLab photo archive.

Other techniques of **natural engineering** have also been used, such as plantation of native herbaceous species typical of swampy areas, such as reeds (*Juncus effusus*), these will function permanently as the current sinks after its rotting, without the need for maintenance. As the reeds grow, they form small clumps of dense vegetation that not only disperse the water of torrential rains, but also retain it and filter solid material that may eventually be dragged from upstream spots.

NATIVE FLORA RESTITUTION

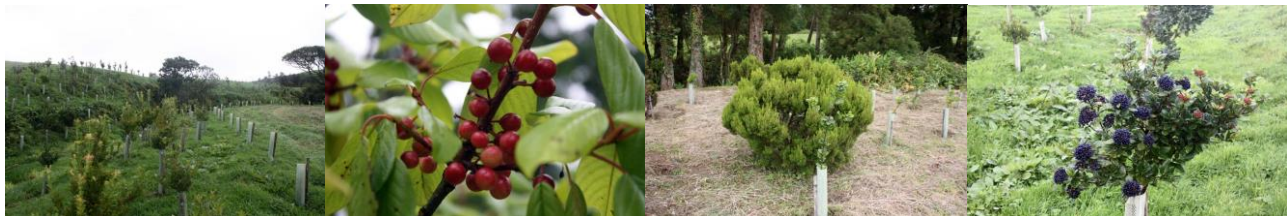


Fig. 9. Native flora reintroduced by the project, where the several species present abundant fructifications. Source: Furnas LandLab photo archive.

In order to halt the erosion in the active ravines of the intervened erosion gullies, it becomes necessary to cover the soil with a herbaceous layer as well as with shrubs and trees, which roots promote soil stabilization, therefore preventing its washing away by water. It is also important to remove the invasive species which ecologically promote erosion, as for the brambles (*Rubus ulmifolius*) that shadow the soil, not allowing the herbaceous ground cover to grow. After a long battle against invasive species and their seed banks, the sowing and plantation of native flora took place. In order to accomplish it, shrubs were planted - *Viburnum treleasei*, *Erica azorica* and *Vaccinium cylindraceum* – on the steep slopes of the erosion gullies. These woody species plantations have also been supplemented with endemic herbaceous species seedlings (for example *Hypericum foliosum*, *Leontodon rigens*, *Rumex azoricus* and *Woodwardia radicans*) produced by Furnas LandLab small nursery. In the less eroded places, near the bottom of the erosion gullies, small sized arboreal species were planted: *Ilex azorica*, *Picconia azorica*, *Morella faya* and *Frangula azorica*. It was important to plant only small-size species in the slopes, like the native shrubs, as

when fully grown the larger species may cause landslides when becoming exposed to the action of the wind.

Several trials have been performed in erosion gullies of different dimensions. In the most recent ones new materials were applied, such as geotextiles impregnated with seeds (among other techniques), to comprehend the best intervention method to the site.

STREAM SOLIDS RETENTION BASINS



Fig. 10. Examples of stream bed sediments usage.
Source: Furnas LandLab photo archive.

To prevent the entry of large quantities of sediments into the lake, six retention basins have been built in three streams (those with highest water contribution to the lake) to retain the solid particles dragged by water. These retention basins were built using stone gabions which allow the percolation of water, retaining most solid particles. Every year, about 20.000 m³ of soil is retained. This soil has been sustainably used in various projects within the Landscape of Furnas (ex. Stream banks elevation, Bensaude Green Print, Furnas Golf Course Driving Range, Furnas Japanese garden, etc.).

POND AND WETLAND RESTORATION



Fig. 11. Wetland created by blocking previous drainages while using stream bed sediments from the installed retention basins. Source: Furnas LandLab photo archive.

There was a necessity to reduce the torrential water flow regime, by increasing the retention time of rainwaters at high-altitude pastures. This action consisted in closing the drainage channels, previously built by farmers, and creating new wetland areas and ponds. This enables water to infiltrate slowly through time, loading the aquifers, contrary to the initial situation where, after the soil has been soaked, the water flowed very fast from high-altitude pastures (650 m) into the Furnas Lake (280 m) without major obstacles to reduce its flow speed or promote its infiltration.

SUSTAINABLE MANAGEMENT OF PUBLIC PASTURELAND AND MEADOWS

Upon the acquisition of dairy farmlands, most pastures were under a semi-intensive management, with frequent and excessive fertilization. The first soil analysis showed high levels of phosphorous, 150-160 ppm, whilst more than 30 ppm is already considered a very high value (the Olsen method). The frequent and abundant rain, characteristic of the high altitude pastures, has been transporting the nutrients to the streams and then to the lake, promoting its eutrophication. Several actions were undertaken to revert this condition, one of the most relevant was abandoning the chemical fertilization practices on favor of addition of nitrogen-fixing species in the vegetative cover.



Fig. 12. Pastureland, which initially presented very high levels of phosphorous, intervened through the seeding of nitrogen fixating clovers. Source: Furnas LandLab photo archive.

To achieve that, pastures with the highest levels of phosphorous were sown with clovers that seize nitrogen from the atmosphere, which becomes available to the surrounding vegetation. Taking into account that nitrogen was the limiting factor to produce grass, however phosphorus continued in high levels, it was necessary to “export” nutrients away from the watershed, which has been done by cutting the herbaceous cover and transforming it into cattle fodder or silage bales. Since the land acquisition in 2007, no fertilizers were used, sowing clovers was the chosen method to provide pastures with the needed nutrient without causing any environmental harm. In this way the long process of reducing the phosphorous in the soils began, as well as the production and selling of 6000 tons of grass silage since the beginning of the project, until December 2014.

The legume family plants used to be part of the farming management in the Azores, at the time when chemical fertilizers were not used and the nutrient refurbishment was achieved through crop rotation. The manual sowings performed at Furnas Lake Watershed enriched the landscape with colors and shapes that had been forgotten in the Azorean landscape. The clovers (red, violet, white) and lotus (yellow flowers) were manually sown in 13 ha pasture to create single color carpets of 25 m wide and 500 m long. The assortment of colorful meadow stripes attracted bees and butterflies, creating the scenery that endorsed the Association of Amateur Photographers of the Azores (AFAA) to accept the invitation to photograph the place during flowering periods.



Fig. 13. Azorean Rustic Golf match at Furnas LandLab pastures. Source: Furnas LandLab photo archive.

The pastures' enhancement also had its economic benefits. In seven years of project implementation 8000 silage bales were produced. The production has been carried out in the flattest pastures, where the mechanical management is possible. The silage bails were sold through a partnership with the Agricultural Association of São Miguel – AASM (farmers' union), representing a large income source to the project. There were years (ex. 2013) when this income

surpassed the functioning expenses and the whole management of the project, besides the staff's paychecks and visitor center (CMIF).

These flowered pastures also brought economic diversification through the partnership with a bee keeper from Furnas, who installed his bee hives in the flowering meadows and whose products (honey and candies) are sold at CMIF's gift shop.

Several leisure activities also took place in these wide pastures, having in mind ecotourism enrichment. The **Azorean Rustic Golf** is one of the new exciting activities. Through a partnership with the São Miguel's Tourism Office, local and foreign golfers were attracted to play this Azorean variant of *pitch & putt* with several "holes" spread out in 20 hectares of recently cut pasture, where small spots of clovers shaped the bunkers. Simultaneously, the Furnas Youth Group had lessons with a professional golfer, through which many of them had the chance to play golf for their first time. This was the first event which opened doors to other events of Azorean Rustic Golf at different sites of Furnas LandLab.

DIVERSIFYING THE FOREST ECONOMY

The diversification of forest economy is assured through planting experimental plots and forest stands, using new species, provenances, products, planning tools, techniques and concepts, with the aim to create a rich and diverse forest mosaic. This multifunctional forest landscape has, among the planted forest, glades with meadows and pastures, as well as fruit orchards (ex. endemic blueberries, apple, pear, cherry, plum trees; chestnuts, walnuts, etc.), natural fibers (ex. willows, linen, etc.) and traditional crops (ex. grain and Italian arum, etc.). It's very important to combine production and conservation measures and, for that reason, there are areas assigned for both protection and conservation.



Fig. 14. Broadleaf hardwoods reforestations at Furnas Lake Watershed. Fernando Guerra fotografia de arquitetura. Source: Furnas LandLab photo archive.

MULTIFUNCTIONAL FOREST LANDSCAPE

A 19 ha area in the south area of Furnas Lake Watershed, with an irregular topography and difficult maintenance that make it hard to use as a pasture, was planted with hardwood trees managed in a close-to-nature Silviculture. The main purpose was to show complementary alternatives to the prevailing monoculture of *Cryptomeria japonica*.

All the planted genetic material came from a certified origin. Each of the first 5 plots included one of three main species: *Fagus sylvatica*, *Quercus robur* or *Betula pubescens*, mixed with about 5% of *Taxus baccata*, to assure the areas' aesthetic during the fall of foliage. Some of the dead plants were replaced by endemic trees, of species which had not been available by the initial planting time. This diversity had a major impact in the forest ecosystem, attracting a more diverse fauna, particularly birds. Former pastures were occupied by a high number of invasive species – with *Rubus ulmifolius* and *Solanum mauritanium* being the most prolific. It became necessary to spray them with herbicides, consequently remove them by shredding with a tractor drawn topper mower, and in places of difficult access, with handheld trimmers.

