Blue Lakes

No microplastics, just waves.

NO MICROPLASTICS, JUST WAVES.

SEPARATE CHAPTER PROJECT IMPACT EX ANTE REPORT

BENEFICIARIO COORDINATORE

LEGAMBIENTE

BENEFICIARI ASSOCIATI

Autorità di Bacino Distrettuale dell'Appennino Centrale

ARPA UMBRIA Agenzia Regionale per la Protezione Ambientale dell'Umbria

ENEA AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

Global Nature Fund

Bodensee Stiftung Lake Constance Foundation

UNIVERSITÀ POLITECNICA DELLE MARCHE

PROGETTO COFINANZIATO DA

PlasticsEurope

www.lifebluelakes.eu / info@lifebluelakes.eu

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Introduction

This Report shows the results obtained by the survey done by ENEA, Legambiente and Arpa Umbria. The goal was to define the state of the art on microplastic monitoring (MP) activities carried out by the Regional and Provincial Agencies for Environmental Protection (ARPA/APPA) of the Italian Regions and Autonomous Provinces as part of action C.1 *Monitoring of project impact*.

The main objective of this survey was to determine whether or not regional ARPAs/APPAs disposed of methodologies for the collection and analysis of MPs in aquatic ecosystems. Particular attention was paid to the identification of any experience in the monitoring of MPs inland, in rivers and in lake waters.

The results of this preliminary survey were collected and evaluated as a separate chapter of the LIFE Blue Lakes Ex Ante Impact Report.

The survey will be repeated during the last quarter of the project to assess the extent to which the standardised protocols developed for the monitoring of MPs under Action B.2 of the LIFE Blue Lakes project. This will be applied by the Water Quality Monitoring Agencies, as a result of the training of ARPA/APPA personnel. The results of the second survey will be included and harmonised as a separate chapter of the Ex Post Report on the impact of the project

Survey

The survey began by sending a formal request to each Director of the 20 ARPAs/APPAs by ENEA, as scientific manager of Action B.2. It was requested to indicate a technical contact from which to find the necessary information for the investigation and with which to share the aims of the project and the future training activities planned for the technicians of the Agencies (Annex A).

Subsequently, technical contact people indicated for any ARPA/APPA received information materials about the LIFE Blue Lakes project together with an Excel file to be filled in with the necessary information related to the ordinary monitoring of MPs. In addition, any information related to any collaborations on ongoing experimental activities of each ARPA/APPA was requested.

Data collection

The 20 directors have appointed the technical referents for any ARPA/APPA. The list of selected referents is shown in Table 1, with the only exception of ARPA Friuli Venezia Giulia and ARPA Toscana, for which there are two contacts instead of one (one person responsible for sampling activity and the other for laboratory analysis).

Each contact person that compiled the Excel file provided the requested data relating to the monitored environment, the sites and the applied methodology, the output produced by the monitoring activity and any websites to be consulted, in accordance with the format listed in the annex (Annex. B).

Table 1: Selected ARPAs/APPAs technical referents

ARPA/APPA	Referente	E-mail
ABRUZZO	Giovannella VESPA	g.vespa@artaabruzzo.it
BASILICATA	Teresa TRABACE	teresa.trabace@arpab.it
CALABRIA	*in attesa*	
CAMPANIA	Lucio DE MAIO	ldemaio@arpacampania.it
EMILIA-ROMAGNA	Veronica MENNA	vmenna@arpae.it
FRIULI-VENEZIA GIULIA	Francesco CUMANI	francesco.cumani@arpa.fvg.it
	Cristina SGUBIN	cristina.sgubin@arpa.fvg.it
LAZIO	Laura AGUZZI	laura.aguzzi@arpalazio.gov.it
LIGURIA	Sonia ALBANESE	sonia.albanese@arpal.liguria.it
LOMBARDIA	Fabio BUZZI	f.buzzi@arpalombardia.it
MARCHE	*Stefania Sarcina*	stefania.sarcina@ambiente.marche.it
MOLISE	Antonietta CIOFFI	antonietta.cioffi@arpamolise.it
PIEMONTE	Francesca VIETTI	francesca.vietti@arpa.piemonte.it
PUGLIA	Nicola UNGARO	n.ungaro@arpa.puglia.it
SARDEGNA	Felicina TREBINI	ftrebini@arpa.sardegna.it
SICILIA	Giovanni VACANTE	gvacante@arpa.sicilia.it
TOSCANA	Michela RIA	m.ria@arpat.toscana.it
	Francesco LAVISTA	f.lavista@arpat.toscana.it
TRENTINO-ALTO ADIGE BOLZANO	Maddalena CASERA	maddalena.casera@provincia.bz.it
TRENTINO-ALTO ADIGE TRENTO	Giovanna PELLEGRINI	giovanna.pellegrini@provincia.tn.it
VALLE D'AOSTA	Alessandra ROMANI	al.romani@arpa.vda.it
VENETO	Giorgio FRANZINI	giorgio.franzini@arpa.veneto.it

The data collected so far highlights a specific activity MPs monitoring in the coastal strip carried out by the ARPAs of the 15 regions overlooking the sea. This is done according to the Marine Strategy Monitoring Program which, in compliance with the Framework Directive 2008/56/EC transposed in Italy with the legislative decree. N° 190/2010, coordinates a complex framework of measures and controls aimed at defining the state of sea quality. Among the many activities implemented by the Marine Strategy, a specific program is dedicated to microlitter and in particular to the MPs present in seawater that are monitored according to standardized procedures and protocols defined and identified in Module 2bis.

The methodology used is common to all ARPAs/APPAs, in the same way the selection of sites. For each area, pick-ups are made at 3 stations located at different distances from the coast (0.5; 1.5; 6 Mn), along orthogonal transepts of the coast line. The procedure provides, for each monitoring station, measurements and sampling at sea with manta net, identification and counting of MP fragments.

During the investigation, in addition to the compilation of the Excel file, a fruitful telephone exchange was added with some technical referents who reported several experimental activities of drawing and analyzing MPs also in fresh water in some of these 15 Regions. In particular, experimental activities carried out by:

ARPA Friuli Venezia Giulia: MPs survey on the Tagliamento river using the boat-drawn manta net;

ARPA Emilia Romagna: *Manta River project*, currently completed, coordinated by the Po River District Authority together with the project partners University of Rome "La Sapienza" and the Interregional Agency for the River Po. In February 2021, a monitoring activity of MPs in the Po river has started, carrying out periodic samplings in strategic points of the riverbed (i.e Isola Serafini, Boretto, Pontelagoscuro, Po di Goro delta).

In regions where experimental activities have not yet been implemented, a strong interest was detected in undertaking studies on the presence of MPs in the inner water bodies. For example, **ARPA Veneto** showed a strong interest in evaluating the possibility of implementing the monitoring of MPs in Lake Garda and the Adige river.

