NET4mPLASTIC TELLS

Summaries of webinars presentations

NEW FRONTIERS FOR COASTAL MONITORING

SUSTAINABILITY, CIRCULAR ECONOMY AND ACTIONS ON POST-CONSUMER MATERIALS

MICRO-POLLUTANTS AND MICROPLASTICS IN WATER: RISKS FOR ENVIRONMENT AND HEALTH

Contribution to deliverable D 2.3.2 “Events and demonstration session”

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Seminar "MICRO-POLLUTANTS AND MICROPLASTICS IN WATER: RISKS FOR ENVIRONMENT AND HEALTH"

The Net4mplastic Project aims at improving the quality of seawater by using a common integrated procedure to identify areas where microplastics accumulate. The purpose is to plan strategies that will turn to mitigate these accumulations of debris.

This project is carried out by a synergy between Italy and Croatia within the European Interreg programme and wants to increase public interest in the topic of microplastics. For this reason, in collaboration with the Professional Order of Engineers of the Province of Rovigo, three seminars have been organized, during which professionals in the sector, university staff and public administration staff will speak.

1. NEW FRONTIERS FOR COASTAL MONITORING

During the first meeting, entitled "new frontiers for coastal monitoring", the central themes have been the measurement, monitoring and study of coastal areas. Experts talked about

- the effects of climatic changes and man’s actions on the coast;
- numerical simulations of microplastic dispersion and accumulation;
- the use of drones and other instruments to evaluate the current state and transformations of marine areas, due to pollution, anthropogenic actions and climate change.

You can see the videos of the presentations at the following link:

Seminar “NEW FRONTIERS FOR COASTAL MONITORING”

1.1. THE NET4mPLASTIC project

Dr. Corinne Corbau. Presentation by Alexandre Lazarou

Marine litter is a growing global problem causing increasingly serious threat to the environment, the economy and health. Indeed, marine debris is nowadays commonly observed all across oceans. Commonly **marine litter** is defined as "*any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores (UN Environment definition)*". Marine litter, including plastics (main component) and microplastics, is known to result from land-based sources in massive quantities but can also originate from ships.

The project N**ET4mPLASTIC** (New Technologies for macro and Microplastic Detection and Analysis in the Adriatic Basin) focuses on this issue and aims to collect data on the distribution and composition of the Microplastic along the Croatian and Italian coastal and marine areas. The project, leads by the University of Ferrara, involves 8 partners: University of Trieste, Marche Region, Hydra Solutions srl (PME), Prosoft Ltd (PME), Veterinary Public Health Institute of Abruzzo and Molise Regions, Teaching Institute For Public Health, Primorje-Gorski Kotar County, Public Institution RERA S.D. for coordination and development of Split-Dalmatia County and University of Split - Faculty of Civil Engineering, Architecture and Geodes.

The project structure consists in:

- Preliminary activities to collect already existing data and information on marine litter (in particular regarding plastic and microplastic) including health issues, to perform 3D transport models in the project pilot sites (two in Italy and two in Croatia) and to develop an integrated platform's structures for data analysis and sharing;
- Field activities to collect water, sediment and biota sampling using traditional and innovative methodology and acquisition of physical-chemical parameters like water transparency, salinity, dissolved oxygen…;
- Laboratory analysis to characterize marine litter and microplastics.

All the results will be integrated in a common platform that will be used to set-up and calibrate an Early Warning System. The main outputs of the project are:

- Validated model for MP accumulation areas prediction,
- Potential scenarios forecasting of MP accumulation areas (MP-vulnerability map creation)
- Early Warning System for MP accumulation areas forecasted after storms/ river overflows,
- Indication to aquaculture and fishing operators, local authorities, stakeholders for safety food production,
- Indication to local authorities for MP vulnerability mitigation

In the first phase of the project a harmonized sampling and extraction procedure has been developed to gain knowledge on MP accumulation in different environmental contexts in the four macro-pilot areas providing a systematic comparison on levels of MP on beaches, marine environment and biota at both a regional/local scale. In the North Adriatic pilot site (Delta Po), field surveys have been performed using traditional and innovative methods using UAV. The comparison between the standard procedure and the UAV one indicates that about 50% of the debris have been identified on the drone orthophotos, in particular large objects or objects characterized by a high color contrast. Consequently, UAV technology appears to be appropriated for marine litter monitoring especially because it allows the repeatability of the surveys in a short time, which is essential. However, automatic classification does not provide additional information and needs further investigations.

1.2. THE EFFECTS OF ANTHROPOGENIC IMPACT AND CLIMATE CHANGES ON COASTAL EVOLUTION

Prof. Umberto Simeoni

Since the 19th century, important variations in the transport of fluvial sediments on coasts have been recorded worldwide, in terms of periodicity and quantity. Indeed, human activities have caused a reduction of the sediment fluvial discharges: -26% for European rivers, -39% for African ones and -19% for North American rivers. One of the main causes is associated to realization of engineering structures along the river courses, especially since the second half of the last century: from 1950 to 1986, an increase of about 688% of dams has been registered. In addition, some authors report that Mediterranean rivers are among those with the highest anthropogenic contribution of any climatic zone.

The influence of past and present anthropic activities on the evolution of the Mediterranean coasts has led to fundamental changes in the relationship between natural processes and the evolution of the coasts. The expressions of this relationship are complex and have influenced both the rocky and low coasts. The effects are more clear and increasingly pervasive on the latter, especially on the deltas.

The Po River delta is characterized by a large system of shallow lagoons, wetlands, and reclaimed lands. Like many other deltaic regions, the Po Delta has largely subsided due to natural processes and anthropogenic activities, with a strong impact on its geomorphological evolution and significant socio-economic consequences.

In the last century, the reduction of the sediment fluvial discharge of the Po and the subsidence have deeply impacted the delta territory and, in particular, its geomorphological asset. As a matter of fact, the elevation of the delta ranged between -2.8 and + 0.3 m in 2007, while in the beginning of 1900s it was between -1 m and +1.6 m.

This general lowering of the territory, associated to the ongoing climatic changes, makes the delta particularly vulnerable to meteorological and marine events, putting at risk the stability of its natural ecosystems such as wetlands, which are important for their environmental values but also for that socioeconomic.

1.3. MEASURE AND MONITORING OF THE LOCAL MEAN SEA LEVEL

Prof. Alberto Pellegrinelli

The sea level rise of the last decades is now a certainty and its monitoring is carried out by space technology (sea surface topography measurements by radar SAR satellite) in open sea (from 1993) and by tide gauge stations measure near the coast. There are tide gauge data with time series of even more than 100 years (for example: Genoa, Venice, Trieste, Marseille). The measurements of the tide gauge are also used to define the Datum of height: zero-height reference surface for national or regional vertical geodetic network; for example, for continental Italy the Datum of height is defined by the mean sea level measured by the tide gauge of Genoa in the period 1937-1946, with the central year 1942 (Genova 1942). All the topographic, cartographic and geodetic surveys of natural and anthropogenic objects and elements are referring to the Datum "Genova 1942". From 1942 to today, the mean sea level in Genoa has risen by about 8-10 cm (from IGM publications), a rise that begins to be significant in many situations, especially in the buildings of new ports and maritime construction and in coast and territory protection structures.

