Introduction and historical record

The Comunità Montana "Val Cavallina" for the lake of Endine, the Comunità Montana n° 2 "Su Sassu, Anglona, Gallura" for the lake of Coghinas, and the Parco Naturale del Lago di Candia for the lake of Candia, have for years been implementing an intense policy of promoting and making known the characteristics, beauty, naturalistic value and characteristic products of these areas, as have their provincial and regional governments.

Even though to different extents, the three authorities have found they have to tackle the same problem of eutrophication of the waters, but also that they have the same determination to find the right solutions.

To achieve this, the three authorities have taken the opportunity to find common solutions by setting up the TRELAGHI [literally "Three Lakes"] project. The project was submitted to the scrutiny of the LIFE AMBIENTE Commission as the inspiring principles of the LIFE funding programme to foster innovative demonstrational pilot projects were considered consistent with the needs indicated by the planning instruments employed by the authorities involved for inclusion of environmental matters in planning and developing the territory, as well as sustainable water management and, more in general, of all local resources.
For the presentation, the project was organised into a hierarchy of competences headed by a coordinating group leader, the Comunità Montana Val Cavallina, referred to as the Beneficiary of the Life regulations.

Approval of the TRELAGHI project was given by the Commission to the Beneficiary on 02.08.2005 with decision C(2002)/2907 final/74. This announcement states: *"the financial support provided for by the regulations (EC) no. 1655/2000 is assigned to project proposal* ***LIFE02 ENV/IT/000079****, title:* ***Eutrophic Reduction Through Natural Technics of Three Italian Lakes Waters****, received on 05.06.2002"*.

After approval was given, very close cooperation formed between the Beneficiary and the Commission. It is based on mutual esteem and trust, and clear ideas about the future.

On 31.03.2003 and on 22.10.2003, as recorded by the Commission, the co-funder, the Comunità Montana Angona, Gallura, Su Sassu started having initial perplexities about its own role and its participation in the project.

Initially, the Comunità Montana Su Sassu, which was taking part in the project as an external co-funder, had put forward the suggestion that it might change its position and become an active partner.

When faced with the uncertainties that had arisen, in 2003 the Beneficiary prompted the Authority a number of times, pledging its full commitment to help solve any difficulties of a technical or administrative nature, as can be seen by the repeated trips made by the project manager, and by the visit of the General Director of the Beneficiary.

On 16.02.2004, the Beneficiary reluctantly informed the Commission of the decision by the Comunità Montana Su Sassu Anglona Gallura to cease to participate in and continue the initiative.

On 30.04.2004, the Beneficiary presented the Commission with a request for Substantial Variation of an administrative, technical and financial nature. Later it declared its willingness to respond to all requests for clarification and additional documents (requested by the Commission on 29.06.2004, 26.08.2004 and 27.10.2004).

On 16.12.2004, the Commission informed the Beneficiary that it had approved the financial modifications indicated in the request for Substantial Variation, while also approving the relative work plan, which was extended to 31.10.2006.

The following report on the tasks assigned, on the objectives and on the schedules, thus refers to the latest programme agreed upon with the Commission.

Conformity of the project with Community programmes.

As concerns conformity with Community programmes for environmental protection, the TRELAGHI Life project aims to achieve the environmental policy objectives of the EC and, in particular, the preservation, conservation and improvement of the quality of the environment, intelligent and rational use of natural resources based on the principles of precaution and preventive action, and on the principle of correction at source of damage caused to the environment. These

principles are included in Dir. 2000/60 of 23.10.00[1], which introduces a framework for community action concerning water management, and the TRELAGHI project intends to abide by the principle created by the directive, stating that "In identifying priority hazardous substances, account should be taken of the precautionary principle, relying in particular on the determination of any potentially adverse effects of the product and on a scientific assessment of the risk."

In particular, the aim is to achieve the GOOD STATUS of surface waters as defined by Dir. 2000/60.

