Session: Environmental Exposures and Health

BEACH CONTAMINATION BY MARINE LITTER: APPLICATION OF DPSIR (DRIVER, PRESSURE, STATE, IMPACT, RESPONSE) ANALYSIS

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BACKGROUND: Composition of beach-stranded material

Accumulation of stranded biomass (*banquettes*) is a natural phenomenon, mostly frequent along Mediterranean coast for the presence of extensive *Posidonia oceanica* meadow

Italian regulation allowed a series of management methods
- On-site maintance
- On-site burial
- Displacement of the deposit
- Agronomic use
- Permanent removal and disposal

(Ministerial Memorandum No. 8838/2019)

Source: Photographic documentation ISPRA (2010)

BACKGROUND: Composition of beach-stranded material

In recent year, the quantities of anthropogenic material mixed to standed biomass is increasing, owing to the global issues of **marine litter**, affecting all the sewaters of the world

Marine litter is commonly defined as "*any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.*" *(UNEP, 2009)*

The presence of beach litter hampers environmental-friendly management options of stranded biomass and their reuse.

In Italy, more than 50% of the beached biomass reaches the landfill, mainly because of the presence of several anthropogenic litter items

Source: ISPRA, 2010

This study tackled the beach contamination issue in the context of a little Municipality located in the North-Western Italy, along Tyrrenian coast

General framework

Data and information were collected and categorized according to the methodological approach of DPSIR (*Driving Forces-Pressure-State-Impact-Response*).

Data acquisition

- Databases and information from a stakeholders' network (i.e., coastal municipality, beach mangers, waste mangers)
- Field monitoring campaigns along the shorelines to acquire information on the state of the environment

- 42 km² territorial extension
- 5 km of sandy beaches
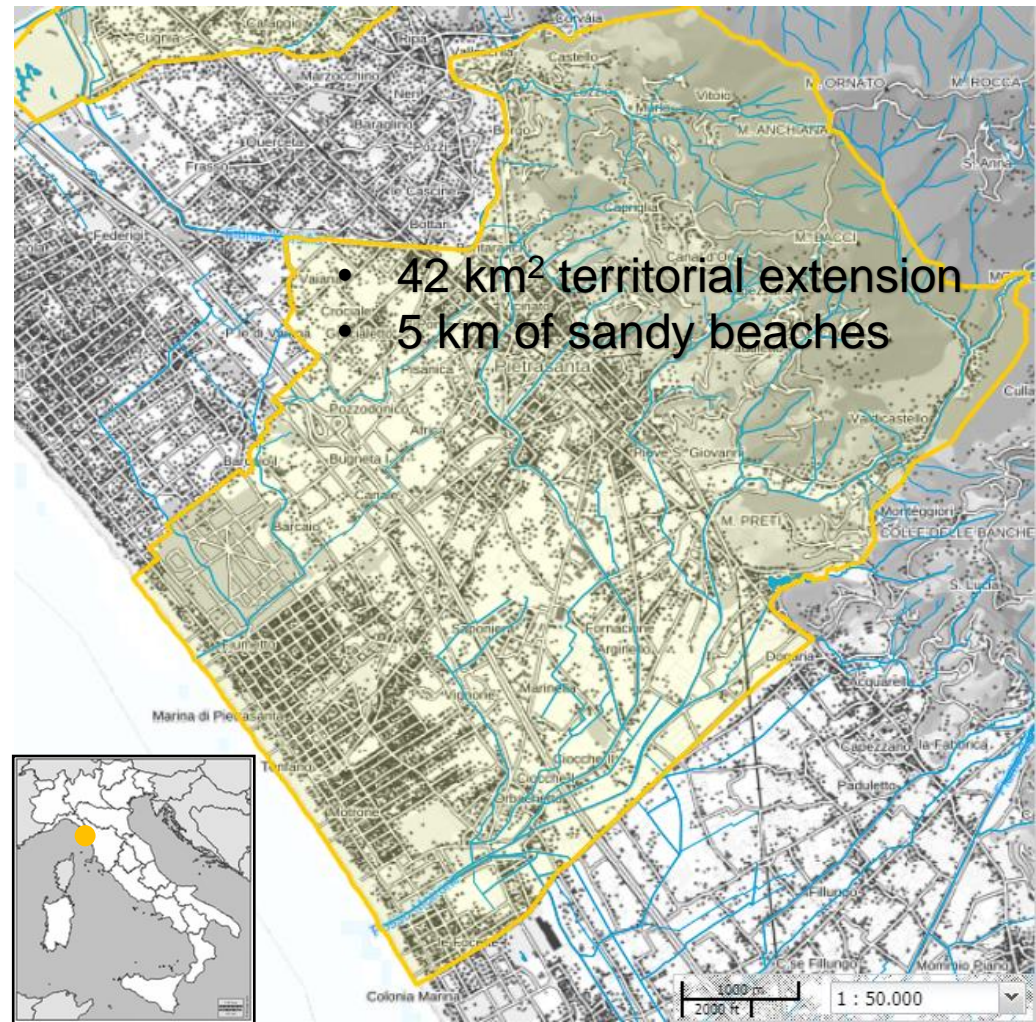
Identification of drivers and pressures for beach contamination