For this reason, it would be important today to calculate the current measurement of the mean sea level. Furthermore, the sea surface topography is a surface that despites from the equipotential surfaces of the Earth's gravity field (geoid) by an amount that can vary from point to point. In fact, we talk of "Mean Dynamic Topography – MDT", to describe these variations which, along the Italian coasts, can reach about 20-25 cm. It is therefore important to define a current mean sea level, updated to date, and also calculate it locally by considering its variations with respect to a national vertical datum. In addition, considering the effects of ongoing climate change and the need to study these effects on coastal environments, it is important to achieve stable and reliable sea level monitoring in the coming decades. To achieve these objectives, in 2009 the Province of Ferrara, now ARPAE Emilia-Romagna (Italy), designed an Integrated Tide Gauge Station in Porto Garibaldi (Ferrara, Italy), with site name GARI. The station is equipped with: two sea level sensors (one primary float system in a stilling well, and one secondary radar system); one GNSS receiver with geodetic GNSS antenna, one barometric and temperature sensors, and other minor sensors. The level data are processed through an international procedure illustrated by the IOC (Intergovernmental Oceanographic Commission), UNESCO (for instance by digital filters like Doodson's X0 filter), which allows to obtain the hourly, daily, monthly and annual mean sea level. Monthly mean sea level is sent to the Permanent Service for Mean Sea Level (PSMSL). GARI is also included in the EPN (European Permanent Network) GNSS of EUREF (European Reference Frame). GNSS processing allows the monitoring of the vertical movements of the station (subsidence) in an absolute system (ETRS89) and thus remove these movements from sea level measurements. In the case of Porto Garibaldi, GARI, the sea level measurements in the period July 2009 - December 2019 have provided a rise in the mean sea level of + 0.112 m compared to Genoa 1942 but, considering the effect of subsidence this value is reduced to +0.096 m: very similar to what other authors found for other tide gauge stations, in particular for Trieste and Genoa in Italy.

1.4. THE USE OF DRONES IN COASTAL ENVIRONMENTS Dr. Elena Zambello

Coastal environments are often subjected to a considerable geomorphological evolution due to sediment transport as well as climatic (wind, waves, sea storms) and anthropic factors.

Aerial photogrammetry by Unmanned Aerial Vehicles (UAVs) is a widespread method to perform rapid georeferenced mapping tasks to reconstruct three-dimensional (3D) models of the investigated area and it is particularly adequate for monitoring evolving environments such as the coastal one.

The formation of dunes, as well as their sudden destruction as a result of violent storms, affects the sediment balance in a significant way. Moreover, the growth of vegetation on the top of the dunes strongly influences the consequent growth of the dunes themselves. Long-term monitoring of a complex dune system by the use of Unmanned Aerial Vehicles (UAVs) has been carried out by the University of Ferrara between 2015 and 2017 on the littoral of Rosolina Mare (Italy). The images have been elaborated for the reconstruction of georeferenced 3D models using the principles of Structure from Motion (SfM). Specific data management was necessary for filtering and classifying the terrain as well as identifying and isolating the vegetation. This task was performed by both performing a slope detection and removal of the residual outliers. The final products of this approach were thus represented by vegetation maps and Digital Elevation Models (DEMs) of the sandy coastal section. In addition, DEMs of Difference (DoD) were also computed for the purpose of detecting and monitoring variations over time.

Unmanned Aerial Vehicles have been also carried out by the University of Ferrara for the modelling of the beach and dunes of the Barbamarco lagoon (Veneto, Italy) during a study for the restoration of the functionality of its habitats financed by the European Maritime and Fisheries Fund. Photogrammetric data have been integrated with topographic and bathymetric surveys in order to provide an overall knowledge of the morphology of the emerged and submerged beach. In particular, photogrammetric monitoring was very useful to quickly highlight the changes and damages caused by a violent storm.

Photogrammetric drone monitoring was also conducted and analysed by the University of Ferrara during the development of the LIFE-Agree project, which financed the construction of a wooden groyne as a trap for the sediment in transit from east-west along the Spit to maintain the functionality of the Lagoon of Goro (Emilia-Romagna, Italy). The drone monitoring made it possible to study the evolution of the area and the shoreline in order to quickly verify the effectiveness of the work.

Generally, the use of the Structure-from-Motion approach by UAVs proved to be both reliable and time-saving thanks to quicker in situ operations for the data acquisition and accurate reconstruction of high-resolution elevation models. The low cost of the system and its flexibility represent additional strengths, making this technique highly competitive with traditional ones.

In the development of the NET4mPLASTIC project, the University of Ferrara is carrying out studies to map the presence of marine litter on the beaches through the interpretation of photogrammetric products. In particular, the analysis of orthophotos has been found to be particularly useful to identify objects larger than 15 cm. Tests have also been carried out to obtain automatic recognition of waste through the analysis of multispectral data, but the procedure must be optimised to obtain reliable results.

1.5. NUMERICAL SIMULATIONS OF MICROPLASTIC DISPERSION AND ACCUMULATION IN THE ADRIATIC SEA

Dr. Francesco Falcieri

The main scope of the lecture was to provide a general overview and some practical examples on what is a numerical model, how they are developed and applied to study various processes and dynamics in the marine environment.

A numerical model is representation of a natural process or dynamic by means of differential equations, basically it is a representation an aspect of reality through the means of mathematics. There are some general rules to develop a mode: it has to focus on what we want to represent, must have only the relevant aspects and cover the appropriate spatial and temporal scales. Numerical models can be used in various ways: to study process, to interpolate sparse data, to quantify processes otherwise not measurable and for spatial and operational planning.

To give an example of an actual application of numerical modeling the main results of Atwood et al. 2018 were presented. This work, whose thematics are very close to the NET4mPLATICS main goals, used a series of numerical simulation of microplastic dispersion from the Po delta into the Adriatic see to evaluate the microplastic main accumulation area along the delta coastlines.

1.6. TRANSPORT AND REPLACEMENT OF WATER IN THE LAGOON AND COASTAL AREAS: MORPHOLOGICAL TRANSFORMATIONS AND MOBILE BARRIERS

Mr Giovanni Cecconi

Due to the rise in sea level, the coastal morphological system is increasingly vulnerable. In particular areas such as the Venice lagoon they are turning into open sea areas with:

- a conspicuous increase in depth
- the resuspension of sediments due to the greater energy of the wave motion from wind
- the deposition of sand and silt at the bottom of canals, especially the minor ones, with the loss of water exchange due to tides and lower transparency of the water
- the increased risk of anoxic crises, the reduction of biodiversity and the loss of bio-structuring habitats (which in turn contributed to keeping the bottom stable and improving water quality)

We examine the effectiveness of two important intervention methods that could also be combined:

• Passive hydro-morphological intervention, through the restoration of morphological structures both of confinement of water flow into the lagoon, and vivification by increasing the volume of the tidal flow and inter-tidal mixing to reduce residence times. Thus, on the one hand, delta systems are healed by retaining freshwater and sediments and, on the other, the quality of the water in non-deltaic bottoms subject to scarce turnover is improved. The Life-Retide project will be presented with its expected results, a project still under examination by the European Commission for a total co-financing of 7.5 million euros.