As concerns the TROPHIC situation, the project also makes reference to the objectives of Dir. 91/676 of 12.12.91[2], concerning the protection of water from pollution by nitrates from agricultural sources. This directive starts out from the consideration that "excessive use of fertilizers constitutes an environmental risk, that common action is needed to control the problem arising from intensive livestock production and that agricultural policy must take greater account of environmental policy", stressing that nitrates of agricultural origin are the leading cause of pollution from diffuse sources of Community waters.

In order to achieve correct application of the directive, it is important to take the necessary steps concerning soil-management procedures and the use in agriculture of nitrate compounds and their accumulation in the ground.

The objectives of the directive, expressly indicated in Art. 1, are to:

- Reduce water pollution caused directly or indirectly by nitrates from agricultural sources;
- Prevent any further pollution of this type.
- The objective is also to respond to the provisions concerning eutrophication as outlined in the 6th Environmental Programme of the European Commission, according to which eutrophication – the excess of nutrients in water, which causes excessive growth of algae or other plants – may constitute a threat to freshwater life forms.

The project implements measures to respond positively to the numerous environmental preoccupations of the European Union. The Commission has placed particular importance on respecting environmental demands and on their integration into Community policies.

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[1]Cf. Dir. 2000/60 of Parliament and of the Council on 23.10.2000, which introduces a framework for Community action concerning water management, OJ *L 327* of 22.12.00, finally modified by Decision 2001/2455 of 20/11/01, OJ *L 331* of 15.12.01

[2] In OJ *L 375* of 31.12.91 **implemented into Italian regulations by Decree Law no. 152 of 11.05.99 (verificare),**

Dealing with the integration of environmental problems into the Common Agricultural Policy, in a Communication[3], "Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy", the Commission analyses processes that are positive or negative for the environment. The document states that some cultivation methods are responsible for harmful effects on the environment: for example the accumulation of fertilizers and pesticides in the soil and in water. The process of environmental pollution is the result of an accumulation of nitrates and other mineral residues, pesticide residues, an excessive presence of salt, and the emission of ammonia and methane.

Another Commission Communication[4], "Statistical Information Needed for Indicators to Monitor the Integration of Environmental Concerns into the Common Agricultural Policy" highlights the initial indicators, which provide the necessary contribution to assess agri-environmental policies, to pinpoint problems and understand the relationships between farming practices and the environment. It is interesting to notice the various indicators:

- soil surface nutrient balance (use of fertilizers);
- water contamination;
- ground water abstraction;
- nitrates/pesticides in the waters;
- ground water levels.

One of the main elements covered in the Commission Communication[5], "Biodiversity Action Plan – Conservation of Natural Resources" aims to reverse the current decline in biodiversity related to the management of water, soil, forests and wet areas. To achieve the goal of environmental quality, as regards the quality of water, it is necessary to use the framework directive on water as an instrument for the conservation and sustainable use of biodiversity, and carry out quantitative and quantitative analysis of water in relation to need for each river basin, including water for industrial, civil and ecological use.

Furthermore, the species that inhabit the areas involved – in particular, mute swans, mallards, grebes, coots and moorhens – are included in the list of those to be protected under Dir. 79/409/CEE, known as the "birds directive".

[3] Cf. doc. COM(2000)20, def., of 26.01.00
[4] Cf. doc. COM(2001)144 def., of 20.03.01
[5] Cf. doc. COM(2001)162 def., of 27.03.01

The TRELAGHI project provides for monitoring operations in accordance with Community regulations, which is to say “operative, investigative and supervisory”.

The TRELAGHI project has provided an innovative solution to the common environmental problem of eutrophication, based on the use of filtration systems consisting of natural components (constructed wetlands) that ensure real reductions in the content of phosphorus and nitrogen (eutrophicating agents) in the water.

Illustrative nature of the project.

The illustrative nature of the project includes the large-scale application of wetland purification systems to solve the problem of eutrophication of lake waters in different climate areas.