Data source: field inspections and data collection from stakeholders

Beach litter abundance can be influenced by two categories of driving forces, natural and anthropogenic, responsible for pressure on the environment.

Natural drivers
- Hydrological system
- Wheater features
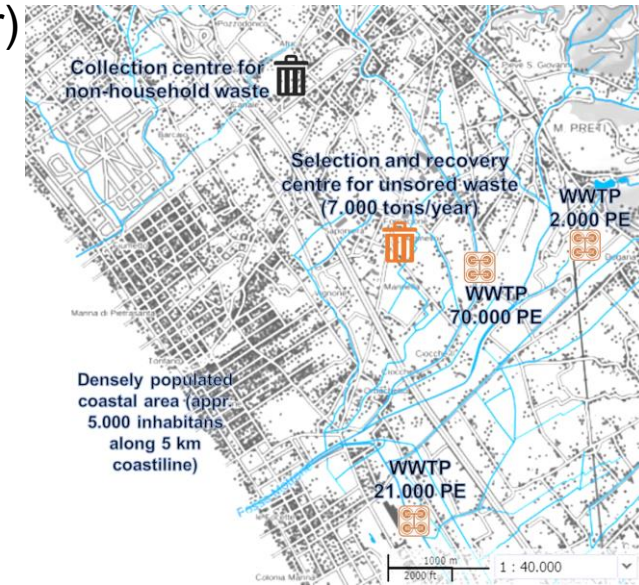- Sea features

Anthropogenic drivers
- Urbanization of coastal area (**577 inh./km²**)
- Coastal tourism (**60.000 tourists** summer)
- Citizens/tourists behaviours

Pressure coming from natural drivers
➢ Storms
➢ High river discharges
➢ High coastal material transport

Source: Archive images from Planning Authority on Reclamation

Pressure coming from human drivers
➢ Production of urban solid waste (771 kg/capita/year)
➢ Emission of urban wastewater
➢ Littering of visitors at beach

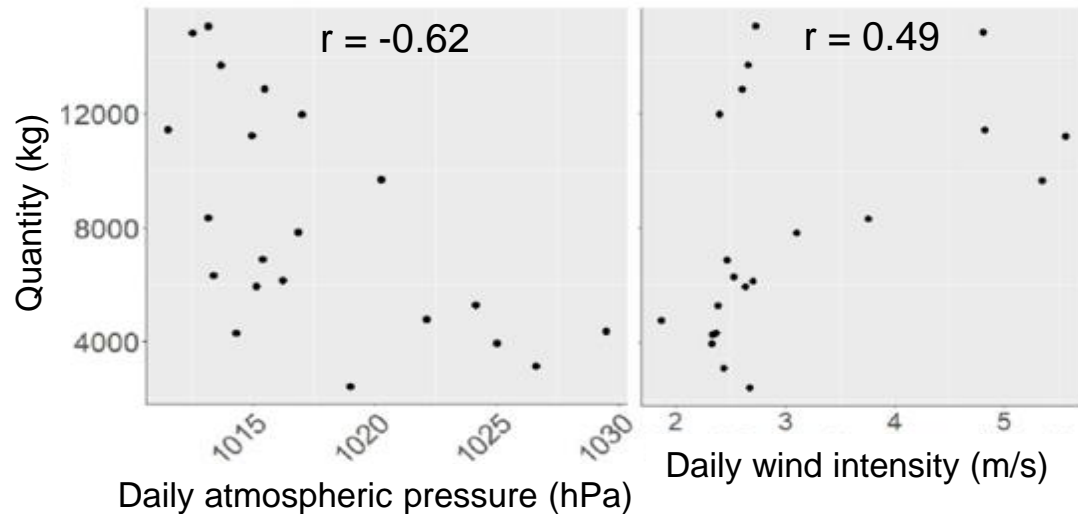
Collection centre for non-household waste

