A NEW life FOR MAR PICCOLO

LIFE 4 MARPICCOLO

A new Life for Mar Piccolo

Layman's Report

Life

LIFE14-ENV/IT/000461

Contents

Layman's Report

This document constitutes the Layman's Report drawn up within the framework of the Life Project "A NEW LIFE FOR MAR PICCOLO" - LIFE14 ENV/EN/000461

The Life programme is the European Union's funding instrument for the environment, which contributes to the implementation, updating and development of EU environmental policy.

Life4MarPiccolo is one of the projects approved in the 2014 EU call under the Environment sub-programme, which aims to develop and apply methods and technologies to meet environmental challenges across Europe, with an emphasis on nature and biodiversity conservation, resource efficiency and environmental information.

Project partners

Coordinating beneficiary:

CENTRO RICERCHE TRISAIA

Enea takes place at the C.R. Trisaia research, technological development, training and information activities specifically aimed at innovation and development of the production system. The main activities include the application of advanced genomics, proteomics and metabolomics methods to support the agro-energy and agro-industrial system.

Partners:

IRSA CNR

Istituto di Ricerca sulle Acque
CONSIGLIO NAZIONALE DELLE RICERCHE

IRSA-CNR Taranto Secondary School
The research activity of the IRSA-CNR Taranto branch is aimed at studying an integrated approach to sustainable management of the coastal strip with specific reference to the interactions between environmental variables and renewable resources of the sea, for their rational and sustainable exploitation. The integrated approach, involving experts from different disciplinary areas, enables the assessment of interactions between chemical-physical and biological processes in different compartments.

Nova Consulting SpA was founded from the idea of a few professionals to put together their wealth of ideas, experience and professionalism to serve the needs of modern companies. The company has gained experience in a variety of sectors, ranging from safety, quality, environment and energy to project management and Europlanning.

Municipality of Taranto is the second largest municipality in the Pu glia region in terms of population. Located in the gulf of the same name on the Ionian Sea, it stretches between the Mar Grande and Mar Piccolo, hence its nickname "City of the Two Seas". The municipal administration has always been at the forefront in trying to solve the enormous environmental problems in the town.

GeneLab s.r.l is a service company, founded from the meeting of young professionals (biologists, engineers, economists), which operates in the field of applied biotechnology and scientific research, both in the field of molecular biology of plants and in that of tangential membrane filtration processes for the recovery and reuse of waste water.

Project description

The **Life4MarPiccolo project** started in January 2016 and ended in September 2021 after various extensions due to delays in obtaining the necessary authorizations for the implementation of the project activities but also due to problems related to the development of the pilot plant purification and related to the COVID-19 emergency.

The project budget was 2,512,171 euros, with a European contribution of 1,325,473 euros

The **Life4MarPiccolo project** is part of a set of actions for the recovery and enhancement of Taranto and its territory, which have been implemented in recent years and are aimed at eliminating the degradation in which some areas of Taranto currently find themselves.

The turnaround in the management of Taranto's

environmental resources, in which the project has been embedded, is bringing beneficial effects on the socio-economic fabric of the entire territory.

The environmental damage that this area has suffered over the last thirty years has dramatically limited the tourism potential of the city of Taranto. The Mar Piccolo, despite of the serious environmental degradation in which it still finds itself, is a unique environment of outstanding beauty. Its environmental regeneration and consequent environmentally sustainable tourist management can be a great attraction for Taranto and its territory.

The Mar Piccolo is a coastal basin that extends north of the city of Taranto over an area of approximately 20.7 km2 and has a total volume of 0.152 km3.

In the central area it is divided into two areas (first and second bay) by the promontory of Pun- ta Penna and Punta Pizzone. Within the Mediterranean coastal environments, it is of central importance, not only from an environmental point of view (in fact it is a Priority Environment for the Habitats Directive, European Directive 92/43/EEC of 21/05/1992), but also from an economic point of view.

In fact, the basin is characterised by varied and complex communities of animal and plant species (biocenosis), which determine a high level of biodiversity, partly due to the

specific hydrogeological features.

Precisely due to these features, there are several mussel farms in the Mar Piccolo, where, amongst other species, the Mediterranean mussel (Mytius galloprovincialis) is bred.