• The active hydraulic control intervention, through the differentiated management of the four mobile Mose barriers with both an environmental objective and to prevent water from exceeding the safeguard quota for now set at 110 cm on the reference point of Venice in 1875 (now placed 35 cm below the current sea level). The 78 Mose gates already entered into experimental service from 12 July 2020 (complete or partial closure of each mouth, with a different number of gates involved and with different time intervals). The environmental objectives that could be achieved with the differentiated manoeuvres of the Mose gates are many: to improve the exchange of water and reduce the risk of anoxia; to retain sediments resuspended by wave motion in the lagoon (especially for the bora wind); to reduce the deposition of sand and silt at the bottom of canals and to increase sedimentation in the salt marshes; to facilitate the recovery of pollutants dispersed in the lagoon or to prevent pollutants present in the sea from entering the lagoon.

Today the Venice lagoon is particularly equipped to experiment on the lagoon scale with the old and new techniques of environmental regeneration typical of the adaptive method used in the ancient Venetian Republic, consisting in learning by doing. For example, they used to create small provisional canals, which were confirmed and enlarged only if they proved to activate a greater tidal transport; techniques like this are now called "Building with nature", helping nature to help us.

Today 33 years have passed since the beginning of the interventions financed by the Special Law for Venice and for the first time in the world an entire lagoon is equipped with an extraordinary system of mobile barriers, that allow to regulate the ebb and flow of each mouth. Widely tested techniques are known and available to allow the reuse of sediments deriving from channel maintenance dredging (sandy and silty, free or protected by modular elements made of polyethylene geo-grids containing shells, sands, pebbles or other recycled materials).

1.7. MAN-ASSISTED AND AUTONOMOUS INSTRUMENTATION FOR ENVIRONMENTAL AND MARINE MONITORING

Mr. Daniele Calore

The progress in the offshore industry at the end of the 20th century have had a significant impact in the evolution of the materials adopted for the construction of scientific instrumentation to be used in marine environment (ashore, offshore and deep sea).

Moreover, the electronic and communication industries have generated microcontrollers and communication devices with low power consumption, high processing capabilities and huge internal mass memory.

Nowadays the market offers off the shelf compact multi-parametric probes with internal battery and small meteorological stations suitable for long term campaign. MEMS sensors are largely adopted for instrumentation used at sea for wave monitoring whereas acoustic devices allow to measure sea current profiles.

The camera integrated with laser sensors are used to detect microplastic and other particles at sea by means of high processing capabilities available in the low power electronic data acquisition units on board of autonomous systems (buoys, marine drones, etc.).

The reliability of the communication segments (satellite, acoustic and wired) make it possible the remote control and configuration of a wide range of instrumented packages (on surface or subsea) adopted for the environmental monitoring.

One of the main problems for the long-term monitoring in shallow waters remains the fouling that makes it necessary a monthly maintenance to get reliable scientific measurements.

2. SUSTAINABILITY, CIRCULAR ECONOMY AND ACTIONS ON POST-CONSUMER MATERIALS

The second meeting, entitled "Sustainability, circular economy and post-consumer materials", focused on what lies behind the monitoring of marine pollution, that is, a policy of conscious use of plastic. We talked about reuse, recycling, legislation and advanced systems/plants.

You can see the videos of the presentations at the following link:

Seminar "SUSTAINABILITY, CIRCULAR ECONOMY AND ACTIONS ON POST-CONSUMER MATERIALS"

2.1. PLASTIC AND ITS DEGRADATION Dr. Luca Cozzarini

Since the middle of the last century, synthetic polymers have started to replace natural materials in most sectors of our daily life, i.e. packaging, automotive, building and construction, agriculture, communication etc. Plastic materials consist of synthetic polymers mixed with additives. Polymers are macromolecules formed by repetitive units called monomers (e.g. polyethylene is a polymer of ethylene). Additives are other substances added to improve properties or reduce costs, depending on the application for which the plastic material is designed. These substances can be inert fillers, plasticizers, dyes, antioxidants, flame retardants etc. Polymeric materials are traditionally divided into two classes: thermoplastics and thermosets (plus a third class: elastomers). Thermoplastics can be brought to a paste-like molten state after increasing their temperature. In this state they can be formed and processed; they maintain their shape after cooling. Thermosets are cross-linked in the three dimensions with the increase of temperature (cure reaction). They cannot be re-processed: they degrade with further temperature increase. Elastomers or rubbers have high deformability and elasticity, they may or may not be cross-linked.

In Europe, about 62 million tons of plastics are produced yearly (2018 data). The majority is used in packaging and construction. About 50% of the production is made up of polyolefins (PE and PP). A plastic object has an average lifetime between 3 years (for electronic devices such as telephones) and 30 years (for household appliances and furniture components). In the first instance, it should be able to withstand environmental degradation during its lifetime. On the other hand, it is to be disposed properly at the end of its life cycle: being composed of non-biodegradable synthetic materials, pollution-related environmental problems may arise. Typically, the time for a complete degradation of a plastic object in the environment lies between hundreds and thousands of years.

Plastic objects are subjected to degradation, i.e. their mechanical or functional properties decay over time, due to temperature, oxygen, light, water or chemicals. Typically, this leads to breakages of primary links, with the reduction of chain lengths and consequent reduction of properties; free radicals that lead to unwanted or cross-linking reactions; release of volatile compounds, with risks of pollution or fire, and variations in aesthetic properties. Stabilizing additives are added to slow the degradation process. The natural degradation caused by microorganisms (biodegradation) occurs on very short chain fragments only. There are special additives that promote degradation, such as "oxo-degradants", which are introduced into plastics to promote their fragmentation in the environment in very small chains that can then be later biodegraded. This, on the other hand, promotes the pollution of the marine environment with micro and nano plastics. Oxo degradants will be banned by EU in 2021. When talking about bioplastics, a distinction must be made between bio-based and bio-degradable. Bio-based plastics are made from raw materials originating from biomass. They can be identical in chemistry and properties to plastics of synthetic origin (e.g. bio-PE and PE) and may be biodegradable. Biodegradable plastics are those that can be degraded by microorganisms, and can be from synthetic or biological origin.