Some ARPAs/APPAs of regions that have no access to the sea have already started, or are interested in starting, MPs monitoring activities in freshwater bodies:

APPA Bolzano: monitoring activity of MPs in the Adige river by carrying out the sampling of riparian sediment according to the guidelines adopted for marine beaches and, in particular, the methods indicated by Georg Hanke (2013)[1] and those suggested by Löder and Gerdts (2015)[2]. Until now, a report has been produced describing the detection of both Small-MP (<1 mm) and Large-MP (1 - 5 mm; https://ambiente.provincia.bz.it/ambiente-salute/microplastics.asp). Moreover, in the coming months the sampling of river water will be implemented by means of a manta net together with an anchoring structure to bridges (material already purchased). The possibility to sample the lake water has also been envisaged.

ARPA Valle d'Aosta: analysis of water samples using the ATR technique (infrared spectroscopy). No information has been provided about the environmental matrix analysed and the sites in which such analysis were carried out.

ARPA Piemonte: preliminary acquisition of information, since the water monitoring activity has not yet begun. The interest of ARPA Piemonte is mainly addressed to the matrix of the inner surface waters and it is not ~~instead~~ interested in analysing urban wastewater. With the aim of increasing the knowledge on the available information on the presence/dispersion of MPs in

[1] "Guidance on Monitoring of Marine Litter in European Seas", (2013) EU Technical Subgroup on Marine Litter (TSG-ML);
[2] Methodology Used for the Detection and Identification of Microplastics—A Critical Appraisal (2015). Marine Anthropogenic Litter pp 201-227

surface waterways, ARPA Piemonte has identified the following operational phases (here below presented in a chronological order):

- development of shared sampling protocols and methods of analysis, through the creation of a network of direct contacts, involving the technicians of the different bodies that have developed projects on MPs issues;
- experimentation of sampling techniques for the surface running waters;
- implementation of microscopic observation techniques and morphological description of the MP components;
- definition of measurement units for the quantification (quantitative analysis) of MP concentrations;
- MPs classification based on the visible characteristics (shape and colour) of the plastics sampled (qualitative analysis);
- planning and implementation of the monitoring plan: identification of monitoring points and frequencies also based on the analysis of the pressures of water bodies
- experimentation of instrumental analytical techniques, also as a function of the development of sampling techniques;
- possible development of experimental methodologies in electron microscopy to complement the morphological description (optical microscopy).

ARPA Piemonte is available in establishing a network of contacts and it will provide an updated framework of what is happening in the Piedmont area. ARPA Piemonte also reports that, as part of the LIFE ESC VisPO project of which it is partnered together with Legambiente Piemonte and Valle d'Aosta, it will carry out the monitoring of river waters in the territory of around 40 SCIs located along the Po river. ARPA Piemonte communicates its availability in sharing the monitoring protocol and the results of the sampling carried out with the representatives of the LIFE Blue Lakes project. Finally, ARPA Piemonte reports that the CNR IRSA of Verbania intends to promote a project similar to LIFE Blue Lakes on the lake Orta area, within the activities for the Lake Contract and in collaboration with Legambiente club of Arona (Novara, Piedmont).

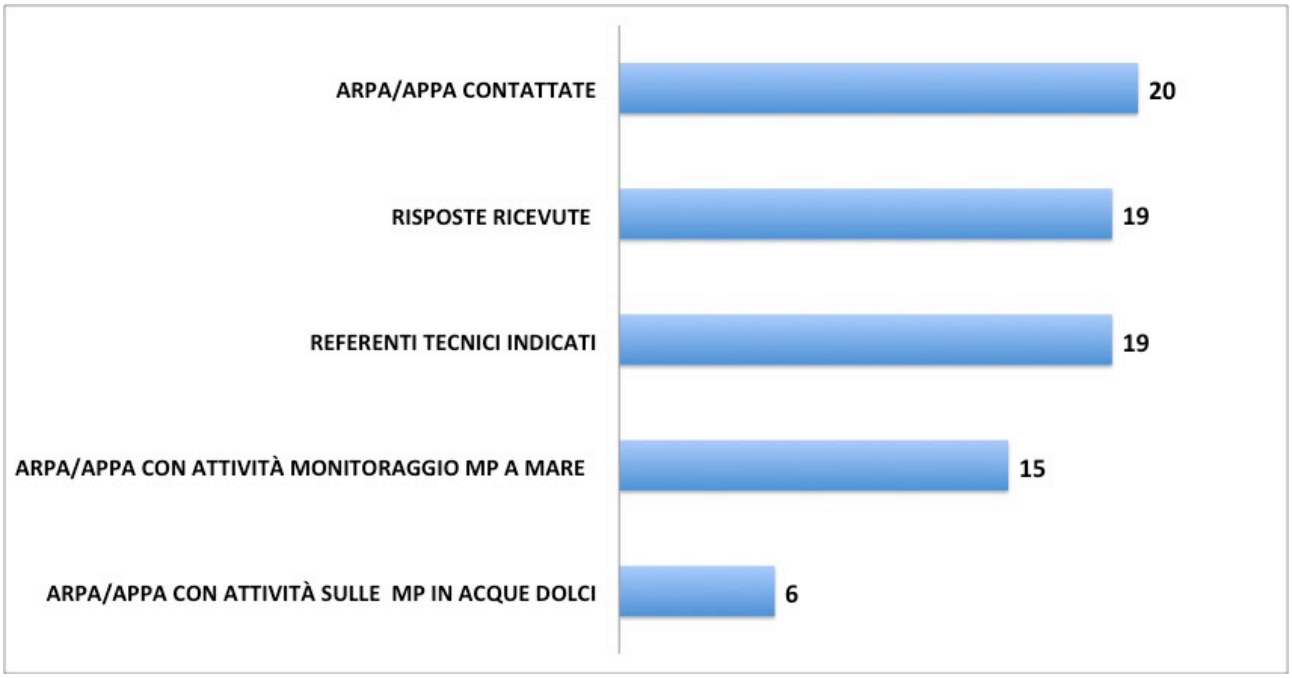

Figure 1: Summary of data on ARPA/APPA collected in the scope of the LIFE project Blue Lakes

Figure 1 summarize the data collected so far, providing a summary of available information obtained in this first phase of the project. This information will be useful for planning the training activities planned for the next year.

Conclusions

The survey has revealed some objective difficulties, related to the current emergency period, in recovering the specific contact person of each ARPAs/APPAs. Consequently, it was difficult to obtain all the information needed for drafting the ex-ante Report. These difficulties have prolonged the time of the two phases stated in the survey namely the identification of the technical contact person for the project by each ARPA/APPA Director (phase 1) and the selection of useful information by the contact person (phase 2).

ARPAs and APPAs promptly replied to our questions and they used different criteria in choosing the contact person. In some cases, the selected contact person was the same person in charge of the monitoring of MPs in sea waters, in other cases the contact person was specifically selected as a referent for the monitoring activity in the inner waters. These operational differences will be taken into account in planning the training courses, for which it will be necessary to diversify the envisaged activities.