Plant-based filtration ecosystems combined with mycorrhizal fungi and rhizosphere bacteria, with zeolite beds and BFS waste, are the first large-scale field application for the protection of a hydrographic basin. These water purification systems can be installed and used at various latitudes, and thus can be introduced in all parts of Europe. The potential reproducibility of the techniques involved is very high, as concerns both the type of filtration ecosystems to be used, and the adoption of zero-impact fertilisation techniques.

In particular, the size of the planned operation constitutes the ideal average dimension for wetlands and lakes of this type. The project can also easily be reproduced in all small aquatic ecosystems which do not have suitable protection plans and that run the risk of disappearing.

These filtration ecosystems will be used to combat the pollution of surface waters using systems that are characterised by low impact on the environment, operational efficiency and low running and maintenance costs. Since running costs do not require the use of electricity, auxiliary chemical compounds or the artificial supply of oxygen, running costs are reduced to half those of traditional systems. Maintenance costs are simply those involving ordinary operations, which can be carried out by a non-specialised worker.

Fertilization with mycorrhizal fungi and rhizosphere bacteria costs less than traditional methods using synthetic materials, which means that this project will be able to reduce the cost of producing

agricultural crops. Furthermore, the agricultural product obtained using a model with a low level of impact on the environment is better in quality, as has been observed in some preliminary tests.

The elimination of chemical fertilisers will make a considerable contribution to reducing the phenomenon of the leaching of nitrates, thus helping combat eutrophication of the lake.

The validity of the project at the international level is assisted by the fact that the two Italian lakes involved in the application of these new techniques are in locations with different climatic and operational conditions. The project is thus an important test bench for reproducibility in all climatic areas across Europe.

To help achieve greater understanding of the environmental problem, and thus provide an incentive for behavioural models that may help achieve environmental objectives, the TRELAGHI project is designed to promote environmental education, facilitating access to information and to the exchange of expertise.

To achieve this, special information points will be set up at the main meetings focusing on environmental issues, with the creation of an Internet site and the organisation of special workshop seminars.

Direct and indirect effects on employment will involve the general improvement of the sites, thus producing job opportunities.
The initiative produces:
1. In the planning and pre-operational stage of the project;
– Expertise, culture, research and innovation with jobs for professionals, researchers, graduates and students

2. In the operational stage;
– Job opportunities for local entrepreneurs for the construction of the infrastructure, thanks to the choice of technology adopted, with low environmental and instrumental impact, privileging the professional skills already available in the area

3. In the running and maintenance phase,

- Organisation of cultural events and services for tourism and leisure activities.
- Creation of multi-objective teaching centres with hands-on ecology classes
- Maintenance of the botanical and zoological resources of the territory, safeguarding the genetic diversity of the local flora and fauna.
- Production and marketing of typical products, biological farm produce, and naturalistic aquatic nurseries (seed savers) protected by an environmental quality label.

Farm-holiday assistance services, typical lodging facilities, bed-and-breakfast facilities.

The territory

LAKE ENDINE [COMUNITA' MONTANA VAL CAVALLINA (Bergamo)]

Lake Endine, in the Prealpine area of Bergamo, in Val Cavallina, between Val Seriana to the west, the Sebino to the east, Val Borlezza to the north and the Po Valley to the south, is certainly the most significant environmental feature of the territory.

Covering 2.34 square kilometres, and with a volume of 163,800 cubic metres, it is the largest natural basin entirely in the province of Bergamo. The flow rate of its outlet, the river Cherio, is 1.4 cubic metres per second, while the average depth is 5.1 m. and the maximum is 9.4 m.

The lake is an important tourist attraction and, despite the fact that bathing still continues to be prohibited, it brings in large numbers of visitors especially during the summer months. Powerboats are not allowed and, over the past few years, with the help of an advertising and promotion campaign, rowing, canoeing and sport fishing have become increasingly popular on the lake. Of post-glacial origin, as from the 1960s it became the subject to a noticeable process of eutrophication, caused mainly by the effects of human settlements, which a number of operations promoted by the Comunità Montana attempted to put an end to.