Since most plastics are non-biodegradable, it would be a good practice to follow the so-called "waste management hierarchy", trying to use alternative materials or maximizing a reuse or recycle of plastic waste. Recycling and energy recovery practices should be used when available, while landfill should be the last option. In recycling, it is possible to distinguish between mechanical and chemical recycling. Mechanical recycling is the transformation of plastic waste into raw materials or secondary products without a substantial change in the chemical structure of the material. In principle, thermoplastics can be processed into granules that can be re-melted to produce new objects, while thermosets are grinded and used as inert fillers in other plastics. Chemical recycling is a process that modifies the chemical structure of a plastic waste, converting it into simpler molecules such as monomers or hydrocarbons. Energy recovery is a viable alternative for plastic that cannot be recycled efficiently. Plastic waste possess high calorific value, equal or even greater than traditional fossil fuels. In Europe (2018 data) ¾ of plastic waste is recovered (recycled or energy recovery), and ¼ ends up in landfill.

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2.2. NEW OPPORTUNITIES FOR THE RECYCLING OF NON-RECYCLABLE PLASTIC WASTE

Dr. Marco Caniato

Generally speaking, marine litter is any object that has been produced or processed by humankind and reached the marine environment after its use. Nowadays, high plastic consumption influences our lives and this material has become the most significant type of waste in any domain, especially seawater. Worldwide, seas have been described as one of the areas most polluted by polymers, including micro- and macroplastics.

The amount of plastic in the sea is constantly increasin, and consequently its collection and final disposal are becoming ever more important issues. Because of their small size, the microplastic particles found in water, sediment and biota can be harmful for humans. Although many studies have shown interest in this topic, we need to do more to attain comprehensive knowledge of this problem. In particular, we urgently require solutions for several problems concerning the handling of plastic wastes both during their life cycle and at the end of it. Accordingly, plastic wastes are considered special pollutants and are therefore landfilled — a non-sustainable and often costly process. As many consumers have to pay for non-recyclable waste, a considerable amount of plastic litter finds its way to the sea. There, plastic is broken up into smaller and smaller particles, until over time they become microplastics.

Recently, rules and incentives to encourage fishermen to recover marine plastics are being discussed. Once retrieved, reusing and recycling plastics is the best way to avoid landfilling and encourage differentiated waste collection, even in difficult environments. Sustainable approaches like these guarantee eco-friendly products, pollutant reduction, a healthier future and better economics. However, cleaner manufacturing processes are also needed to reduce the environmental impact of waste and sustainable bio-based materials would be useful in this regard.

To this end, many studies on diverse waste recycling approaches have been published. Likewise, plastic recycling has been the subject of many lines of research. Curlee (1986) started to discuss this topic in his book, concluding that it is associated with a positive economic balance . Accordingly, El-Naga and Ragab (2019) have proposed PET waste as fillers for asphalt mixtures , while Al-Humeidawi and Al-Qadisiyah (2014) have discussed using plastic in hot-mix asphalt . Nevertheless, Dauvergne (2018) correctly observed that it is rather difficult to recycle plastic marine litter in such a fashion, because items are not sorted by type, are often coupled with other plastic (or non-plastic) materials and covered with marine salt. Brown and Buranakarn (2003) observed that adaptive reuse systems are good approaches to follow in plastic recycling; however, it is common to burn plastic wastes or to use them as a filler for something completely different from their original use.

Natural polymers have been traditionally used in the field of regenerative medicine, thanks to their biocompatibility. Among them, polysaccharides have been widely used as scaffolds, i.e., macroporous 3D bodies. Alginates, linear anionic polysaccharides (unbranched) are a common example, being available in nature. Sodium alginate is extracted from brown algae and consists of two monomeric units, β-d-mannuronate (M) bound to 1.4 and α-l-guluronate. Sodium alginate can be hydrolysed to form a rigid "egg-box" structure due to the selective binding of divalent cations to the G blocks of two adjacent polymer chains. In fact, an interesting property of sodium alginate is its ability to ionically cross-link with bivalent cations such as Ca2+. It is therefore possible, using a natural low cost material, to produce trabecular structures, with very good durable properties.

Previous research (Caniato and Travan, 2019) has shown that alginate of medium density is able to also produce foams with interesting thermal and acoustic properties. Other elements may be added to bio-matrix in order to achieve some other properties, like resilience. The use of plasticizers inside polymers is a well-known practice for increasing their flexibility. Among these, in the case of alginate foam, glycerol is already in use in similar contexts as a possible solution, being an eco-friendly plasticizer. The benefits of such novel materials in terms of environmental indices and life cycle analysis are evident.

The combination of sustainable foam production using alginate matrix and the insertion of plastic waste powder creates a new, cleaner, open-cell material whose potential thermal and acoustic properties may be desirable in many fields. One of these is construction. It is now known that buildings produce 40% of CO2 emissions in the U.S. and Europe. Hence, thermal insulation is one of the paramount needs in the construction industry, while occupants demand acoustic insulation for acoustic indoor comfort.

We therefore set out to produce, study and characterize an innovative open-cell foam based on a bio-based polymer as matrix and microplastic litter as filler. We analysed the macro- and microscopic properties of the new material in terms of variation of filler quantity and type. A sensitivity study was performed in order to correlate physical parameters with overall performance. Finally, the thermal and acoustic properties of the material were characterized, correlating the microplastic influence to macro behaviours.

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2.3. CIRCULAR ECONOMY AND BIOREEF TO IMPROVE ENVIRONMENTAL ASPECTS OF COASTAL AREAS

Prof. Umberto Simeoni

In 2016, the world shellfish production amounted to 17.1 million tons, with a turnover of 29.2 billion US dollars. Of these 17.1 million tons, molluscs with limestone shells represent 16.9 million, corresponding to 58.8% of marine and coastal aquaculture production. Depending on the species, the shells can contribute up to 75% of the total body weight.

However, an issue in shellfish food production is the waste generation, namely the production of calcareous shells. Moreover, the percentage of empty shells that could be reused is much lower than that accumulated in landfills or in more or less correctly managed sites. Consequently, their exploitation on a large scale is difficult, but their disposal can and must change from simple accumulation in landfills to reuse, following the principles of the circular economy.

Many studies regard the exploitation of the shells. In fact, the calcium carbonate constituting the shells has important mechanical and structural properties, and they have been used for buildings along the Mediterranean coasts from immemorial time. Currently, the legislation limits the use of shells as a component of cements and conglomerates, since for safety reasons construction materials are highly regulated.

About 40% of the national production of shellfish is in Emilia-Romagna, with about 2,500 tons per year of clam and mussels' shells which are considered as fish by-products that cannot be used for food sales.

To favor the use of mollusk shells (circular economy), three eco-compatible bioreefs were built using a specific additive manufacturing technology (3D printing) for large dimensions (technological innovation). These bioreefs, consisting in 70% crushed shells, will be used to stabilize or increase the marine biodiversity (blue economy). The bioreefs, placed on the bottom of the Goro lagoon, were colonized with oysters to provide socio-economic benefits and a variety of ecologically services such as habitat improvement and biodiversity restoration.

