lifephoenix.eu

Perfluorinated compounds
HOlistic ENvironmental
Interinstitutional eXperience

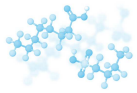
LAYMAN'S REPORT

Preventing, Ensuring, Promoting

LIFE PHOENIX Project

An integrated approach for the effective management of water pollution risks from emerging contaminants

EMERGING CONTAMINANTS: PMOC & PFAS

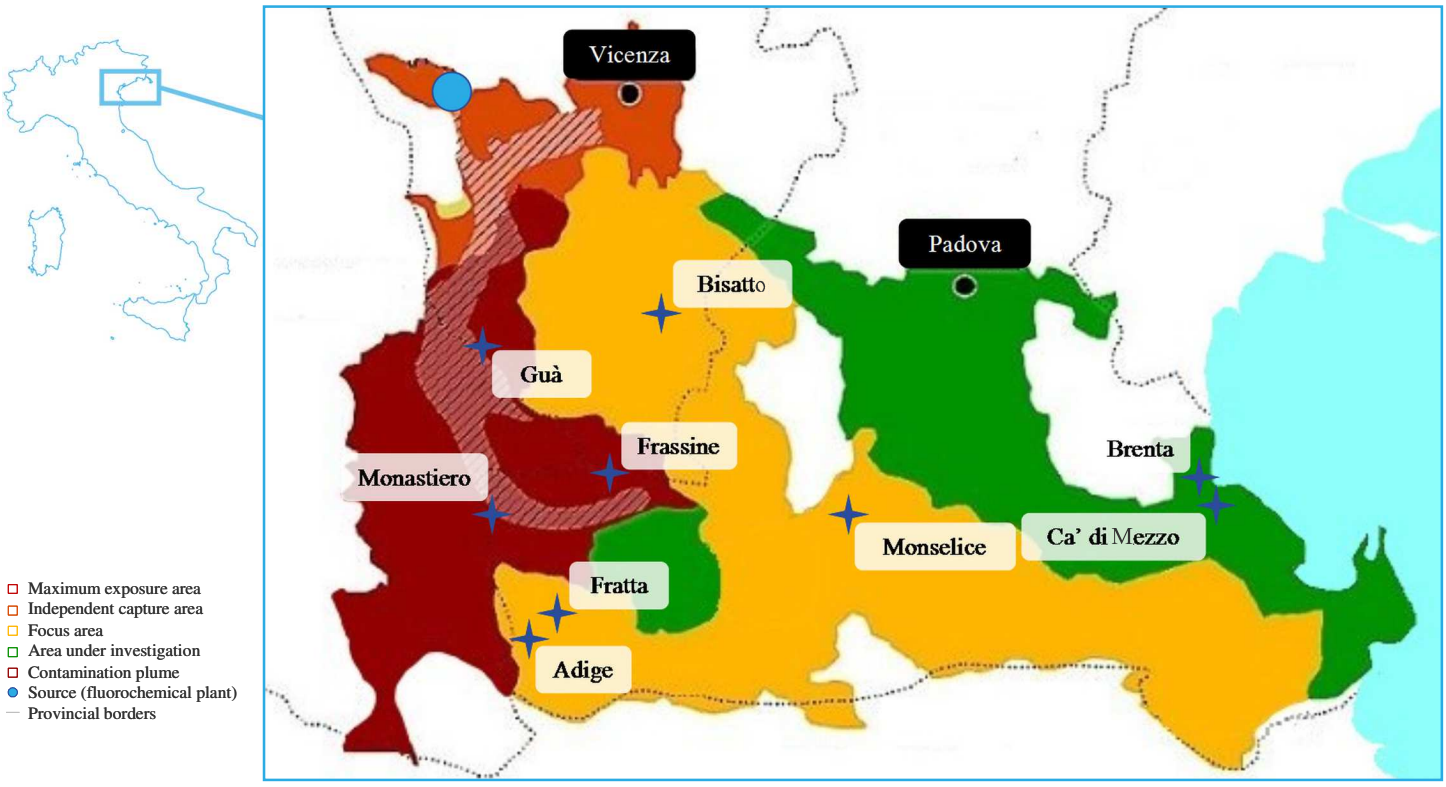


Water pollution is the contamination of water bodies that occurs when pollutants are discharged into water bodies without an adequate treatment to remove harmful compounds. The direct or indirect discharge of substances into the aquatic environment leads to results that could cause hazards to human health, harm to living resources and to aquatic ecosystems and interferences with all the legitimate uses of water.

The European Union pays special attention to ecological and health problems linked to water environment with specific legislation, according to the compartment involved, such as: Water Framework Directive, Drinking Water Directive, Urban Waste Treatment Directive, Bathing Waters Directive, REACH Regulation (Registration, Evaluation, Authorisation and Restriction of Chemical). In particular, the emission of the so-called "emerging" unregulated organic contaminants has become a priority environmental issue for the preservation of water resources. Emerging contaminants are mainly products used in large quantities in everyday life, such as human and veterinary pharmaceuticals, personal care products, surfactants and surfactant residues. Contaminants of emerging concern are not necessarily new chemicals, but generally, they are neither regulated by the legislation nor newly detected in the environment.

Persistent Mobile Organic Compounds (PMOC) are, among contaminants of emerging concerns, a case of a particular interest. PMOCs are highly polar compounds and likely to move and persist in the water cycle (e.g. drinking water and irrigation), they degrade very slowly and are very mobile in the water matrix and often in biological tissues.

Exposure to PMOC can lead to serious health effects, which in many cases can not be adequately and effectively assessed due to lack of monitoring data, adequate knowledge of the eco-toxicological properties of new substances and difficulties in managing the emergency situations. This is the case of the most important family belonging to PMOC, which are the perfluorinated substances (PFAS), the main issue of the LIFE PHOENIX project. This problem, in an overall view of water protection, takes a high priority in European policymaking.



Monitoring area and sampling sites

THE REFERENCE AREA

In the specific area of the project – i.e. the phreatic zone of medium-lower Agno Valley (Northern Italy, Veneto Region, Vicenza Province) – several episodes of pollution took place in the past, due to the high density of production sites and industries. More recently (2013), following a report by IRSA-CNR, committed by the Italian Environmental Ministry (Ministero dell'Ambiente e della Tutela del Territorio e del Mare), new investigations assessed a more severe contamination episode characterized by dispersion of PFAS in the surface and ground waters of the same area, with PFOA and PFBS among the most abundant compounds.

The source of contamination has been identified in a chemichal plant producing PFAS since the late Sixties. Specific studies demonstrated the propagation of PFAS through the phreatic table and the close interconnection between surface and ground waters bodies compromising all the water system of the area. The water outflow and hydrogeological network are quite complex because they are composed of different branched water bodies – such as resurgences, which are also important for irrigation. Furthermore, drainage effects are critical in this area characterized by specific habitats.

The reference area is located in the Vicenza Province, in the northern part of Veneto Region, between Lessini Mountains and the contiguous plain in southern direction until the area of Colli Berici and the Municipality of Vicenza. Nowadays the total catchment area involves three Provinces (Vicenza, Padova and Verona) with a total area of about 595 km2 and 150,000 inhabitants. However the total estimated involved area is wider (930 km2). During the emergency phase several PFAS where detected with range of concentration from 10 up to 60000 ng L-1 along the plume axis. In order to manage the contamination, Veneto Region has undertaken a complex series of actions that have proved to be very expensive.

