

1. INTRODUCTION TO FURNAS

1.1. FURNAS VALLEY HERITAGE

The Azores archipelago is situated in the middle of the Atlantic Ocean and consists of nine islands of volcanic origin. The Azorean landscape is marked by the volcanic activity, which periodically has been giving rise to moments of deep drama for the inhabitants and has been the major landscape generator, the consequence of which is a rich geological heritage. The islands morphology was determined by its volcanic nature and conditioned by the action of natural elements. In São Miguel island, depressions created by collapsed volcanic craters originated numerous lakes such as Sete Cidades, Fogo, or Furnas.

Since the exploration of the island of São Miguel, Furnas has been attracting visitors to experience the phenomenon of its geothermal water baths and fumaroles fields', where a traditionally prepared stew is cooked in the ground (poster, Fig.12). Furnas Lake and the adjacent village has been a magical landscape for tourist destination, astonishing with its volcanic activity, geological diversity of caldera and lush vegetation. The village has about 1800 inhabitants, doubling this number in the summer months. Furnas valley has a significant cultural heritage, rich in gastronomic traditions; religious and folk festivities; astonishing well-known parks and gardens such as Terra Nostra, and quality architectural buildings, such as a neo-gothic Chapel (poster, Fig.19) a result of the XIX century gentlemen-farmers trend. At present, tourism, dairy and beef farms, as well as *Cryptomeria japonica* based forestry are the basis of the local economy.

1.2. LANDSCAPE DEGRADATION PROBLEMS

Since the beginning of the settlement of the islands in the XV century the natural resources have been depleting. Over the centuries most of the natural forest was cut down, giving way to agricultural land and its monocultures. The economic history of the Azores is characterized by the phenomenon called "colonial monoculture export". The agricultural cycles of mono-specific crops have been dominating the Azorean economy, and have deeply marked the landscape.

Given the insularity that slowed some periods of technological and cultural evolution, and competition from continental producers, the export dependent monocultures went into eclipse, one after another, creating the need to search for new productions that would be viable during the coming decades.

Recently, Furnas landscape has struggled with the following problems:

Monoculture of dairy and beef farms – Furnas Lake eutrophication. With the input of subsidies into dairy and beef farms, there has been a decline and loss of traditional fruit orchards and vegetable gardens which resulted in growing dependence on imported products. Farming is the major contributor to the local economy and since the intensification and mechanization in the 1960's it has been associated with growing environmental problems. The pollution of the water is due to extensive areas of artificial pastures with no forest cover; erosion problems; livestock overload; fertilizers and manure discharge to the lake tributaries. In particular, Furnas Lake has been suffering from the excess of phosphorus and nitrogen from the pastures runoff within its watershed, resulting in the lake eutrophication.

Biodiversity loss – invasive species. Due to the geographical isolation there are diverse endemic species of flora and fauna in the islands. Azorean native forest *Laurissilva* is a living fossil, with about 70 endemic vascular plants. Currently, the native flora occupies only a small percentage of the total vegetation cover existing on the Azores islands. Many of the introduced species coexist harmoniously with humans and the landscape; however, some species have become invasive by dominating and suppressing native flora, and have contributed to the landscape and biodiversity degradation. For example hydrangeas have been seen an ex-libris of the Azorean roadsides but if not confined, they are spreading aggressively to new areas of abandoned pasturelands and native forests. Furnas landscape has suffered a significant human impact, as a result of many invasive plants having escaped from the gardens, proliferating in this mild climate with no natural enemies, outcompeting the native vegetation and its biodiversity.

Monoculture of *Cryptomeria*. Since the end of the XIX century, the forestry sector has been dominated by a massive cultivation of *Cryptomeria japonica*. Although it remains an important species for the forestry sector there is a need for its diversification. This is essential because its timber value is very low, its ecology requires clear-cuts, which originate large-scale erosion processes, and it creates dark forest stands with no undergrowth, deprived of biodiversity. The *Cryptomeria* is grown in a short rotation cycle of approximately 30 years; this intensive cultivation has resulted in an accumulation of pathogenic agents such as *Armillaria* sp. fungus.

1.3. SOLUTIONS - Plans and policies

The emblematic Furnas Lake urged solutions to the progressing degradation of its water quality as the blooms of green, yellow or fluorescent blue micro algae on its surface and putrefying smell were clear signs of its eutrophication. For this reason the Regional Ministry of Environment created the **Furnas Lake Watershed Plan**, published in 2005. Since 2007 the actions of the Plan have been implemented under the name of **Furnas Landscape Laboratory (Furnas LandLab)**, a large scale ecological and landscape restoration. The *Furnas LandLab* concept was established to give an exemplary value to be repeated in other sensitive Azorean sites. It combines the objectives of the Furnas Lake Watershed Plan, complemented in past years with the aims and regulations of **Furnas Landscape Protected Area** and the **Management Plan** (the policies described in the *Application Form*, point 10).