In conclusion, the information collected so far, while showing a limited occurrence of MPs monitoring activities in fresh waters carried out by ARPAs/APPAs, has clearly shown a significant interest by all the national agencies in developing it during the LIFE project Blue Lakes duration. An evident willingness to cooperate in the project activities, as well as in attending the training courses, was also manifested by all the ARPAs/APPAs.

Annex A – Lettera di invito

AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE,
L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

Dipartimento Sostenibilità dei Sistemi produttivi e territoriali
Il Direttore

Roma, 16 ottobre 2020
Prot. ENEA/2020/53227/SSPT-PROTER

ARPA **XXX**
dirgen@cert.arpa. **xxx** it

Gentile Direttore,

Le scrivo in qualità di partner di **LIFE Blue Lakes (https://lifebluelakes.eu/)**, un progetto europeo coordinato da Legambiente che ha come obiettivo principale la prevenzione e la **riduzione dei rifiuti di plastica e microplastica nei laghi italiani** attraverso un programma articolato di attività di formazione, informazione e sensibilizzazione di specifici gruppi target, per invitarla come Agenzia a collaborare alle attività del progetto.

ENEA coordina e svolge in collaborazione con ARPA Umbria una delle principali attività del Progetto **LIFE Blue Lakes**, che prevede la stesura di un protocollo tecnico standardizzato per il monitoraggio delle microplastiche nei corpi idrici lacustri e che verrà proposto ai referenti tecnici delle Arpa e Appa italiane nel corso di uno specifico corso di formazione previsto nella primavera 2022, e costituirà un utile strumento per la pianificazione e la realizzazione di programmi di monitoraggio dei rifiuti plastici nelle acque interne a scala locale.

Per la stesura di tale protocollo, avremmo bisogno di acquisire informazioni in merito allo stato attuale delle metodologie e dei programmi di monitoraggio dei rifiuti plastici nelle acque interne e marine che vengono attualmente utilizzate dalle singole Agenzie Regionali e Provinciali di Protezione Ambientale. Questo quadro informativo di partenza ci consentirà di conoscere nel maggior dettaglio lo stato delle metodologie di monitoraggio in essere e capire come convogliarle in un unico programma di monitoraggio standardizzato a livello nazionale.

A tale proposito, Le vorremmo chiedere se potesse indicarci un referente tecnico all'interno della Sua Agenzia che sia in grado di fornirci le informazioni richieste e che possa partecipare alle future attività di formazione che verranno realizzate nell'ambito di **LIFE Blue Lakes**.

Dipartimento Sostenibilità dei sistemi produttivi e territoriali

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Partita IVA 00985801000 - Codice Fiscale 01320740580 - www.enea.it

Tale referente verrà da noi contattato nei prossimi giorni e in tale occasione sarà per noi possibile fornire maggiori informazioni sul progetto di **LIFE Blue Lakes** e sulle attività specifiche destinate alle Agenzie regionali e provinciali.

In attesa di una sua risposta, Le invio i miei cordiali saluti.

ENEA
Dipartimento Sostenibilità dei Sistemi
Produttivi e Territoriali
Il Direttore
Dr. Roberto Morabito

Annex B – File Questionario

ARPA/APPA	Nome Referente/i	Monitroraggio microplastiche	AMBIENTE MONITORATO	TIPOLOGIA ACQUE INTERNE	NOME SITO MONITORATO	MODALITA' DI MONITORAGGIO	OUTPUT/REPORT PRODOTTI	SITO WEB CONSULTABILE	NOTE

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Summary

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Introduction

This report presents the results of the survey conducted by UNIVPM to evaluate the state of art of selected Italian and German water and wastewater treatment plants within Blue Lakes. The survey activities aimed to define the current status of water/wastewater treatment plants and their efforts to face the problem of microplastics (MPs) in the environment. A particular focus is paid to identify any specific methodologies and/or treatment processes to reduce the discharge of MPs and to create possible future collaborations for better understanding the problems/solutions and upgrading existing facilities.

The surveys are mainly addressed to the managers of water utilities and treatment plants.

The results of the preliminary survey are collected and harmonized in this separated chapter of the Project Impact Ex- ante Report.

The survey will be repeated during the last quarter of the project to assess to what extent the technical protocol and guidelines developed within action B.3 are applied by Italian and German treatment plants as a result of the training of managers and technical operators of wastewater treatment plants (WWTPs), drinking water treatment plants (DWTPs, also called potabilization treatment plants DWTPs) and combined sewer overflows (CSOs).

Stakeholder selection

A list of Italian and German stakeholders was compiled to identify possible subjects for the interviews, including actors that could be interested or even further involved in the project. The experience of Water and Waste Environmental Engineering Lab (WWEELab) in UNIVPM in water and wastewater sector, with its participation to many EU projects and local technical consulting activities, was extremely useful and allowed to collect a wide number of contacts from different water utilities, operating both potabilization and wastewater treatment.

Italian water utilities were selected with particular attention to the ones operating in the surroundings of Garda and Castreccioni Lakes, where the field activities of UNIVPM take place in Blue Lakes.

German water utilities were selected from contacts of UNIVPM from previous collaborations and partnership in European projects. The GNF and the LCF added further regional stakeholders in the lake areas. The contacts of the WWTPs and DWTPs were partly involved in early projects. All contacts were informed about the Blue Lakes project and in some cases already participated in other Actions of the project. The stakeholders contact was via Email (2x) and phone call.

The lists of stakeholders contacted from Italian and German water utilities are given in Table 1 and 2, respectively.

Table 1: Contacts of Italian water utilities

Utility Name	Reference	Role
AGS	Alberto Cordioli	Project management
	Michele Cimolini	Project management
Depurazioni Benacensi	M. Giacomelli	Director
Acque Bresciane	Mauro Olivieri	Technical Director
Veritas	Patrizia Ragazzo	Responsible R&D
Acque Veronesi	Roberto Mantovanelli	President
	Mario Dalgrande	Quality control manager
Viveracqua		Vice President (D.G. Centro Veneto Servizi)