Selection and recovery centre for unsored waste (7.000 tons/year)

WWTP 2.000 PE

WWTP 70.000 PE

Densely populated coastal area (appr. 5.000 inhabitans along 5 km coastiline)

WWTP 21.000 PE

1 : 40.000

Quantities of beach-stranded material and relationships with environmental variables

Data sources: analysis of data acquired by stakeholders

In a 7-year period, an annual average of **1550 tons** of beach-stranded material has been collected along the 5 km coastline under investigation.

Accumulation of debris occurs mainly during periods of bad weather (minimum atmospheric pressure), with medium-strong winds (max = 10.7 m/s)
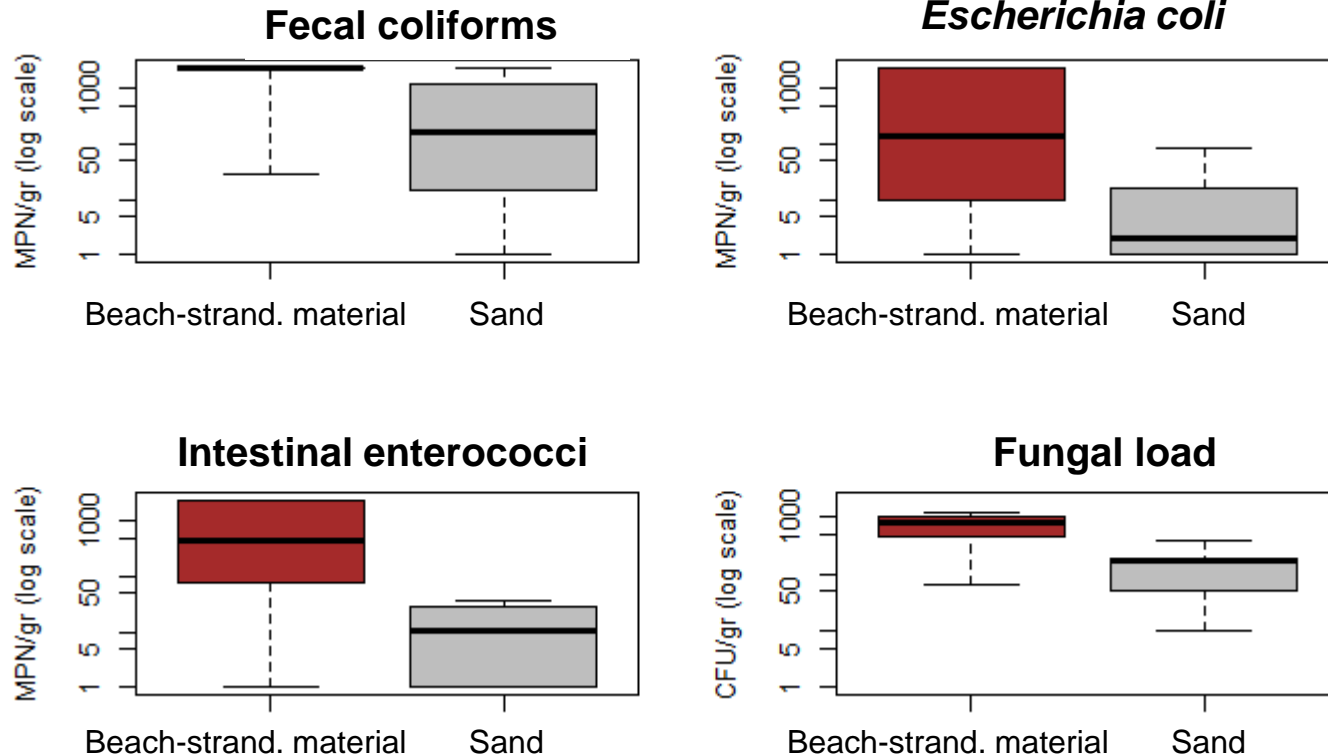

r = -0.62

r = 0.49

Quantity (kg)