The basin was influenced by an intense process of industrialisation of the city of Taranto. This is an area "at high risk of environmental crisis", where industrial developments have heavily influenced the socio-economic, environmental and landscape framework.

Factors influencing the spread of contaminants into the water and subsequent bioaccumulation in mussels are related to the resuspension of sediments due to wave motion, shallow water, shipping and non-legalised trawling.

In this scenario, the design, implementation and monitoring of the remediation inter-

ventions involve interdisciplinary aspects of a scientific and technical nature, as well as political and economic aspects, which require the participation, sharing and determination of the various institutional and social components involved. Communication between the various stakeholders involved requires support and encouragement, so that consensus on the endorsement of innovative strategies and technologies in daily practice is consolidated.

In this context, the **Life4MarPiccolo project** overlapped with other existing reclamation projects, but it represented an opportunity for the application of a reclamation technology with a low environmental impact, an alternative to dredging and capping, which present very high levels of "disturbance" to the ecosystems affected by these activities.

Membrane microfiltration is not a frontier technology in itself, but has never been applied to seabed decontamination. This represented an absolute novelty in the panorama of remediation of coastal marine sites with serious environmental pollution problems.

The approach proposed in the **Life4MarPiccolo project** represents a valid alternative to more invasive technologies for the delicate ecological balance of the Mar Piccolo.

On the one hand, microfiltration technology guarantees good effectiveness in removing contaminants from water and, on the other, it acts in a non-invasive manner, as it does not alter the delicate biotic components that make the natural environment of the Mar Piccolo basin unique.

In addition, membrane filtration technology is highly modular and can eventually be extended on a large scale with low installation and maintenance costs.

The chosen experimental area is located in the First Seno del Mar Piccolo, overlooking the Tamburi district of the city of Taranto, within the Mancini shipyards. The concentrations of pollutants present in this area were representative of the contamination of the Mare Piccolo, the chemical characterisation of which was carried out by staff of the CNR-IRSA Taranto site.

This area had suitable characteristics for the installation of both the pilot purification plant and the photovoltaic plant that powered the pilot purification plant.

The project's innovative approach

The innovative approach of the **Life4MarPiccolo project** is mainly linked to the pilot purification plant, consisting of a mobile unit for the resuspension and uptake of the fine fraction of the sediment (represented by the raft at sea) and a fixed unit formed by an MBR (Membrane Bio-Reactor) type filtration system, which was positioned on land.

The first step was to delimit the sea area with a system of bulkheads.

Then the system was assembled. It consists of a tank that collects the liquid coming, in a discontinuous manner, from the mobile system; from the tank designed to contain the filtering systems; from a storage tank of the permeate product connecting with the mobile system within the perimeter area for the transfer of the permeate produced from the membranes and all the equipment, instrumentation, valves and piping

necessary for its proper functioning.

Mobile equipment within the perimeter area is connected to the ground water purification system via: a water intake pipe, an electrical power cable for the supply of the extraction pump, an electrical power cable for the supply of the submersible pump as described below.

All instrumentation installed in the engine plant is connected and controlled via the electrical panel of the pilot purification plant.

The ground installation was placed on a concrete platform with a partial

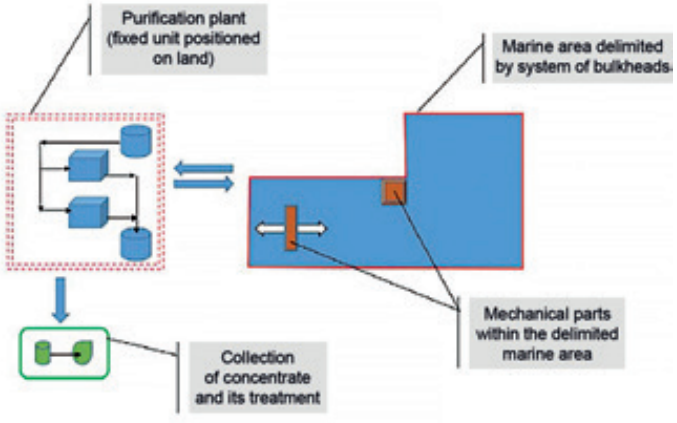
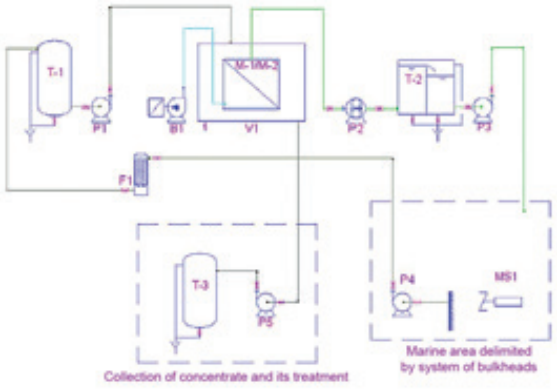