Each plot was planned to have only one main production species, combined with others. These focus species are to be conducted in order to grow with good and straight trunks, with few branches (to reduce timber imperfections, i.e. wood nodes). The initial plantation compass was two by two meters. However, the trees that don't present the desirable standards will be removed throughout the thinning operations, which will also promote clearings for regeneration of native perennial flora, proving that conservation and production can coexist. During the first forestry thinning's, pedestrian and equestrian trails were opened to allow visitors to enjoy the forests and, therefore, increase their multi-functionality.

After the forest installation stage (3 years) some of the initial windbreaks, composed of invasive bramble bushes and hydrangeas, were replaced by native flora species. The same process was undertaken along the access roads. The plantation of thousands of endemic blueberry plants (*Vaccinium cylindraceum*) has allowed to name the access road the "Blueberry Trail".

As for innovative techniques, individual protection tubes were used, to increase the success rate of new plantations and improve the quality of the timber obtained, also reducing maintenance costs and minimizing damages caused by rabbits and other rodents. These protection tubes were placed in a range of 75% to 90% of the trees of each plot. Three years after, some of the trees initially planted with nursery seedlings (about thirty centimeters) had already reached three meters. It was a significant growth, combined with a low mortality rate. In some areas small experimental plots were established for *Platanus hispanica*, *Laurissilva* forest type (several native species), *Juglans nigra*, *Picconia azorica*, *Cryptomeria japonica* and even endemic blueberry and apple orchards.

For timber production, beech and oak trees have about a sixty year rotation while birch has forty years. However, instead of clear cutting, the management of these gardened forest stands is planned in a way to obtain specimens in various growing stages. A tree-to-tree management will allow to have multifunctional forests and to keep some trees up to two hundred years, as occurs in the North of Europe (*close to nature silviculture*)²⁵.

Another way to exemplify the multifunctionality of these forests is through their inoculation with fungi mycorrhiza, of high market valued edible mushrooms.

This type of forest management strongly contrasts with the currently applied model of *Cryptomeria japonica* which, due to its ecology and low commercial value, leads to clear cuts in extensive areas, with all the resulting ecological and aesthetical problems.

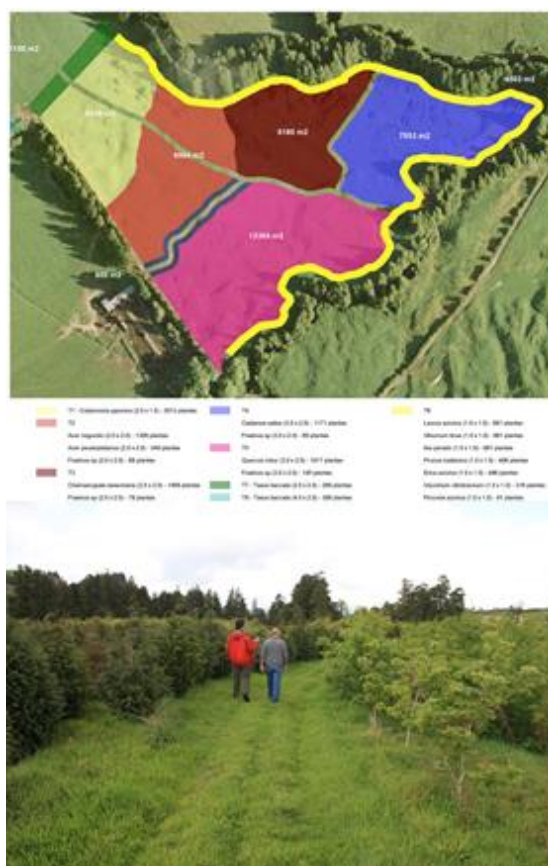


Fig. 15. Planting scheme at the first planted area of Furnas LandLab in 2007 and photography of the main access road, 2012.

Source: Furnas LandLab photo archive.

²⁵ See brochure PRO SILVA mentioned in bibliography.



Fig. 16. Maintenance works along a riparian buffer line, in the sub watershed of *Ribeira do Salto da Inglesa's* stream.
Source: *Furnas LandLab* photo archive.

RIPARIAN BUFFER STRIPS

The plantation of native species (*Laurissilva* forest) was undertaken in linear stands, which protect streams and their margins in a range of 2 km. In these sensitive areas, there will be no timber cuts in the future, to minimize the risks of erosion and degradation of the stream banks. The use of new forestry techniques was implemented, whenever possible, by using mechanical methods for soil preparation and, again, by using individual protection tubes, which revolutionized the plantation of native species. The planted species were *Viburnum treleasei*; *Erica azorica*; *Vaccinium*

cylindraceum; *Ilex azorica*; *Picconia azorica*; *Morella faya*; *Frangula azorica*; *Juniperus brevifolia*; *Taxus baccata*; *Prunus azorica* and *Laurus azorica*. Given the fragile ecosystem of the areas intervened, control and removal of bramble bushes was performed without using herbicides, which resulted in the need for more frequent maintenances. To minimize costs and increase the survival rate of species with scarce seedlings, throughout the two kilometers of already installed “buffer strips”, individual protection tubes were used in a substantial amount of plants. Since this is a new technique in Azores, especially its application in native forest species, some plots were left without tubes to compare survival and growth rates. The annual monitoring has been proving the efficiency of the protection tubes. Before these trials, species planted in pastures had a high mortality rate. New techniques have promoted the survival rate of these species, in the first years, of about 90%, moreover, some species have growth rates of 1,2 m/year. This growing capacity was unknown, as the myth circulated that *Laurissilva* forest species had very low annual growth. possibly a result of observation of *Laurissilva* spots that persisted only in the most inhospitable places (high altitude areas, with poor soil and high exposure to wind). Plantation of the buffer strips with thousands of native shrubs and trees were performed with the involvement of various schools whereas the terrain preparation was done by the militaries.

NATIVE SPECIES SEED ORCHARDS

With an increasing need for native and endemic species seedlings, it became evident that the anthropogenic pressure of collecting the seeds and cuttings had negative effects on the natural populations. For this reason, seed orchards of native species were planted in public areas at *Furnas LandLab*, not only to reduce the impact on natural plant populations, but also to allow other techniques of ecological restoration to take place. An easy access to large amounts of seeds allows direct sowing at ecological restoration sites, reducing costs, in comparison to the costs of plantations and nursery produced seedlings. Some of the native species seed orchards planted had the support of partners, being integrated into joint projects (eg. SataForest, PT Logo, Bensaude Greenprint, ICCA on Google, e ValorPneu).

AZORES FOREST GENETIC BREEDING PROGRAM



Fig. 17. *Picconia azorica* experimental plot.
Source: Furnas LandLab photo archive.

In the scope of the Landscape Laboratory some of the newly forested areas were included in the Genetic Breeding Program of the Regional Directorate of Forestry Resources that aims to add economic value to some of the Azorean endemic species (*Picconia azorica*) and study forestry management techniques that, in the future, can help private owners to install production areas of this species.

MIT GREEN ISLANDS – WOODY BIOMASS

This trial aims to study the potential of biomass production of several tree species (native and non-native). The various species planted with different densities and in different soil types, are being studied by the University of the Azores Biology Department, to assess annual increments of biomass. From an economical point of view, this study may allow independence from the use of fossil fuels for energy supply in the Azores. These plantations are to be managed using a coppicing system, while the surrounding forest will grow older, which will be an added value to the landscape aesthetics and its biodiversity.

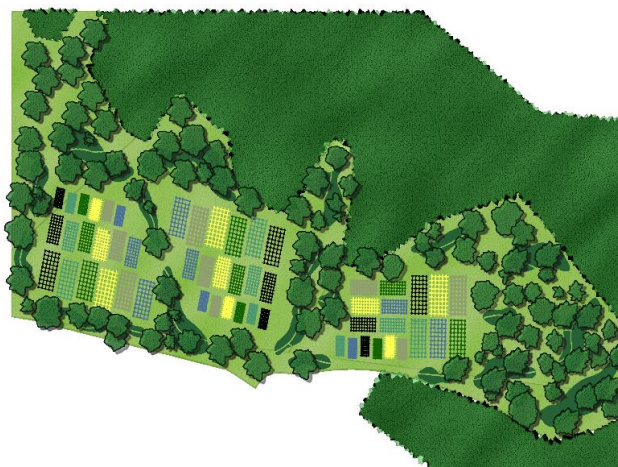


Fig. 18. MIT Green Islands- Woody Biomass, south trial overview. Source: Furnas LandLab.

REINFFORCE ARBORETA

Two arboreta were established in Furnas, a smaller one (poor soils) and another of large dimensions (rich soils), with about 13 ha. These areas were planted with several species, with numerous provenances for each species, that integrate an European network that aims to study climate changes in the European Atlantic Coast. Two listed species were excluded from Furnas planting schemes: *Robinia pseudoacacia* and *Acer pseudoplatanus*, due to their potential to become invasive. The selected list of arboretum species contains taxa that already exist in the islands, species of biology that doesn't represent an ecological threat and species that have been authorized by the Directorate of Nature Conservation Services. Either way the ecological risks are controlled, since there is a close management and monitoring of these arboreta. This allows to evaluate the risks and, if necessary, to remove a species. These arboreta are monitored every year, when all plants are measured and their phytosanitary conditions accessed for comparison with the other arboreta installed at the partner countries.

