Marine litter in the Mediterranean sea: prevention and mitigation actions, and EU initiatives supporting them

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Economia circolare: le plastiche. Prevenzione, recupero e materiali alternativi. Bologna, June 19, 2017

Outline

Marine litter: sources and general problem;

Marine litter in the Mediterranean sea;

The Bioclean Project;

Integrated actions for mitigating and preventing marine litter;

EU instruments sustaining R&I in the sector

Marine litter: sources and impacts (a)

Marine litter is waste created by humans that has been discharged into the coastal or marine environment.
It is defined as “any anthropogenic, manufactured, or processed solid material (regardless of size) discarded, disposed of, or abandoned in the environment, including all materials discarded into the sea, on the shore, or brought indirectly to the sea by rivers, sewage, storm water, waves, or winds” (UNEP and NOAA, 2012).

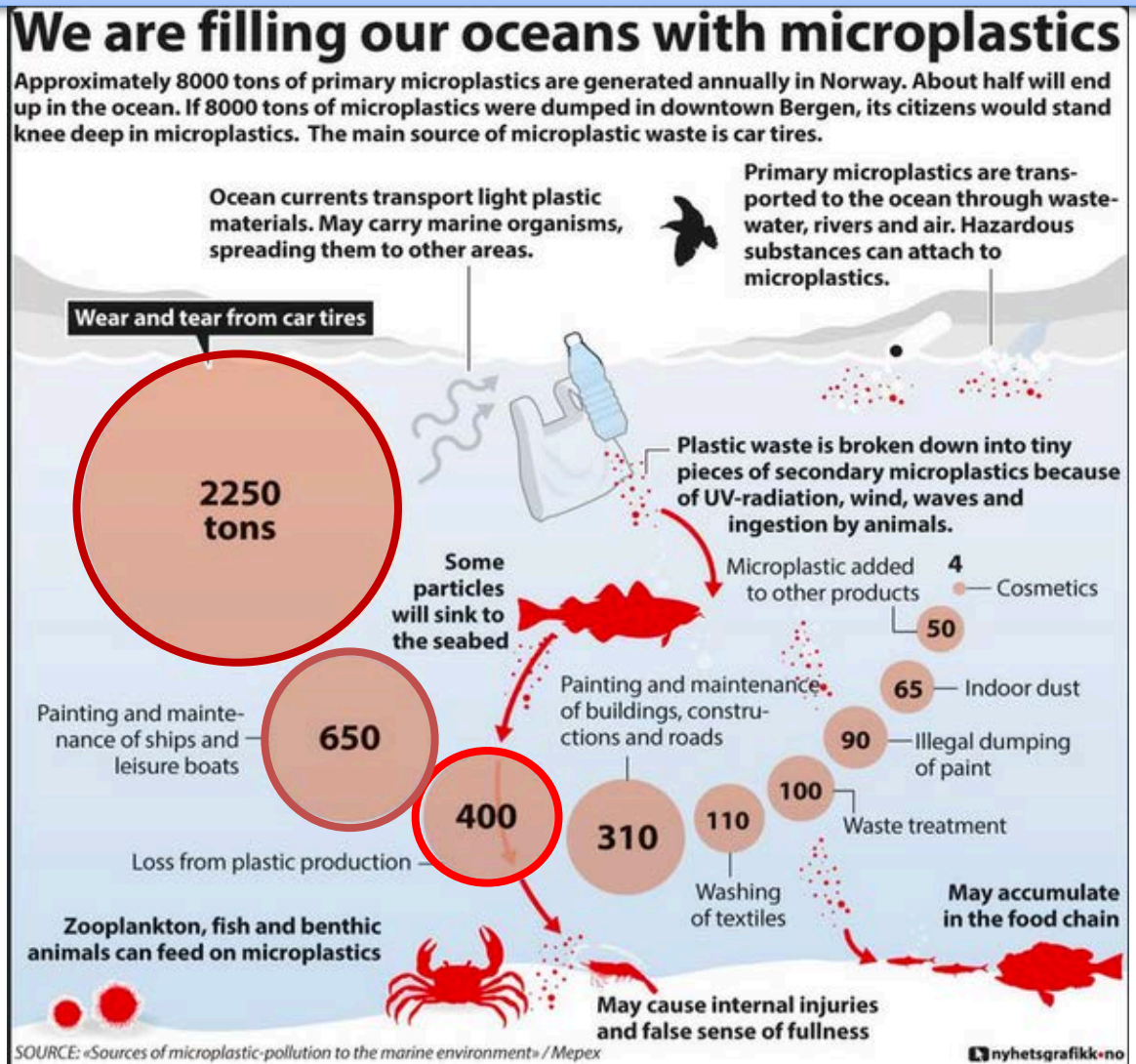
Between 60 and 90 per cent – sometimes as much as 100 per cent – **of the litter that accumulates on shorelines, the sea surface and the sea floor is made up of one or a combination of different plastic polymers**. Likewise, 90 per cent of the litter collected from sea floor trawls is made up of plastic (Derraik, 2002; Galgani et al., 2015)