Therefore, this specific PFAS contamination represents an ideal case study to demonstrate the possible application of an integrated and multidisciplinary and inter-institutional action, as proposed by the LIFE PHOENIX Project, which can be proposed for other compounds with similar characteristics of persistence and mobility (i.e. other PMOCs). This approach has been thought mainly has a preventive governance system to avoid future contamination phenomena and to save public money.

THE PHOENIX PROJECT

The LIFE PHOENIX project (co-funded by the European Union through the LIFE Programme) proposed an innovative and multidisciplinary approach to the management of environmental contamination, concurrently involving the institutional bodies and the scientific research community in decision-making processes.

Ended in March 2021, LIFE PHOENIX aimed to demonstrate how a new inter-institutional governance system, supported by innovative forecasting tools and targeted mitigation strategies, may allow to manage in a timely and effective way the risks deriving from water contamination by persistent mobile organic contaminants (defined by the acronym PMOC). This model was proposed in order to avoid or, at least, reduce the public expenditure necessary to deal with the damages caused by persistent emerging pollutants, in terms of human health and the environment. The specific focus of this project concerned a subclass of PMOC, such as short-chain perfluoroalkyl substances (PFAS), and involved both drinking and irrigation water.

Budget and duration of the project
The European Union co-financing rate from LIFE Programme provided 60% of the total eligible project costs, while the remaining 40% concerned the working time for the personnel of the various participating partners involved in the project . A budget of 2.176.493,00 euro has been planned for the implementation of the LIFE PHOENIX Project (2.107.283,00 euro the eligible costs), with a contribution of the European Union equal to 1.264.369,00 euro. The overall project duration covered the time span from 1 September 2017 to 31 March 2021.

THE LIFE PROGRAMME

Established in 1992, the LIFE programme is the financial instrument of the European Union entirely dedicated to environmental projects. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental policy and legislation by co-financing pilot or demonstration projects with European added value.

PROJECT ACTIONS AND RESULTS

During its multi-year operational course, the LIFE PHOENIX project has carried out targeted actions and achieved tangible results, inspired by 3 guiding principles.

PREVENTING

ENSURING

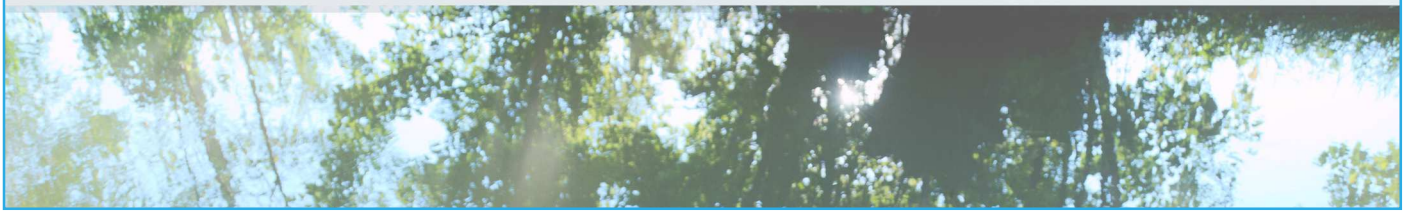
PROMOTING

Specifically, the project has:

- prepared surveys and methods, towards **PREVENTING** in an effective and timely manner the risks associated with the spread of emerging contaminants in the environment;
- developed programs and tools, onto **ENSURING** systematically the safety of a drinking water system, the quality of the water supplied and the protection of consumer health.
- created products and initiatives, for **PROMOTING** at all levels a sustainable and aware use of water, in line with the European objective of water resources preservation.

Best practices and innovative solutions implemented with the LIFE PHOENIX project

- A **new model of inter-institutional governance**, supported by expert working groups and accurate forecasting systems, to promptly and effectively manage the problems arising from water contamination caused by mobile and persistent organic substances (PMOC), such as perfluoroalkyl compounds (PFAS).
- A **long-term action plan** (*policy measures, prevention protocols, guidelines, recommendations*) complemented by the use of innovative technologies, able to assist public decision makers in the process of assessing, preventing and mitigating risks for the environment and for human health.
- A **smooth information and statistical system** (*data warehouse* and *web portal*), integrated with numerous databases from various local, regional and national institutions, and organized in different thematic topics to facilitate specialists in the necessary technical and scientific elaborations.
- An **effective testing process** supported by pilot plants for water purification, with *upscaling* to real-scale for irrigation water in three wet areas identified in the project zone between the provinces of Vicenza, Verona and Padua (about 930 km²) in the Veneto Region.
- A **series of fast and integrated tools**, supported by methods based on risk analysis (mathematical models and bio-indicators), to estimate the diffusion of contaminants (PMOC) in the different environmental matrices and to set biological and eco-toxicological early warning systems.
- A **replicable work methodology**, based on the *know-how* and results deriving from the multidisciplinary approach, that can be transferred and adapted in other European geographical contexts or nearby areas characterized by similar environmental contaminations.



ENVIRONMENTAL MONITORING

The monitoring activity carried out by the LIFE PHOENIX project made it possible to quantify the level of PFAS contamination in irrigation water and agricultural soils within an area potentially among the most compromised by the release of these substances into the environment. This work focused specifically on the determination of PFAS in plants, samples in which these compounds were found to be sporadically present. Hence, particular attention was paid to edible crops, as the values found in the edible fractions can provide useful information for human risk assessment due to vegetable consumption.

Based on the previous results of biomonitoring and analysis of drinking water, the Veneto Region has divided the contaminated zone into: maximum exposure area (red), independent capture area (orange), focus area (yellow) and area under investigation (green). Taking this classification into account, nine sampling stations representative of the different impact areas were selected, as well as a control site. So, the monitoring plan designed made it possible to study the variability of the PFAS concentrations in irrigated waters, to verify the pollution from these substances in agricultural soils open to irrigation and to evaluate the accumulation capacity of PFAS by spontaneous and cultivated plants. All the collected samples were analyzed using existing methods, but redefined and optimized at the beginning of the project.

The concentrations recorded in irrigation water are characterized by a significant variability due to the different water supplies throughout the year. Regardless of the sampling area, the contamination found in irrigation water revealed to be dominated by short-chain, more water-soluble compounds, while long-chain, more lipophilic PFASs appeared more abundant in the soil. On the contrary, the sampling source affected the quality of the contamination found in the plants. In particular, in the plants coming from the non-directly impacted area, long-chain compounds prevailed, due to diffuse pollution by "traditional" PFAS, while in the samples collected in the red area, more recent short-chain PFAS were dominant. Also regarding the soils, their degree of contamination reflects the subdivision by areas: in fact, the highest concentrations were recorded in the red zone while the lowest levels were identified in the green zone.

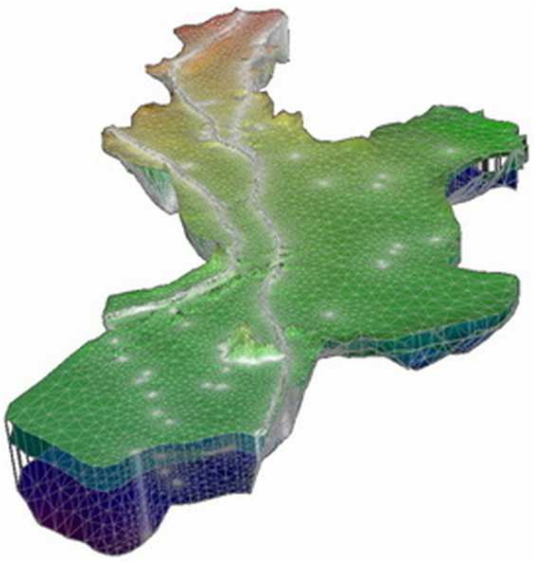
NUMERICAL MODELING

Among the activities carried out within the project, the development of forecasting tools by implementing a numerical model of PFAS transport in water, the environmental matrix most affected by pollution, proved to be of great importance.