Acquevenete Spa	Giacomo Carletti	Responsibile Potabilization
ATS	Alberto Piasentin	Responsibile wastewater sector
CAFC	Michele Mion	Operative Director
CAP	Andrea Lanuzza	General Director
	Desdemona Oliva	Director R&D
Metropolitana Milanese	Andrea Aliscioni	Director water service
	Marco Blazina	Responsible wastewater sector
HERA	Francesco Avolio	Water Quality Technician
SMAT	Gerardo Scibilia	Research Centre SMAT
IRETI	Lorena Guglielmi	Process engineer
A2A	Pratesi Francesco	Quality engineer
	Maura Malgaretti	water sector
ACEGAS	Paolo Jerkic	Responsible wastewater sector
ACEA	Giancarlo Cecchini	Responsible R&D
ACQUAMBIENTE	Giuseppe Farina	Responsible technical division
	Fabiola Gigli	Coordinator potabilization
APM	Daniele Passacantando	Wastewater sector
Marche Multiservizi	Simona Francolini	Director network management
Vivaservizi	Andrea Deangelis	Technical Director
CIIP	Claudio Bernardo Carini	Energy manager
ASA Livorno	Camillo Palermo	Chief Innovation Officer
Acquedotto Pugliese	Francesca Portincasa	Director network, plants and customer care
	Nicola Tselikas	Engineer
Nocera	Luca Pucci	Process engineer
SIDRA SPA	Marco Morello	Responsibile wastewater sector
AMA Palermo	Angelo Siragusa	Responsibile wastewater sector
ETRA	Enrico Parelli	Responsible R&D
ASET	Claudia Zoppi	Technical office wastewater sector
Brianzacque	Ludovico Mariani	Technical Director
Paviaacque	Stefano Bina	General Director
TEA SPA	Giovanna Pesente	Investment and Engineering Manager
Padania Acque	Stefano Ottolini	General Director
ComoAcqua	Enrico Pezzoli	President
Uniacque	Stefano Sebastio	General Director
Livenza Tagliamento Acque SpA	Massimiliano Panigutti	Responsibile wastewater sector
ASTEA	Martina Santinelli	Process engineer
CADF	Nicola Dallamuta	Responsible plant management
Provincia Autonoma Trento	Giovanni Battista Gatti	Manager wastewater sector
ECOCENTER	Marco Palmitano	Director
CALTAQUA S.P.A.	Giovanni Casamassima	Responsibile wastewater sector

Table 2: Contacts of German water utilities

Utility Name	Reference	Role
Stadtwerke Dachau, Abwasser- und Anlagenbetrieb	Alexandra Jelic	Division manager
AGGERVERBAND	Erik Akkersdijk	Technical manager
KWB	Nicolas Caradot	Technical manager
	Ulf Miehe	Engineer KWB
Betrieb Kläranlage und Pumpwerke [Stadt Konstanz]	Mirco Ebeling	
Kläranlage [Stadt Radolfzell am Bodensee]	Paul Merk	
Kläranlage Stockacher Aach	Carsten Bucksch	
Kläranlage Gaienhofen	Andreas Graf	
Zweckverband Abwasserbeseitigung Überlinger See	Dominik Männle	
Abwasserverband Lipbach-Bodensee	Michael Schlegel	
Klärwerk Friedrichshafen	Dieter Schandelmeier	
Abwasserverband Unteres Schussental	Claudia Schubert	
Zweckverband Abwasserreinigung Kressbronn-Langenargen	Ernst - Alexander Müller	
Zentralklärwerk Pflegelberg	Yinka Omidiji	
Klärwerk Langwiese, Abwasserzweckverband Mariatal, Ravensburg	Alexander Härdtner	
GTL Lindau Abwasser	Snjezana Kovacic	
IGKB	Dr. Bänz Lundsgaard-Hansen	
LRA Bodenseekreis	Caroline Brosy	
LRA Konstanz	Thomas Buser	
Wasserwerk Staad der Stadtwerke Konstanz	Wolfgang Fettke	
Kläranlage Radolfzeller Aach	Her Blazej	
Kläranlage Steißlingen	Herr Weber	
Kläranlage Honstetten	Herr Martin	
Abwasser- und Umweltverband Chiemsee		

In total, 41 Italian and 23 German water utilities were contacted.

For each contact, e-mails were sent together with invitation letters (see Annex A), in order to briefly present Blue Lakes project and contextualize the survey within its activities. In this regard, many stakeholders were informed about Blue Lakes objectives and activities, with a particular focus on MPs sampling in water and wastewater treatment plants and on training activities for utility managers and plant operators.

Survey

The survey was elaborated in order to get a general overview of the current status of DWTPs and WWTPs, with a particular focus on their sensitivity to the presence of MPs in water environment. The content of the survey is reported in Annex B.

An English version of the survey was initially prepared and further translated into Italian in order to facilitate the communication with the related utilities. For an easy access for the local German partners a German version of the survey was translated and adapted by a technician for waste water treatment.

The survey was structured in a way to be adaptable both for potabilization and wastewater treatment plants, since many water (multi)utilities manage the whole water service and it would be easier for them to manage the survey in a single format.

Wherever possible, the questions were structured with the possibility to select multiple choices from predefined options, in order to make the process faster and simpler for the utilities.

First questions were related to the general outline of the plants layout, their treatment capacity, the contextualization in the territorial framework and their representativeness with respect to other plants managed by the same utility. It was also suggested to include a schematic representation of the plant layout, photographic material or satellite images to get a clearer vision of each case.

Following questions helped to understand sources and influent flows of each plant. For WWTPs, it was asked to define the type of sewer network collected to the plant, if combined or separated, in order to define possible influences from run-off waters and/or stormwater. It was also asked to consider the presence of CSOs in the associated catchment. Contributions such as municipal or industrial flows, infiltration waters or other possible inflows were asked, considering different ranges as options. In case of potabilization plants, it was asked to define water sources and to list different contributions from surface waters, lakes, groundwater or other sources.

Next section was dedicated to a deeper description of the treatment steps, detailing pre-treatment units and primary treatments. A specific question was directed to better understand the functionality of tertiary units of filtration and disinfection.

In order to identify the fate of MPs along the treatment chain, total sludge production and their final destination or disposal were also considered.

In the last section, a deeper focus on MPs was given to determine how these treatment plants approach to the issue. First, we tried to understand if the occurrence of MPs was seen as a priority issue in the region or in the territory of the utility. Next questions included any monitoring activities in the plant or from other projects in the region. A specific question was dedicated to identify if any methodologies or treatment units currently exist in the plant to reduce the release of MPs in the environment. In most cases, MPs, as included in contaminants of emerging concern (CECs), are not considered as process parameters in plant design. However, current common configurations can anyway remove MPs from the final effluent with relatively high performances. (Pittura et al., 2021; Pivokonský et al., 2020; Wang et al., 2020). As an example, from a previous study conducted by UNIVPM in WWTPs, it was observed that conventional activated sludge configuration can reach MPs removal efficiency as high as 86%, while this could be enhanced up to 94% with innovative technologies as in the case of up-flow anaerobic sludge blanket (UASB) reactor coupled with anaerobic membrane bioreactor (AnMBR) (Pittura et al., 2021).

In this regard, we further asked if the plant is provided with such treatment units that, even if not designed specifically for MPs removal, but could anyway show good performances on their minimization in the water environment. The managers/operators also had the change to evaluate the flexibility of their plant for future upgrading possibilities, in case of MPs occurrence, optimizing existing treatment units or installing new technologies.