The proposed innovative system allows: i) to transform the mollusks shells into a resource; ii) improve the conservation/restoration of the marine-coastal biodiversity; iii) have important positive impacts on the socio-economic territorial development. Furthermore, the construction of these bioreefs requires low investments with enormous ecological advantages because oysters improve water quality, and the reef provides a complex structure to house other organisms.

2.4. METHODS OF CAPTURING PLASTIC MATERIAL IN LAGOON AND RIVERS AND THE POSSIBILITY OF REUSE IN BUILDING WITH NATURE

Mr Giovanni Cecconi

In recent years there has been a growing interest in improving the quality of water and the aesthetic and environmental value of the landscape of rivers, deltas, lagoons and sandy or rocky coasts, attacked by a veritable tide of floating waste not biodegradable. In particular, the plastic materials, which conveyed by the rivers then end up depositing along the coasts near the mouths and within the adjacent lagoons due to the effect of tidal currents and waves and wind.

The multitudes of volunteers who in recent years have taken part in the increasingly frequent “waste collection days” both in parks and along waterways, lagoons and coasts have certainly contributed to this greater sensitivity, often in agreement and with the collaboration of local government bodies.

Recent studies and research have also created a keen focus on the invisible risk represented by microplastics dispersed in the aquatic environment and omnipresent even at high concentrations, particles that pose a serious threat to aquatic species and human health.

On the one hand, much can be done with prevention, limiting the use of disposable or fragmentable plastics, responsible for pollution with micro-plastics in seas and waterways, and an obstacle to recycling processes, through the imminent (3 July 2021) mandatory adoption at a national level of the “plastic free” directive (EU) 2019/904. On the other hand, however, there remains the need to intercept and recover plastics that are already in the water, moving with currents and wind or immobilized following flood events and storm surges, together with the need to recover beached plastic waste. along the banks of beaches, rivers, sandbanks and internal canals; the aim is to remove them or concentrate them in more favourable places so that they can be naturally incorporated into natural growth-enhancing bio-structures (as happens in some sandbanks of the southern lagoon of Venice) or to be more easily collected and disposed of.

Methods and operating procedures for intercepting removal will be presented and compared, techniques of which we know, alongside devices in current use, to highlight the most promising ones for a generalized reduction and removal of floating plastic objects present along the coast and rivers and lagoons of the Veneto Region.

Organic material mixed with stranded plastic and subject to slow degradation processes in areas of sedimentation and plant growth deserves particular attention: while plastics must be removed, the removal operations must not affect these other materials that contribute to biodiversity and functionality of the special ecological niches on the shore.

2.5. THE EXPERIENCE OF THE MARCHE REGION: REGIONAL PROVISIONS TO ENCOURAGE THE REDUCTION OF PLASTIC WASTE IN THE SEA AND ON THE BEACHES (Regional Law no.33 / 2018)

Massimo Sbriscia and Angelo Recchi

The experience of the Marche Region in terms of reducing plastics in the sea started few years ago and it was inspired by a set of reports coming from fishermen signaling of significant quantities of plastic in the sea.

The reports led to a pilot action, held in San Benedetto del Tronto, which led to the collection of 6 tons of waste at sea, of which 3 tons of plastic. Characterization and product analysis of the latter were made: which resulted on the possibility of recovery of the plastic material equal to 20%.

The Regional Law no.33 / 2018 was born in this context: with the aim of reducing plastic waste in the sea and on the beaches. It is developed in accordance with European, national and regional guidelines and regulatory provisions such as:

- the European Strategy for Plastics in a Circular Economy (COM (2018) 28 final of 16 January 2018);
- the legislative decree 24 June 2003, n. 182 which deals with port reception facilities for ship-generated waste and cargo residues;
- the Regional Waste Management Plan (PRGR of 2015).

The law foresees both awareness-raising actions and concrete actions, as well as study and research activities, with the aim of:

- raising awareness of citizens and sectoral stakeholders;
- encourage the collection in port areas of plastic waste deriving from fishing and aquaculture and favor its subsequent treatment;
- encourage the inclusion in port areas of separate collection systems;
- quantify the environmental impacts of the dispersion in the sea and the stranding of plastic waste by experimenting adequate tracing systems;
- eliminate this impact through the adoption of sustainable fishing and aquaculture techniques (e.g. choice of materials).

A tool for achieving the objectives set by the law is the Institutional Technical Table (TTI), consisting of a representative for each public, private, professional and supervisory bodies stakeholder. The issues faced up to now by the TTI relate to both regulatory aspects and operational actions.

The TTI dealt with the relationship between the previsions of the regional law and the current legislation ("Salvamare" law decree in progress, Legislative Decree 182/2003 which regulates port collection facilities for waste produced by ships and residues from cargo; the MARPOL 73/78 international convention; the Directive 883/2019).

It has fostered network activities through participation in European projects such as: Clean Sea LIFE, Repair Italy-Croatia (FEAP funds), Net4mPlastic Italy-Croatia (Interreg VA), Divers United for the Enviroment, Blue Packaging Project di Blu Marine Service, HOM - Humans of Mediterranean, CNR SoleMon Project, etc.

It favored study activities aimed at the possibility of recovering the marine litter, the technical, operational and administrative aspects of the delivery of the collected waste.

On following a list of projects currently under implementation on the topic of plastic waste in sea and involving the Marche Regional Authority:

- the continuation of the experimental project "Fishing for plastic" in the port of San Benedetto del Tronto, which capitalizes on the experience of the Clean Sea LIFE project;
- similar experimentation in the port of Pesaro of waste accidentally collected at sea;
- the CISP Project (Center for Fisheries Innovation and Development), funded by the OP EMFF 2007-2014;
- the implementation of integrated projects aimed at replacing the polystyrene drawers with reusable plastic drawers in the fishing sector, for example the project for the transition to the use of plastic boxes in place of polystyrene boxes for fishing;
- the NET4Mplastic project;
- The "Zero plastic in the sea" project in the port of Civitanova Marche (promoted by Legambiente, BNL, COSMARI consortium).

2.6. ROBOTIZED ACTIONS AND PYROLYSIS MICRO-PLANT IN RAVENNA Prof. Andrea Contin

The recycling of plastic waste is difficult and costly due to constraints on water contamination and on separation costs. The energy conversion is also possible because plastics are derived from petrochemical sources, either by burning in CHP or via Pyrolysis, having as products liquid oil, gas, char.

Pyrolysis is the thermochemical process for degrading long chain polymer molecules into smaller, less complex molecules through intense heat with short duration and in absence of oxygen. The process is flexible, as the process parameters (temperature, heating rate, duration, catalysts, carrier gas) can be tuned to optimize the product yield.

The main plastic types are Low- and High-density Polyethylene (LDPE, HDPE), Polypropylene (PP), Polystyrene (PS), Polyvinyl chloride (PVC), Polyethylene terephthalate (PET). The relative share is shown in Figure 1 (left).