Marine litter: sources and impacts (b)

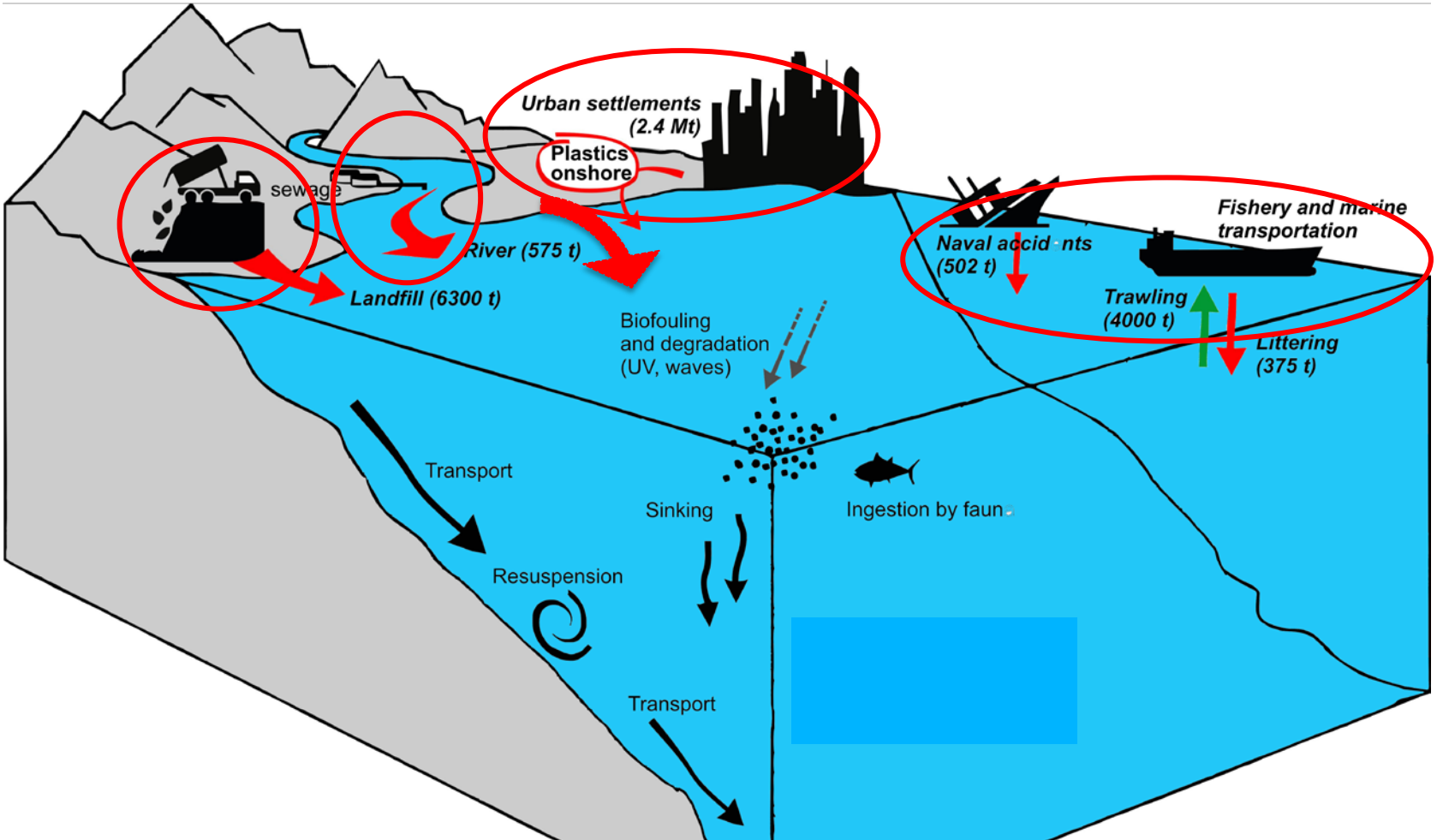
Negative Impacts:

- Small size (easily ingested by many marine organisms)
- High surface area (per unit mass) → Sorption of organic pollutants in seawater
- Leakage of additives (e.g., plasticizers).

Problems in handling: very difficult to remove litter components from the seawater and especially from sediments..



Marine litter: sources and impacts (c)



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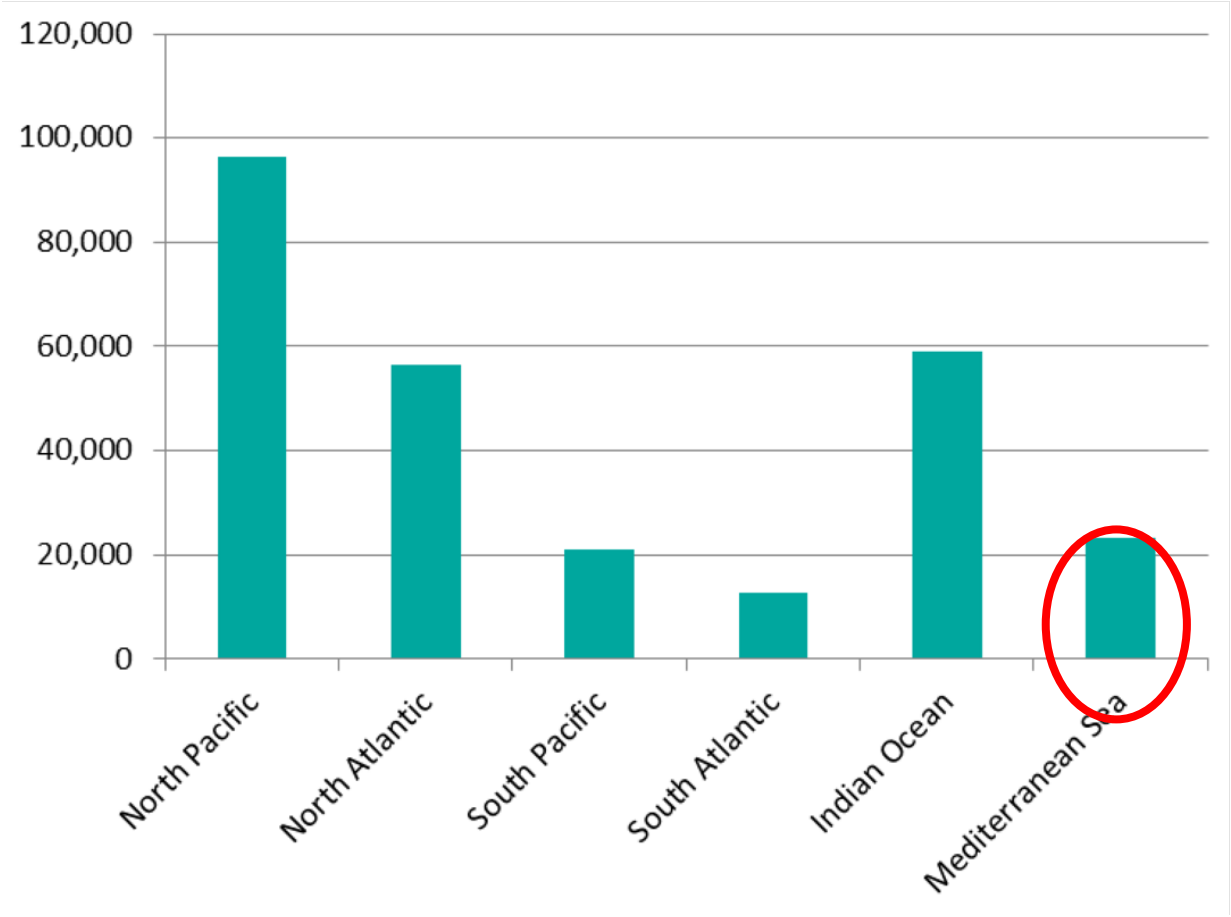
Marine litter in the MED sea: basics