Finally, utilities' interest in future Blue Lakes activities was checked, asking their availability in the organization of sampling campaigns and their willing to involve in training courses for MPs removal during water and wastewater treatment.

Data collection

The surveys were distributed to the utility contacts using a format from Google Modules, since it is a simple and open-source tool that allows users to answer and send back questionnaires in a fast and easy-to-use way. Using this online tool, the participants were able to fill in the questionnaire and directly send back their answers in an automatic way. Moreover, the online format facilitates the collection and the elaboration of the data. The number of answers collected was periodically checked and a reminder was sent to the interested contacts, in order to enhance the participation and the number of replies.

The online tool automatically makes some elaborations from the answers collected, providing at a glance basic information, such as the percentage of answers selected from multiple choice options together with graphs for a quick visual check.

In total, 24 surveys were collected from 17 Italian water utilities, of which 17 were referred to WWTPs and 7 to DWTPs, corresponding to 41% of replies from Italian utilities.

For the German part the survey was distributed to the utility contacts attached via e-mail. 5 surveys were collected all WWTP.

Evaluation

As can be seen from Figure 1, almost 71 of the replies from Italian stakeholders considered WWTPs, while about 29% were referred to potabilization. Taking into consideration that these water utilities usually manage both services, it could be deduced that the MPs is considered as a main concern mostly in wastewater treatment and sludge disposal. Although current regulations don't apply any restrictions for MPs concentration in drinking water and treated wastewater discharge, the final destination of sludge could be influenced by the presence of MPs, especially in case of land or agriculture application, since a significative part of MPs removed from water streams are retained in sludge (Pittura et al., 2021).

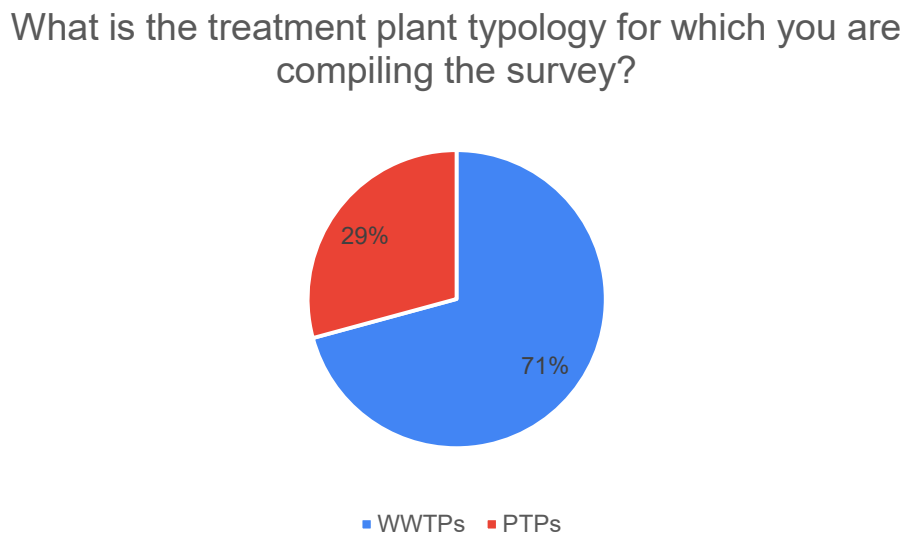

Figure 1: Replies for Italian WWTPs and DWTPs

100 % of the replies for the German part are from WWTPs. 4 surveys were answered in the Lake Constance Region, 1 in the Chiemsee region. It is uncommon in Germany that WWTPs and DWTPs

are managed by the same company. At Lake Constance for instance 170 Mio. m³ water are used for drinking water. 130 Mio. m³ are managed by one DWTP. 40 Mio. m³ are divided up by 16 companies.

With the exception of the utilities that were directly involved in Blue Lakes project (i.e., near Lakes Garda and Castreccioni) for MPs sampling activities, most of the Italian utilities selected a configuration typical in their territory, while less were referred to their biggest or most relevant plant in terms of population served.
The majority of the Italian utilities that participated to the survey were mostly located in Northern Italy (66.7%, see Figure 2), while central Italy was represented by almost 21%, and Southern Italy by 12.5%.

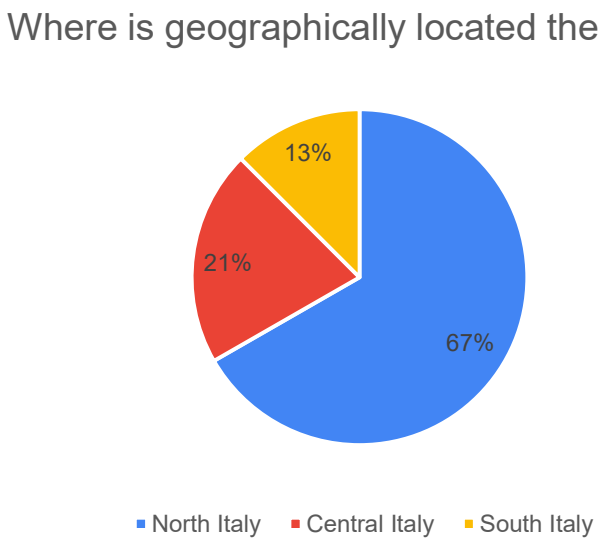

Figure 2: Geographic location of Italian utilities participating

The locations of German utilities are in Bavaria and in the federal state of Baden-Württemberg.

The considered Italian DWTPs have a treatment capacity ranging from 10 to 2400 l/s, while for Italian WWTPs it varies from 40000 to 800000 PE. Typically, the most common configuration in WWTPs is represented by pre-treatment, primary sedimentation, biologic treatment and tertiary treatment with disinfection.
Generally, there are two steps of coarse and fine screening that can remove particles of size up to 2 mm. Primary treatments are present in 8 of the 14 WWTP (LC+C: Frage configurations. The most common biologic unit is conventional activated sludge (CAS), enhanced in a few cases with biologic nutrient removal (BNR). Less common secondary treatment processes include membrane bioreactors (MBR) and integrated fixed-film activated sludge (IFAS). In 41% of the surveys filled by WWTPs, there is also a tertiary filtration unit, with various technologies applied such as sand beds or cloth filters. When specified, the mesh size is reported around 20 – 40 µm, reaching down to 35 nm in specific cases. The solids removal efficiencies are reported in the range of 50 – 70%. In all plants a disinfection unit exists, mainly with UV or peracetic acid.
Sludge line usually includes thickening and dewatering units, sometimes coupled with anaerobic or aerobic digestion. In DWTPs, the plants often include a pre-treatment using ozonation, filtration with sand and activated carbon and finally disinfection. Sedimentation is present in two DWTPs, one of which is also characterized by a patented technology of accelerated sedimentation. In one case, there is a compact layout with membrane ultrafiltration.
In most cases, the WWTPs receive influent from combined sewer systems (87.5%) and discharge in surface water bodies. Municipal wastewater is the main influent contribution, as shown in Figure 3,

mainly between 60 – 70%, followed by infiltration waters, that influenced on average 10 – 20% of the influent flow. Industrial contribution was less than 5% in most cases.