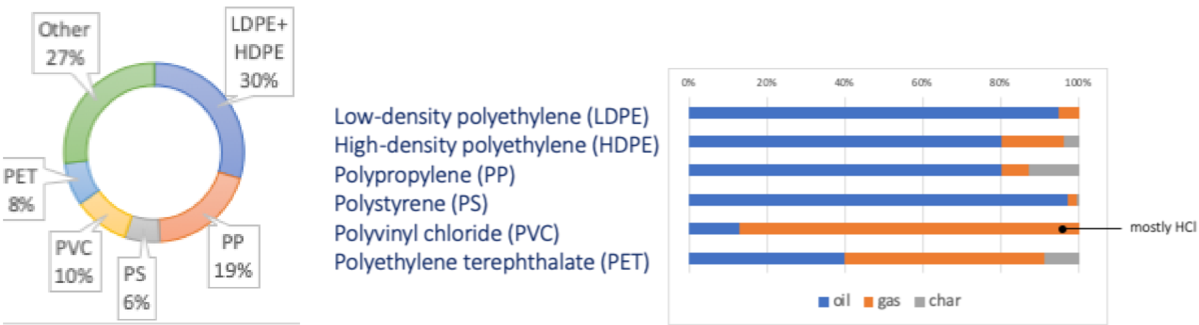

Figure 1. Left: Share of the different plastics in use. Right: average share of the pyrolysis products from various plastics.

The share of the products from the pyrolysis of various plastics is shown in Figure 1 (right). Several undesired products are produced, like Benzoic acid in PET oil, Clorobenzene in PVC oil and HCl in PVC gas, Aromatic rings in PS oil, Dioxins and Furans, depending also on the additives (e.g. flame retardants).

A pyrolyser with an original has been developed in 2015-17, as part of a Doctorate jointly activated by the University of Bologna and the Fraunhofer Institute UMSICHT, Sulzbach-Rosenberg Branch. The student, Dr. Peter Hense, developed a bench scale reactor with innovative parts for Polybrominated Dibenzo-p-Dioxins and Furans (PBDD/F) and Polychlorinated Dibenzo-p-Dioxins and Furans (PCDD/F) decomposition into HBr or HCl by using a blend of polypropylene (PP) and lantanium hydroxide ($La(OH)_3$/LaOOH) deposited on spheres surface through which the hot gas fluxes.

A 70 kg/h pilot plant, called iCycle®, has been built and is presently operative at Fraunhofer UMSICHT.

The overall goal of the Interreg IT-HR MARLESS Project is to Improve the environmental quality conditions of the sea and coastal areas by use of sustainable and innovative technologies and approaches. In particular, the objectives are:

- to monitor the waste dispersed at sea and to model the transport and dispersion of the same by marine currents, so as to evaluate the marine litter present in the Adriatic by identifying accumulation points and trajectories of movement;
- to perform awareness campaigns on marine litter management and environmental education activities;
- to recover and to capture marine litter in rivers, coast and harbours;
- to demonstrate the feasibility of several new technologies in the field of marine litter prevention, recovery and processing;
- to analyse of the use of pyrolitic solutions in pilot plants and to help the main stakeholder in planning decisions on this possible solution among the others.

The role of my research group is to test the iCycle technology on 250 kg of plastics collected in the see by Partners and then separated in different streams by the team.

Another connected activity of the research group is the LOOP-PORTS Climate KIC project which aims at facilitating the transition to a more circular economy in the port sector, where products, materials and resources are maintained in the economy for as long as possible, and the waste generation minimised (https://www.loop-ports.eu0.

Many initiatives are active in dealing with the problems derived by the dispersion of plastics in the seas: The Ocean Cleanup (https://theoceancleanup.com), Ocean Plastic Program – Parley (www.parley.tv), Oceanworks (oceanworks.co), Waste Free Oceans (www.wastefreeoceans.org), Ocean Plastic (ocean-plastic.com) and others. However, just a few thousand tons/year are recycled today.

There are still a lot of open questions on the pyrolysis of plastics, many of which has to do with juridical aspects of end-of-life treatments. In particular a regulation “End-Of-Waste” is absolutely necessary to really open a really huge market, and increase the total treated amount, avoiding landfilling.

3. MICRO-POLLUTANTS AND MICROPLASTICS IN WATER: RISKS FOR ENVIRONMENT AND HEALTH

In the third and final meeting, entitled "micropollutants and microplastics in water: risks for an environment and health", the topic under discussion have been the danger to health caused by debris dispersed at sea. Sometimes this aspect is overlooked compared to environmental damage but it is equally important. Professionals from the Experimental Zooprophylactic Institute of Abruzzo and Molise shared their experience in studying how some species of mussels and molluscs can be detectors of the pollution level of seawater and carriers of microplastics and chemical contaminants. Besides, specialists from the University of Ferrara talked about microplastics, the digestive system and possible effects on human health.

You can see the videos of the presentations at the following link:

Seminar "MICRO-POLLUTANTS AND MICROPLASTICS IN WATER: RISKS FOR ENVIRONMENT AND HEALTH"

3.1. GEOCHEMICAL ANALYSIS ON WATER-PLASTIC INTERACTIONS

The main objective of this presentation is to illustrate the problems relating to the main types of plastics, that are commonly recovered in river, coastal and marine environments, with particular attention to their propensity for degradation.

Several significant SEM and chemical analyses images are presented, illustrating plastic degradation products. The purpose is to illustrate the morphologies of the products of encrustation, degradation and traces of usury. These information are useful for understanding how materials are degraded and for illustrating their propensity to produce micro and nanomaterials, potentially dangerous to health and environment.

3.2. MUSSELS AS USEFUL INDICATORS OF MICROPLASTIC POLLUTION Dr. Nadia Barile

Every year between 5 and 13 million tons of plastic end up in the oceans, an amount that could increase tenfold by 2025. Among the 20 largest waste producers, China ranks first, followed by Indonesia and the Philippines, which contribute 44% of plastic pollution at sea. Europe pollutes less, but always too much, in fact, every year 150,000 to 500,000 tons of plastic end up in the sea.

Plastics reach the sea for 20% due to activities linked to the same sea such as commercial and tourist shipping, aquaculture activities and off-shore platforms. The remaining 80% of microplastics arrives at the sea from the mainland through malfunctions of sewage systems, tourism on the coast and industrial activities.

The microplastics that we find on the surface of the sea are only the tip of the iceberg, that is 1% of the total. The greatest concentration of plastics and microplastics is found on the sea floor, carried by ocean currents and accumulated there. The currents of deep waters act as real "conveyor belts" that drag small fragments and fibers of plastic on the deep seabed.

To date, we can also say that microplastics have fully entered the human food chain. In fact, a study, conducted in 2018 and presented in Vienna at a gastroenterology congress, revealed the presence of microplastics in the faeces of a group of men from different countries. The size of the plastic samples found in their stool ranged from 50 to 500 micrometers. The authors hypothesized that the microplastic fragments were ingested through seafood, but also through water from plastic bottles and food packaged in plastic.