Besides the study of climate change as part as the Reinforce network, the arboreta also enable the study of alternative forest species, that could prove to be more ecologically, economically, socially and aesthetically sustainable than the current *Cryptomeria japonica* monoculture.

With 50 trees per genetic unit (provenance) occupying 600 m², and a minimum of 150 to 350 trees per species, occupying areas between 1800 and 4000 m², one of the installed arboreta enables to evaluate, at real scale, the performance of species and provenances that may have economic interest to the forestry industry in the Azores. If some species/provenances achieve good results, we may eventually diversify the species that are currently used for forestry production. With more valuable timber it's possible to improve wood extraction techniques and reduce the clear cuts dimension, one of the main ecological and landscape problems currently inherent to the forestry production in the Azores.

In 10 to 15 years, it will be possible to show to forest producers visiting Furnas Landlab other species that can be explored inside protected areas (such as the watersheds of Furnas and Sete Cidades lakes), without forest production jeopardizing ecological sustainability. The ecology and economic value of these species can eventually allow the shelter wood cut and tree to tree management (*close to nature silviculture*, similar to what happens in natural forests) in opposition to the clear cuts of *Cryptomeria japonica*. Through direct observation we can prove to forest owners that they can grow other species in their land. In summary, a more diversified landscape ensures less ecological risks and bigger opportunities at the economic, social and aesthetical level.



Fig. 19. *Furnas LandLab* large arboretum planting scheme. Photo of the area after planting in 2012. Source: *Furnas LandLab*.



Fig. 20. Nursery produced herbaceous.

Source: *Furnas LandLab* photo archive.

More endemics – herbaceous plants propagation was inserted in the “Mais endémicas” strategy for Azores Biodiversity Conservation 2012-2022. Two small greenhouses located at Furnas Traditional Orchard by the Calderas have been an important tool for the small nursery of herbaceous endemic plants. The annual seed collection of endemic species safeguards these populations’ genetics, by storing some at the Faial’s Botanic Garden seed bank, and by propagating some of the rarest and endangered endemics and those with an ornamental potential. At the earlier reintroductions of native flora at Furnas LandLab, herbaceous plants were missing. Therefore since 2012 over 30.000 herbaceous and shrubby seedlings were produced, and consequently reintroduced to the landscape of Furnas. Other populations across the island where few individuals existed were reinforced with new plants,

as were: *Angelica lignescens* and *Rumex azoricus* at Canário Lake. Also many herbaceous plants were offered to schools and used for environmental education purposes at the new autochthonous flora gardens.

The main species that have been produced are: *Angelica lignescens*, *Leontodon rigens*, *Pericallis malvifolia*, *Hypericum foliosum*, *Luzula purpuloscedens*, *Lysimachia azorica*, *Rumex azoricus*, *Woodwardia radicans*, *Calluna vulgaris*, *Euphorbia stygiana*, *Ammi trifoliatum*, *Azorina vidalii*. The biodiversity promotion through the herbaceous species reintroduction is already visible, because many of them have prolonged flowering periods, which sustain numerous butterflies and bees by the end of autumn, a season when food is becoming scarce.

RETURN OF THE ORCHARDS AND OTHER CULTURAL VALUES

RESTORATION OF A TRADITIONAL FURNAS FRUIT ORCHARD



Fig. 21. Overview of aromatic herb garden and Orange tree at the restored fruit orchard. Source: Furnas LandLab photo archive.

The two and a half hectares orchard, acquired in 2008 under the implementation of Furnas Lake Watershed Plan, with its divisions, hedges, and remaining old orange trees, carries a heritage with cultural and educational interest. Its location is one of its main advantages, as it is neighboring one of the most visited spots of São Miguel, the Furnas Lake Fumaroles.

This Orchards' restoration began in 2008 with the cleanup of the abandoned plots, by applying treatments and pruning of old trees and tall hedges. At one of the plots children from Furnas Elementary School planted native forest species, replacing the previous *Cryptomeria japonica* monospecific stand. Currently the orchard has many new trees, all grafted with the regional varieties that have been collected from old farms and gardens across São Miguel.



Fig. 22. Draft plan over aerial photograph of Furnas Traditional Fruit Orchard. Source: Furnas LandLab photo archive.

This restoration also aims to exhibit the history of Azorean monocultures since the early population settlement to the present days, and to develop a collection of fruit tree varieties traditionally cultivated in the Azores: several apple, pear, citrus and plum trees or even more exotic species such as avocado, apple guava, coffee, tea plants, sugar cane and rose apple (*Syzygium jambos*).

A unique signposting with bilingual interpretative signs has been created to guide visitors along the diversely planted plots.

There are also several structures to promote biodiversity, such as the insect hotel, the bat shelters and the starling nesting boxes, all of them have been successfully colonized.

This orchard is intended to host visitors of all ages, for them to acquire knowledge about the history of agriculture in the Azores and also to rediscover and enjoy fruit varieties which are forgotten in the regional market. The orchard restoration has also the purpose of organizing cooking workshops, with the use of the orchard's products, as well as guided tours, educational activities, lectures and practical classes.

The restoration of this orchard, with the support of the Agricultural Development Services of São Miguel, at Lagoa Seca, and the activities associated to it, fulfill two objectives of Furnas Lake

Watershed Plan, namely the *promotion of local values* and *diversification of the local economy*, anchored in a demanding environmental education.

NEW ORCHARDS IN THE HIGHLANDS

The installation of new orchards in the former high altitude pastures is part of the forest landscape diversification. The management of these orchards consists of integrated protection techniques, ensuring a pacific coexistence between the agricultural production and Furnas Lake protection. The plantation of these new orchards in highlands is due to the chilling requirements of some species, to subsequently bear an abundance of fruits, as well as to reduce fungal diseases and insect attacks, resulting in fewer plant protection interventions. The algae removed from Furnas Lake margins have been used to add organic matter and natural fertilizer to the fruit trees.

This highland orchard of Furnas apples has 21 traditional varieties grafted on three types of rootstocks, and occupies half an hectare of a formerly neglected and exotic species invaded pasture. The once abundant Furnas apples had been, until recently, almost “extinct”. The Agriculture Development Services of São Miguel (specifically its office in Lagoa Seca, Furnas) has been making a persisting work to revitalize the Furnas apple culture through the restoration of various orchards along the island.

The local cooperative *Celeiro da Terra* has been commercializing local jams and liquors from fruits of the private orchards in Furnas. There is the possibility to increase the production since there is a growing tourism market and greater demand for locally grown products. Some of them are already available at CMIF’s gift shop.



Fig. 23. Maintenance at the highlands orchard, with Furnas traditional apple tree cultivars. Traditional apple cultivar. Source: Furnas LandLab photo archive.

CHERRY ORCHARD

As an attempt to diversify the Azorean agricultural production, where the cherry fruit trees do not exist, several varieties of cherry trees were introduced. They were imported from Madeira Island where they fructify well even though the winter time has few cold hours, this adaptation could be very valuable for the Azorean climatic conditions and the production will be evaluated in the highlands of Furnas. If successful the fruits can be sold fresh or transformed, reducing the importation from the mainland.

ENDEMIC BLUEBERRY ORCHARDS



Fig. 24. Endemic blueberry experimental fruit orchard at *Furnas LandLab* highlands.

Source: Furnas LandLab photo archive.

The endemic Azorean blueberry (*Vaccinium cylindraceum*) is a species with beautiful flowers and reddish sprouting leaves, which formerly occupied large natural areas at high altitudes, where water is abundant. Until a few years ago, this shrubby species persisted in some remote places of Furnas Landscape in small groups.

In *Furnas LandLab*, two orchards were planted (replicated in poor and rich soils) each with over 800 plants of identified genetic units. In addition to these, adjacent areas were also planted with hundreds of blueberry shrubs, those without trial regime. The purpose of establishing experimental orchards is to monitor the growth of each plant, as well as its fruit production in quantity and quality (flavor, size and antioxidants), in order to select the best individuals to establish new production orchards of selected plants. These *Furnas LandLab* trials have been developed in partnership with several entities, Azores Biotechnology Center, the Agriculture Development Services and the University of the Azores. These orchards are included in a MSc. thesis which foresees the domestication of this wild blueberry, an initiative to be continued throughout the coming years.

BEAUTIFUL INVASIVE SPECIES GIVE PLACE TO BEAUTIFUL ENDEMIC SPECIES



Fig. 25. *Viburnum treleasei*, scientific illustration.

Source: Fernando Correia

One of the actions to promote the endemic flora consisted in replacing two ornamental invasive species by an ornamental endemic species. It was implemented along a touristic road, which emblematic alley of London plane trees has appeared in several regional and national advertisements.

In this alley, the shrubby invasive species: *Hydrangea macrophylla* and *Hedychium gardnerianum* were replaced by the endemic *Viburnum treleasei*, with white flowers and clusters (similar to *Hydrangea*), that turn into beautiful metallic blue fruits, and evergreen foliage conserves an attractive appearance during the whole year (contrary to *Hydrangea*).

It is hoped that the famous “Azorean” *hydrangea* will be replaced by the future-famous Azorean endemics, in protected landscape areas. This type of intervention will soon be implemented in other protected landscape areas of São Miguel, as a result of a partnership with the Regional Directorate for Road Services.