Numerical modeling applied to groundwater and surface waters certainly constitutes the most suitable tool for quantifying, interpreting and predicting, with the necessary scientific rigor, the many aspects linked to the spread of PFAS contamination. A mathematical model is in fact a simplified representation of reality on scale, by which the physico-chemical processes driving the diffusion of the pollutant in the real world are simulated for interpretative and predictive purposes. Such a tool is more generally applicable to environmental contamination events.

For the determination of the site-specific parameters, a definite experimental research activity was carried out, which saw the gathering of numerous soil samples from the subsoil through the realization of three boreholes pushed to a depth of 35 m from the ground level. This activity ended positively with the sampling of 5 different soil matrices (including gravels, sands and clays), representative of the contaminated aquifer of the high and medium plains.

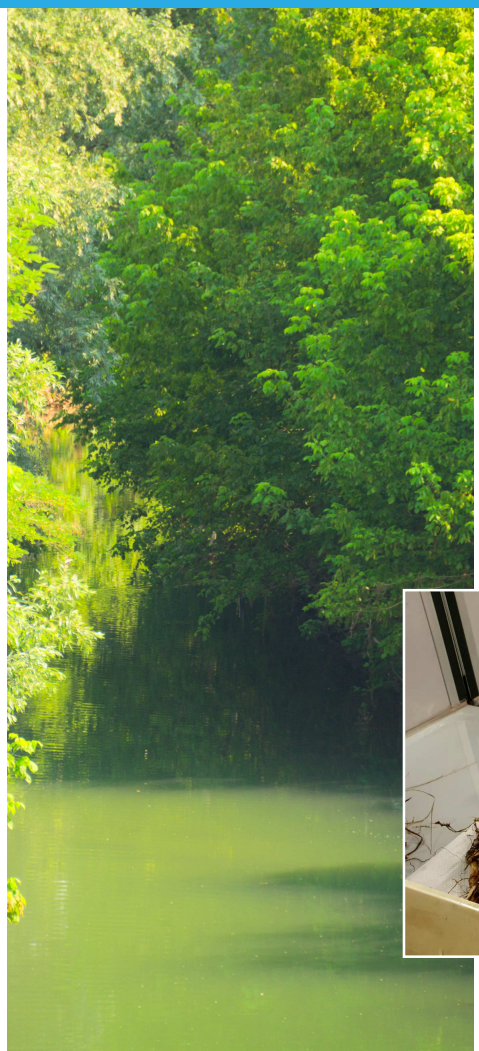
These samples were then delivered to a specialized laboratory. The results are particularly important, as they made it possible to achieve a dual objective: an improvement in the model of dispersion of pollutants and a more relevant determination of the environmental parameters on the spreading of PFAS.



THE MATRIX SAMPLING

The project team has performed an intense sampling activity on four different environmental matrices (water, soil, plants and animals) in ten sampling sites present in the project areas, in order to figuring out if and how these perfluorinated substances are spreading in the ecosystem. The sampling sites were identified so that the sampling of all four matrices was easily accessible, to have a clear picture of the extent of PFAS pollution.

The zones identified within the project area had to be endowed with outlets or water intakes used for irrigation of agricultural fields. And around these irrigated outlets a series of vegetable matrices (corn, red chicory, onion and reeds) were collected, together with the soil on which they grew. It was therefore possible to hypothesize the path taken by the pollutant from the aqueous matrix to the soil matrix, subsequently examining the transfer methods to the various structures of the plant matrix.



In the two years of study, thanks to this sampling strategy, it was possible to achieve a reasonable picture about the diffusion state of PFAS in the four matrices investigated and, more generally, of PFAS themselves.

THE "EARLY WARNING" METHODOLOGIES

One of the key actions of the LIFE PHOENIX project concerned the implementation of environmental *early warning* methodologies based on bioindicators, that is biological organisms used to evaluate a generally degenerative change in the quality of the environment. Specifically, the chosen bioindicators were earthworms, detritivorous organisms considered a good soil quality index and indicated by the OECD, since 1989, among the 5 best terrestrial bioindicators.

During the project, earthworms were sampled from the soils of the differently polluted areas considered at the regional level. Subsequently, in the laboratory, the earthworm pools were examined both to detect PFAS concentrations and to evaluate some eco-toxicological biomarkers, i.e. biochemical, cellular, physiological or behavioral changes due to exposure and/or effect of one or more polluting compounds.

In recent decades, biomarkers have established themselves as an innovative element in the field of eco-toxicological investigations, responding quickly and precisely to basic questions such as:

- *What are the effects that contaminants have on populations and/or natural communities at the molecular, biochemical, cellular or tissue level?*
- *Could the correct evaluation of these effects represent an early sign of the stress caused by environmental contamination?*

Hence, the objectives of the use of bioindicators and biomarkers is to estimate, predict and, consequently, take timely actions to avoid unacceptable events on an ecological and human health level. The development of biomarker testing protocols, which can be replicated in contexts similar to those seen in Veneto, offers a tool for predicting and preventing environmental stress caused by the presence of pollutants.

THE OPTIMIZATION OF ANALYTICAL METHODS

To monitor the effectiveness of the forecasting and mitigation tools adopted in the operational actions of the project, and to assess the results of the environmental monitoring plan, it was necessary a preliminary work on the development of analytical protocols aimed at determining the concentration of PFAS. Broad analytical methodologies for PFAS determination were already known, however it was essential to refine specific procedures for the purposes of the LIFE PHOENIX project and, therefore, to obtain fit-for-purpose procedures for the specific contaminants and the matrices selected. Hence, the laboratories of the project partners have implemented and refined the Standard Operation Procedures (SOPs) on over 10 types of perfluoroalkyl acids, including the so-called short-chain PFAS, also focusing on the validation of methods for the analysis of drinking water and environmental water (groundwater, surface waters and wastewater), sediments of agricultural land and vegetal and animal matrices. The validated PTOs allowed, on the one hand, to verify the efficiency of the mitigation tools proposed for drinking water (pilot plant of ion exchange resins) and for irrigation water (phyto-purification pilot plant and its implementation on a wetland scale) and, on the other hand, to quantify the levels of PFAS in the environmental compartments considered.