The *Furnas LandLab* gives top priority to the sustainability and multi-dimensional actions, focusing on ecological and landscape restoration, highlighting the economic as well as social, cultural, aesthetical and quality aspects. Its experimental plots have been established across the landscape as a result of a multitude of collaborations and partnerships with private institutions, associations, universities and research centres, among others. Most experiments that have been taking place study sustainable soil occupancies and activities, complementary or alternative to current monocultures, helping to diversify the local and even regional economy.

The field trials do not only have environmental but also socio-economic and cultural objectives, involving disciplines such as: Forestry, Agronomy, Biology, Horticulture, Ecology, Biotechnology, Environmental Psychology, Landscape Architecture, LandArt and Nature Tourism. The *Landscape Laboratory* concept is not new; there are already several functioning examples such as Sletten in Denmark, Alnarp and Snogeholm in Sweden.

The *Furnas LandLab* ecological and landscape restoration actions gained visibility and a channel to provide and exchange information through the **Furnas Monitoring and Research Centre**, inaugurated in 2011. The Centre has been the headquarters of the *Furnas LandLab* management and the Natural Park of São Miguel front desk, serving also as a visitors centre consisting of an exhibition room and auditorium (chapter 3).

2. FROM PAPER TO PRACTICE

The milestone in the landscape and water quality restoration was the acquisition of approximately 300 hectares of farmland and *Cryptomeria* forest by the Azorean Government that took place in 2007. Since the establishment of Furnas Lake Watershed Plan and availability of the public land acquired, the *Furnas LandLab* project was settled. It took an ambitious course not only of the water quality restoration, but became a **multifaceted and multisectoral project of transformation and revitalization of the landscape**, involving individuals and collective bodies at local, regional and international level. **Numerous interventions** have been **successfully accomplished**, several of which are described below.

2.1. CLEANING UP THE LANDSCAPE

One of the first steps taken on the farmland purchased was the removal of tons of various types of waste, including silage plastics, packaging of pesticides, oils, chemicals and barbed wire. The state of ecological and aesthetic degradation was such, that there were several dozens of tires and entire scrap vehicles removed from the water lines. Segregation by different classes of toxicity was done, followed by redirection for recycling to waste treatment stations.

2.2. COMBATING INVASIVE SPECIES

This was one of the key actions for a full landscape restoration. At the Furnas Lake watershed, invasive flora predominated the abandoned pastures, the streams and erosion gullies, being represented by species from different parts of the world: *Hedychium gardnerianum*, *Rubus ulmifolius*, *Leycesteria formosa*, *Gunnera tinctoria*, *Solanum mauritianum*, *Clethra arborea*, *Pittosporum undulatum* and *Acacia melanoxylon* among others.

Since the beginning of the project, 146 ha of degraded pastures and woodlands were subjected to invasive flora control. The eradication of the invasive plants have been a time consuming process, requiring repeated treatments due to abundant seedbank in the soil and high dispersion rate by birds. Without this intervention, the plant invaders would continue to thrive and subjugate native plants, reducing considerably the biodiversity by forming mono-specific stands.

2.3. PREVENTING EROSION AND LAKE SILTATION

Erosion gullies. Most of the land had a natural hilly topography, which played an important role in accumulating and dispersing the water through various land depressions. Agricultural intensification led to major clear-cuts of natural forest, followed by land levelling and creation of high-altitude pastures. The flattened pastures, covered only with the herbaceous strata became eroded by the force of torrential water and as a result erosion gullies were formed. Each year those erosion gorges grew bigger, reaching the size of several meters long and 6-8 meters wide and deep, with the water dragging huge amounts of soil and sediments to the streams and ultimately to the lake. Since early 2008, there have already been eight gullies intervened and restored in an area of over two hectares; where the erosion process has been ceased.

Green engineering and restitution of native flora. Using the trunks of cut down invasive trees, the water energy sinks were created to reduce the water velocity inside the erosion gullies, therefore diminishing the soil eroding processes. Upstream the erosion gullies, v-shaped wooden structures (poster, Fig.30) serving as water dispersal were also built to scatter water away from its accumulating points. The native species were reintroduced, shrubs and herbaceous such as reeds, adapted to waterlogging and able to retaining the water in the sod and filtering its sediments, preventing its entrainment by water. Other soil stabilization trials included use of geotextiles impregnated with seeds, as well as coconut fibres and nets.