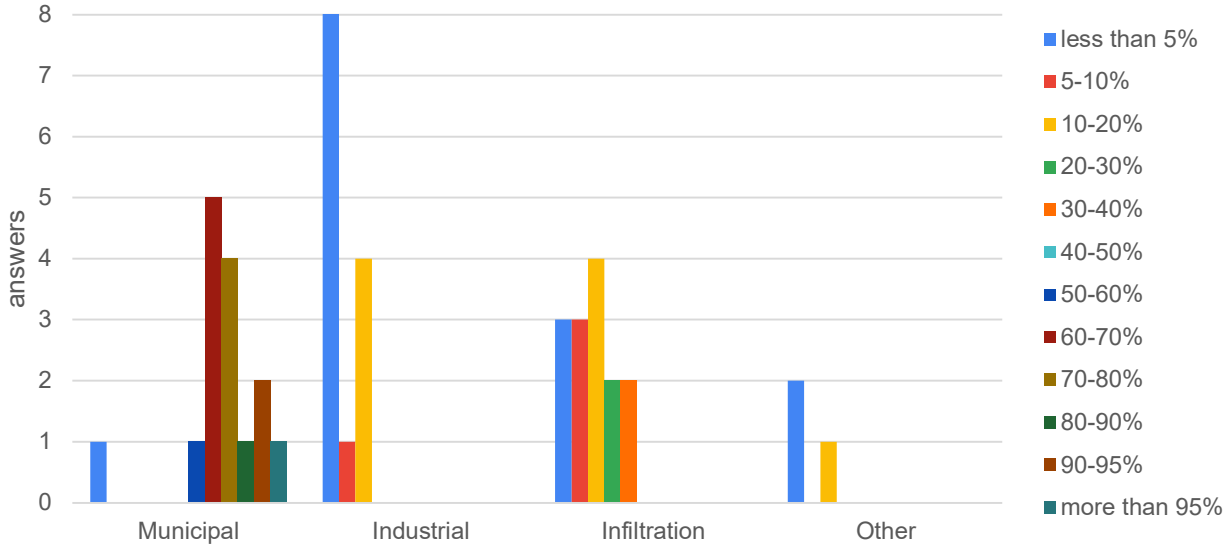

Figure 3: Italian WWTPs contributions

German WWTP represented in the survey have four treatment stages:
These are in all cases:

1. Mechanical purification: Screen (6 mm), aerated grit and grease trap, primary sedimentation tank
2. Biological treatment with an upstream zone and aeration tank, secondary clarifier with denitrification (sand filtration)
3. Chemical treatment
4. 4th treatment stage for the removal of micro pollutants (MP) and trace substances. The removal is effectuated by powdered activated carbon filters or processed by ozonation. The use of activated carbon filters is integrated between secondary sedimentation tank and sand filter.

The sludge treatment takes place in conventional sludge digester towers. The sludge dewatering by centrifuge. The sludge is stored in silos. The dried sewage sludge is collected by external service provider and goes to thermal utilisation (incineration).
The Ministry of Environment of the federal state of Baden-Württemberg prescribes in 2018 that WWTP that discharge of the effluent of the wastewater treatment plant into Lake Constance or in the Lake Constance drinking catchment area, including the Upper Danube region require a 4th treatment facility. The transition period for the technical changes of WWTP started in 2018.
Like in Italy in all cases municipal wastewater is the main influent contribution. In general, there is no special treatment for industrial wastewater. The wastewater infrastructure allows a combined collection of wastewaters and a centralized water treatment in WWTPs. In four out of five cases the exact number of the received influent is unknown in the answers of the German WWTPs. One WWTP estimates that approx. 60 % of the wastewater is from municipalities, 20 % from industry and 20 % of infiltration. Treated wastewater is in all cases derived in adjacent ecosystems. 3 WWTPs derive the purified water directly in the lakes 2 in rivers that flows to the lakes.

As reported in Figure 4, the main water supply for the Italian DWTPs that participated to the survey is lake water, followed by river surface water and groundwater.

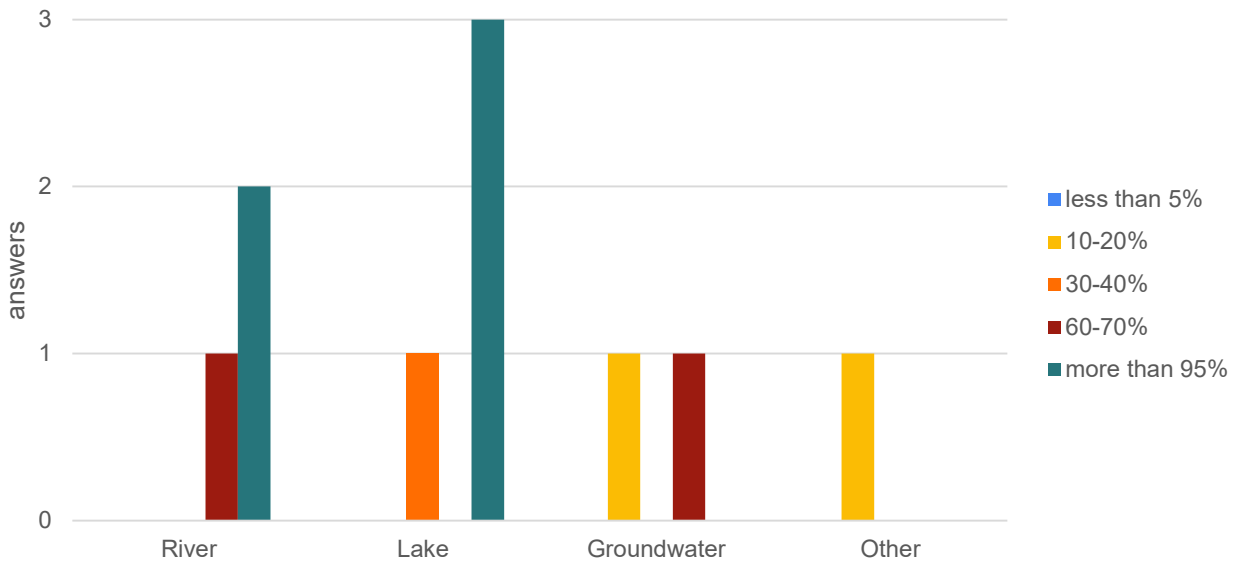

Figure 4: Italian DWTPs contributions

The sludge produced in Italian WWTPs are mainly subjected to composting or defecation lime production to be reused in land or agricultural applications. The second destination is landfill disposal, while in 5 plants, some parts of the sludge are sent to incineration.
The results of surveys for German utilities show a 100 % incineration of the sludge in these cases. Much has been done in recent years for a further restricting the use of sewage sludge in agriculture. Since 2015, the federal Agricultural Fertiliser Act makes it difficult to use sewage sludge as fertiliser. In 2017, the Sewage Sludge Ordinance was also amended. According to this, large sewage treatment plants that treat the wastewater of more than 100,000 or 50,000 inhabitants may only use sewage sludge for soil-related purposes as fertiliser until 2029 or 2032. Sewage sludge containing at least 20 grams of phosphorus per kilogramme of dry matter and ash from sewage sludge incineration must be subjected to phosphorus recovery after the transitional periods have expired, so that this valuable resource remains in the cycle. In lake regions the recommendations for the use sludge do not intend to use for fertilizer.