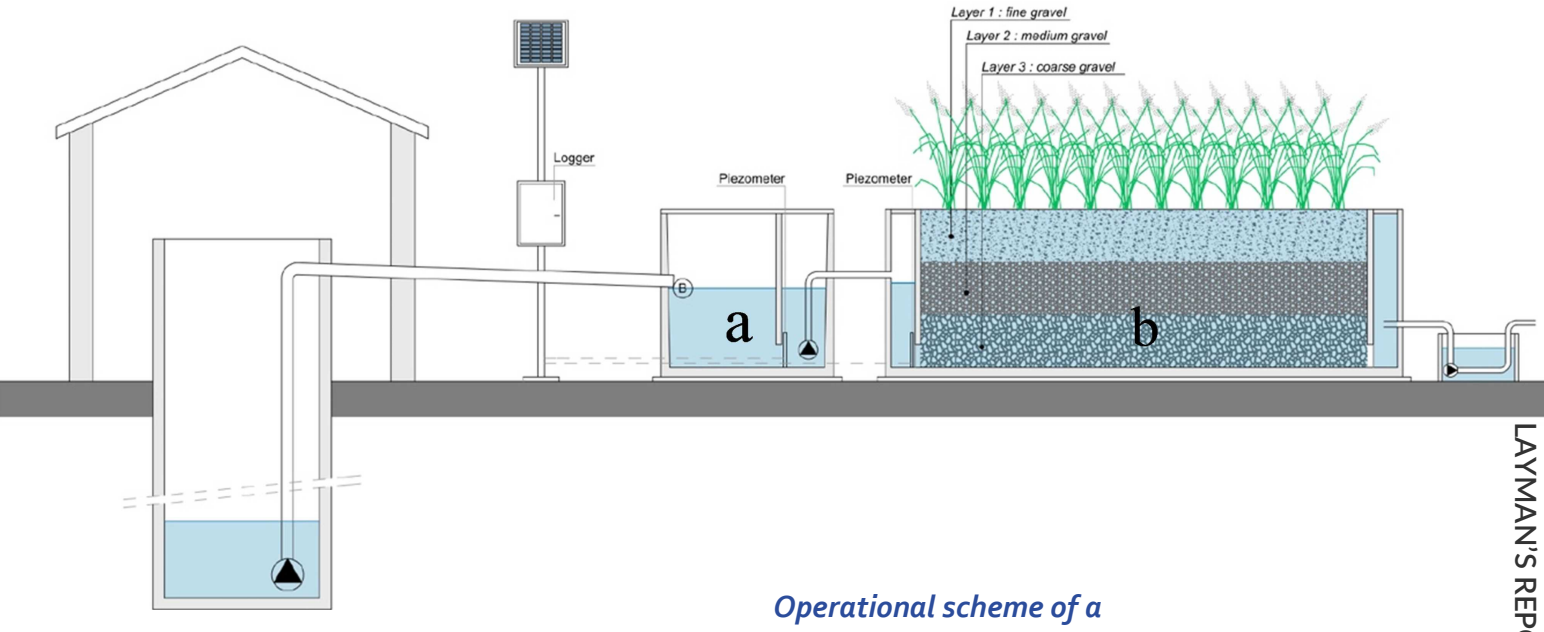
THE USE OF INNOVATIVE TECHNOLOGIES

As part of the LIFE PHOENIX project, two innovative methodologies have been tested and developed to mitigate the diffusion and concentration of perfluorinated pollutants (PFAS) in drinking water and surface water used for irrigation.

In the first case, the technology of ion exchange resins was identified and tested, which, in addition to being adoptable for specific types of PFAS and therefore being implemented to purify drinking water from short-chain PFAS, allows the regeneration of resins, which can be reused several times directly in the plant. In this way it is possible to obtain both an environmental and an economic advantage. The test took place at the Acque Veronesi scarl drinking water distribution plant, which provided all the necessary support for setting up the pilot plant. From the data acquired through the experimentation it has been noted that ion exchange resins can be considered a promising technology, with interesting and more advanced results compared to the use of the ordinary activated carbons, even if at the moment further studies are needed for the economic tuning of regeneration activities.

As regards to irrigation waters, the LIFE PHOENIX Project was among the first at European level, and the first in Italy, to address the issue by testing low-impact and low-cost methods, such as phytodepuration, in order to naturally mitigate the PFAS concentration. The initial phase of the study involved the setting up of a phytodepuration pilot plant to analyze the absorption and storage capacity of this pollutant by an aquatic plant, which was ubiquitous in Veneto, such as the marsh reed (*Phragmites australis*).

The facility was located in Lonigo, inside the Vivai Dall'Ava, which provided the technical and logistical support to be able to make the tests. Since the end of the first year of operation, it was seen that the pilot plant worked excellently. Subsequently, this approach was applied on a large scale in three humid zones present within the district of the Consorzio di Bonifica Adige Euganeo: the Ca' di Mezzo wetland (green area), the Monselice wetland (yellow zone) and the Monastiero wetland (red zone). The experimentation conducted in the three wetlands gave significant results. The wetland system (and specifically the phytodepuration) represented a valid method to intercept the PFAS present in surface waters, acting as natural filtration areas and reducing the presence of PFAS in irrigation water.



Operational scheme of a phytodepuration pilot plant:
a) water storage tank
b) main tank

THE CONTROL AND MANAGEMENT GUIDELINES

The action of the LIFE PHOENIX project included the drafting of a document containing the control and management guidelines of the issues of water resources contamination by emerging pollutants, counting, at the same time, the possibility to define a safeguard system and an action plan for the management of the post-contamination scenario. The underlying rationale is to allow the transfer of practices to other relevant European contexts. These Guidelines, proposed both in Italian and in English for a wider national and international spreading, organize technical and governance solutions developed by the project (analysis protocols, methods and tools for collecting and comparing data, management procedures, etc.), in order to provide possible assistance to other regional and local institutions and authorities facing similar situations. The final document gathers the main results produced within the LIFE PHOENIX project, following its original structure divided into specific actions (monitoring, operational, dissemination actions) and takes advantage, for its refinement, from the contribution of other structures' experiences acquired through technical meetings in different EU countries.

THE INTER-INSTITUTIONAL GOVERNANCE MODEL

The governance model implemented with the LIFE PHOENIX project supported the goal of equipping the Veneto Region with an Environment and Health Commission.

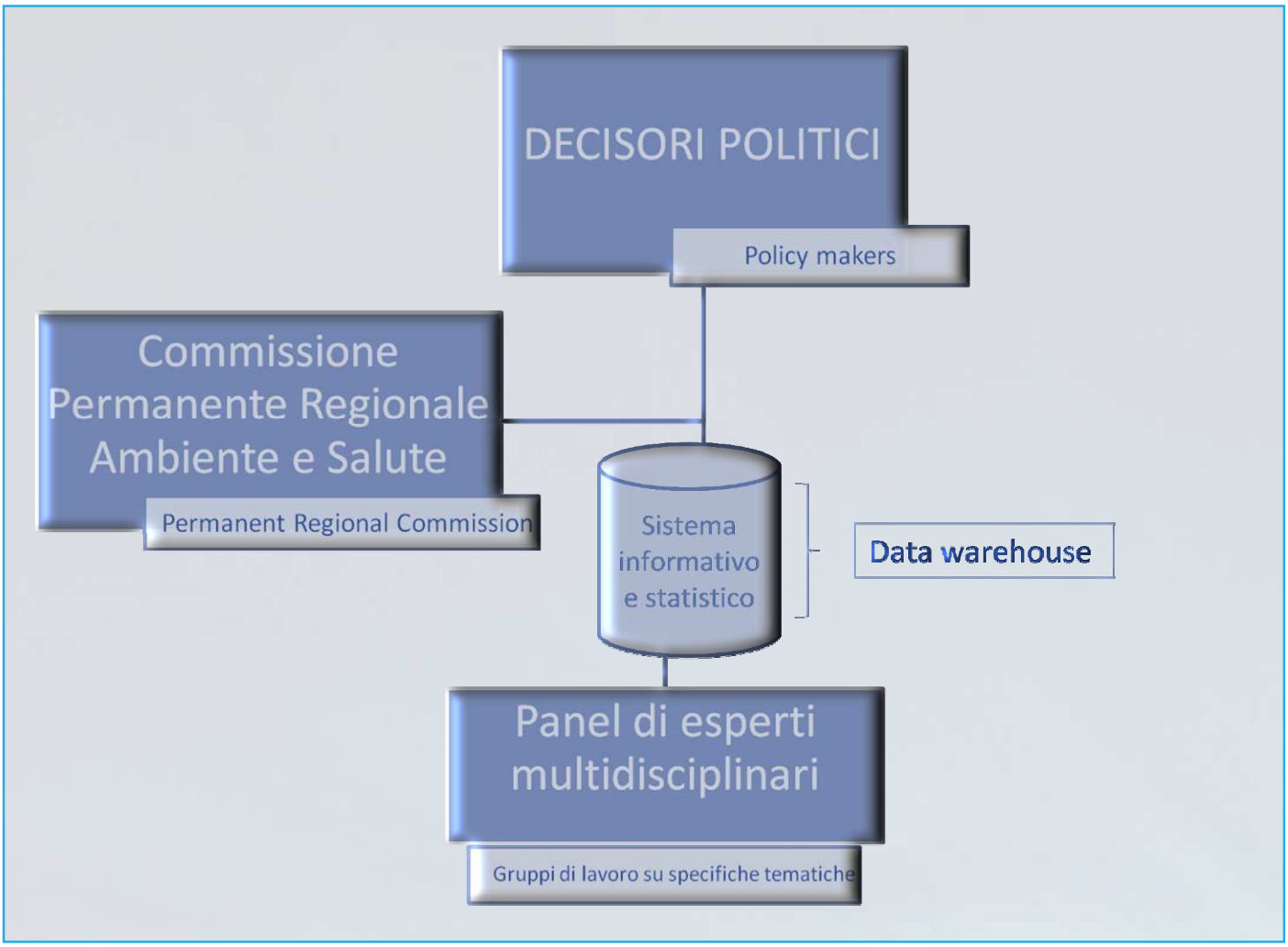
This working group, set up by a provision of the Council, has as its components all the managers of the regional structures with expertise on environment and health issues, together with the representatives of the Regional Agency for Environmental Prevention and Protection (ARPA). The worktable also provides for the participation of other local bodies and agencies involved in these issues.