Diagram of the complete system



Complete installation layout

cover that protects the equipment and prevents rainwater from invading the filtration tank.

The pilot purification plant was powered by a 16.8 kWp photovoltaic system also supported by the grid, as the operation of the pilot plant involved sessions lasting 24 hours, also operating at night.

Specifically, the photovoltaic system, which became operational at the end of October 2018, was installed on the roof of a shed in the experimental area. Sixty 280 Wp polycrystalline silicon modules were used, capable of withstanding above-average levels of salt spray due to their proximity to the sea.

Development of the operation mobile unit

The mobile unit is the part of the pilot plant responsible for the controlled resuspension of the marine sediment and the selective uptake of the pelitic fraction.

It consists of a floating raft with a walkable surface of about 6 m^2 to which confinement panels are anchored to ensure the isolation of the resuspended within the underlying water column.

Initially, the resuspension took place through a propeller, that is, a mechanical system. However, due to the continuous breakage of this propeller, it was preferred to equip the raft with a hydrojet system.

For this reason, a dedicated pump was mounted on the raft in place of the old submerged agitator and a submerged frame adjustable in height and

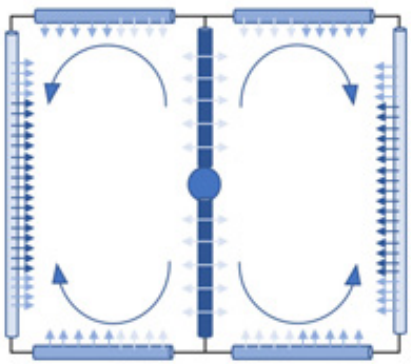
Floating raft

anchored to the raft, in order to:

- eliminate the interference of confinement booms with resuspension and collection systems;
- allow the installation of the new resuspension system.

The hydrojet structure was tested, modifying its geometry several times until reaching the optimal definition in terms of diameters, number and distribution of holes.

The hydrojet system has made it possible to improve the resuspension phase and allow a more regular operation of the entire purification pilot plant.



Schematic of the functioning of the hydrojet

Submerged frame

Hydrojet structure

Results

The pilot purification plant ran for about 400 days and treated a total of approximately 10,000 cubic metres of water with a quantity of particles present in the captured between 0.08 and 0.12 g/l.

The optimisation, operation and testing of the pilot treatment plant was the operational focus of the project. In this action, all suitable procedures were applied for the development of the systems and parameters of the controlled resuspension process, uptake of the re-suspended sediment and microfiltration-concentration of the resuspended sediment.

Specifically, during the optimisation of the system, the following were also assessed:

- the effect of sediment re-suspension;
- the effect of oxygenation and turbidity of water on the biological communities present.

The effect of water filtration on plankton concentration was also assessed.

