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Reflecting on hypertrophic plastic waste: concerns and levers

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ABSTRACT

This paper intends to critically review the concerns and levers of the plastics management sector. Here we emphasise the need for seamless integration between all stages (production, consumption and recycling) of the plastics supply chain and the fundamental role played by the state as a promoter of coherent policies for sustainable development. The connection between pandemia and the current regulatory framework is thoroughly discussed.

KEYWORDS: Plastics waste. Plastic pollution. Policy coherence. Circular economy.

1. INTRODUCTION

Today, plastic is present in every aspect of our daily lives: transport to construction, telecommunications to consumer goods, food to healthcare. While plastic is one of the fundamental materials in our everyday lives, it is also a significant source of pollution (Schmid et al., 2021; Rochman and Hoellein, 2020; Jambeck et al., 2015). The problem of environmental plastic pollution is compromising biodiversity, the food chain, and the wellbeing of all living things (Thompson, 2015). Such motivations have prompted more and more scholars to investigate the phenomenon of plastic pollution (Aragaw and Mekonnen, 2021; Schmid et al., 2021; Silva et al., 2020; Ryberg et al., 2019; Payne et al., 2019; Jambeck et al., 2015; Rochman, 2016). Although numerous studies have proposed new models of plastic waste management, there is a need for further contributions to promote a coherent and sustainable plastic waste management system. This paper proposes a critical review of concerns and levers dealing with the current plastics management. In the following, we emphasise the need for seamless integration between all stages (production, consumption and recycling) of the plastics supply chain and the fundamental role played by the state as a promoter of coherent policies.

The paper is based on the more recent data and reports on plastic pollution and is structured as follows: (1) Plastic pollution and the link between health and the environment; (2) Plastic waste: worrying data and the energetic dimension; (3) The current regulatory framework; (4) the main efforts for a plastic-free world and the need for a policy coherence: towards an integrated approach; (5) The effects of Covid-19 on the plastic packaging waste management chain, and (6) Final remarks.

2. PLASTIC POLLUTION: THE LINK BETWEEN HEALTH AND THE ENVIRONMENT

Health is not only the absence of illness. In 1948, the World Health Organisation (WHO) provided a holistic definition of health: "Health is a state of complete physical, mental, and social wellbeing and not merely the absence of disease and infirmity". The concept of total health developed by the WHO is very current because it leads us to reflect that our health depends on the ecosystem. Total health must therefore be understood as the health of humanity, fully aware of its social bonds' vital importance and environmental roots (Laurent, 2022). Environmental health and human health are inextricably linked. The concept of health is connected with the social determinants of health: conditions in which people are born, grow up, live, work, age, and the systems implemented to combat the disease, based on economic, social and political factors. The concept of total health has been enriched, and today it includes the concept of ecosystem health, indicating the relevance of the environment in determining good health status. This leads to a related concept: the co-benefit (Laurent, 2022). The co-benefit highlights that **improving the environment and stopping or slowing down the degradation lead to an improvement in health**. Moving from this systemic view of the relationship between health and the environment, it has been underlined that plastics may affect our health via three pathways [<https://www.plastichealthcoalition.org/>]:

-we eat, drink and breathe microplastics every day. These small plastic particles may harm our health once they have entered our bodies;

-plastic products contain chemical additives. A number of these chemicals have been associated with severe health problems such as hormone-related cancers, infertility and neurodevelopment disorders like ADHD and autism;

-when plastics and microplastics end up in the environment, they attract microorganisms, such as harmful bacteria (pathogens). If microplastics containing these pathogens enter our body, they may increase the risk of infection.

-Moreover, as to concern the environmental impact, recent data highlights that plastics affect the environment and climate change as follows [<https://www.weforum.org/agenda/2022/01/plastic-pollution-climate-change-solution/>]:

-Just 9% of plastics are recycled – the rest goes to landfill for incineration or is just dumped.

-Many plastics end up in the ocean, releasing greenhouse gases as they slowly break down.

-Plastic incineration is a significant source of air pollution.

-Much of the plastic that doesn't make it to the recycling plant ends up in our rivers and ocean. Not only is this a danger to the animals and plants whose habitats have become aquatic garbage patches, but it also poses a threat to the climate, as plastic releases greenhouse gases as it slowly breaks down. Sunlight and heat cause it to release methane and ethylene at an increasing rate as the plastic breaks down into ever smaller pieces.

Plastic proliferation threatens the climate on a global scale.