Implementing a governance model in situations of environmental contamination means taking up the challenge of a holistic approach in addressing issues with an impact on human health and the ecosystem, integrating concepts such as risk analysis, planning and control in an interinstitutional and multidisciplinary framework.

In its action, the Environment and Health Commission is supported by a Technical-Scientific Committee (a multidisciplinary panel of experts from academies and research centers of regional and national level) which, on the basis of its own knowledge and backed by the innovative systems designed within LIFE PHOENIX, like the data warehouse or the predictive transport model of pollutants, provides the Commission with possible solutions to mitigate the risk and to manage environmental contamination. At the end of the assessments, the Environment and Health Commission reports to policy makers on the opportunity of adopting certain technical solutions in order to deal with the emergency.

The model plays its challenge on a timely and effective management of a contamination event, taking into consideration the regional territory through an accurate risk analysis. Substantiating itself in the concept of "Environment and Health Network", this model is ideally close to some methodologies already expected in the European context, which will soon have to be implemented by the Member States. An example is the Water Safety Plan (WSP), which represents an innovative approach to ensure the safety of drinking water supply systems.

Functional diagram of the governance model of the LIFE PHOENIX project



THE INFORMATION AND STATISTICAL SYSTEM

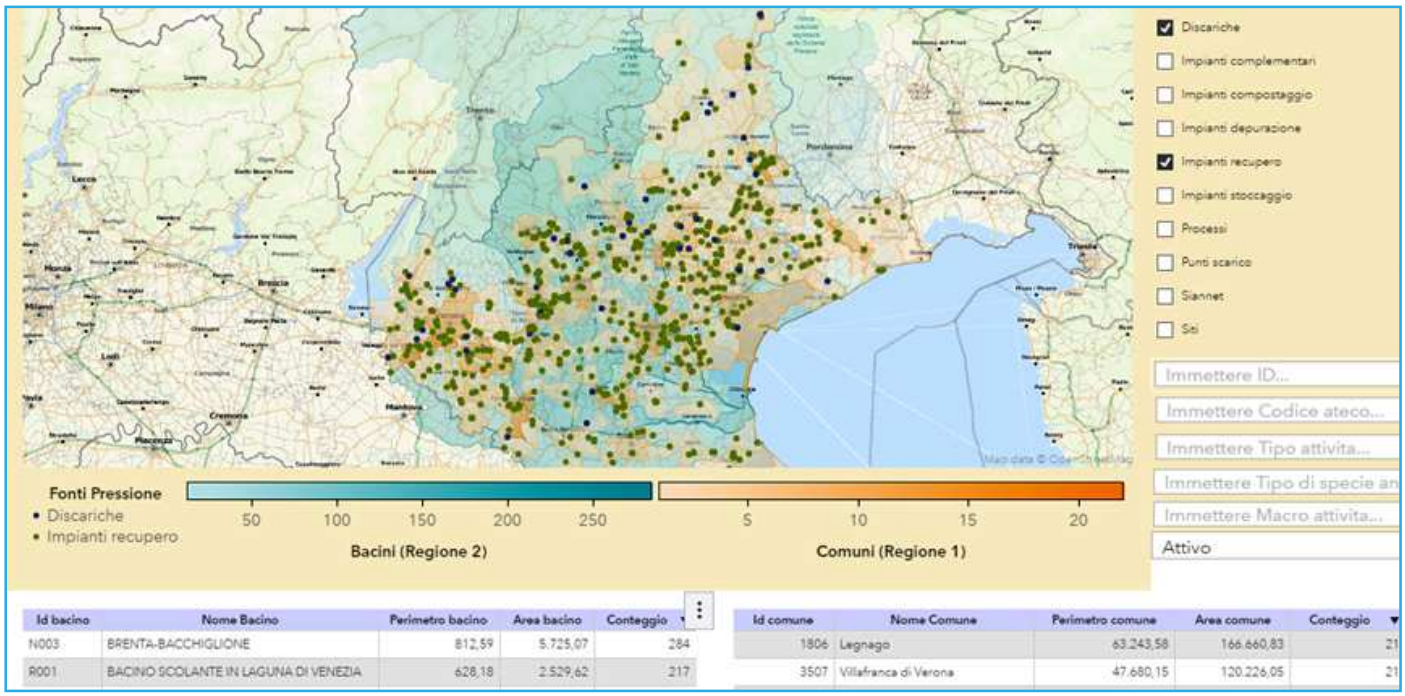
One of the key actions of the LIFE PHOENIX project concerned the development of an integrated information and statistical system, aimed at facilitating the competent institutions in the human health risks related to the presence of emerging contaminants in the environment. The tool, developed with the contribution of all project partners, was designed to gather and interconnect, within a single virtual container, the territorial, environmental and health data held by various public bodies in the Veneto Region.

As an essential part of the governance model proposed by LIFE PHOENIX, the information and statistical system will be regularly nourished according to deadlines agreed with the data providing bodies, allowing the various regional institutions that deal with the Environment and Health to share their information assets in a structured and systematic way via a common platform. But the potential does not end here: the tool in fact it will be able to create links between the various types of data, returning a higher information value.