WILLOW COLLECTION RESTORES STREAM BANKS

During the restoration of degraded stream banks, the invasive vegetation was replaced by a willow collection. At the first stage the invasive herbaceous and shrubby species were removed. Posteriorly the invasive tree species (*Pittosporum undulatum* and *Acacia melanoxylon*) were cut down and the acacia timber was sawn and used in the construction of infrastructures at the Furnas protected landscape. This invasive species removal operation produced a large amount of biomass with no commercial value, mostly of *Pittosporum* and of some *Acacia* distorted wood. Following the values of ecological, economic and social sustainability, the scrap wood was offered to the local community

(for house heating) who removed it without additional costs to the project. The huge amount of branches and foliage was shredded by the local cooperative *Profrutos* and utilized as mulching and fertilizer at the pineapple cultivation glasshouses.



Fig. 26. Rosal's stream bank restoration works, with wicker collection planting.
Source: Furnas LandLab photo archive.

After the invasive vegetation removal, the irregular stream banks were exposed, still holding a large seed bank in the soil. The final step in the invasive vegetation eradication consisted in covering the stream banks with a thick layer of soil that was taken out from the retention basins inside the river bed. At the same time, the stream banks were shaped and prepared for plantation.

The plantation of the regional willow varieties and a selected collection from the Rothamsted Research Institute in the United Kingdom, aimed to revitalize an economic and cultural activity with a long tradition in Furnas. By introducing new varieties, with different colors and properties, and through a partnership with the *UK Basketmakers Association*, it is intended to qualify the local artisans with new techniques, as well as to attract new adepts not only of basketry but also of Land Art activities. It is also important to mention that willows allow the sustainable management of stream margins since they consolidate the embankments which in the past were frequently damaged by the fall of acacias, which superficial roots, not adapted to soaked soil and strong winds, frequently obstructed the stream bed. Furthermore, willows are efficient in absorbing nutrients preventing further contamination of stream waters.



Fig. 27. Willow rods, imported from UK's National Collection at Rothamsted Research.
Source: Furnas LandLab photo archive.

The annual maintenance of willow plantation consists of their pruning, resulting in availability of significant amount of rods. This fact created an unique opportunity to develop and stimulate the Azorean willow handicraft. With the plentiful of rods and the support of several partners (the *UK Basketmakers Association*, SATA regional airline, CRAA Regional Handicraft Directorate, etc.) "Furnas Willow and Natural Fibers Festival" has initiated and already had two successful editions. This initiative allows the local basket makers to learn from their English counterparts and vice-versa. It is also an opportunity for annual gathering of the basketmakers to present and sell their productions to a wider public.

Besides this festival and workshops, several LandArt sculptures have also been built with dry willows (eg. Cow; Dragonfly; Charcoal Furnaces and hedge) and live willows (eg. Igloo; Trigloos; live hedge; Spiral). The living sculptures are created during the first months of the year, so that the willows can root and sprout into the green *LandArt* sculptures, more permanent in the landscape than the ephemeral dry willow sculptures.



Fig. 28. *LandArt* willow sculptures created at Furnas. Source: Furnas LandLab photo archive.

MULTIPURPOSE TRAIL NETWORK

The creation of the multiuse trail network aims to disperse the users through the protected landscape, reducing the existing pressure on the hotspots of the volcanic calderas in the North Shore of Furnas Lake.

This network comprises trails for different user groups, in order to minimize friction and possible conflicts between them.

Pedestrian trails are the most used and there is an effort to create new trails connected to the current ones providing the users with several options for circular trails, with varied difficulty levels and duration. The new trails lead through spots of great landscape and cultural beauty, such as the *Grená* trail that goes along the top of the crater of Furnas Lake and passes through the remnants of an old manor house (*Grená*) surrounded by remaining traces of a garden-woodland. The Furnas LandLab trail in the Pico de Ferro area was planned to show the different interventions that have been taking place in the landscape, passing through 20 interest points and having its own interpretative guidebook to help visitors understand the undertaken actions.



Fig. 29. Hike during São Miguel's Open Park day, at Furnas LandLab trail. Source: José Franco AFSA.



Fig. 30. Pedestrian trail registration point. Source: Furnas LandLab photo archive.

There have been made improvements to the conditions of the existing trails through the installation of new wooden structures, such as eco-toilets, rustic benches, bridges, railings, steps and mountain huts, to provide hiking lovers a comfortable experience, particularly considering the unstable climate of Furnas. Hiker's registry points were also installed in order to know more about number of visitors, their background, their observations and suggestions.

The former trail around Furnas Lake had a lot of intrinsic scenic value and many foreign users, however attracted very few locals to hike it, due to lack of novelty. At this trail there was a need to create new interest points that would aid to attract the local

population to visit it.

Through the annual Furnas WoodCarving event, several living trees of invasive character were disbranched and carved along the lake's margins and trail. These sculptures focus on the local fauna and together with their interpretative signs they help visitors to learn about species such as ferret

(*Mustela putorius furo*), owl (*Asio otus*), tern and carp (*Sterna hirundo* and *Cyprinus carpio*), goldcrest and hedgehog (*Regulus regulus azoricus* and *Erinaceus europaeus*), frog (*Rana perezi*), the dragonfly (*Anax imperato*), endemic beetle (*Crotchiella brachyptera*), newt (*Triturus cristatus carnifex*). Other sculptures were also carved, such as the wolf cub, to celebrate the partnership among Furnas LandLab and the Furnas scouts, and other ludic sculptures dispersed through the landscape. such as the tourist and Gandalf (mythic figure looking over the recreational area by the south margin's parking lot).

These pieces of art, alongside with others created with natural materials during the Willow and Natural Fibers Festivals help tourists and residents to hike the trail around the lake with their cameras ready to record this iconic landscape with its new “hotspots”. This increases the time needed to hike around the lake, while visitors remain in Furnas for longer periods to register the sculptures with photos that then flood the social media in a free advertisement of Furnas and the Azores.



Fig. 31. Official calendar competition at Furnas-DownHill, 2012.
Source: Furnas LandLab photo archive.

The **Furnas Downhill trail** was created to move the cyclists away from the *Grená trail*. Therefore, a new trail exclusively for the Downhill practice was established on the other side of the watershed, which shall have several tracks and sidesteps for this extreme sport and releasing other pedestrian trails from disruptive practices of Downhill. This “16 second” trail, as it is known of, is included in the official annual competition calendar for DH.

Multi-use trails are former farm roads where gateways were placed to limit access, and currently car traffic is restricted to the maintenance vehicles. These roads are wide enough to allow multiple uses (pedestrian, equestrian, cross-country, cycling, etc.) without the risk of conflicts. Moreover, these will be granted for rights of exploitation to tourist operators, in order to create more nature activities to the numerous visitors of Furnas Protected Landscape.



Fig. 32. Wooden boardwalk by Furnas lake calderas, seen from Pico do Ferro.
Source: Furnas LandLab photo archive.

Reduced Mobility Trail is associated with Furnas Lake margins restoration, which will also allow the recovery of the trail that surrounds the lake enabling the visitors with reduced mobility to complete the circuit. This is to be the first loop trail in the Azores adapted to the users with reduced mobility.

Through a partnership with the local Municipality (Povoação), a wooden boardwalk was built at Furnas lake Calderas, which allows easy access for reduced mobility people in a natural area, which presents many dangers. Although this is one of the most visited places in São Miguel, a lack of management led to several accidents to occur, sometimes with severe outcomes to those involved.

The boardwalk regulated the visitors flow, avoiding the extreme erosion and consequent environmental degradation which occurred earlier. Local materials were used for the construction of the boardwalk, such as stone and acacia wood (invasive species) the latest removed from ecological restoration sites.

FURNAS LAKE DEGRADED MARGINS RECONSTRUCTION THROUGH COHESION FUNDS (POVT) AND THE EUROPEAN REGIONAL DEVELOPMENT FUND (ERDF)



Fig. 33. Furnas Lake south margin, requalified area. Recreational areas: Rosal's stream, pick-nick area, landscaping and paths through the wildlife promoting flowering meadows.

Sources: Fernando Guerra fotografia de arquitetura and *Furnas LandLab* photo archive.

Ecology and Aesthetics

Furnas Lake South Margin was submitted to a remarkable landscape restoration, with a special focus on its flora. The Furnas Lake margins were devoid of native vegetation, with only a few indigenous species sporadically scattered across a wide area covered with invasive vegetation. During the implementation of the Landscape Architecture project, developed by PROAP (Landscape Architecture Project and Planning Partnership), the herbaceous and woody invasive plants were removed. Moreover, there were over 3000 plants reintroduced, representing ten species of the autochthonous Azorean flora, significantly increasing biodiversity. As the project evolved, new endemic species were added, mainly herbaceous.

The stream banks were stabilized by sowing herbaceous cover and plantation of *Salix* sp. and *Alnus* sp., which are a source of raw material for local artisans and for Furnas *LandArt* structures. Previously exposed to erosion by water force and to invasive species, the stream banks' slopes were rectified for a better management of the area, allowing the enlargement of the previous bottle necks which caused additional erosion. Along the lake margins, the green spaces were seeded with a mixture of clovers, which absorb the air nitrogen and require no fertilization. Since a tall meadow is a richer habitat than a frequently trimmed lawn, the reduced number of grass cuts enabled Nature to create an abundant herbaceous cover, increased arthropods biodiversity and enabled savings in human resources and fossil fuels. The access to the South margin has been restricted to vehicles, allowing visitors to enjoy Nature, walking or cycling, in the cobblestone road or in the green paths, made by trimming vegetation in the meadows.