Retention basins of solid particles. To prevent the entry of large quantities of sediments into the lake, there were six retention basins raised in the beds of three streams. They were constructed using gabion stones and metal nets, which allow the percolation of water, retaining most solid particles. Every year there are about 20.000 m³ of soil detained at the retention structures and subsequently removed mechanically. With an aim of sustainability of labour and resources this soil has been used in various projects within the Furnas landscape. Such projects include the stream banks elevation and simultaneous invasive species suppression to enable the establishment of a willow collection; establishment of a Driving Range for the Furnas Golf Course (poster, Fig.4); *Bensaude Green Print*: creation of viewing points among the plantations.

Creation of swampy areas. Rainwater used to be channelled away from the agricultural land, towards streams and then to the lake, through the drainage channels made by farmers. It was flowing very fast from the high-altitude pastures (680m) to the lake (280m), dragging huge amounts of soil with its strong currents. The actions taken in the *Furnas LandLab* areas, consisted of blocking drainage channels with soil and stabilizing them with vegetation, so that now the water accumulates in natural topography depressions and slowly infiltrates to the aquifers, not causing erosion. The new swampy areas promote biodiversity in the landscape and are frequently visited by birds.

2.4. SUSTAINABLE MANAGEMENT OF PASTURES AND MEADOWS

Nutrients in excess. Upon acquisition of dairy farmlands, most pastures were under a semi-intensive management, with frequent, excessive and unnecessary fertilization. The first soil analysis showed very high level of phosphorus, 150-160 ppm, whilst more than 30 ppm is already considered a very high value (the Olsen method). It was necessary to reverse this situation because of constant nutrients leaching into the streams that consequently ended up in the lake.

Flowering meadow and its biodiversity. The first step was to recuperate degraded pastures by sowing grasses and a clovers mix to ensure that a natural process to regulate the levels of nutrients in the soil has been undergoing. The sowing of over 13 ha of a pasture with the clovers: the red, violet, white and yellow *Lotus*, was performed to create single-colour flowering carpets, each 25 m wide and 500 m long. The landscape aesthetic enrichment with the collation of the unusual colours and biodiversity of insects brought to the scene members of the Azorean Association of Amateur Photographers. (poster, Fig.8)

Revenue and removal of nutrients. Another advantage of herbaceous cover improvement was its economic effect in the production of 6500 silage bales within a period of 5 years by harvesting the grassland in the watershed. These silage bales sold through São Miguel Farmers Union to their associates, have been a large source of revenue for the *Furnas LandLab*. It is also a way to diminish soil saturation with fertilizers, as the nutrients absorbed by the organic matter, have been exported away from the lake watershed in the form of silage bales.

Local products. There was also diversification of economic activities by creating a partnership with the local beekeeper from Furnas, who installed several beehives among the flowering pastures and whose artisanal products such as honey and sweets have been sold in the gift shop of Furnas Monitoring and Research Centre.

Ecotourism. The new management of large areas of grassland gave opportunity to various activities boosting ecotourism such as *Azorean rustic golf*, (poster, Fig.5) organized in collaboration with São Miguel Tourism Board. Local and foreign golfers were playing this Azorean variation of “pitch and putt” scoring into holes over the 20 ha of the grassland. Simultaneously, golf classes were given to the local youth.

2.5. DIVERSIFYING THE FOREST ECONOMY AND FORESTRY TECHNIQUES

Multifunctional forest landscape. In the *Furnas LandLab*, diversification of the forest economy is guaranteed through actions such as planting the experimental plots and forest stands, using new: species, provenances, products, planting tools, equipments, techniques and concepts. This is to create a rich and diverse forest mosaic. This *multifunctional forest landscape* consists of areas of clearings with meadows and pastures, others that are occupied with fruit orchards and planted with forest. In *Furnas LandLab* it has been important to combine production with conservation measures; however there are also areas committed almost exclusively for protection and conservation purposes.

New production model. The primary objective was to demonstrate the production model where noble hardwoods dominate (poster, Fig.27), as complementary alternatives to the present monoculture of *Cryptomeria japonica* stands. The first five experimental plots included three main species: *Fagus sylvatica*, *Quercus robur* and *Betula pubescens*, mixed with some conifers. This diversity of hardwoods and conifers had a considerable impact on the promotion of the habitat, attracting wildlife, birds in particular, resulting in a diversified and better quality landscape, and aesthetically interesting during the winter months. What is more the pathways were left open for a pleasurable experience in the forests, in this way expanding its multi-functionality.

Innovation. New techniques: individual protection tubes were used to increase the success of new plantations and the quality of timber obtained, reducing the maintenance costs and damage caused by rabbits and rodents. Four years after planting noble hardwood stands, the trees showed a high growth rate, combined with a low mortality rate.

Biodiversity “islands”. Hedges of invasive plants occupying the pasture borders, were removed, making way for the placement of endemic flora dividing these different species forest stands. Along the forest road, the endemic blueberry was planted in large quantities; thenceforth it has been named “the blueberry trail”. Other areas were occupied with experimental plots established with various tree species as well as orchards of apple trees and endemic blueberries.