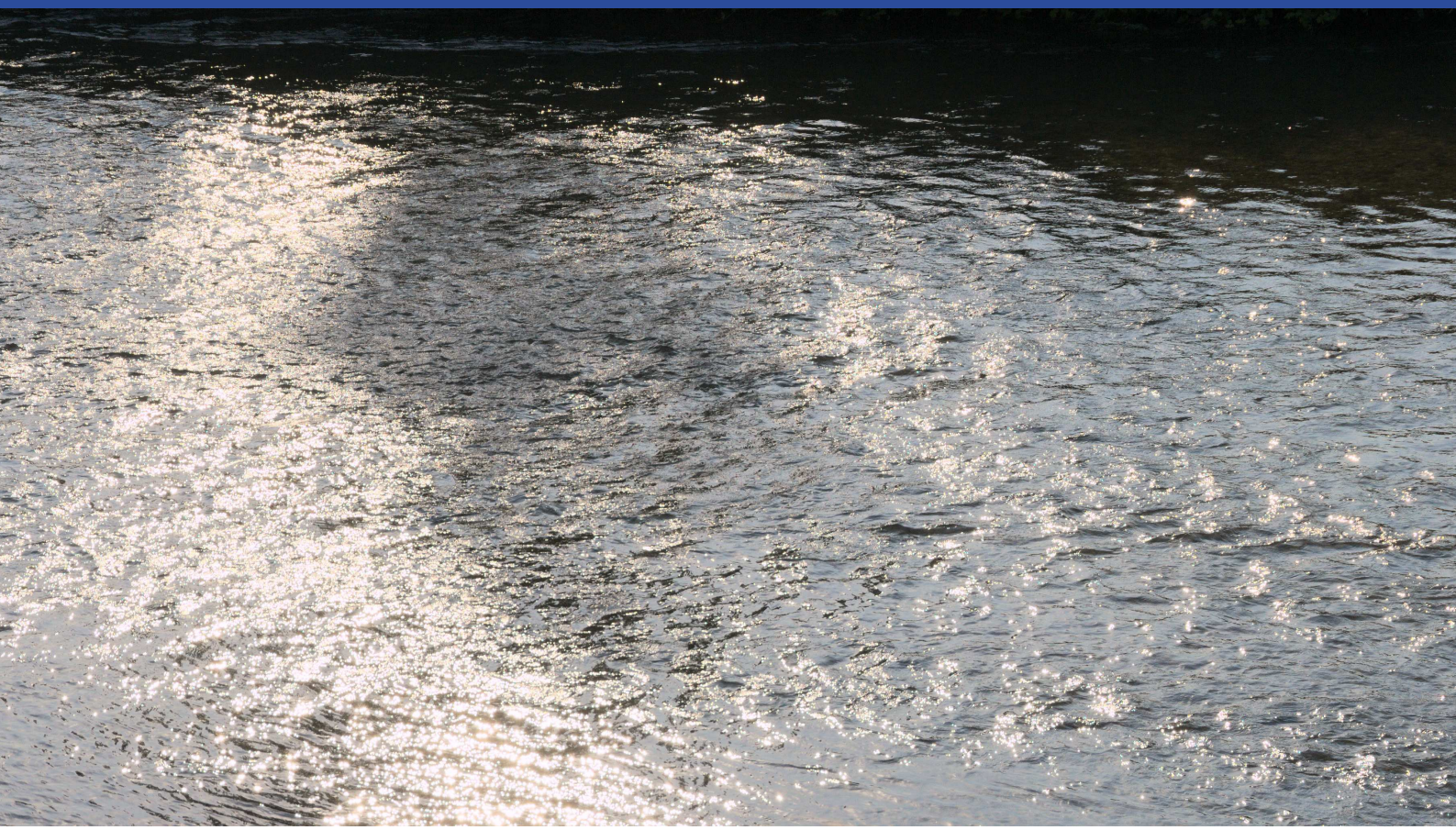
As part of the project, a data warehouse was developed able to contain, among other things, information on potential polluting sources, drinking-water supply chain (and its catchment area) and water quality data. The data warehouse of the LIFE PHOENIX project, further integrated by a forecasting model able to estimate the movement of contaminants within the aquifers, arranges effectively the interaction of data from the various institutions involved, overcoming the information-finding difficulties that characterized the previous phases of PFAS pollution management.

The portal, for example, easily allows viewing on a map the possible sources of pollution that insist on a given hydrographic basin, or to produce graphs about the contaminants time trend in the different environmental matrices, or to identify the agricultural areas irrigated by a specific water source. In this way it becomes possible to predict or reconstruct the path followed by a pollutant in the environment, from the source of pollution to the potentially impacted targets.

The information and statistical tool developed by the LIFE PHOENIX project, helping to identify potential human health risks and to monitor their evolution over time, constitutes therefore a useful and versatile system to support the prevention and mitigation of environmental contamination, facilitating the Management Bodies and the Control Bodies in the overall assessment of risks affecting the entire drinking water supply chain and consequently in the possibility to take action in a timely and effective manner.



Example of user interface of the information and statistical system: some types of pressure sources (landfills and recovery plants) are geo-localized on the map of the Veneto Region in relation to the hydrographic basins and the Municipalities.



ALIGNMENT WITH WATER SAFETY PLANS (WSPs)

The Water Safety Plans (WSPs) are an innovative tool designed to proactively guarantee the salubrity of the water supplied by the aqueduct complex to the consumer, through a structured approach of evaluation and management of site-specific risks along the entire drinking-water supply system (from water supply sources, to the treatment facility, up to the distribution system). Recommended by the World Health Organization, the WSP tool has been introduced into European legislation with Directive (EU) 2015/1787, implemented in Italy by Decree of the Minister of Health of 14 June 2017. The adoption of WSPs is mandatory by 2025 in the whole national territory. The Veneto Region, struck by the PFAS emergency in 2013, was one of the first Italian regions to have started, in collaboration with the Italy's Higher Institute of Health (ISS), the test of this new approach, through the preparation of the WSP for the Lonigo aqueduct complex, which serves over 100,000 inhabitants in 26 municipalities inside the provinces of Vicenza, Verona and Padua. Then, in June 2019, the first Water Safety Plan was presented for the entire Veneto region.

WSPs represent an epochal cultural change for the guarantee system of drinkingwater safety, marking a fundamental step in strengthening the quality of water to protect human health. A transition that requires a strong presence of institutions in order to be supported and directed. The LIFE PHOENIX project acts synergistically with this process .The competent Institutions and the Integrated Water Service Managing Bodies will have to systematically assess the risks that quantitatively and qualitatively threaten the drinking water supply along the entire supply chain. This evaluation process requires knowledge of the sources of danger present inside the supply basin, which is only possible by integrating numerous data flows from different sources.

THE COMMUNICATION CAMPAIGN

PROMOTING

A series of communication and dissemination activities was addressed to the general audience (interested parties, citizens, local publics, etc.) in order to disseminate the results of the project, focus attention and raise awareness on water and environmental sustainability issues, as well as to encourage more eco-friendly lifestyle and choices. The project also received specific media coverage from newspapers and television news of regional and national significance, with dedicated articles and press reports.

In its action LIFE PHOENIX has disseminated widely, throughout the regional territory and beyond, information on the characteristics and benefits of the project. To this end, a communication plan was originally designed to coordinate and standardize dissemination efforts in the most effective way, and a visual identity of the project, starting with the logo, was developed to facilitate the recognition of all planned initiatives.

Multiple communication and public awareness products have been implemented, in particular:

- The project website (www.lifephoenix.eu), developed in Italian and English as a key communication platform and as the main online contact point.
- The YouTube channel of the project, in which the informative videos and the webinar recordings produced during the project activity were published.
- An information brochure, disseminated over the course of the implementation phases, especially during public events, to raise awareness among regional audiences and user groups about the key aspects of the project.
- An informative poster, produced in hundreds of copies and posted in various public places (e.g. health centers, town halls, etc.) in order to draw attention to project issues and the importance of sustainability, environmental management and green choices, with particular reference to the water resource.
- The Notice-boards, located in the sampling and study sites, to illustrate the fundamental characteristics of the project within the framework of the LIFE Programme and to serve as an information tool during any guided visits at the sites related to the implementation actions.
- The Roll-ups, containing brief information on the project and located at the institutional headquarters of the partners or employed during workshops, conferences and public events.