In this context, mussels, specifically Mytilus galloprovincialis, are a valid biological indicator of the presence of microplastics in the marine environment thanks to some characteristics such as wide distribution, sedentary life, tolerance to a wide range of environmental conditions, metabolism very low and the ability to bioaccumulate contaminants in their own tissues. They are therefore used in several bio-monitoring activities (bio-indicator organisms or sentinel species).

Among the most important morpho-functional characteristics of mussels are: a) a rigid and protective outer covering, a shell composed of 2 convex valves joined by an elastic protein band; b) adductor muscles, which act in antagonism with the ligament and, by contracting, cause the valves to close even for long periods of time; c) the foot, muscular appendix which allows them to probe the surface on which they are located and make small movements; d) a byssus, which allows them to adhere effectively to hard substrates; e) the mantle, a lamina of connective tissue adhering to the internal surface of the valves which encloses the entire visceral mass; f) the gills, lined with a ciliated epithelium important for both filtration and respiratory exchanges.

Among the bio-monitoring activities in which mussels have been used is the "Mussels watch", a bio-monitoring program proposed for the first time in 1975 and based on the analysis of four types of marine pollutants in the tissues of mussels naturally exposed to these. Among the main advantages offered by the "Mussel Watch" there is a contamination degree's assessment of the coastal area, according to a measure "integrated over time" and not referable only to the moment in which the sampling was carried out. Another advantage is to be able to estimate of the "bioavailability" of toxic substances present in the marine environment with a subsequent risk assessment related to the transfer of these pollutants through the food chain.

Over the years, the practice of "Mussel Watching" has been consolidating and has been further developed.

The S.H.A.P.E. project "Biomonitoring of coastal marine waters subject to anthropogenic use: development and application of the biosensor Mosselmonitor®", in which IZSAM participated, had the purpose of adopting a biological early warning system, using in fact mussels, in a critical area of the basin Central-southern Adriatic near an extractive platform, in order to identify any critical environmental situations.The data obtained allowed to expand the knowledge on the behavior of mussels in areas subject to anthropogenic impact, such as oil extraction platforms.

another project in which IZSAM is a partner is NET4mPLASTIC, which has the following objectives: a) to collect data on the distribution and characterization of microplastics in bivalve molluscs, in order to monitor the marine-coastal areas of the Adriatic basin and evaluate the purification of mussels contaminated by microplastics.

In conclusion, mussels can be defined as global indicators of pollution in general and therefore also of pollution by "microplastics".

3.3. MICROPLASTIC PURIFICATION IN BIVALVE MOLLUSCS

Dr. Federica Pizzurro

Following the EFSA's report published in June 2016 relating to the presence of microplastic particles in food, the world of research focused mainly on two important lines of research concerning the bivalve molluscs.

The first line of research is the detection and monitoring of microplastics' presence in bivalve organisms, in order to be able to implement data present in the scientific literature and thus allow EFSA to define threshold limits to be included in the legislation to guarantee the healthiness of the food product.

In this direction, there are Italian studies such as the one conducted by Renzi et al. (2018). In this scientific study, samples of Mytilus galloprovincialis were collected both from Italian mariculture establishments and from natural banks, in order to evaluate the differences between commercial and natural stocks as regards the levels of MPs and their main characteristics.

The MPs recovered were mostly filaments ranging from 750 to 6000 µm and the dominant colors of these were black and blue. These higher frequencies of blue and black microplastics are likely to come from materials frequently used in mussel farming, such as ropes, hanging buoys and net bags. Instead, as regards the most present category among the MPs was the filaments. This is probably due to the geometry of these microplastics that allows them to remain trapped in the gills and in the hepatopancreas and not be easily removed through filtration.

Another Italian work on the monitoring of microplastics in bivalve molluscs is that of Gomiero et al. (2019). The authors of this study performed a monitoring in the Adriatic Sea, a semi-enclosed basin with a low rate of water recirculation that has high anthropogenic pressures. The aim of the work was to compare the MPs content between bivalves collected offshore areas and those collected in coastal areas.

Indeed, the authors found that coastal organisms showed a greater accumulation of filaments and fragments within their soft tissues compared to organisms sampled in offshore areas. Furthermore, the most commonly encountered type of polymer was polyethylene (PE), given in accordance with other studies as polyethylene is the most common plastic on a global scale deriving mainly from plastic bags and bottles and cutting boards.

In addition to field studies, mussels have also been widely used in laboratory experiments to study the absorption, accumulation, and elimination of microplastics. Among bivalves, mussels are most studied for some their biological characteristics such as ease of retrieval, dimensions suitable for carrying out analyses and resistance to laboratory conditions.

To date, there are several studies performed in the laboratory that used bivalves. Among the most recent studies, we mention that of Chae et al. (2020), which started from the assumption that mussels continuously filter sea water through a coordinated action of the cilia located on the surface of the gills, at a rate of about 50 ml of water sea per minute. The aim of the work was to examine the effects of the presence of food (microalgae Dunaliella salina) on the elimination rate of microplastics in Mytilus galloprovincialis.

The experimental model involved creation of 2 experimental groups: a group left to house for 1 hour in water contaminated with polyethylene microspheres and fed with Dunaliella salina, and a second group not fed. The results of this study showed that mussels exposed to microplastics without food cleared the microplastics faster than mussels exposed to microplastics in the presence of food. This could be due to the ability of the mussels to distinguish between nutritious food and unusable suspended particles.

A second interesting study was conducted by the Danish researcher Rist (2019), with the aim of tracing the fate of microplastics during the exposure and purification phases. The experimental model involved the creation of 2 experimental groups: one exposed to low concentrations of polystyrene microspheres and one exposed to high concentrations for a time of 10, 20 and 40 minutes. The subsequent purification phase, after having transferred the organisms to special systems with clean sea water, lasted 2 hours.

The experimental system was divided into 4 compartments for which the distribution of the microspheres was individually quantified. The largest fraction of microspheres was found in the exposure water, because probably the exposure times were not sufficient for the mussels to filter the entire water volume, while the smaller fraction was found in the purifaction phase's water, because probably the 2 hours of purification were not sufficient for the complete elimination of microplastics.

From the studies carried out to date, we can highlight some limitations, to be taken into consideration for future experiments, such as the variability of microplastics present in the marine environment, the presence of aged microplastics in the marine environment and the purification time.

3.4. MICROPLASTICS CARRIER OF CHEMICAL CONTAMINANTS IN BIVALVE MOLLUSCS

Dr. Gianfranco Diletti

A great number of studies have demonstrated that microplastics (MPs) adsorb measurable amounts of pollutants such as persistent organic pollutants (POPs) [including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and polybromodiphenyl ethers (PBDEs)], other types of persistent bioaccumulative and toxic substances [including halogenated flame retardants, pesticides and nonylphenols] and metals [arsenic, cadmium, lead, chromium and copper]. These scientific studies show that MPs adsorb organic compounds concentrating them several orders of magnitude than the levels found in their surrounding environment, therefore they could be potential vectors of these contaminants to biota. Several factors influence the adsorption of environmental pollutants on plastic surface concerning both plastic characteristics such as the age, the type and structure of the polymer, and environmental properties (e.g. water pH and salinity, temperature). A consensus on MPs as vectors of persistent organic pollutants (POPs) has not been reached since are opposing views among different researchers on this topic. However, all agree that more extensive studies are needed to clarify this relationship.