2.6. BUFFER STRIPS

Given the fragile ecosystem of the stream banks, control and removal of bramble bushes were performed manually using only mechanical methods without chemical spray. Following the clean-up, the native species were planted in linear stands approximately 10 m wide and 2,5 km long, to protect streams and their margins. In these sensitive areas, forest cuts will not be performed, to minimize the risk of erosion and degradation of the stream banks. Plantation of the buffer strips with thousands of native shrubs and trees were made with the involvement of various schools (poster, Fig.2) while the terrain preparation was done by the militaries.

2.7. INDIGENOUS SPECIES SEED ORCHARD

The native plant performances were previously not studied, and so were unknown. There was a preconception that the *Laurissilva* species had a very small annual growth rate. With the utilization of the individual protective tubes, the plants survival rate has reached approximately 90%. The monitoring proved the growth of some species can reach 1,2 meters annually.

With a growing need for the plantation of indigenous and endemic species, it became evident that the anthropogenic pressure of collecting the seeds and cuttings had negative effects on the natural populations. For this reason, the installation of orchards producing seeds took place in public areas at *Furnas LandLab*, not only to reduce the impact on natural plant populations, but also to allow other techniques of ecological recuperation to take place. An easy access to large amounts of seeds allows direct seeding in areas of ecological restoration, reducing costs, in comparison to the costs of nursery production. Some of the native species seed orchards planted had the support of partners integrated into joint projects (eg. Sata Forest, PT Logo, Bensaude Green Print, MIT - Woody Biomass).

2.8. MIT GREEN ISLAND – 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 types of soils, 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.

2.9. ARBORETA REINFFORCE

The two arboreta established in Furnas, with numerous provenances for each species, are integrated in the European network of arboreta REINFFORCE (REsource INFrastructure for monitoring and adapting European Atlantic FORests under Changing climatE), to study climate change across the European Atlantic Coast and its influence on the trees.

Apart from the global objective, these tree collections enable the evaluation of the forest species and provenances which could become more sustainable ecologically, economically, socially and aesthetically; as well as give alternatives to the current monoculture of *Cryptomeria sp.* In the future, species or provenances obtaining good forestry characteristics could contribute to the diversification of the forestry sector. Good quality timber species would also allow the improvement of the wood extraction methods, contributing to reduce the dimension of clear-cuts which is one of the biggest ecological and aesthetical problems currently inherent to forest landscape in the Azores. The new tree species, of ecology different than *Cryptomeria*, combined with the added economical value of timber may eventually allow selective cutting and close-to-nature silviculture (mimicking the natural forest cycle). Already in 10 to 15 years, the trees performances can be evaluated by forestry entrepreneurs concerning their utility and aptitude to the sector.

2.10. RETURN OF THE ORCHARDS AND OTHER CULTURAL VALUES

2.10.1. FURNAS TRADITIONAL OLD FRUIT ORCHARD RESTORATION

The three ha orchard was acquired in 2008 under the implementation of Furnas Lake Watershed Plan. It contains its divisions, hedges and remaining old orange trees and carries a cultural heritage of educational interest, being adjacent to the Furnas Lake fumaroles (poster, Fig.13), one of the most visited spots on the island of São Miguel.

Restoration of this orchard started in 2008, by removing the weedy species, applying treatments and pruning of old trees and tall hedges. New rootstocks have been placed and grafted with regional varieties of citrus, apple, pear and plum trees, all collected from old gardens of São Miguel. The Agricultural Development Services of São Miguel and the local community became involved in its recuperation; children from Furnas Primary School planted a windbreak of over 250 native shrubs and trees, replacing the previous *Cryptomeria japonica* stand.

The aims and activities associated with the orchard fulfil two objectives of Furnas Lake Watershed Plan, namely, the *promotion of local values* and *diversification of the local economy*, anchored in demanding environmental education. A display of monocultures that have been grown throughout the Azorean history is being established, along with a collection of traditional varieties of fruit trees. The orchard welcomes visitors of all ages to acquire knowledge about the history of agriculture in the Azores, and allows them to rediscover and enjoy the forgotten varieties that have almost disappeared from the regional market. There is also the objective of organizing cooking workshops with the use of products from the orchard, as well as guided tours, activities, lectures and practical classes (poster, Fig.14).

2.10.2. NEW ORCHARDS AT HIGH ALTITUDE

Diversification of the forest landscape includes the installation of new orchards on *Furnas LandLab* high lands (approx. 500 m). This 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 system of the *integrated plant protection* assures the coexistence of the fruit production and the improvement of the lake water quality. The algae removed from the lake have been used to increase the level of organic matter in the soil, providing nutrients to trees.