THE INVOLVEMENT OF STAKEHOLDERS

Specific communication and dissemination activities involved technical-scientific audiences (researchers from universities and research centers, technical officers of the public administration, technicians from water supply companies, etc.) and stakeholders (policy makers, producers, farmers, etc.). This action has developed initiatives aimed at increasing the awareness of interested parties about the problems caused by emerging pollutants, with particular reference to citizens' health.

To this end, a periodic digital newsletter, in Italian and English, was designed since the beginning of the project as an essential tool to inform, through a selection of news and in-depth articles, specific audiences interested in the evolution of the LIFE PHOENIX project, at all stages of implementation.

A participatory process was also carried out through a series of dedicated meetings, mainly conducted online, during which objectives, strategic choices, products, results and future collaboration opportunities were shared: a technical workshop on the theme of analytical methods, held in the form of a webinar, saw the participation of about 250 experts; a cycle of webinars on the various aspects related to the PFAS issue envisaged the involvement of farmers, enterprises, public managers and the academic world, registering over 100 attendances for each of the four scheduled sessions; and specific videoconferences were reserved for the representatives of the Veneto health units (ULSS), to include them in the project dissemination actions at the local offices and reference municipalities, also through the use and distribution of specific information materials.

Other activities concerned the development of several demo videos relating to the wetland area and the water depuration system, and the use of the collaborative platform ResearchGate, a social network addressed to researchers.

In order to disseminate the technical-scientific results and facilitate the transferability of the project experience, a final publication of about fifty pages was therefore produced, in Italian and English, aimed in particular at policy makers, water supply management companies and scientists and technicians dealing with persistent emerging pollutants.

The final Conference, organized in the form of an online macro-event and intended for all target audiences, finally stated the closure of the project experience (March 2021), with the presentation by the entire project team of the results achieved in over three years of analysis and research.

THE "LIFE PHOENIX FOR SCHOOL" INITIATIVE

The LIFE PHOENIX project wanted to dedicate specific actions to the new generations, to promote awareness towards environmental issues and to encourage greater attentiveness about the use of water as a precious resource. Through the "Life Phoenix for School" initiative, in particular, many activities were carried out for students from upper secondary schools in the Veneto Region, such as training sessions, educational materials and audiovisual products. To make the process more effective, teachers were also involved, through the use of specific in-depth kits developed with the contribution of the scientific partners of the project.

The involvement of schools (Art High Schools and Art Institutes, on the one hand, and Scientific High Schools and Technical-Industrial Institutes, on the other) was launched during the 2019/2020 school year with an invitation to participate at the initiative. Educational meetings were organized for students and teachers, which saw the project partners as protagonists in the explanations and answers to the young people's questions about the value of water and the pollution-related issues, especially from PFAS.

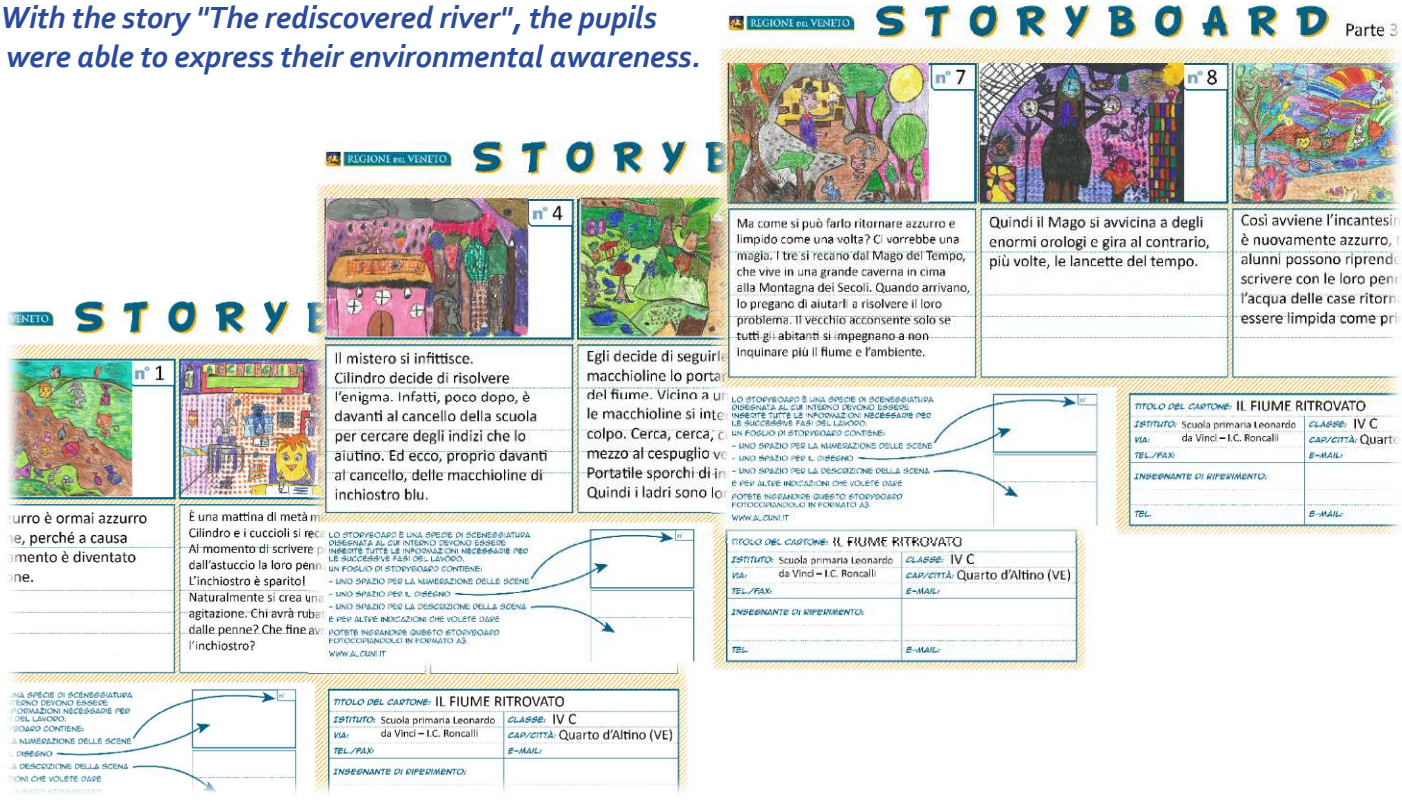
Following the Covid-19 health emergency and the consequent closure of upper secondary schools, these educational sessions were carried out remotely, with the wrapping up of two webinars attended online by over 160 classes. Subsequently, the webinar recordings were also published on the LIFE PHOENIX YouTube channel, thus making it possible to increase the number of teenagers and schools able to take advantage of these interesting insights on the subject. Numerous emails were also received from teachers and school managers in response to the issues treated, demonstrating the interest aroused.

At the end of this path with the experts, the school students were asked to write a brief subject for a short film that would help to understand some of the scientific contents of the project and to think about the absolute value of water in human life and art. Among the papers received, two were chosen: "The importance of water and nature", from the Rosselli Art School of Castelfranco Veneto (TV), and "Ideas for disseminating the Life Phoenix project", from the IIS Scalcerle of Padua.