Ruins restoration

Furnas Monitoring and Research Center (CMIF) was conceived within the project for the restoration of Furnas Lake margins, and it was constructed on the site of ruins of an abandoned hotel. Designed by the world-known architect Manuel Aires Mateus, this project gave visibility to Furnas Lake at the architectural level, in addition to the environmental/natural attributes for which it is usually recognized. The contemporary building merges with the surrounding landscape through its covering in basalt, regional volcanic rock. It was awarded with the "*Premio Internazionale*

Architetture di Pietra 2011 – XII edizione”, in the Italian city of Verona and, previous to its inauguration, it was already publicized in the national and international editions of the magazines “*Blue Design*”, “*House Traders*”, “*Casabella*” and “*El Croquis*”.

This building includes an area for research, project monitoring and development, comprising an open space office and small backup rooms, where the Furnas LandLab project management team works. It also has an auditorium for workshops and seminars as well as a large exhibition room dedicated to exhibit *Furnas Landscape Laboratory*.

The contiguous building has four temporary residences prepared to host researchers and collaborators invited to assist the ongoing project. These residences have allowed to host several researchers and interns, national and international, from Spain, France, Holland, Germany and Hungary.

In the surroundings of these infrastructures, visitors can appreciate landscape and leisure activities in a set of outdoor areas, including a picnic and rest area, toilet facilities, a car parking and a wide green space with a privileged view over the Lake.



Fig. 34. Abandoned ruins demolition at Furnas South margin, where Furnas Monitoring and Research Center (CMIF) was built. Comprising a frontend, an interpretation area about the restoration project, and the Furnas LandLab management team's office.
Source: Furnas LandLab photo archive.

After the large-scale project of margins requalification financed in major part by the European funds of (POVT and Proconvergência), other smaller and low-cost interventions have been undertaken, making use of the local endogenous resources. These interventions were partly promoted by the annual events of *Furnas WoodCarving* and the *Furnas Willow and Natural Fibers Festival*, creating new hotspots in the landscape.

Through the carpentry, created from the very beginning, it was possible to install diverse wooden structures for visitors' support and biodiversity promotion. The carpentry has been operating inside a shipping container granted by one of the project partners; machinery and equipment were acquired through European funds and other donations. Labor is from workers that have been contracted via unemployment support programs.

With small investments and mainly through an exemplary management of the scarce resources, these wooden structures (benches, information signs, bat shelters and starling nesting boxes) willows and other natural materials helped to promote the unique margin of Furnas Lake.



Fig. 35. Furnas WoodCarving and Furnas Willow and Natural Fibers Festival sculptures, biodiversity shelters and park furniture at Furnas lake margins.
Source: Furnas LandLab photo archive.

CHAPTER 4. A SOCIAL PROJECT: COMMUNITY AWARENESS FOR THE QUALITY OF LANDSCAPE

PARTNERSHIPS

Through the establishment of **numerous partnerships** it became possible to involve the local community, businesses, scientific institutions and associations, along with other governmental institutions. This has been one of the major components of the project, so that the population can realize that the obligation of restoring this degraded landscape comprises the society as a whole, and not only the public entities.

Most of the partnerships involve field trips for volunteering activities. These actions have an informal atmosphere, promoting a high level of public participation since it creates a proximity relation with the project managers, through which the population can influence decision makers by expressing its opinions and suggestions.

Furnas Lake Watershed restoration project, has established new communication channels, more direct, through the in situ actions. These enabled to explain the reasons why decisions were taken, and the type of management and planning implemented in the present and envisioned for the future.

LOCAL COMMUNITY

Furnas Scout Group

Through the establishment of a protocol, a small wooded parcel was assigned to the local scouts, for their direct management with the technical support of Furnas LandLab. In this area, located in CMIF's surroundings, the young scouts not only learn about the invasive and endemic species, but also create their constructions and take their exams for the rite of section passage.



Fig. 36. Furnas Scouts during their activities.
Source: Furnas LandLab photo archive.

Furnas Elementary School

With the support of Furnas LandLab technical staff and São Miguel's Ecoteca, this school has been integrated in several activities that promote its drive for the *EcoSchool* awarding. Under this partnership, several hundreds of endemic plants (woody and herbaceous) were planted in Furnas Lake shores. The students have also been involved in various educational activities from CMIF, in order to learn about Furnas LandLab project, and diverse environmental and ecological concepts.

COMPANIES AND ENTERPRISES

STIHL, A.S. Maia

Owing to this partners' sponsorship four editions of **Furnas Woodcarving Event** have been organized, where the French champion of chainsaw woodcarving (Emmanuel Courtot) sculpts trees, debilitated or of invasive species, and transforms these into art pieces. The last years' events have had as theme the Furnas wild fauna and attracted a large number of visitors that also visited CMIF and acquired additional knowledge on Furnas landscape



Fig. 37. Emmanuel Courtot carving a sculpture at "Furnas WoodCarving 2011" sculpture created by using a dying rooted tree, portraying the mythic Gandalf.
Source: Furnas LandLab photo archive.

ecosystem and the work that is being carried out for its restoration.

Simultaneously to these events, there have also been held training programs to several field teams working on environmental projects (*Furnas LandLab*, *LIFE Laurissilva Sustentável* and *Azores Water management*). The aim was to provide the workers with knowledge about motorized equipment (ex. Chainsaws, brush cutters, motorized sickles, ground drillers, blowers, among others), in order to enhance safety and ergonomic standards, as well as their capability to intervene at the environmental restoration actions.

Regional airline SATA

The **SATA Forest** was planted with the assistance of the airline staff members, in one of the few pastures in Furnas that was not bulldozed and flattened, maintaining its irregular micro topography. The planting scheme was designed with the assistance of a *Landscape Architecture consulting office*, with underlying concept to plant each of SATA's destinations with a species representative of the destination, in a hilly area of 12 hectare pasture. Symbolically, São Miguel Island was the first destination to be planted, with one of the most threatened endemic species of the native flora, *Prunus azorica*.

From the 25 destinations already planted, all the islands of the Azores were occupied with autochthonous species, to reflect the flora and culture of each of the nine islands. International destinations were planted with the species already existing in the Azores, not to take risk of introduction of possible invasive ones. For example destinations of London, Copenhagen and Madrid were planted with *Quercus robur*, *Fagus sylvatica* and *Platanus hispanica*, whereas Faro, Lisbon and Oporto were planted with *Cercis siliquastrum*, *Quercus ilex* and *Cupressos lusitanica* respectively. The different destinations create clumps of a wide diversity of native and exotic species (non invasive), conifers and broadleaves, deciduous and perennial, trees of diverse colors and shapes. This species mix helps to form a forest of great landscape beauty, which in the future is expected to be one of Furnas big Icon's.



Fig. 38. Teambuilding SATAForest plantation with SATA's staff.

Source: Furnas LandLab photo archive.

PT Foundation

An area of 1 hectare (100m x 100m) was planted to form the **PT Logo**, which is a representation of the national telecommunication company logo. The blue areas of the logo were planted with Azorean Juniper (*Juniperus brevifolia*), an endemic species whose annual sprouts are blueish. This partnership directly involved approximately 70 PT employees and their families in São Miguel in a volunteering and team building action. The project was acknowledged not only by the workers engaged in it, but it was also disseminated among the 10.000 PT employees that attended to the 2010 Christmas dinner at *Pavilhão Atlântico*, Lisbon.

The endemic juniper is a relatively slow-growth species, but even though the trees are not big enough to be seen on an aerial picture, the grass has been mown allowing the PT logo to be visible from the nearest hill as well as from the aerial image of the Google Earth.



Fig. 39. PTLogo overview, seen from Pico do Ferro's Hill and Google. Sources: Google Earth; Furnas LandLab photo archive.



Fig. 40. Bensaude GreenPrint, Project logo. Source: Miguel Melo /MAGMASTUDIO.

Bensaude Group /

Bensaude Greenprint plantation was installed in the landscape with the support of over 150 employees and their families of one of the largest economic groups of Azores. Considering this large group of volunteers, the planting took time in turns, and it was combined with visits to CMIF's exhibition room to learn more about Furnas Landscape Laboratory activities and the lake's restoration. Over 1200 plants of two indigenous species were planted. The selected species and a design of plantation brought up the historical roots of the Bensaude Group, in this way *Morella faya* species was used to fill in the canopy element of an orange tree design, while the trunk element was planted with *Erica azorica*. The branches were left as meadow passageways for an interpretative path, whereas the leaves, flowers and fruits' elements were destined for leisure areas to be hot-spots of Land Art pieces. At one of these hot-spots a "mound" was already installed, with the use of

sediments removed from the nearby stream, allowing visitors to view the plantation from above.

This Partnership also aims to develop a Land Art Festival in Furnas, engaging Furnas Lake Watershed Protected Landscape, the internationally known Terra Nostra Garden and several national and international Art Schools. By late 2014 meetings were initiated with the organizers of the renowned *Walk & Talk Urban Art Festival* with the intention to start a joint LandArt festival to take place at Furnas LandLab and Furnas village.