Furnas apples, once abundant but recently almost “extinct”, have been revitalized in a partnership with the Agriculture Development Services of São Miguel. An area of one hectare of former neglected pasture covered with invasive species has been planted with 21 regional varieties, grafted on three types of rootstocks (poster, Fig.29). With similar domestic fruit production orchards being established by private owners, there are already local products being

developed including jams and liqueurs made by the local cooperative *Celeiro da Terra*. By adjusting to tourist market demands it will be possible to increase the cultivation areas and production of these and other goods.

2.10.3. ENDEMIC BLUEBERRY ORCHARDS

The endemic Azorean blueberry (*Vaccinium cylindraceum*) is a species that has beautiful flowers with reddish sprouting leaves. Its fruits, although smaller and more astringent than the commercial blueberries, are extremely rich in antioxidants. Formerly, it occupied large natural areas at high altitude; however, during the forest clear-cuts and conversion to agricultural land, many plants have perished.

In the *Furnas LandLab*, there were two orchards planted (replicated in poor and rich soils). Each one has over 800 plants of identified genetic units. The objective is to follow the growth of each plant and its fruit production taking into consideration the quantity and quality, such as flavour, size and antioxidants. Once established, the best fruiting specimens will be selected to create new economically viable fruit orchards. These *Furnas LandLab* trials have been developed in partnership with both the Agriculture Development Services and the University of the Azores.

2.11. BEAUTIFUL INVASIVE SPECIES REPLACED BY BEAUTIFUL ENDEMIC SPECIES

Along the charismatic, well-known alley of outstanding London plane trees in Furnas, a strategy to promote endemic flora with the replacement of exotic flora was implemented. This consisted of replacing ornamental invasive species: *Hydrangea macrophylla* with an endemic species *Viburnum treleasei*, with beautiful white flowers and clusters of dark blue metallic fruits and evergreen foliage, decorative the whole year, contrary to *Hydrangea*. By these interventions, the Azorean flora is being promoted among the locals, as well as the tourists. As a result of a partnership with the Regional Road Services Board, this type of intervention will take place in other protected areas of São Miguel, along the roads and panoramic sites.

2.12. WILLOW COLLECTION AT THE STREAM MARGINS

During recuperation of degraded stream margins all the invasive vegetation was removed. The huge amount of biomass extracted was utilized having in mind the ecological, economical and social sustainability. The useful acacia timber was sawn and used for structures on the trails and within the Furnas landscape. Other wood was given to the local community as firewood, whereas the branches and foliage were shredded by the local cooperative *Profrutos*, and utilized as mulching for glasshouse pineapple cultivation; all of this at no extra costs for the *Furnas LandLab*.

After the invasive vegetation removal, the irregular stream banks were exposed, still carrying a huge amount of seed bank in the soil. For this reason, the stream banks were shaped by covering them with a thick layer of soil that was taken from the retention basins inside the river bed (an example of the sustainable use of resources).

Finally, a collection of 26 varieties of osiers acquired from the Rothamsted Research UK national collection was established (poster, Fig.24). The deep-rooting osiers were planted to stabilize the soil and consolidate the embankments, filtering the sediments, which is also a sustainable way to manage water line margins. The aim of the new varieties introduction with different colours and weaving properties was to diversify the handicraft, attract new artisans not only to do basketry but also for Land Art activities. This can be achieved as a result of the collaboration with the *English Basketmakers Association*, which delegated the tutors to teach the innovative craft in the Azores.

2.13. MULTI-PURPOSE TRAIL NETWORK

The creation of the trail network channels allows the users to walk through the landscape of Furnas Lake watershed, diminishing the existing pressure on the hot-spots of the fumaroles fields by the lake. The Furnas trail network includes trails for different user groups to minimize friction and possible conflicts between them.

The pedestrian trails have been created in a connection with the present trails, to enable users to have several options of loop circuits, with diverse degrees of difficulty and varied duration. Improvements to the conditions of the existing trails have been made, including new wooden structures installed for eco-toilets or mountain huts. The new trails include *Grená trail* that goes along the top of the crater of Furnas Lake and passes through the remnants of an old manor house (poster, Fig.10) surrounded by a garden-woodland; and a short picturesque *Waterfall trail* (poster, Fig.26).

The Furnas downhill trail was created in the southern part of Furnas watershed to move the cyclists away from the pedestrian trails. It successfully became exclusive for mountain bike users, and since its opening has hosted two regional downhill championships (poster, Fig.25).

Multi-use trails are former farm roads, where car traffic is restricted. Their dimension allows multiple uses (pedestrian, equestrian, cross-country, cycling).

Reduced mobility trail is associated with the recuperation of the margins of Furnas Lake, which includes upgrades of the pavement and creation of restroom facilities for those with disabilities. This is to be the first loop trail in the Azores, adapted to the users with reduced mobility.