Distribution of Marine Litter (Floating) Between Marine Regions (Tonnes)



Kalogerakis N, personal communication, 2016

Marine litter in the MED sea: needs

Marine litter in the MED is a very critical issue, as it is almost closed (with limited exchanges with the oceans), densely populated and with a highly developed tourism and an intensive local maritime traffic. Marine litter is adversely affecting the healthy status and productivity of the area.

Urgent actions addressed to **remove existing marine litter** components are required. Integrated measures for **lowering/preventing new releases** of litter components from both the European and the non-EU countries of the area (Marine pollution knows no border…) are also necessary.

These actions require reliable information of **current status** of marine litter and on its **fate** and **ecological and socio economical impacts** in the whole MED. These data are essential for developing more effective and robust **regulations, R&I actions, education and communication plans**.

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New BIOtechnologiCaL approaches for biodegrading and promoting the environmEntal biotrAnsformation of syNthetic polymeric materials (BIOCLEAN)

Grant Agreement Number 312100

FP7 2011 call topic : KBBE 2012.3.5-02: Biotechnological solutions for the degradation of synthetic polymeric materials

A 3 years project. Overall cost: € 3.946.235,37; EU contribution: € 2.995.988,00; 27% of the EU contribution is for SMEs

Coordinator: Fabio Fava, University of Bologna, Italy

This project is supported by the European Commision under the Food, Agriculture and Fisheries and Biotechnology theme for the 7° Framework Programme for Research and Technological Development