12000

8000

4000

1015   1020   1025   1030

Daily atmospheric pressure (hPa)

2   3   4   5

Daily wind intensity (m/s)

Microbiological analysis of beach-stranded material

Data sources: field study

Results from three monthly monitoring campaigns in 2020 (Aug. - Sept.) suggested that beach-stranded material is more contaminated than the underlying sand

Bacterial pathogens (*St. aureus*, *Salmonella* spp.) and viral pathogens (human adenovirus, norovirus, enterovirus) were not detected

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Physical characterization of beach-stranded material

Data sources: field study

Beach-stranded material: Biomass
During a monitoring survey on Sept. 2020, biomass was mainly represented by wood (mainly little size pieces < 5 cm) and terrestrial plants. Little quantity of the seagrass *Posidonia oceanica* was also detected.

Beach-stranded material: Beach litter
High amount of anthropogenic material has been counted with an average of 380 items/100m. Plastic was the most prevalent litter item found on the beach, followed by rubber and metal

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Impacts

Data sources: analysis of filed study results and data acquired by stakeholders

The analysis of the "state" subjected to pressures allowed to identify the following impacts on economy, human health, and environment

Economic impact	Safety and Health impact	Environmental impact
• **Costs for beach cleaning and marine debris treatment**. In a 10-years period, the annual cost for the service has been quantified in approx. 132.000 € • **Socio-economic loss.** The presence of marine debris on the beach is associated with an aesthetic detriment of the coastline (negative impact on tourism)	Field study showed a wide contamination of beach-stranded material and sand. The results suggest the possibile role of these meterials as veichle of potentially pathogen microorganisms, since not yet detected.	Field study showed high quantities of human litter mixed to biomass in the beach-stranded material. Human litter, especially plastic, can be a vehicle of invasive species as well as chemical contaminants.

Policy actions

Data sources: information collected from stakeholder's network

✓ In 2018, revision of the Technical Specification for Waste Management, to improve reducing, recycling and recovering of wastes (collaboration between local decision-makers and waste management company)

✓ In 2019, banning of the single-use plastic from beaches and its replacement with biodegradable products (collaboration among local decision-makers, waste management company, and association of workers in bathing establishments)

Litter management #1: Floating barrier along watercourses

Data sources: field study (periodical monitoring of watercourses)