2.14. FURNAS LAKE MARGINS RECUPERATION (THROUGH COHESION FUNDS: PROCONVERGÊNCIA AND POVT)

2.14.1. ECOLOGY AND AESTHETICS

The Furnas Lake margins were devoid of native vegetation, with only a few indigenous species sporadically scattered across the landscape and a large area covered by invasive vegetation. During the implementation of the Landscape Architecture project developed by PROAP (Landscape Architecture Project and Planning Partnership), all the herbaceous and woody invasive plants were removed. Moreover, there were over 3000 plants reintroduced, representative of ten species of autochthonous Azorean flora.

The stream banks were stabilized by sowing herbaceous cover and the implementation of fascine made of *Salix* sp and *Alnus* sp., which serve as a source of raw material for local artisans and for Furnas *LandArt* structures. Along the margins, the green spaces were seeded with a mixture of clovers, which absorb the air nitrogen and require no fertilization. Grass cuts were reduced to twice a year, as a tall meadow is a richer habitat than a frequently trimmed lawn. The reduced maintenance has caused the plants to grow abundantly, increasing the biodiversity levels and saving resources (hand-labour, machines, fossil fuel). Access to the south margin of the lake has been restricted for vehicles, allowing visitors to enjoy nature walking or cycling on the sidewalk or paths shaped by the grass cutting in the meadow.

2.14.2. SITE RE-ADAPTATION

Furnas Monitoring and Research Centre was designed by the world known architect Manuel Aires Mateus and it was built in the 1st phase of recuperation of Furnas Lake margins. The building was constructed over the abandoned ruins of a hotel (poster, Fig.21). This contemporary structure blends with the surrounding landscape through its coating of basalt volcanic rock from the region. It won the International Award of Architecture in Stone, attributed in 2011 in Verona.

The Centre has an area for management, research, monitoring and projects development, in an open office space. Facilities also include an exhibition room and an auditorium to host seminars, workshops, audiovisual projections.

Another construction adjacent to the Centre consists of **four temporary residences** prepared to host researchers and collaborators, invited to assist with the ongoing projects at the *Furnas Landscape Laboratory*. In addition to this, the outdoor space offers a picnic zone, public toilets, car park and vast green space, with a privileged view of the lake, where visitors can appreciate the landscape and enjoy leisure activities.

3. RAISING ECOLOGICAL AWARENESS - FURNAS MONITORING AND RESEARCH CENTRE

Since 2007 numerous educational activities have been implemented, stressing the practical component of fieldtrips and hands-on activities. In particular, university students and school youth and children have been participating in the fieldwork by planting endemic flora, placing protective tubes and maintaining young plants (poster, Fig.20). Apart from that, many volunteering opportunities open to the public took place and various partnerships with institutions were “marked” with the planting activities, made by their personnel.

The Centre in its day-to-day functioning receives visits from tourists, locals, schools, universities, as well as various institutions. The exhibition through interactive tools accessible to users (poster, Fig.22), multimedia platforms and guided tours leads visitors to the discovery of the lake ecosystem, as well as the local geology, flora and fauna, focusing on the ecological and landscape restoration of the Furnas Lake and its surroundings. It plays an important role in raising the environmental awareness, alerting the community about the landscape and lake water quality problems, as well as showing the solutions and actions that were implemented.

The Furnas Monitoring and Research Centre is the front desk of the Natural Park of São Miguel, which is composed of a series of protected areas across the island and is also an important source of information regarding these protected areas. It is also the headquarters of Azores Geopark, and the European Sustainable Tourism Chart – *Terras do Priolo* (Azores Bullfinch Lands).

Since the inauguration of the Centre in July 2011, even more events and free activities have been taking place, directed at the local community under the initiative of the *Open Park*. Such events included sports and recreational activities of: yoga classes (poster, Fig.18), a fishing contest, learning archery, paintball games, photography hikes, and interpretative hikes. The environmental education was a strong component of all the activities (poster, Fig.16).

4. COMMUNITY INVOLVEMENT & PARTNERSHIPS

Public participation was imperative for the success of *Furnas LandLab* project implementation. That is why numerous partnerships were established to involve the local community, businesses, scientific institutions, and associations along with governmental bodies. This has been the first initiative of this kind in the Azores. Stakeholders have realized that the role of recuperation of degraded landscape is an obligation of the whole society, not just the bodies of public administration.

Most of the open to public events and the development of partnerships involve field trips and volunteering activities, which are mutually beneficial. This allows for an increase of public participation and interest in the project, as it creates proximity between visitors and the managers of the area. The on-site dialogue includes discussions of the actions implemented in the field, explanations of the decisions that were made, the type of management adopted and what planning exists for the future. In return, the stakeholders, by expressing their opinions, can actively contribute to the projects within *Furnas LandLab* and positively influence the decision making process.