In addition to the short films, a water theme cartoon was also made for younger children. In order to realize the cartoon, a storyboard entitled "The rediscovered river"), conceived by the pupils from the "Leonardo da Vinci" primary school in Quarto d'Altino (VE), was selected via the Veneto Region initiative "Raccontiamo la Salute" ("Let's talk about Health").

All the audiovisual products have also been dubbed into English to allow a greater diffusion at European level.

With the story "The rediscovered river", the pupils were able to express their environmental awareness.



NETWORKING ACTIVITIES

The networking action has fostered the exchange of information and awareness-raising activities with interested parties in a wider area. National and European projects operating on similar problems were identified in order to build a network for sharing knowledge and good practices.

The project partnership has participated in numerous conferences and events both in-person and remote, organized in Italy and in other European Countries, to illustrate the methodologies and results attained by LIFE PHOENIX and to share experiences with other similar programs and initiatives, also going beyond the framework of projects financed by the LIFE programme.

In the final phase, the project team also arranged various virtual meetings addressed to experts from other countries where similar situations are present (notably France, Netherlands and Belgium), with the aim of transferring the main outcomes of the project and presenting some management and mitigation solutions related to emerging pollutants issues.

THE SOCIO-ECONOMIC IMPACT

The economists of the project focused on the analysis of the socio-economic effects concerning the quality of water, reckoned as a non-rivalrous and non-excludable public good. Particularly for the drinking water (food and domestic use) it was essential to identify a specific monetary value, in the absence of an intrinsic market and the possibility to trade it at a defined price, while searching for a rate adequate to a possible change in condition (PFAS reduction) as assumed by the LIFE PHOENIX project setting.

This process took place through a setup and an estimate that considered both the results of similar studies concerning the economic evaluation of water quality and the data observed in the population primarily affected by PFAS pollution, especially people residing in the contaminated area and stakeholders operating in sectors at risk (e.g. public institutions, companies in the agri-food industry, etc.). The subjects involved were then submitted to targeted interviews.

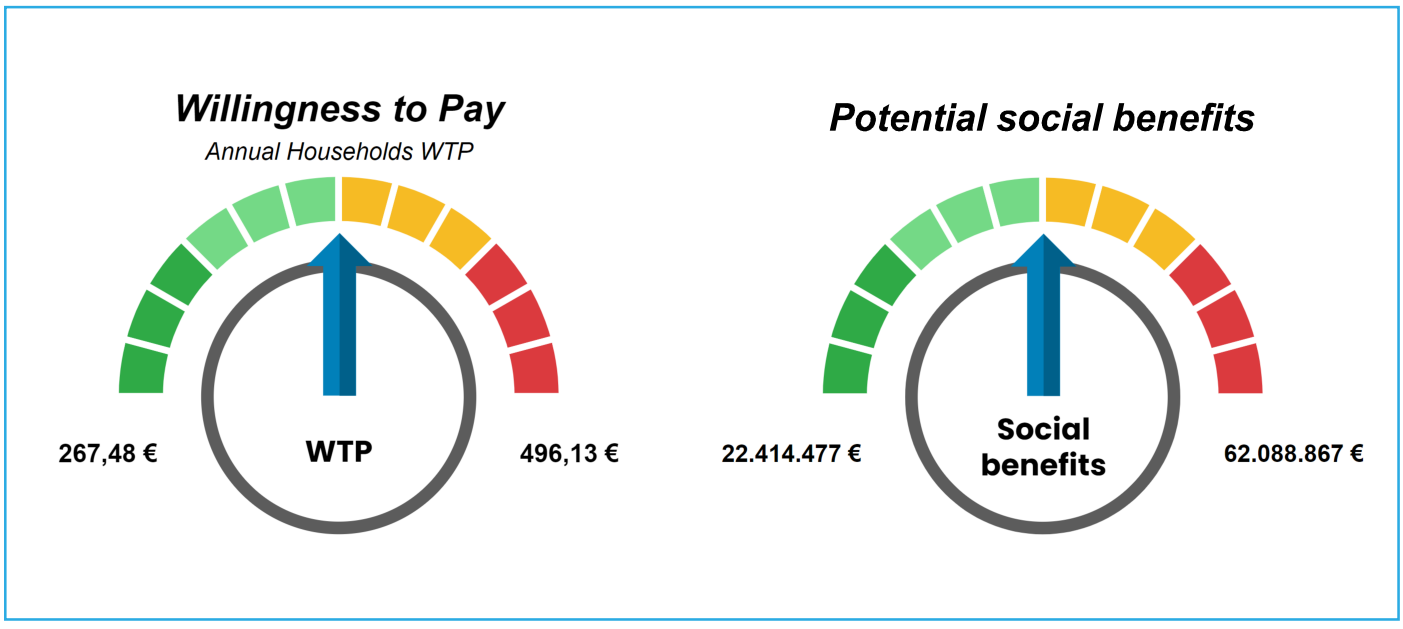
With regard to households, it was found how their overall perception of the PFAS emergency has changed, as well as what choices they are willing to take in order to cope with it and to maintain a good quality tap water. Specifically, people exposed to health risk were asked what their Willingness to Pay (WTP) would be to solve the problem, as a percentage of the costs already sustained.

The WTP calculated for a potential reduction of PFAS contamination in drinking water falls within a range between € 267.48 and € 496.13 per year per household, with higher values in the areas with the highest concentration of PFAS and in which the contamination is higher in terms of its impact on individuals. This calculation made possible to estimate the potential social benefits deriving from the mitigation of the polluting phenomenon, which fall within the range between € 22.414.477,06 and € 62.088.867,17, closely correlated to the family size of the analysed area.

On the other hand, with the stakeholders survey the goal was to qualitatively identify, by retracing the historical events linked to the PFAS affair, the main social and economic impacts related to the phenomenon for the referral organization. In the case of municipal administrations, the high communication costs aimed at making the population aware of a technically complex problem; for water services management bodies, the development of emergency techniques linked to the mitigation of pollution and the reduction of exposure; for Farmers' Associations, the "irrational" price of the agricultural sector which reflected above all in a generalized fear of loss in turnover.

Finally, an analysis of health costs from water contamination was carried out by structuring data connected to the experience of a Veneto Region's organization model in addressing cases of emergency events.

The Willingness to Pay (WTP), calculated for a potential reduction in PFAS contamination, and the estimated value of the social benefits.



THE PROJECT PARTNERSHIP

Veneto Region (Coordinating institution)
The Veneto Region is a public body with institutional commitments related to the definition and implementation of policies in multiple sectors, including the competence to achieve water quality objectives.

Azienda Zero (Partner institution)
Azienda Zero is the governmental authority of the Veneto Region for the health sector. The corporate mission is to guarantee the rationalization, integration and efficiency of health, social-health and technical-administrative services of regional structures.

ARPAV (Partner institution)
The Regional Agency for Environmental Prevention and Protection of Veneto is a public body founded with the regional law n. 32/1996. The Agency's goal is to monitor and preserve the environment in order to help identify and eliminate risks to humans and the environment.

IRSA-CNR (Partner institution)
IRSA (Water Research Institute) was established in 1968 with the task of carrying out research in the areas of water resource management and protection and in the development of methodologies and technologies for water purification and treatment of waste water (urban and industrial).

UNIPD (Partner institution)
The University of Padua is an Italian state university founded in 1222, among the oldest in the world. Its role in civil society and in the international context is proved by its many activities, such as the uncountable research cooperation projects promoted by professors and researchers.

"Strategic project aimed at timely, effective and efficient action in case of pollution of drinking water and irrigation water"

Life Phoenix

COORDINATOR

REGIONE DEL VENETO

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IRSA CNR

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