Fig. 41. Group photo, during guided visit to Terra Nostra Park. Source: Grupo Bensaude



Fig. 42. Valor Pneu's Logo. Source: Valor Pneu

Valorpneu CO₂ Offset

Valorpneu is a tyre recycling company. This partnership consisted in the plantation of a company's logo in an area of approximately 700m² as a way to compensate the ecological footprint of the 12th National Encounter of Valorpneu network members. The plantation took place on October 9th 2014, involving 105 participants from the national encounter, and it promoted the Teambuilding amongst the Valorpneu team.

The planted species were *Juniperus brevifolia* for the dark green, *Erica azorica* for the lighter greens, and *Viburnum treleasei* to represent the contour lines.

In the future these areas will not only be a memoire of the event, but the consolidated group plantations will also be used as seed orchards of native species. Currently for the propagation of native flora, large quantities of seeds have been harvested at natural populations that on the long run might affect negatively the whole ecosystem (flora, arthropods, birds). With the availability and easy access to large quantities of seeds at the seed orchards, costs for seed harvesting can be decreased, and ecological restoration of flora can be aided by direct sowings instead of plantings alone.

This partnership supported a "Zero turn" lawn mower for the management of the flowering meadows by Furnas lake margins. Allowing workers previously dedicated to this chore to be available for other ecological restoration works.



Fig. 43. Native species planting event with Valorpneu's members. Source: Furnas LandLab photo archive.

Furnas Golf Course

The **Furnas Driving Range** results from a partnership with the company *Ilhas de Valor* which manages the Golf Course. It was installed in a public pastureland of Furnas Protected Landscape, one of the areas included in São Miguel Island Natural Park and, for that reason, the environmental concerns are particularly important.

To implement the Driving Range outdated illegal infrastructures were demolished and polluting residues removed, therefore improving a previously degraded landscape. The soil used to elevate this *Driving Range Tee* came from the retention basins previously mentioned. This pasture used to be part of one of the dairy farms that negatively contributed for the excessive intake of polluting nutrients, from fertilizers and manure, discharged to Furnas Lake tributaries. The current practices do not involve the use of fertilizers or other chemicals harmful to Furnas Lake water quality, only consisting in more frequent cuts of the semi-natural meadow. The natural water flux was not disturbed, as the surrounding area of the *Tee* continues to be a wetland. Wetlands are also promoters of biodiversity, not only for the flora with the proliferation of native plants (ex. reeds at the left side of the *Tee*), but also for the avifauna (ex. migratory ducks), insects and butterflies. This partnership enables the diversification of touristic offer and the existence of Pro tournaments, since previously Furnas Golf Course didn't have this infrastructure, indispensable to receive these events.



Fig. 44. Soil samples ready for shipping for pollen studies. Samples obtained through partnership with the Azorean Renewable Energy Company.
Source: Furnas LandLab photo archive.

EEG Lda – EDA Group

The Azorean renewable energy company, upon its geological prospection study to build a water reservoir to back up a reversible hydropower plant in the highland pastures, sponsored extraction of two unaltered soil samples that went down 10 meters deep. These soil profile samples were sent to Porto University for the **study of the pollen** present along the different soil horizons, as a way to identify the species which composed Furnas flora throughout the last hundreds/thousands of years. The first results show a total devastation of the entire woody flora at a certain depth, probably the result of the last volcanic eruption of 1630. Below this pollen sterile horizon, pine tree pollens are again identified, only possible due to the anthropogenic action during the islands settlement.

Euroscut, Forest Management

During the construction of the highway segment between Lagoa and Ribeira Grande some areas of mixed native and exotic forest (*Morella faya*, *Acacia melanoxylon*, *Pittosporum undulatum* e *Solanum mauritianum*) were clear cut, which had an impact on the endemic wood pigeon (*Columba palumbus azorica*) habitat. The environmental impact assessment recommended this clear cut to be compensated with a new mixed forest plantation, contiguous to existing forest or to natural areas.

To achieve this, the road construction company (Ferrovia, Agroman) supported Furnas LandLab to acquire vehicles for the reforestation works of 10 ha of mixed forest, of native flora and diverse broadleaf hardwoods which are also a food source for the wood pigeon in continental Europe.

Euroscut is the company responsible for the management of the highways in São Miguel, and it has the duty to maintain the 10 ha of planted forest. Therefore a contract was established to finance the maintenance of 10 ha of *Furnas LandLab* forest over a period of 25 years. The adopted management plan focuses the promotion of the wood pigeon and its habitat, which consequently also improves the habitat for other associated species. The forest stands are to be managed through “close to nature Silviculture”, where there are no monospecific plantations, and native flora is promoted through new plantations and through the protection of natural regeneration.

Group Holding

This partnership involved the family of a foreign investor and created a small thematic forest in which each family member is represented by an endemic species. In return of this plantation it was possible to provide the field crew with new equipment, machines, personal protective equipment and a pick-up truck, as well as the project divulgation abroad.

Landscape Architecture Consultant

In the initial stage of the Furnas Lake Watershed project consulting landscape architecture offices prepared a masterplan that includes the entire Watershed. This was called Furnas Lake Integrated Park, a project previous to Furnas Landscape Laboratory. The Architects offices were Arch. Daniel Monteiro and PROAP.

SCIENTIFIC INSTITUTIONS

University of the Azores

There have been several departments involved in diverse research projects, conducting practical lectures, field trips, conferences and congresses, internship for graduate and undergraduate students at Furnas LandLab.

Biotechnology Centre of the University of the Azores

The protocol signed with this institution for the micro propagation of endangered endemic species has been accomplished through the supply of thousands of plants. These are used for the reforestation and to install the first trials for genetic breeding programs. The selected species for micropropagation were those of the most endangered natural populations, or the hardest propagation through seed, and therefore very rare. This was the case for the *Prunus azorica*, *Picconia azorica*, *Juniperus brevifolia* and *Vaccinium cylindraceum* that have benefited from this population reinforcement.



Fig. 45.
Micropropagation in laboratory. Source: Furnas LandLab photo archive.



Fig. 46. SLAM Trap at Furnas LandLab, reforested site.
Source: Furnas LandLab photo archive.

Azores Biodiversity Group (BGA)

This research group has been developing a study to “assess the ecological long term impact of climate change on Azores natural forest” and has installed 24 SLAM traps distributed through several native flora plots across seven Azorean islands, to determine the seasonal variation of flying insect’s biomass. The first planted area of Furnas LandLab has also been included in these research plots.

The first results indicated the occurrence of 28 native arthropod species at this restored site of Furnas LandLab, with high abundances for the following endemic species: *Rugathodes acoreensis* Wunderlich; *Sancus acoreensis* (Wunderlich); *Atheta dryochares* Israelson; *Cixius insularis* Lindberg; *Eupteryx azorica* Ribaut; *Hemerobius azoricus* Tjeder.

The monitoring is extremely important to assess if the restoration taking place is indeed restoring the ecological and landscape values for Furnas Lake watershed. The study will allow answering several questions of great ecological interest. The preliminary results of arthropods’ captures indicate positive progresses regarding biodiversity increment.

Oporto University Department of Sciences

In addition to the pollen study previously mentioned, this university contributed to the project by assigning landscape architecture interns that contributed to the project's small technical team.

Faculty of Art at the University of Edinburgh

This new partnership aims to develop workshops where small groups of students, from different backgrounds (Graphic Design, Product Design and Landscape Architecture), with their tutors, would gather in Furnas to work together in relevant topics. One of the proposed topics is the handicrafts diversification, as a way to stimulate the local economy, engaging cultural traditions and revitalization of natural materials usage.

European Forest Institute (EFI)

Through this prestigious institute, associated Universities and Research Centers, *Furnas LandLab* integrated the arboreta network of Reinfforce and hosted an international EFI meeting with researchers from ten countries. This is a project with international recognition, which has encouraged more countries to express their will to participate in this network of arboreta installed for climate change studies.

Through this partnership Azores gained an active voice and representation regarding the European Forest policies.



Fig. 47. Reinfforce project meeting and EFI's International Annual Meeting. May 2012.
Source: *Furnas LandLab* photo archive.



Fig. 48. Zephyr's consortium visit to endemic species planted field trails.
Source: *Furnas LandLab* photo archive.

ZEPHYR project

ZEPHYR, Zero-impact innovative technology in forest plant production, is a European 7th framework project for research and technological development in environmental sciences; the main European funding for research during 2007-2013.

The Zephyr consortium is composed by more than 13 partners from several European countries (Portugal, Spain, France, Belgium, UK, Italy, Greece and Sweden). It is an important project because it places Azores in the center of European scientific knowledge. Projects like Zephyr represent an opportunity for knowledge exchange, therefore being an important step for the Azores, and a door opening to new

collaborations and funding opportunities.

The importance of Zephyr project to the Azores is mainly due to its contribution to *Laurissilva* forest restoration, in the development of new germination protocols, seed dormancy breakage, and Led lamps trials in search of better germination growth performance.

Furnas Landscape Laboratory has been involved in acclimation field trials. Zephyr has had a direct impact at Furnas lake watershed by providing resources for the propagation, reintroduction, study and monitoring of various endemic plants.

NON PROFIT ASSOCIATIONS

The Portuguese Society for the Study of Birds (SPEA)

The cooperation with the project *Life+Laurissilva Sustentável*, and the previous *Life+Priolo*, has been established through the exchange of expertise and techniques for intervention and ecological restoration. SPEA's field workers participated in training courses organized in Furnas and there was a plot allocated to install their sowing beds for native species production.