BIOCLEAN consortium

Research/Academia
SME/Industry
Association/other

NJU

IHIZ
SIMA
UFZ

PLIPOC

OU

IMR
MMB

OWS
PLASTEU

CNRS
BBE

FNHW
MADEP

UniBO
FELS

TUC
EPE
DEDISA

EU

AC

ICPC

BIOCLEAN Objectives

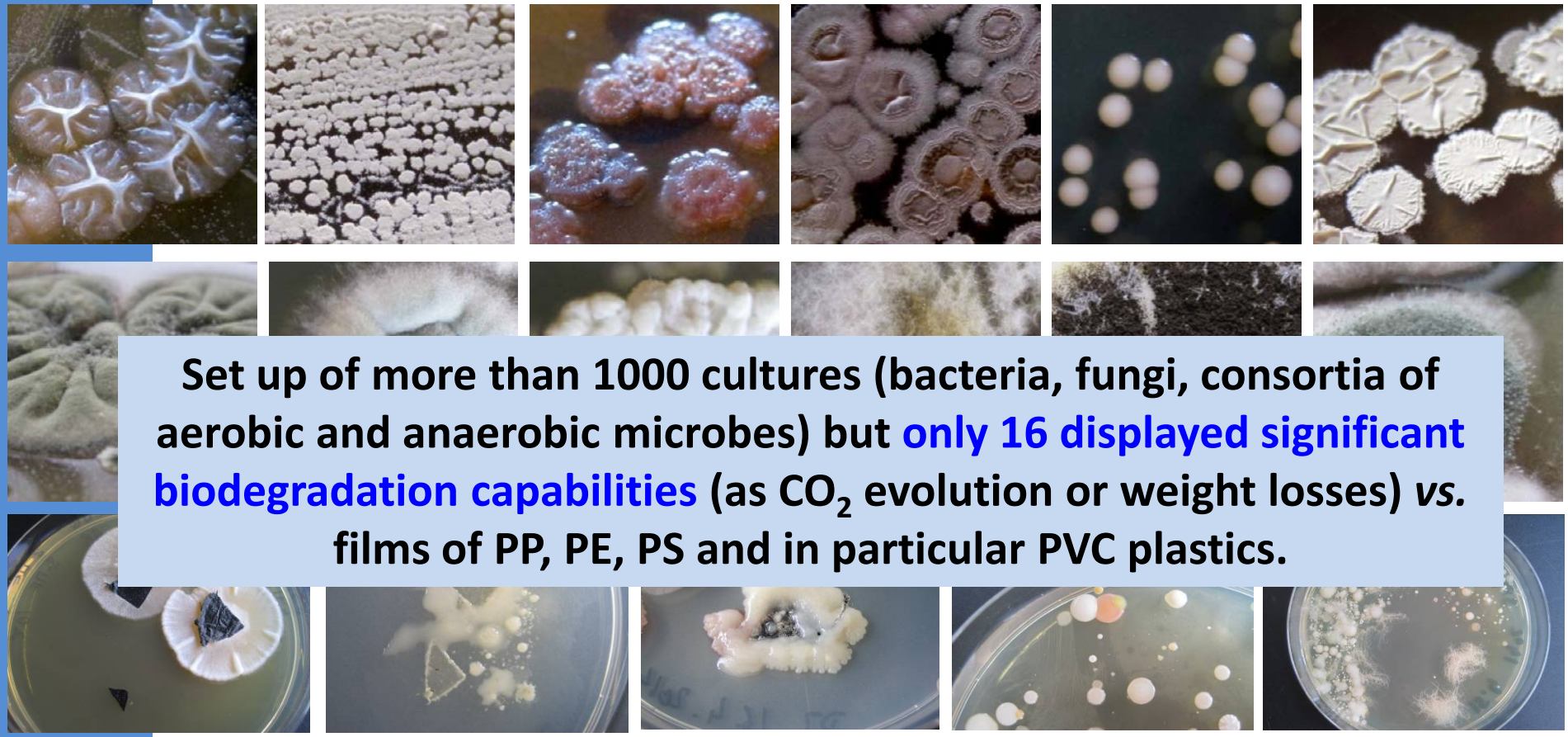
Develop biotechnological solutions for i) degrading/valorising wastes of Polyethylene (PE), Polypropylene (PP), Polystyrene (PS) and Polyvinyl Chloride (PVC) plastics and **ii) enhancing degradation of PE, PP, PS and PVC plastics persisting in composting, anaerobic digestors and marine environments.**

Actions:

- ✓ Obtain robust naturally-occurring mixed and pure aerobic and anaerobic **microbial cultures degrading PE, PP, PS and PVC plastic wastes;**
- ✓ Develop **biological or hybrid physical-chemical/biological processes** for the biodegradation of target plastics;
- ✓ Develop **strategies for enhancing native biodegradation** of plastics occurring in **composting/waste treating facilities** and in **marine habitats**.
- ✓ Aid in the implementation of the MSFD by i) developing **monitoring tools** for establishing the level of plastics pollution in the marine environment, ii) **developing strategies of mitigation measures**.

Plastic-degrading cultures enriched from plastic waste

Most active cultures (measured as plastic weight reduction, % w/w)



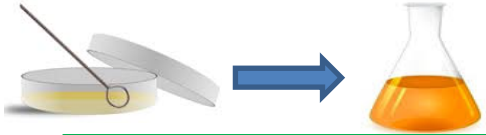
Set up of more than 1000 cultures (bacteria, fungi, consortia of aerobic and anaerobic microbes) but only 16 displayed significant biodegradation capabilities (as CO_2 evolution or weight losses) *vs.* films of PP, PE, PS and in particular PVC plastics.

Processes for the biodegradation of PVC

Pilot-scale (15 L)

Pseudomanas sp. agar plates

Preculture 30°C at 150 rpm



2 g/L PVC film

PVC plastic film without additives, PVC polymer to be recycled.

Bacterial Biomass. It can be used to produce enzymes, bio products, etc.