To avoid land-based debris and biomass to reach the seawaters, a floating barrier has been posed near the river mouth. However, some technical problems hamper the effectiveness of this measure
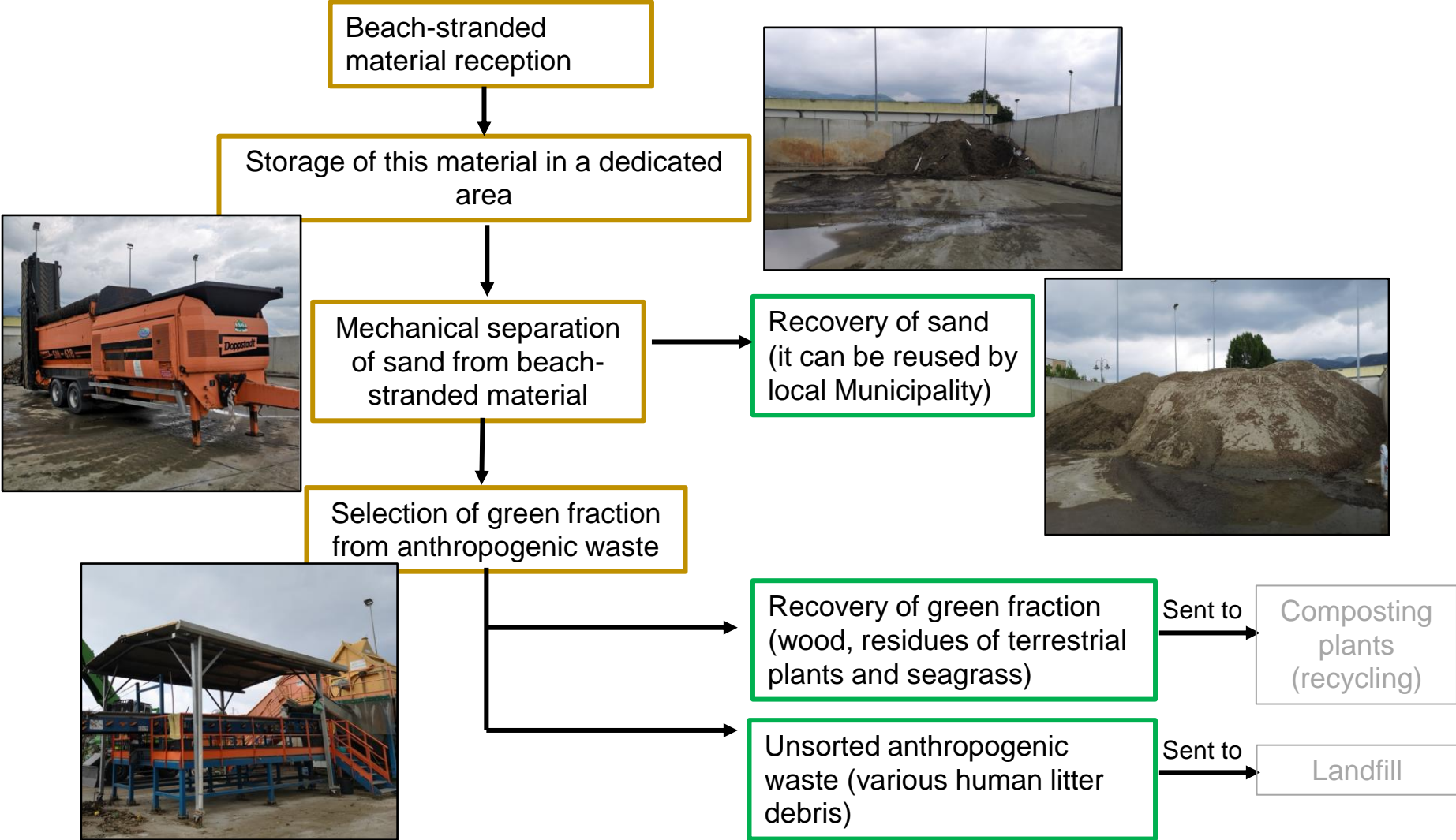
Lack of periodical cleaning during dry weather

Effect of wet weather and rough sea conditions

Litter management #2: Beach-stranded material treatment facility

Data sources: inspection of the treatment facility

Beach-stranded material reception

↓

Storage of this material in a dedicated area

↓

Mechanical separation of sand from beach-stranded material → Recovery of sand (it can be reused by local Municipality)

↓

Selection of green fraction from anthropogenic waste

→ Recovery of green fraction (wood, residues of terrestrial plants and seagrass) — Sent to → Composting plants (recycling)

→ Unsorted anthropogenic waste (various human litter debris) — Sent to → Landfill

Formulation of further possible responses

In the study area, some strategies are already in place to remove or minimize the problem of beach contamination. However, such measure can be enhanced, and other ones can be suggested.

Improvement of the measures for litter management

- Improvements of floating barrier to stop litter along watercourse by a periodical maintenance of the barrier and cleaning of the accumulated residues
- In situ reuse of green fraction obtained from treatment of beach-stranded material (i.e., production of bio-containers)

Citizen involvement for the engagement against beach contamination

- Organization of sensibilization campaigns to promote waste reduction and correct separate collection of waste;
- Coordination of beach-cleanup activities along shoreline (but also along watercourses) with a double aims: removing trash and acquiring scientific information on litter (physical characterization).

FINAL REMARKS

The accumulation of beach-stranded material represents a complex environmental problem, causing environmental, sanitary, social, and economic impacts.

Currently, such issue has not yet been tackled using an integrated approach and data related to beach contamination are often non-homogeneous and fragmented

For the first time, beach contamination has been structured following the DPSIR framework and the conceptual model has been applied to a concrete case study. The DPSIR has been used:
- ❖ to analyze drivers, pressures and state of this specific coastal issue, integrating filed monitoring and data collected by a local stakeholders' network;
- ❖ to describe the management responses already in place in order to valorize them and to suggest further management options to improve the current situation.

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