4.1. LOCAL COMMUNITY

Furnas Scouts. A small parcel of forest by the lake has been provided for the scouts, who are responsible for its direct management. In this area, close to Furnas Research and Monitoring Centre, the young scouts learn about invasive and endemic flora, plant autochthonous forest and make wooden constructions to earn their next rank.

Furnas Primary School. The local school has been integrated in various activities that promote their status of Eco-school. The schoolchildren have planted several hundreds of endemic species on the shores of Furnas Lake, and have actively participated in the environmental activities conducted at the *Furnas Monitoring and Research Centre*.

4.2. BUSINESS INSTITUTIONS

Regional airline SATA. A SATA Forest has been established, in a hilly pasture of 12 hectares, where each hill will represent a destination of SATA by planting with a tree species typical for that destination (city or region). Over 20 members of SATA staff have participated in the first plantation (poster, Fig.7) that was the destination of *São Miguel* island, planted with *Prunus azorica*, which is an endangered endemic species typical for this island.

PT foundation. The plantation was made in an area of 100 m x 100 m, with a large scale reproduction of the company logo (poster, Fig.3). The blue areas of the logo incorporate endemic *Juniperus brevifolia* whose new shoots are bluish. There were approximately 70 PT employees participating in this volunteering and team building activity. The work developed in Furnas was shown to 10.000 PT employees at the company Christmas dinner at the Atlantic Pavilion in Lisbon.

Bensaude Group. This major economic group in the Azores has been collaborating on a new project called **Bensaude GreenPrint**, receiving support from over 2200 employees. The plantation will include native *Morella faya* trees, forming a large-scale outline of an orange tree, where its branches and trunk will create interpretative paths, whereas the foliage, flowers and fruits will create points of interest, filled with *Land Art*. The use of the orange tree and *Morella faya* has symbolical meaning as it refers to the historical roots of the Bensaude Group.

Another goal of this collaboration is to create a **Land Art festival in Furnas**, involving the entire Furnas Protected Landscape Area, the internationally recognized Terra Nostra Garden, run by Bensaude Group, as well as diverse national and international institutions and faculties of Fine Arts.

STIHIL, A.S. Maia. The margins of Furnas Lake hosted two weekly editions of the **Furnas Woodcarving Event** sponsored by STIHIL and its local representative. The French champion in chainsaw carving, Emmanuel Courtot, sculpted several trees that were in decline or had an invasive potential. The tree trunks were transformed into Furnas wildlife specimens' pieces of art. In conjunction with the event, there was a free training provided for various fieldworkers from different organizations. The participants were educated on how to properly use handheld power tools (chainsaws, streamers, blowers etc.), thus increasing overall knowledge, safety standards and ergonomics.

Furnas Golf Course, Ilhas de Valor. Ecological Driving Range was created within the limits of Furnas Lake watershed, which is why environmental management practices are of great importance. For sustainable use of resources, the soil from stream retention basins was used in creating the *Tee* of the *driving range*. Apart from that, the natural water flux was not disturbed, as the surrounding area of the *Tee* continues to be a wetland (poster, Fig. 4). This also promotes

diversity, proliferation of native plants (reeds) but also the insects, butterflies and avifauna such as migratory birds. Contrary to the former pasture management, the current practices do not involve the use of any agents harmful to the environment.

This partnership enables the existence of Pro tournaments; previously the Furnas Golf Course didn't have such amenities and sufficient area for the Driving Range. This is an example of providing diverse tourism opportunities.

EEG Group EDA. The renewable energy company conducted a geological study for implementation of a support reservoir for reversible hydropower within the Furnas Lake watershed, providing free samples of unaltered soil profiles of up to 10 m deep. The University of Oporto analysed these soil profiles, concerning the presence of pollens to identify the flora species which have existed on the island over the centuries.

MMAM Group Holding. This collaboration involves a family business comprised of foreign investors. A forest plantation has been established where each member of the family is represented by an Azorean endemic species. In return, *Furnas LandLab* fieldworkers gained new equipment, machines and a pick-up truck.

Advantage Reisen Travel Agency. The protocol brings German tourists to visit the *Furnas LandLab* and its headquarters in the Furnas Monitoring and Research Centre. All the visitors when purchasing the travel package contribute to the plantations of new native flora species.

4.3. SCIENTIFIC INSTITUTIONS

The University of the Azores. There have been various departments involved in diverse research projects; establishing trials, conducting practical lectures in the Furnas Protected Landscape.

Laboratory of Scientific Illustration of the University of Aveiro. Students develop the scientific illustrations of Azorean flora fauna and landscape features, as a part of their vocational training. Free accommodation is provided at the Furnas Monitoring and Research Centre residences for trainee periods.

Biotechnological Centre of the University of the Azores. An outcome of a protocol is the accomplishment of micropropagation of endangered flora species resulting in thousands of plants produced and planted in Furnas to serve as seed orchards. Also the first trials for a genetic breeding program for timber and fruits production have begun.