15 L stirred tank aerobic bioreactor

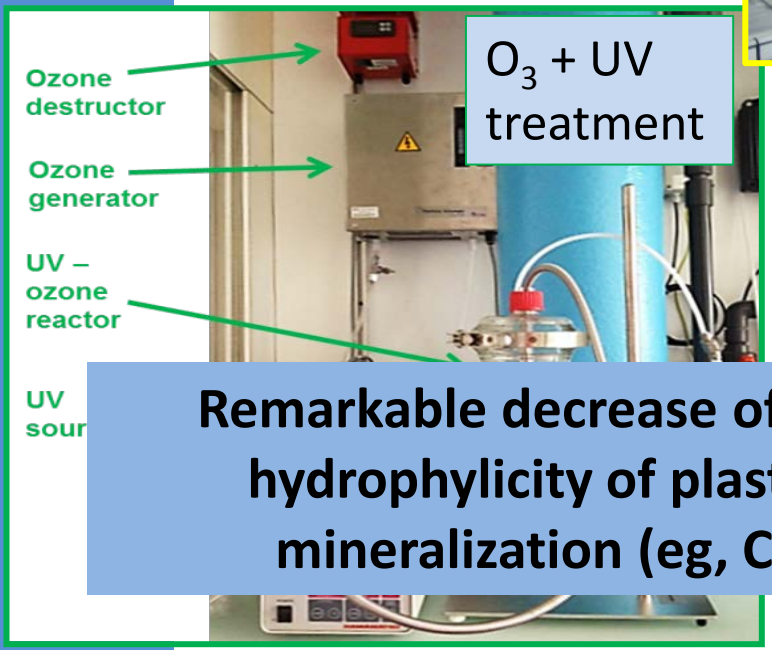
PVC film biodegradation: 21 ± 0.5 %w/w (control: 6%)

Processes for the (pre)treatment of plastics

ɣ ray treatment

Thermal treatment

O_3 treatment



O_3 + UV treatment

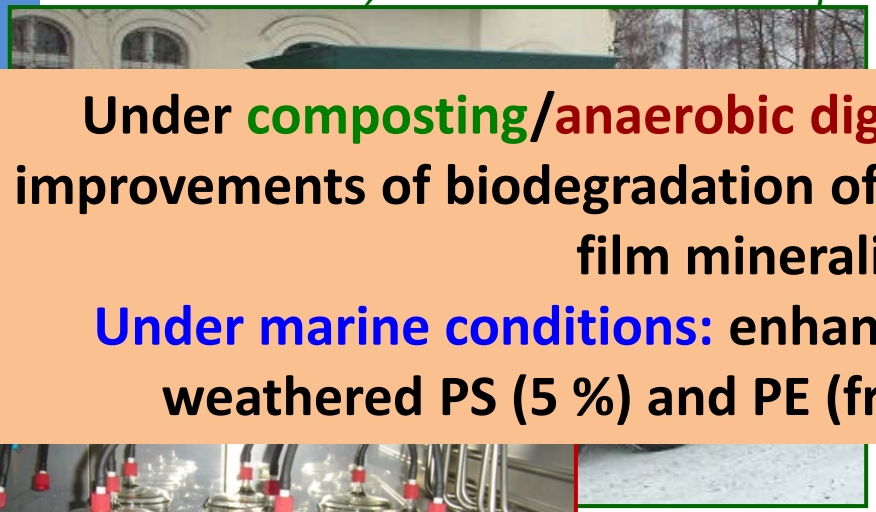
Scale-up of O_3 + UV treatment

Remarkable decrease of molecular weight and improvement of hydrophylicity of plastics but only limited increases of their mineralization (eg, CO_2 evolution) by specialized cultures

Biodegradation of plastics under actual site conditions

Aerobic: Pilot-scale (1000 L)

Compost with PE, PS, PP or PVC films inoculated with *A. terreus, T. hamatum, P. ellipsoidea, T. abietinum, R. ruber and Bacillus sp. B17*

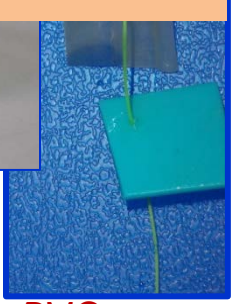


Aerobic: Lab-scale (1 L)

Marine site water with weathered PE and/or PS films with *Shewanella* sp., *Pseudomonas* sp., *Lysinibacillus* sp., *Salinibacterium* sp. and

Under composting/anaerobic digestion conditions: no significant improvements of biodegradation of PP, PE and PS films but higher PVC film mineralization rate.