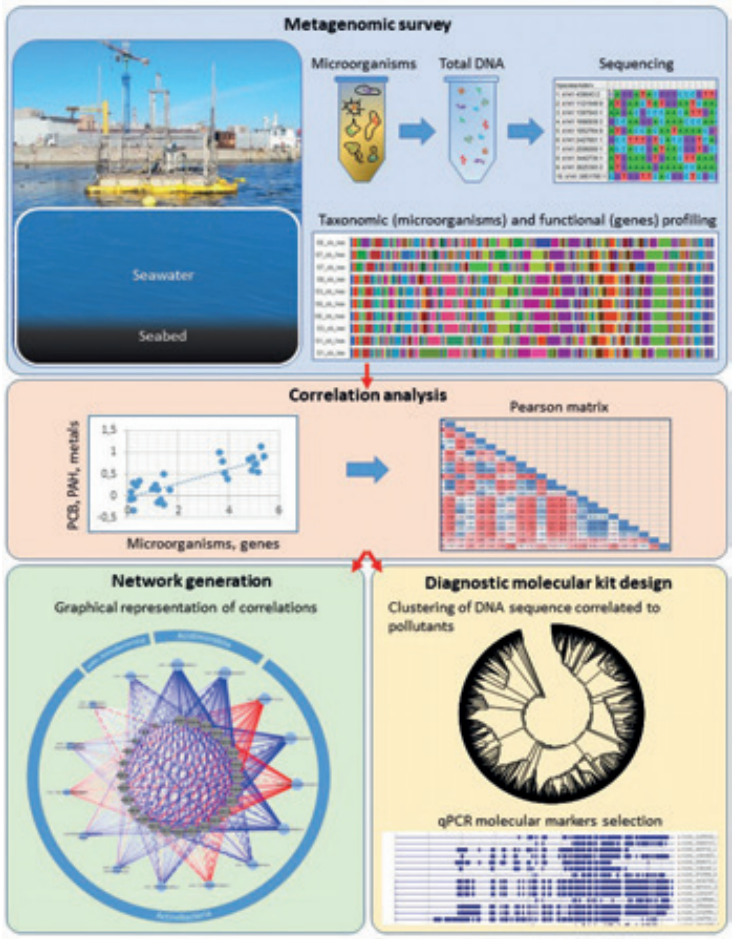
Following the optimisation of the operating parameters of the pilot purification plant and the assessment of the environmental impact on the marine ecosystem, a standard oper-

ating protocol applied to the entire piling area was drawn up in order to reclaim the confined portion.

Thanks to the integrated monitoring (chemical, chemical-physical and metaomic), it was possible to establish a close correlation between the type/concentration of pollutants present in the sites and the composition/abundance of microbial species in the study area.

In addition, the diagnostic power of metaomic technologies has made it possible to associate specific gene functions with the accumulation of pollutants.

In fact, it was possible to carry out a complete metagenomic and metaproteomic characterization of the water and the seabed, in relation to



Outline of the metaomic monitoring activity

the level of pollution of the seabed and have been identified: about 13,600 microbial species whose abundance is related to the pollution of the seabed; about 6,000 genetic functions accumulated differentially with respect to the level of pollution of the sediments and about 100 biomolecular markers, able to provide information on the health of the water.

This information has been used to develop a diagnostic tool (the molecular kit) than can predict the health of marine waters in areas subject to high anthropogenic impact. Through the analysis of specific DNA fragments, this kit provides an instant overview of gene functions and an estimate of their relative abundance in the area. This kit complements and supplements all the tests already required by law.

Unlike the determination of chemical, physical and microbiological parameters, which require longer analysis times for the delivery of the result, the kit is a simple, fast, deep and accurate analysis system that can also be used in other marine-coastal environments to quickly assess environmental conditions.

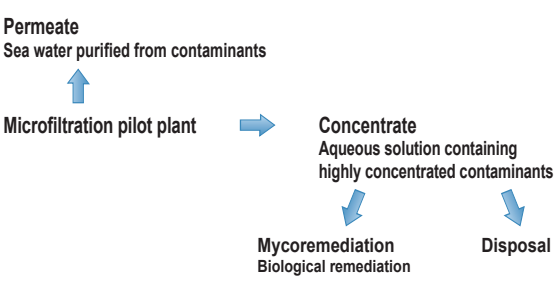
A small part of the waste produced by the pilot purification plant (about 900mL) was subjected to a biological remediation process by fungal microorganisms (mycoremediation).

The biological treatment of waste generated by the purification activity represented a further innovative feature of the process, as it proposed an alternative management of contaminated waste that is environmentally friendly, sustainable and economical.