Oporto University Department of Science. The Department developed the pollen study of Furnas soil samples provided by EDA. In addition, it contributed to the *Furnas LandLab* development by assigning landscape architecture interns to work on current projects.

Faculty of Fine Art at the University of Edinburgh. Involves students with different backgrounds (Graphic Design, Product Design and Landscape Architecture) to work on different projects, in order to diversify the local handicraft and stimulate the local economy by revitalizing the use of locally available natural materials.

European Forest Institute (EFI) – through this prestigious Institute, associated Universities and research centres, integrated the *Furnas LandLab* into the international network of Reinforce arboreta, and Furnas hosted an international EFI meeting with researches from nine countries (poster, Fig. 23).

4.4. NON-PROFIT ASSOCIATIONS

The Society for the study of Birds (SPEA) contributed with following projects: *Life + Sustainable Laurissilva* and *Life + Azorean bullfinch*; through the exchange of expertise in field intervention and ecological restoration techniques. In the *Furnas Landscape Laboratory* a plot of land was assigned to SPEA for the creation of germination beds of endemic species. In addition, free training regarding machinery use and safety was provided for SPEA workers.

Athletics Club of Lagoa Preparatory School (CALAG). This dynamic partner has supported and organized various nature and sporting events at the *Furnas Protected Landscape*, always with great success and participants keen to support ecological and landscape restoration.

Cycling Association of the Azores – A downhill trail was open at *Furnas LandLab* for exclusive use of downhill cyclists, whereas the recuperation of the lake margins and conditions of the vehicle access made the margins bike-friendly. Downhill and biking competitions have been taking place within newly open areas of the *Furnas Protected Landscape*.

Association of Amateur Photographers of the Azores (AFAA). Through photography events it was possible to register and share information regarding the results of field interventions made within the *Furnas LandLab*. The pictures circulate in blogs and social network websites showing the scenic landscapes and some of its lesser-known peculiarities.

Azores Geopark Association (GeoAÇORES). Furnas geological richness and diversity makes it the most important geological site in the entire archipelago. That's why there have been thematic events, opened to public, promoting its geological values and the *Furnas Protected Landscape*.

Association of Immigrants in the Azores (AIPA). During their *PanAzorean* International Film Festival, funds were raised to perform an offset of the festival's carbon emissions, by plantation of indigenous trees and shrubs.

Association of landowners and residents of Furnas Lake. The relationship proximity with the *Furnas LandLab* management team, helped in resolving 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 collaborated with the development of the Furnas Watershed Plan from 2000-2005, and supported negotiations with its associates to reduce the agricultural pressure within the lake's watershed.

4.5. PUBLIC ENTITIES

Agency for Qualification and Employment of Ponta Delgada. Such as in the National Parks of North America during the crisis in 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. Also, unemployed carpenters were admitted and a Park Carpentry was established, allowing construction of various outdoor structures. For the promotion of biodiversity, shelters for bats, birds and insects were created. For the promotion of eco-tourism, support structures such as eco-toilets and rain shelters were raised to disperse users across the Furnas landscape.

Azores Military Zone (ZMA). This is one of the first and quite crucial partnership for the project. During the first year and a half of the field intervention in the Furnas Lake watershed implementation, field team did not exist, for this reason the day-to-day hand labour came solely from military personnel. Continually every week, Monday through Thursday, the *II Regiment of Arrifes* has been sending a team of nine soldiers to perform various tasks, such as the cleaning of waste, combating invasive species as well as the opening of trails and the maintenance of plantations. This ecological restoration work in Furnas received a **first place Award of National Defence and Environment in 2009**, attributed by its respective national ministries.

Azores Hydrographic Administration (AHA). This entity directly manages the interventions carried out in water bodies to improve its physico-chemical quality. At Furnas Lake there has been experimental trials for bio-manipulation; the suction of sediments from the bottom of the lake. On a regular basis there are algae removal from the lake's shores and removal of sludge from the streams retention basins, preventing the lake's siltation.

Agricultural Development Services of São Miguel. This institution has been providing a practical support with multiple *Furnas LandLab* trials concerning the establishment and management of various fruit trees orchards, focusing on the demonstrations of grafting and pruning, as well as recommendations for plant protection regarding organic or integrated production.

5. CONCLUSION

The *Furnas LandLab*, included in the Protected Landscape Area that is part of the Natural Park of São Miguel is a project that **will never be concluded**, given its scale and the fact of the **constant transformation of the landscape** but also **of the mentalities and attitudes** towards it. A lot of work has been already done resulting in Furnas visible landscape restoration, however still more is required to maintain and increase the dynamics of community involvement and partnerships. With the Landscape National Award we can expect the *Furnas LandLab* to prosper and find its place in the international community.