Athletics Club of Lagoa Preparatory School (CALAG)

This dynamic partner has been supporting and organizing several nature and sports events at Furnas Protected Landscape, always with great success and many participants keen to support this ecological and landscape restoration. It has also been one of the key entities promoting the pedestrian trail network that has been created at Furnas. Through this partnership the most successful event, in terms of participants, was organized at the Open Day of the natural parks of the Azores. Over 150 people participated in the several activities that took place throughout the day.



Fig. 49. CALAG activities at Furnas LandLab.
Source: Furnas LandLab photo archive.

International Congress and Convention Association (ICCA)

ICCA's Iberian chapter had its annual convention on April 2013 in Ponta Delgada, and chose the awarded Furnas LandLab for a teambuilding event to be associated with a social and environmentally-aware activity.

The Teambuilding event consisted in the plantation of a large ICCA's logo by the Iberian members of this international organization. The used species were all native: *Juniperus brevifolia*, *Erica azorica* and *Viburnum treleasei*. Its dimension (30 meters diameter) enables it to be viewed from Google Earth. In the first aerial picture update from Google Earth this logo was already visible, due to the use of geotextile in the base layer of the logo. This projected Azores archipelago in ICCA's universe, through the presentation of "ICCA on Google Earth" joint application to ICCA's Best Marketing Awards.

The initiative promoted the brand "Azores" among this extraordinarily interesting target group, and it could be beneficial for attracting their future activities and events, because ICCA International has over 1000 associated members across the world.



Fig. 50. ICCA's logo planting event and overview. Source: Google earth, Furnas LandLab photo archive

Association of Amateur Photographers of the Azores (AFAA)

The photo excursions endorsed the divulgation of the project, scenic landscapes, some of the less known spots and peculiarities of the interventions are shared in blogs and regional sites of photography.



Fig. 51. Photographic excursion across Furnas LandLab intervened sites.
Source: Furnas LandLab photo archive.

Azores Geoparque Association (GeoAÇORES). It has its São Miguel island headquarters at Furnas Monitoring and Research Centre (CMIF).

Azores Regional Association of Archery (ARATA)

An outdoor area was granted to this sports group for the installation of a training field for precision archery as well as a simulated hunting trail. There is also a joint organization for archery activities open days.



Fig. 52. ARATA event, 2012.
Source: Furnas LandLab photo archive.

Association of Landowners and Residents of Furnas Lake

The close relationship between its members and *Furnas LandLab* management team has helped to solve issues of land use planning, in terms of agriculture and forestry, so that the private areas of the Furnas Lake Watershed can also adopt the concepts of ecological, social, cultural and aesthetics, along with economic sustainability.

Agricultural Association of São Miguel – AASM (Farmers' Union)

The AASM is the intermediary in the establishment of prices and contacts with local farmers, regarding silage bales sales. It also assisted in the negotiations with its associates to reduce the agricultural pressure within the lake's watershed and took part in the public consultation process during the development of the Furnas Watershed Management Plan 2000-2005.



Fig. 53. II Furnas Willow and Natural Fibers Festival.
Source: Furnas LandLab photo archive.

The Basketmakers' Association (BA)

This organization has helped to create Furnas Willow and Natural Fibers Festival, through the promotion of the event on their newsletter in England, and on the pre-selection of English candidates to participate in the festivals.

For three consecutive years Furnas Landscape Laboratory welcomed the English basket makers, who volunteered to organize workshops, create LandArt sculptures and teach new artisanal techniques, during the week of the festivals.

The Azorean willow handicraft got a new dimension and visibility in Britain due to the foreign artisans, who organized seminars and wrote articles regarding the Festivals and the techniques used by the Azorean basketmakers.

An exchange of techniques, plants and seeds of traditional varieties of willows and wheat, took place. At Furnas a collection with dozens of willow varieties from England's National collection was established, as a way to diversify the local handicraft. The different varieties of willows have diverse colors, textures and properties adapted to certain uses, some are best for basket making, while other suitable for LandArt. At São Miguel there were only three known varieties of willows, therefore the imported collection considerably diversifies the raw materials available.

Ribeira Chã Youth Association

A parcel of approximately 900m² was made available to this association, to plant Italian arum (*Arum italicum*), with the objective to cultivate it for transformation and commercialization. Italian arum was introduced in the Azores islands for its culinary use as a flour, which is extracted from the tuberous root. This flour is much cherished and is part of the local gastronomy of São Miguel Island, mainly at Ribeira Chã and also at Povoação's municipality, being used to bake a dessert called "papas de serpentina".

This plant is unnoticeable during the summer months, because its green leaves and foliage grows only in the autumn and vanishes in the spring. It's a plant from the same family as the famous ornamental Arum lily (*Zantedeschia aethiopica*), with a very similar ecology. They are both easy to distinguish by the flower; Italian arum has a light green coloration, while the lily has a beautiful white flower.

By supporting the cultivation of Italian arum and production of culinary flour, Furnas LandLab envisions the restoration of old traditions; promote cultural values, and the diversification and consolidation of the local economy, these being some of the major guidelines of the Furnas Lake Watershed Restoration Project.



Fig. 54. Arum lily young plant.

Source: Furnas LandLab photo archive.

PUBLIC INSTITUTIONS

Agency for Qualification and Employment of Ponta Delgada

Such as in the National Parks of North America during the great depression of the 1930's; there is a regional program that involves and occupies unemployed workers, giving them extra financial benefits and the possibility of an extension of their professional skills. In this context, the *Furnas LandLab* received 24 workers supporting the permanent team of only six men, to perform daily field assignments. Thanks to this partnership several large scale and very specialized projects have been possible to move forward.

Unemployed carpenters were also admitted, and a Park Carpentry was established, allowing constructions of various outdoor structures. For the promotion of biodiversity, bat shelters, bird nesting boxes and insect hotels were built. For the promotion of ecotourism, support structures such as eco-toilets, benches and park furniture and rain shelters were built to disperse users across the Furnas landscape.



Fig. 55. The first group of unemployed workers who integrated Furnas field crew. Source: Furnas LandLab photo archive.

Azores Military Zone (ZMA)

This was one of the first and most crucial partnership for the project. During the first one and a half year of field intervention, there was no permanent field team and the daily hand labor came exclusively from military personnel assigned for Furnas ecological and landscape restoration. Every week, aside from the vacations periods, from Monday to Thursday, since 2008 till 2014, the *II Regiment of Arrifes* assigned a nine soldier team to perform various tasks, such as waste cleaning, invasive species “battling”, opening and maintenance of trails.

This ecological restoration work in Furnas was awarded with the first place in the **National Defense and Environment Award 2009**, conferred by the respective National Ministries.

Azores Hydrographic Administration (AHA)

This entity directly manages the interventions carried out in water bodies with the aim of its restoration. Some examples of its activities were the experimental trials for biomanipulation, sediment dredging from Furnas lake bottom, the constant algae removal from the shorelines and the sediment removal from the retention basins.

Regional Directorate for Forestry Resources (DRRF)/

Joined Furnas LandLab project through the monitoring of forestry experimental plots installed by Furnas LandLab, planted with endemic species such as *Picconia azorica*.

Agricultural Development Services of São Miguel

Through technical support and help from the field workers from the experimental agriculture station of Lagoa Seca in Furnas, this entity supports several Furnas LandLab trials in new orchard areas with diverse fruit trees.

Regional Centre for Handicraft (CRAA)

This partnership promotes and reactivates the arts that make use of traditional crops, by seeding wheat, rye, linen and planting willows; in order to produce cereals straw and willow rods that are used for handicraft workshops.

Three have been already three editions of Willow and Natural Fibers Festivals, organized with the support of CRAA, the regional airline SATA, and the municipality of Povoação. The festivals included local and British artisans, which allowed an exchange of knowledge and techniques between both artisan groups, along with the general public, in order to attract new enthusiasts of these traditional arts.

LandArt sculptures were constructed with willows, and several workshops using natural fibers (willows, wheat, reed, cane and New Zealand flax) also took place. Furnas LandLab also gained new attractions across the lake’s margins.

These activities are an example of economic, ecological and social sustainability; and again they accomplish the guidelines from Furnas lake watershed restoration plan such as the promotion of local values, diversification of the local economy and safeguard of income sustainability.



Fig. 56. Militaries from ZMA during experimental trial planting. Source: Furnas LandLab photo archive.



Fig. 57. Highlands fruit orchard grafting. Source: Furnas LandLab photo archive.



Fig. 58. II Furnas Willow and Natural Fibers Festival, workshop tent. Source: Furnas LandLab photo archive.

POPULATION AWARENESS – FURNAS MONITORING AND RESEARCH CENTRE- CENTRO DE MONITORIZAÇÃO E INVESTIGAÇÃO DAS FURNAS (CMIF)

At CMIFs' the project team has created a permanent exhibition where visitors are guided upon the discovery of the Furnas Lake's ecosystem and the local fauna and flora, through interactive mechanisms, user friendly tools, multimedia platforms and guided tours. The main focus is on the project for the restoration of Furnas Lake and its surrounding landscape, which makes the visit to be a unique experience.

In its daily activities, the Centre hosts tourists, local community, schools, universities and institutions, playing an important role for the environmental awareness, and increase consciousness about the problems that Furnas Lake and its protected landscape are facing, as well as the solutions and actions carried out in the watershed. It is also an important information source on other protected areas as it represents the Head Office of São Miguel's Island Natural Park.