Under marine conditions: enhancements of weight reduction of weathered PS (5 %) and PE (from 10-16 %) after 6 months.



Anaerobic: Lab-scale (1 L)

Anaerobic sludge with PVC film inolculated with PVC degrading NO_3^- *reducing or methanogenic microbial consortia*

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Marine litter: actions required (a)

The majority of traditional plastics currently used in our daily life are not significantly biodegraded, ether in the terrestrial waste disposal facilities and in marine habitats. Thus, the management of marine litter requires an integrated approach.

1) Better define and assess the problem. There are knowledge gaps on the litter composition, amounts, fate and actual impacts on the local ecosystems for some of the MED areas. Needs:

a) build a denser marine sampling network with scientists/ citizens of the area;
b) better identify the local land based sources of litter;
c) build a Mediterranean marine litter data base.

The full engagement of scientists and citizens coming from all countries across both the Southern and Northern Mediterranean are required.

2) Implement site specific strategies for removing/lowering the marine litter already existing in the basin. Needs:

a) removal of microplastics from surface, water column, seafloor and shore via the cooperation of pelagic and benthic trawlers;
b) regular removal of beached debris from the beaches, plastics from rivers, watercourses and continental runoff waters, via fishermen and citizens;
c) stimulate *in situ* biodegradation of marine litter components.

Marine litter: actions required (b)

3) development of treatments/strategies for valorizing the collected materials to produce energy, new products or chemical building blocks.

4) prevention of marine litter. Needs:

a) selectively collect and recycle sustainably waste plastics by reducing use landfills;
b)eliminate the land-based open and open-air dumps,
c) remove (via filtration) plastics and tire fragments from highway and urban runoff, and wastewater treatment effluents;
d) restrict use of non-essential plastic products and micro-granules in products;
e) gradually adopt biodegradable (bio)plastics, by starting from those used in marine habitats (for fishing gears, tubular net for marine aquaculture, additives for painting and maintenance of ships and leisure boats…).

5) Identify and promote: a) effective and robust regulations/legislation, b) tailored incentives (for recovering plastics from the sea, for recycling plastics, etc), c) R&I actions, d) education and communication plans, e) robust partnerships between academia, industry, public institutions, regulatory bodies and the society, and f) long-term coordination of European/non-EU countries of the area, providing added value to regional, national and EU investments and efforts.

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Programs sustaining measures and R&I in the field (a)