In the part of the questionnaire where the presence of MPs in water and wastewater treatment plants are focused, most of the Italian stakeholders interviewed (91.7%, Figure 5) declared that actually the MPs occurrence is not currently considered as a priority issue for plant management or in the surrounding region. Nonetheless, the issue of MPs in water environment has already been considered by other projects or activities conducted by research institutes or Universities, such as ENEA and UNICT, in the territories of some of the utilities that participated to the survey.
During previous projects, such as the programme VALUE CE-IN, some of the utilities that participated to the survey were involved in sampling campaigns for MPs detection in WWTPs. For example, the project VALUE CE-IN was developed in Emilia Romagna region and aimed to the valorisation of wastewater and sludge according to circular economy concept and industrial symbiosis. In particular, environmental and health safety aspects related to wastewater reuse and sewage sludge application in agriculture are investigated, with a specific focus on CECs and MPs. Sampling procedures and analytic techniques are tested for the quantification of some CECs and MPs in different wastewater treatment plant units. Technologies are analysed, verifying CECs and MPs removal rates from wastewater and evaluating their potential implementation within WWTP treatment processes.
Except for the plants that participate to Blue Lakes project, where sampling campaigns have already initiated, a specific monitoring activity for MPs is currently carried out by only one of the utilities,

measuring MPs concentration in the effluents. It was found that secondary treatments and filtration units are characterized by elevated MPs removal performances (95 – 99%) in the final effluent.

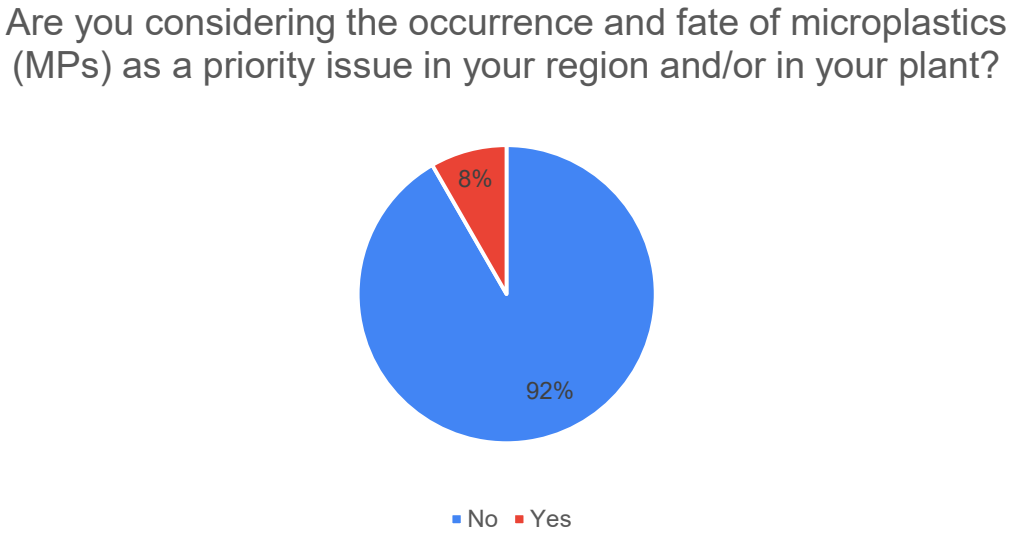

Figure 5: Consideration of MPs as a priority item in plants and in the Italian territory

As concern German utilities, the expectation of the 4th stage of wastewater treatment with active carbon and ozonation and the therefore necessary technical adjustments (filtration) are very high in regard of MP treatment. 75 % of the answers concerning the prioritization of MP shows an interest in MP management systems. However, in all cases there are no strategies or monitoring systems for MP. Specific technical installations are not mentioned.

Regarding the specific methodologies or treatments to remove MPs, at first only one DWTP utility answered that a dedicated unit exist accordingly. However, when a deeper detail was provided, the technologies which they were referring to are actually applied for solids removal, that could have a positive effect on MPs reduction. The particular technology is a patented system for solids separation, called CYCLOFLOC, which consists of an accelerated sedimentation unit, where micro-sand granules are added to increase the weight of sludge particles and accelerate their sedimentation. Moreover, this unit could be improved with a preliminary step of coagulants dosage in order to enhance sludge flocculation.
The replies from all utilities reflect the current situation in most of the water and wastewater treatment plants, since nowadays technologies specifically designed for MPs removal are not developed or diffused. However, in the existing configurations, there are already treatment units that are able to reduce MPs from water fluxes, such as screening, coagulation-flocculation, sedimentation and filtration.
In all DWTPs interviewed, there is at least a filtration unit, that in one case is an enhanced technology of membrane ultrafiltration. Moreover, sand filtration is usually coupled with activated carbon (GAC) in order to improve treatment performance and efficiency. Coagulation-flocculation is another unit commonly applied in DWTPs, as confirmed by the survey, finding 3 cases where this treatment unit is applied. In WWTPs, screening can remove coarse and fine materials from the influent, retaining particles as little as 2 – 3 mm Sedimentation is the most common unit used for solids removal, having positive effects also on MPs reduction. That unit could reach up to 95% efficiency on TSS removal and a solid concentration < 10 mgTSS/l in the effluent, as specified in one of the cases analysed. Filtration is generally used as a tertiary treatment, as seen in some of the WWTPs analysed, where in one of the plants microfiltration with a mesh size of 20 µm is used, while ultrafiltration with a porosity of 35 nm is applied in another plant. MBR configuration can also

increase MPs removal, since it includes a filtration process, that usually is in the range of microfiltration.
The plants configurations were analysed not only based on the treatment units currently applied, but also on their flexibility to future upgrading or new requirements. In case the occurrence of MPs is demonstrated as an issue of bigger concern and further treatments or enhancements should be necessary in the future, 4 of the plants replied that it could be possible to increase removal performances by modifying the existing treatment units, such as pre-treatments or filtration, by restricting the mesh size, while new units should be installed for other plants.
Almost all the utilities interviewed showed their availability to organize sampling campaigns to detect MPs in their plants and expressed their interest to have a specific free training on the occurrence and removal of MPs in water/wastewater treatment plants under the future activities of Blue Lakes.