Since 2007, even before CMIF was built, several environmental awareness actions had been carried out, frequently using a practical approach for the awareness-raising of the target audience. Students from regular and vocational schools, from the University of Azores and foreign universities, have participated in field works such as plantation of native flora, tree protective tubes placement, maintenance and monitoring of young forest stands. In addition to the educational partner, several partnerships with a broad range of institutions have also been "stamped" with teamwork plantations.

Since the Centre official opening, on July 2011, several events and free activities have been organized in the weekends, directed to the local community as part of the Open Park initiative. The events marked by a strong environmental approach, included sports and leisure activities such as: yoga classes, recreational fishing contest, bow and arrow apprenticeship, Paintball games, photographic excursions, pedestrian walks.



Fig. 59. Environmental awareness with school children.
Source: Furnas LandLab photo archive.



Fig. 60. Guided tour at CMIF's exhibition room.
Source: Furnas LandLab photo archive.

FURNAS LANDLAB TEAM



Finally, we present the small team working on the project that with great determination, commitment, perseverance and love for the landscape, has managed to implement this enormous transformation.

The restoration of the intervened area is a result not only from the management team decisions, but also from the involvement of the entire field crew, and frequently of the various project partners.

The objective has always been to have a highly motivated and involved field team, aware of what is expected for the area on the short, medium and long term, encouraging the sense of ownership for the landscape and its project actions.

It must be emphasized that this was one of the first working places (field work) in Azores, where personal protective equipment was provided and its use became mandatory during handling with equipment such as chainsaws, brush-cutters and hazardous substances, showing a great concern for the wellbeing of field workers.

Management Team:

Miguel G. Caetano Ferreira – Founder of *Furnas LandLab*, Manager from Sept. 2007 to Jan. 2015; Forestry Engineer and Natural Resources Manager; *MSc. Urban Forestry & Urban Greening*.

Malgorzata Pietrzak – Co-manager of *Furnas LandLab* from Nov. 2008 to Jan. 2015; Horticulture Engineer and Garden Designer & *MSc. Agronomic Engineering*.

Filipe Teixeira – Trainee and later contracted at *Furnas LandLab* from 2012-2014, Landscape Architect and Art Historian;

Over 30 plus local, national and foreign trainees, who contributed to Furnas LandLab, enriching it with their work and ideas.

Field Team:

Cláudio Silva – Highlands Foreman;

Sérgio Melo – Furnas Lake south margin Head Gardener;

Hugo Ambrósio – Traditional Furnas fruit orchard Foreman;

Fernando Melo – Tractor driver and Foreman;

Emanuel Medeiros – Foreman, transferred to initiate the new project at Sete Cidades Lake.

The 85 unemployed workers enrolled on occupational programs who worked at Furnas LandLab.

The extensive partners list:

It is to mention that all of those who embodied institutional partnerships or by their personal involvement helped to implement this ambitious project, have been cherished as part of the team, and without their help it would have been impossible to accomplish *Furnas Landscape Laboratory* or even transpose the borderline from intentions to actions.

To all we would like to express our most sincere appreciations!

CONCLUSIONS AND FINAL REFLEXIONS

Furnas LandLab in the Protected Landscape Area of Furnas, included in São Miguel Island Natural Park, is a project that will never be concluded due to its dimension, the constantly changing landscape and the great dynamics and interactivity of the project and ongoing partnerships.

The quality of the landscape and the perseverance of this ecological, social, cultural, aesthetical and economic rehabilitation will only be possible through a very active presence in the field, involving the various partners in the creation of a landscape in constant transformation, evolution and maturing. This is a landscape that can achieve its maturity but should never lose its dynamics and innovative character. The landscape restoration is the fundamental issue; however it should not be limited to the restoration of an historic and cultural landscape, but should also seek to create an innovative multifunctional forest landscape.

This entire transformation is just a beginning in what concerns the change of mentalities and attitudes towards the landscape, since it needs additional involvement and support from the local community. The success of it to be an ecologically, economically, socially, culturally and aesthetically sustainable landscape depends on the interactivity with the local community and visitors, consequently, sponsoring a sustainable development by means of ecotourism.

From the numerous trials carried out in *Furnas LandLab*, even if just a few turn to be successful cases enabling the harmonious coexistence between ecological and economic interests, which can be reproduced and adapted to other protected areas in Azores, then this will be already a praiseworthy accomplishment.

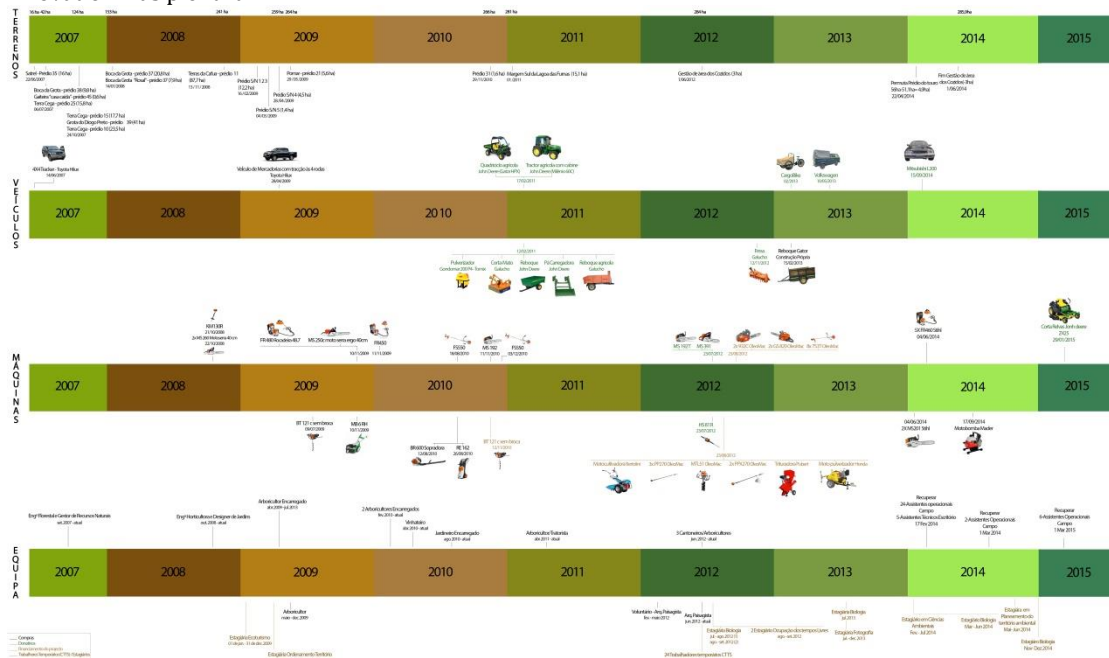
Furnas Landscape Laboratory has already won prestige at national and international level, by means of the granted awards, as well as for the recognition by its peers through the Council of Europe, who classified it as an example to follow and included its management guidelines into the toolbox available for others involved in the management of similar areas.

These results represent the recognition of an innovative, integrated and complex strategy, which is expected to be long lasting in the future.



Summary of 7 years work at Furnas LandLab:

- 2 National Awards;
- About 300 ha of land being managed;
- A small field team with 4 excellent foremen in charge;
- Over 35 partnerships established;
- A small fleet of 6 vehicles (5 of which offered by our partners);
- Numerous field machines were acquired (most of them through projects, partnerships and donations);
- A small carpentry was created, which produced a number of pieces that has facilitated to embellish the landscape;
- About 300 young soldiers from the Azores Military Zone were trained in the environmental field work;
- Over 85 workers through unemployment occupational programs (average 12 months of stay);
- Over 1000 volunteers;
- Over 30 trainees: local, national and international;
- Dozens of guided interpretative walks to the intervened areas;
- Welcoming of several ministers, European commissioners, ambassadors, regional representatives and international groups;
- Two successful annual festivals have been established: Furnas Woodcarving and Furnas Willow and Natural Fibers Festival;
- Hundreds of thousands of trees, shrubs and herbaceous were planted;
- Over 30.000 herbaceous endemic plants have been produced, that were reintroduced to Furnas and other places in the island;
- Diverse research trials, international projects, local experimental plots and thematic forests were established (MIT Green islands – Woody biomass; Reinforce –arboreta, Zephyr; forest genetic breeding programs, SLAM traps for arthropods; endemic species seed orchards; PT logo, SATAForest; Bensaude GreenPrint; ICCA Logo; Logo Valorpneu; Management Plan for EuroScut; willow collection; production of Italian arum, wheat, rye and flax).
- Several orchards in altitude either with traditional cultivars of apples, pears, plums etc. or with endemic blueberries were established;
- A traditional Furnas fruit orchard formerly neglected, was regenerated, has a vast collection of species and cultivars, and it is ready to be opened to public;
- New pedestrian and multi-use trails were opened, one of them recently homologated;
- Numerous invitations to project presentations at national and international level were accepted;
- The first bat shelters in the Azores were constructed and colonized with success;
- Over 8000 silage bails were made, which financed a large part of the operations and management;
- Removal of pollutant waste, combating invasive flora, native flora plantation , and countless other tasks were part of a daily work of our small field team;
- Innovation was plentiful...



All of this mentioned above was only 20 % of what we would like to have done or obtained, and only 50% of what we could really have done or obtained. Nevertheless it is what we managed to achieve regarding the budget restrictions and other constraints that our society has been going through.

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