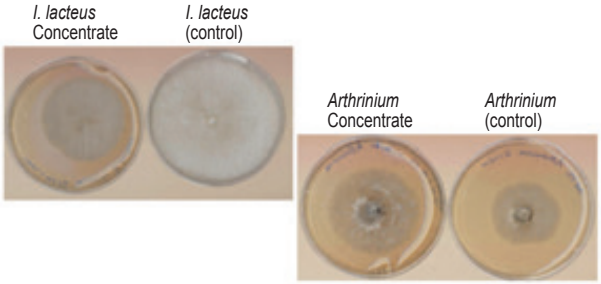
The operation of the plant made it possible to decontaminate the water and sediment of the treated portion of the Mar Piccolo basin. Furthermore, through the assessment of the impact on the ecosystem, it has been shown that a plant with optimized operating parameters does not disturb the biocenotic communities present in the treated portion of the sea but also outside it.

In economic terms it was possible to compare the technology developed in the pilot project with another remediation technique, the dredging.

MYCOREMEDIATION ACTIVITIES



Mycoremediation activity scheme



Examples of tests conducted

Assuming that there is an area of 3,000 m^2 (at indifferent sea depth) to be decontaminated down to a depth of 0.5 m (value determined to obtain 100% efficiency), it has been calculated that the total cost of dredging is equal to € 117,300. Instead, the total cost of microfiltration is € 108,138.

Therefore, the data obtained with the implementation of the **Life4MarPiccolo project** demonstrated the best efficiency of membrane microfiltration in both ecological and economic terms.

Through the analysis of the data, the project team ascertained that the pilot purification plant was 100% effective in decontaminating the captured and its effectiveness in the collection phase on each sector and, by extension, on the entire portion of the sea was 32%. It was also assessed that in order to obtain complete efficiency in decontaminating the sediment, it will be necessary in the future to size the system appropriately. To do this, it will be necessary to intervene on three parameters: duration of operation; production capacity of the ground plant; ability to resuspend. In particular, it will be necessary to reduce the duration of operation by increasing the production capacity of the ground plant.

Conclusions

The **Life4MarPiccolo project** is part of a set of actions for the recovery and enhancement of Taranto and its territory, which have been implemented in recent years and are aimed at eliminating the degradation in which some areas of Taranto currently find themselves.

The turnaround in the management of Taranto's environmental resources in which the project has been channelled is having beneficial effects on the socio-economic fabric of the entire area.

The environmental damage that this area has suffered over the last thirty years has dramatically limited the tourism potential of the city of Taranto. Mar Piccolo, despite the serious environmental degradation in which it still finds itself, is a unique environment of enchanting beauty. Its environmental rehabilitation and subsequent environmentally sustainable tourism management can be a great attraction for Taranto and its territory.

It is with this in mind that the mussel sector in Taranto was involved in the project's dissemination activities. Specifically, there was a heavy involvement during the events organised during the implementation of Life4MarPiccolo, also with the help of the website (*www.lifemarpiccolo.it*) and the social channels of Facebook and Twitter. In this way, it has been

possible to create a network of collaboration with other projects (local, national and European) that have addressed the issues of environmental rehabilitation of marine-coastal waters.

The aim was to open up a national and international debate on new technologies used for water reclamation, also with a view to exploiting the strengths of previous experiences and avoiding falling into previous mistakes.

First Project Conference - Taranto - December 2017

Fourth Monitoring Meeting - Taranto - December 2019

Second Networking Meeting and Press Presentation of the pilot purification plant - Taranto - December 2019

First Networking Meeting and Visit to the experimental area - Taranto - May 2018

Coordination Meeting and Visit to the experimental area - Taranto - April 2016

First Networking Meeting and Visit to the experimental area - Taranto - May 2018

Kick-off Meeting - Rotondella - February 2016

First Monitoring Meeting - Rotondella - September 2016

Third Monitoring Meeting - Taranto - November 2018

First Networking Meeting and Visit to the experimental area - Taranto - May 2018

Second Networking Meeting and Press Presentation
of the pilot purification plant - Taranto - December 2019

Kick-off Meeting - Rotondella - February 2016

A NEW life FOR MAR PICCOLO

www.lifemarpiccolo.it
info@lifemarpiccolo.it

Coordinating beneficiary:

ENEA
CENTRO RICERCHE TRISAIA

Project partners:

IRSA CNR
Istituto di Ricerca sulle Acque
CONSIGLIO NAZIONALE DELLE RICERCHE

nova consulting

TARAS

GeneLab