LAKE CANDIA [Parco Naturale Provinciale del Lago di Candia (Turin)]

It is believed that the lake of Candia is of relatively recent origin, dating back about 20,000 years. A glacier coming down from the Valle d'Aosta is believed to have expanded beyond the foot of the Alps, making its way about twenty kilometres into the plain. Then, when it withdrew from the amphitheatre it had created, it left marshy, peaty areas but also the two lakes: that of Candia, with its marsh, and that of Viverone.

The lake is situated at an altitude of 226 metres above sea level, it covers an area of 1.52 square kilometres, and has a 5.5 kilometre-long shoreline. The average depth is 4.7 metres, while the maximum depth in the centre is 7.7 metres. The lake has no tributaries and is fed partly by rainwater and partly by a series of underwater springs along the southern shore.

The entire basin is an essential environment for the resting and reproduction of aquatic birds. 190 species of birds, 80 of which are nesting, are reported. The most important include the little bittern, the purple heron and the tufted duck. 425 plant species are reported, of which 227 in the actual lake area. Lastly, the marsh area of Candia gives a clear idea of the far larger area of the actual lake basin and it includes, together with the marsh (0.5 square kilometres), the small drainage channels and ponds now known as the Paludetta (0.2 sq.km).

The biological situation of the two lakes reveals some common elements: indeed, while indicating a general improvement in the health of the lakes, the most recent analyses put the overall level at somewhere between sufficient and poor. The phenomena of eutrophication, which have appeared in recent decades in the waters of the two lakes and in the Candia wetland area, caused by excessive influx of nutrients from residential waste waters and from farmlands, have led to a gradual impoverishment of the biotypes, leading to the loss and rarefaction of some forms of life in the trophic chain of lacustrian ecosystems.

Technical proposal

Present-day engineering, biological, chemical and naturalistic knowledge makes it possible to draw up an environmental intervention plan that uses tools taken from nature itself, consisting of plants, mycorrhizal fungi, rhizosphere bacteria and zeolithic rocks.

In order to better understand how these instruments can work together, we can now briefly summarise their potential in terms of safeguarding the environment.

Plants are organisms that are able to interact with the surrounding environment by means of their leaf system and rootage. By means of their roots, plants absorb their nutrients from the soil.
Symbiont mycorrhizal fungi are earth fungi that bind to the roots of the plant, helping the plant absorb nutritional substances and taking their own nutrition from the plant without causing harm.

The action of absorption by plants is also facilitated by PGP (Plant Growth Promoting) bacteria in the rhizosphere, which are capable of transforming organic substances in the soil into compounds that can be assimilated.

Zeolites are minerals classified as tectosilicates. Their structure, characterised by cavities occupied by large ions and molecules of water (both highly mobile), is responsible for their main chemical-physical peculiarities: structural and textural micro-porosity of a "real" type (since the pores communicate with each other and with the outside of the rock), high-capacity for cationic exchange in a selective manner, mainly as regards K+, NH4+ and Pb2+ (reaching values of up to 2-4 meq/g), molecular adsorption of water molecules and other polar molecules.

Zeolites are capable of absorbing 20% of their weight in water, and act as a temporary container for pollutants taken from the pollutants carrier and later absorbed by the plants.

Chabasite is a type of zeolite able to exchange the ammonia ion (NH4+) in a not overly selective manner, which means it does not compete, in terms of absorbing nutrients, with the roots of the plants, especially if they are well protected by bacteria and mycorrhizae. The extraction mechanism that takes place is caused by the interaction between zeolite and plant, which gives a twofold advantage:

- on the one hand the rock retains the ammonium from the flow of water and makes it available for the roots of the plant,
- while on the other hand the roots "regenerate" the zeolitic grains, exchanging the ammonium with the humic acid they emit.