The BLUEMED INITIATIVE

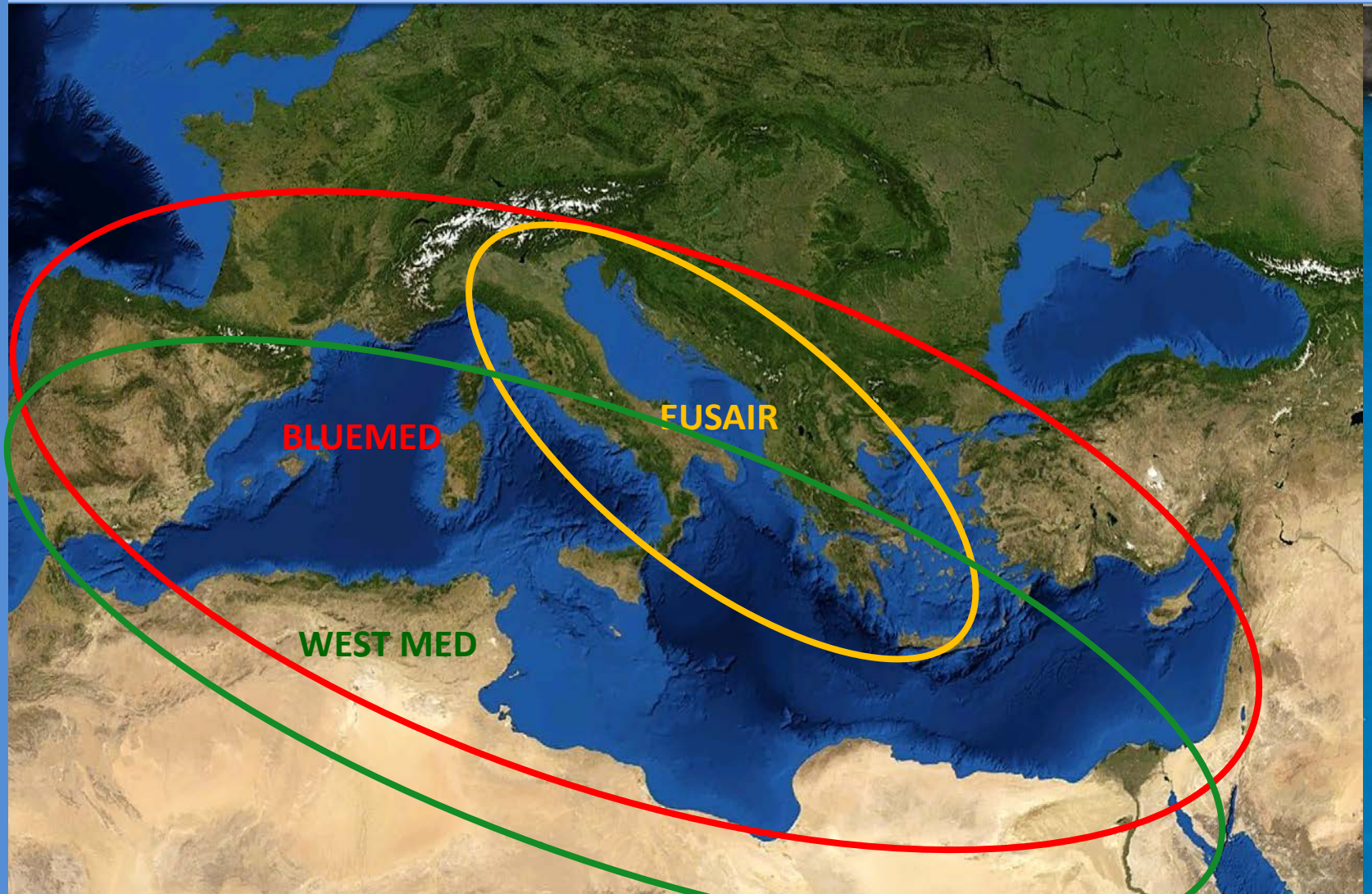
Aim: to foster a joint action of the EU MS of the Mediterranean basin to promote a sustainable and healthy bluegrowth in the area.

Implemented by Italy in close cooperation with Cyprus, Croatia, France, Greece, Malta, Slovenia, Spain and - since July 2014 –Portugal and, since May 2015, Belgium and the European Commission (DG RTD, DG MARE).

A Strategic Board and a specific CSA, both under the EU coordination, are on place. Marine litter management and prevention is one of the key priorities of the Strategic Research and Innovation Agenda

Vision document and Strategic R&I Agenda available at: goo.gl/ZbJTWH

Programs sustaining measures and R&I in the field (b)



Programs sustaining measures and R&I in the field (c)

Horizon 2020, the EU Commission R&I funding programme (~79 Bil, 2014-2020)

Societal challenges

1. Health, demographic change and wellbeing (7.472 Bln)
2. Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bioeconomy (3.851 Bln)
3. Secure, clean and efficient energy (5.931 Bln)
4. Smart, green and integrated transport (6.339 Bln)
5. Climate action, resource efficiency and raw materials (3.081 Bln)
6. Inclusive, innovative and reflective societies (1.310 Bln)
7. Secure societies (1.695 Bln)

Programs sustaining measures and R&I in the field (d)

LIFE Environment (call expected on Sept 2017)

topic 1 - water; 2. Projects aiming at preventing and **reducing marine litter** or microbial contaminants, addressing the sources of marine litter and microbial contaminants.

Interreg A Italia-Croatia (call launched on April 21, 2017)

Objective 3.3 : Improve the environmental conditions of the sea and coastal area by use of sustainable and innovative technologies and approaches

With expected outputs indicators :

2) Microplastic waste collected in marine areas

And examples: support cooperation among different sectors for the development of new possibilities of **recycling marine litter** and development of a crossborder strategy to asses, prevent and **reduce marine litter pollution** in the area.