3.5. MICROPLASTICS AND THEIR POSSIBLE EFFECTS ON HUMAN HEALTH

Prof. Luca Maria Neri, Dr. Ilaria Conti

Plastic items are currently used in several sectors of human life, such as industry and health, but their increasing consumption has led to an emerging environmental pollution [1]. Since their non-degradable nature, plastic waste accumulates in oceans, rivers and landfills where it can be fragmented in Microplastics (MPs) as results of stress and weathering [2].

Besides its danger for the environment, MPs could exert toxic effects on human health. Micro-and nano-particles can be internalized inside cells causing the development of pathologies (“Nanopathology”), such as cancer. Two major routes of exposition could allow the MPs intake by human: i) oral-intake and ii) inhalation [3]. However dermatologic access is not excluded.

Presence of MPs has been evaluated in food, such as drinking water, beer, salt, sugar and honey. Moreover, the food chain is another source of MPs exposition for human. Birds and fish could confuse plastic debris as their usual food, that can accumulate in their tissue after ingestion and could reach us, as consequence of the trophic transfer [4]. Moreover, MPs can enter in the respiratory tract after inhalation. Waves in aquatic environment and waste water treatment are the main contributors of airborne MPs [3].

Currently, no data are available about the fate and the toxicity of MPs within the human body. Nowadays, the putative hypotheses result from the few in vitro and in vivo studies performed on human cell lines and animals, respectively [5]. Ingested MPs may accumulate in the human Gastrointestinal Tract (GIT) or be carried through the body circulation toward secondary target organs (e.g. liver and spleen), where they could alter biological processes (i.e. induction of oxidative stress) [4]. After inhalation, MPs may accumulate in lung causing a pro-inflammatory response or be transported to the GIT increasing its plastic exposure. For example, foreign-body giant cells, reduced lung capacity and dyspnea were associated to long exposure to Polyvinyl Chloride (PVC) dust and other plastic flock fibers (i.e. nylon, Polyethylene (PE) and Polypropylene (PP)) in workers of the textile industries [4]. Finally, ingested particles can be directly excreted by the digestive tract, as evaluated in the stools collected from eight healthy volunteers in different countries [6].

Concerning the dangerousness of MPs, their toxicity is not related only to the particles shape and dimension but includes also their composition. Plastic production requires the involvement of several hazardous additives to guarantee the plastic properties and a high polymerization reaction yield. Bisphenols and phthalates are additives acting respectively as antioxidant and plasticizers, but they have been identified as “Endocrine Disrupting Compounds” (EDC) since they interfere with the murine endocrine system [7]. Furthermore, some of the additives are not chemically bound to the polymer matrix and can be released into the environment or migrate from plastic packaging to food or drinking water [8]. A recent study has evaluated the migration of nearly 100 compounds from several plastic food contact material and for only the 13% of them, the use was permitted by EU regulation [9].

Moreover, plastic items can adsorb environmental contaminants, such as Persistent Organic Pollutants (POPs), Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) and heavy metals. The surface area of MPs allows to concentrate, protect and transport in the water, the adsorbed contaminants increasing their potential toxicity toward the human health [10]. Finally, plastics can carry toxic microorganisms, such as pathogenic and antibiotic resistant bacteria that colonize the MPs surface

[11]. The ingestion or inhalation of foreign microbes could alter the host-microbiome community and its functions affecting the health of the organisms [4].

One role of the "Dept. of Translational Medicine" of the University of Ferrara, in the Net4mPLASTIC project is to analyse the toxic effects of MPs and associated contaminants on human cell lines. Testing MPs alone or in combination with additives and /or environmental contaminants on in vitro cell cultures, we will investigate the cellular response as consequence of different exposures, improving our knowledge on plastic potential toxicity. Moreover, light and electron microscope studies on both MPs treated cell lines and mussels' tissue (gills and hepato-pancreas) will be performed to analyse the fate and localization of internalized plastic particles in human seafood.

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3.6. PLASTIC OR MICROPLASTIC AND DIGESTIVE SYSTEM

Prof. Sergio Gullini

In 2004 Thompson coined the term "microplastics" and since then many papers have been published regarding their global distribution, ecological and environmental aspects, but so far few concerning the possible effects on animal and human health. For Kieran D. Cox et al. annual microplastics consumption per person, ranges from 39000 to 52000 particles depending on age and sex. These estimates, increase to 74000 and 121000 when inhalation is considered. In 2019 P. Schwalb et.al detected various microplastics in human stool, demostrating their presence in the Human body.

Their biopersistence is an essential factor contributing to their risk, along with dose. The degradation of plastics produces different forms and sizes of debris; nanoplastics (≤ 0.1 µm), microplastics (< 5 mm), mesoplastics (0.5–5 cm), macroplastics (5–50 cm), and megaplastics (> 50). Microplastics with a dimension > 150 µm, are not absorbed, they remain bound to the intestinal mucus layer.This may lead to inflammation of the gut and local effects on the immune system. The smaller particles can cross the mucus barrier, becoming lodged or embedded, inducing acute or chronic inflamation. (Stephanie L. Wright, Frank J. Kelly. 2019). Furthermore, the reports aiming to study the intestinal microbiota in microplastic-exposed animals, have observed dysbiosis.

Mato Y et al. In 2001, reported how the ingestion of micro or nanoplastics and additive chemicals, determines an absorption rate by the gastrointestinal tract, mainly influenced by the chemical fugacity gradient, between the tissues of the organisms and the plastic, by the intestinal retention time of microplastics and by the specific material kinetic factors, with effects on human health which are not yet well known. Manynanimal studies have shown that exposure to nano- and microplastics leads to impairments in oxidative and inflammatory intestinal balance, and disruption of the gut's epithelial permeability. Other notable effects of nano- and microplastic exposure include changes in the gut microbiota and immune cell toxicity. Moreover, microplastics contain additives, adsorb contaminants, and may promote the growth of bacterial pathogens on their surfaces: they are potential carriers of intestinal toxicants and pathogens that can potentially lead to further adverse effects

The relationship between absorption of microplastics and alterations in the human organism has only been studied for a few years and therefore further studies will be needed to deepen our knowledge and reveal the mechanisms of damage to human organs and the pathologies that in the near future, surely will be due to this new type of pollution.

4. CONTRIBUTING PARTNERS

You can see the videos of the presentations at the following links:

Seminar "NEW FRONTIERS FOR COASTAL MONITORING"

Seminar "SUSTAINABILITY, CIRCULAR ECONOMY AND ACTIONS ON POST-CONSUMER MATERIALS"

Seminar "MICRO-POLLUTANTS AND MICROPLASTICS IN WATER: RISKS FOR ENVIRONMENT AND HEALTH"