Conclusions

The survey was conducted to define the current situation of water and wastewater treatment plants regarding their ability and capacity to remove MPs. We analysed any existing measures in WWTPs and DWTPs considering the occurrence of MPs and technologies applied to remove them from water environment. The utilities were contacted in order to obtain information for a complete overview of the territory they are serving, and the plant configurations applied for water and wastewater treatment. The survey gave preliminary overview of the regional context, type of influents to the plants, the layout and the treatment units applied. The most common Italian WWTP configuration consists of preliminary treatments, CAS and disinfection units, while DWTPs include coagulation-flocculation units, sand and/or GAC filtration, sedimentation and disinfection. Even if these units are not specifically designed and applied for MPs removal, the current configuration of all the plants could anyway affect the MPs removal from water fluxes. It was observed that, even if MPs is not actually considered as a priority issue in most of the regional territory served by the utilities, some research activities have already been conducted by other research institutes or universities or even by the utilities themselves. This demonstrates that the interest in MPs detection in environment is becoming of increasing interest and concern.
Utilities responded positive to the organization of new sampling campaigns to measure MPs in their plants, showing a constructive collaboration to deeper investigate the fate of MPs in water and wastewater treatment plants.
Moreover, all the utilities are interested in participating to training activities about the occurrence and removal of MPs in water and wastewater treatment, in order to be informed and prepared to overcome any related problems in their plants.
For German utilities, the results of the survey describe on the one hand a high technical configuration of the WWTPs and restrictive use of the sludge according to the legislation and recommendations in lake areas. On the other hand, MP is an actual item but expect of the high expectation of the active carbon or ozonation systems, there are neither specific strategies for MP treatment, nor monitoring systems for the WWTPs in Germany. Training activities may be interesting for the technical managers, but need to be part of the formalized training activities they have to attend to or be part of the on-the job trainings.

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Annex A – Invitation letter

Dear,

We kindly invite you to take the survey for the LIFE Blue Lakes (https://lifebluelakes.eu/), an EU-funded project coordinated by Legambiente that aims to prevent and reduce plastic wastes and microplastics in Italian and German lakes through a programme of training, information and sensibilization activities of specific target groups.

One of the main activities in LIFE Blue Lakes project is the development of a technical report and an operative manual to improve microplastics removal in water and/or wastewater treatment processes, led by Polytechnic University of Marche in collaboration with Legambiente Onlus. The final report and the manual will be further proposed to Italian and German water utilities, in addition to the organization of training courses for water professionals, public authorities and environmental protection agencies. In order to provide the technical report, we need relevant information about the actual and possible treatment and methodologies applied for microplastics removal in treatment plants. The informative background will allow us to obtain a deeper knowledge about the current status of treatment technologies and to define novel solutions to remove MPs in the water cycle.

Therefore, we kindly ask you to suggest a technical referent in your utility, who could provide - the information required and participate to the future training activities that will be organized within the LIFE Blue Lakes project by 2022-2023. The referent person will be contacted by the research team of UNIVPM in the next days who can provide more information about the LIFE Blue Lakes project and its specific activities for water utilities.

We are looking forward to your reply and possible collaboration.

With kind regards,

Francesco Fatone, Polytechnic University of Marche

Link to the survey, English version: https://forms.gle/LSCuPiHtBTEceDLHA

Annex B – Survey

Methodologies applied by Italian and German treatment plants to reduce microplastics (MPs) in the environment

1. E-mail address/identification:

2. What is the treatment plant typology for which you are compiling the survey? *

   - Wastewater treatment plant
   - Potabilization treatment plant

3. The selected configuration is typical for how many plants and for which treatment capacity? *

4. Where is geographically located the plant? *

   - North
   - Center
   - South

5. What is the maximum and the actual capacity of the plant? *

6. What is the layout of your plant and what are the treatment units applied? Is there a dedicated sludge line in your plant? *

7. Please add images of the layout, even from Google Maps

8. What are the source(s) and final users (in case of drinking water), or receiving body (in case of wastewater) in your plant? *

9. How many Combined Sewer Overflow are present in the catchment? *

10. In case of wastewater treatment plant, the sewer network is mixed or separated? *

- Mixed
- Separated

11. What are the different contributors of the influent wastewater (e.g. municipal, industrial)? Please specify percentages for each contribution

	less than 5%	between 5 and 10%	between10% and 20%	between 20% and 30%	between 30% and 40%	between 40% and 50%	between 50% and 60%	between 60% and 70%	between 70% and 80%	between 80% and 90%	between 90% and 95%	more than 95%
Municipal												
Industrial												
Infiltration												
Other												

12. In case of potabilization plant, what are the different contributors of the influent water? Please specify percentages for each contribution

	less than 5%	between 5 and 10%	between10% and 20%	between 20% and 30%	between 30% and 40%	between 40% and 50%	between 50% and 60%	between 60% and 70%	between 70% and 80%	between 80% and 90%	between 90% and 95%	more than 95%
Riga 1												
Lake												
Growndwater												
Other												

13. Please give details on the preliminary treatment section (i.e.: grit removal screens mesh size) of your plant *

14. Please give details on the primary treatment section of your plant *

15. Does the plant apply filtration and/or disinfection as tertiary treatment? What are their solid removal efficiencies and/or filtration mesh size?*

- No
- Yes, filtration (please, detail in Other")
- Yes, disinfection (please, detail in "Other")
- Other: _____

16. What is the final destination of waste and sludges produced in your plant? What is the amount of total sludge produced? *

17. Are you considering the occurrence and fate of microplastics (MPs) as a priority issue in your region and/or in your plant? *

- No
- Yes

18. Do you monitor and/or measure MPs at the moment? If yes, in what frequency and by which method? Can you describe sampling and measuring procedure that you are applying? *

- No
- Yes (please, detail in "Other")
- Other:

19. Are there any specific methodologies/treatments applied at the moment to reduce MPs in your plant? If so, what kind of methodologies/treatments? *

- No
- Yes (please, detail in "Other")
- Other:

20. Is there any evidence (e.g. from other projects or activities in your region) about the occurrence of MPs in the final treated water? *

- No
- Yes (please, detail in "Other")
- Other:

21. Are there any methodologies/treatments in your plant that, even if not specifically designed for MPs, are expected to remove them from water (e.g. sedimentation, filtration)? If yes, what are the supposed/measured removal efficiencies? *

- No
- Yes (please, detail in "Other")
- Other:

22. In case of MPs occurrence, is your plant flexible to be upgraded to increase removal performances? Could an existing unit be optimized or a new one needs to be installed? *

- No
- Yes (please, detail in "Other")
- Other: _____

23. Are you available/open to organize a sampling campaign in your plant to detect MPs? *

- No
- Yes

24. Would you like to have a specific free training on the occurrence and removal of MPs in water/wastewater treatment plants? *

- No
- Yes