A plant that establishes a symbiosis with mycorrhizal fungi and bacteria of the rhizosphere improves its own ability to absorb nutritional substances that are present in the soil in small quantities. A bio-naturalistic system designed to restore the microbiological equity of the soil, respecting its biodiversity, can only use plants, mycorrhizal fungi, earth bacteria and zeolites as its substrate.

The root-fungus-bacterium-zeolite system is a significant innovation in the field of water and soil preservation and reclamation.

Making use of the characteristics of chabazitic zeolites, together with the capabilities of plants and the metabolic activity of bacteria and mycorrhiza of the rhizosphere, leads to good results in the removal of pollutants from the soil, and from waste water and leach water.

Recent experiments in Australia (Sakadevan et al. in 1997) have examined the adsorption capacity of phosphorus (P) by industrial byproducts, to study the potential use of adsorbent materials in wetlands, in order to remove these pollutants from waste water. The results obtained show that certain by-products from the iron industry (BFS – Blast Furnace Slag) can be used together with earth and zeolites to improve the performance of wetlands.

Thanks to the chemical and physical properties of zeolites, ecosystem filters are able to take the pollutants out of water and release them into the roots of the plants above, which share the bacteria and mycorrhizae introduced with the zeolites in the rhizosphere.

Actions and Objectives

The ultimate objective of the actions promoted by the Life TRELAGHI project is to achieve a consistent reduction of eutrophicating elements (nitrogen and phosphorus) in the waters of the lakes involved. The initiatives undertaken in the project are in fact designed to drastically reduce the quantities of phosphates and nitrates that enter the lakes in waste water from human settlements and farming activities.

The actions implemented by the project guarantee the safeguarding of the aquatic environments in order to improve the quality of the biotypes in the area and to foster the development of eco-sustainable tourism and agricultural activities.

In order to decontaminate the water, seven distinct tasks have been included in the project, each with its own specific objective. The inclusion of each task within the context of the project is consistent with a structure that points to the general objectives of LIFE Environment, giving prominence to the priorities, as follows:

- project management with communication of the results to the European Community (task 1);
- propagation, promotion and transferability of the project to other European areas (task 2);
- actions necessary to obtain a reduction in eutrophication (tasks 3, 4, 5);
- actions necessary to monitor results (task 6);

- training activities and certification of the results (task 7).

TASK 1: Management of the activities and presentation of reports to the Commission.
This task consists in coordinating and managing the project. It takes the form of direct relationships of the Beneficiary with the Commission, and between the Beneficiary and the Partners to coordinate activities.

TASK 2: Propagation, promotion and dissemination.
The objective of this task is to make the initiative known to as many interested people and authorities as possible. Promotion and dissemination activities on progress made are planned for both sites.

TASK 3: Local actions to reduce the influx of eutrophicating elements (phosphorus and nitrogen).
The aim of the third task is to plan constructed wetlands designed to reduce quantities of eutrophicating substances by means of special filtration ecosystems at the drainage outlets into the lake, or to complete the treatment carried out by existing purification plants, improving the quality of the effluent.

TASK 4: Wide-area actions to reduce the influx of eutrophicating elements (phosphorus and nitrogen).
The objective of reducing eutrophicating substances is achieved by introducing farming practices with low-impact forms of fertilisation in place of traditional chemical fertilisers.

TASK 5: Territorial actions to reduce eutrophication.
Task 5 consists in reducing eutrophication of the waters in the lake of Candia by revitalising the marshlands and recovering the natural power of phytoextraction of nutrients by typical wetland phytocoenoses.

TASK 6: Analysis, verification, monitoring.

The task of monitoring the results is designed to quantify the environmental benefits in terms of the reduction of eutrophication in the two lakes, the application of constructed-wetland purification systems and phytoextraction, and to assess the level of technological innovation introduced.

TASK 7 Certification and training.

The objective of this task is to achieve, at the end of the project, environmental certification of the two lakes in accordance with EMAS and ISO 14000 standards, and the introduction of training courses and environmental education.