In particular, greenhouse gas emissions from the plastic lifecycle threaten the ability of the global community to keep global temperature rise below 1.5°C. By 2050, the greenhouse gas emissions from plastic could reach over 56 gigatons—10-13 per cent of the entire remaining carbon budget (see Figure, source: CIEL, www.ciel.org/plasticandclimate)

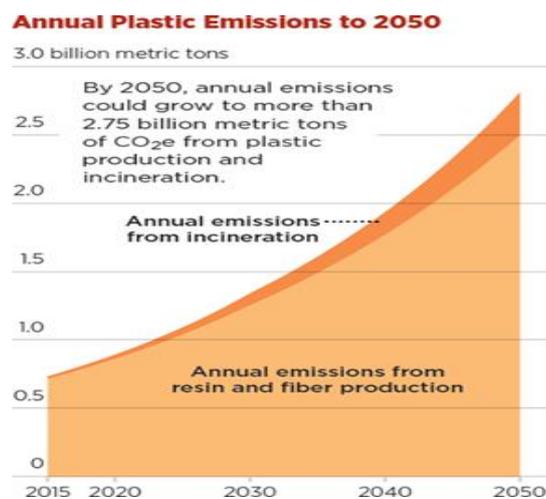




Figure: The main agenda 2030 SDGs dealing with plastic pollution

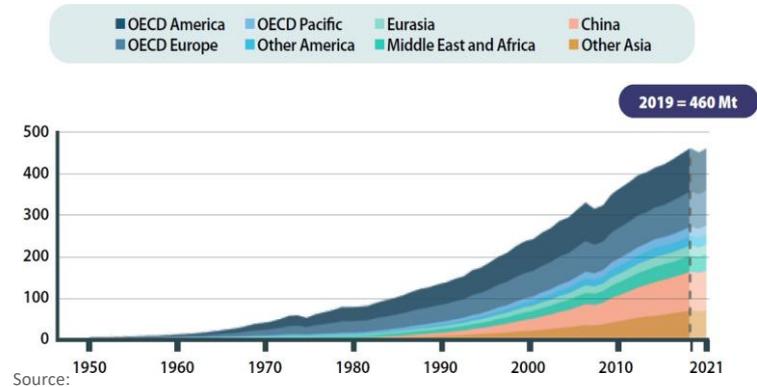
Agenda 2030 is one of the main supranational initiatives to foster a co-benefit approach. Among the seventeen SDGs, SDG 3-Good health and wellbeing, SDG11-Sustainable cities and communities, SDG12- Responsible consumption and production, SDG13-Climate action and SDG14-Life below water are those systemically dealing with plastic pollution.

One of the rising issues related to the co-benefit approach deals with the relationships between the ecological transition and the digital transition. Firstly: are they enemies? Or are they win-win or win-lose processes? For instance, if we consider the digital ecosystem of California, we notice that this ecosystem for elaborating and storing data consumes about 80% of energy derived from fossil fuels. Secondly, what about the digital transition and plastic waste? The first relevant aspect of the digital transition (stressed during the COVID-19 pandemia) is the role of packaging (mainly plastic packaging). As we shift from a consumer society to a delivery society, we increase the risk of plastic pollution. This affects the risk of an economic recoupling (Laurent, 2022; Kreiger et al., 2013). A second critical aspect deals with the diffusion of 3D printing and related additive technologies. In future, these technologies could involve an increasing demand (and production) of the filaments obtained by plastic waste (according to the circular economics principle "from cradle to cradle"). In turn, this demand could involve the risk of exploitation of children and racism, in particular in poor and rural countries (Paradi-Guilford and Henry, 2015).

3. PLASTIC WASTE AND WORRYING DATA

In this section, we enlighten some relevant worrying data from the more recent international reports dealing with plastic waste.

Global plastics use has doubled between 2000 and 2019 Million tonnes (Mt), 1950-2021



Source:

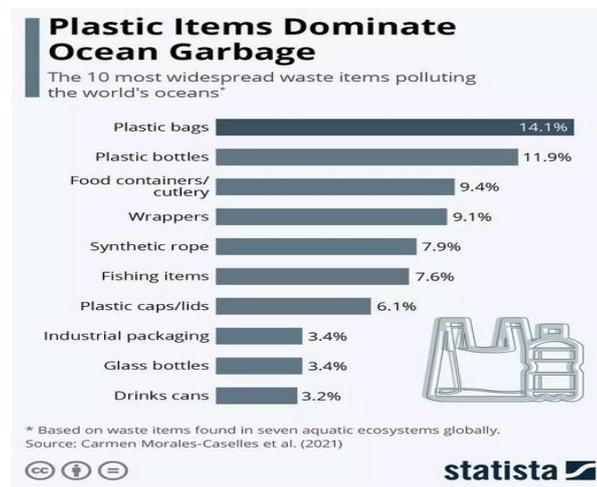
«Global Plastics Outlook Economic Drivers, Environmental Impacts and Policy Options»,

OCSE, 2022 https://read.OCSE-ilibrary.org/view/?ref=1128_1128022-j5scrhacc6w&title=Global-plastics-outlook-highlights

The most significant users of plastics are OCSE countries and China (together 66% of global use), with the packaging (31%), construction (17%) and transportation (12%) sectors as the main consumers. Source:

«Global Plastics Outlook Economic Drivers, Environmental Impacts and Policy Options»,

OCSE, 2022. https://read.OCSE-ilibrary.org/view/?ref=1128_1128022-j5scrhacc6w&title=Global-plastics-outlook-highlights



Source: <https://www.weforum.org/agenda/2022/01/plastic-pollution-climate-change-solution/>

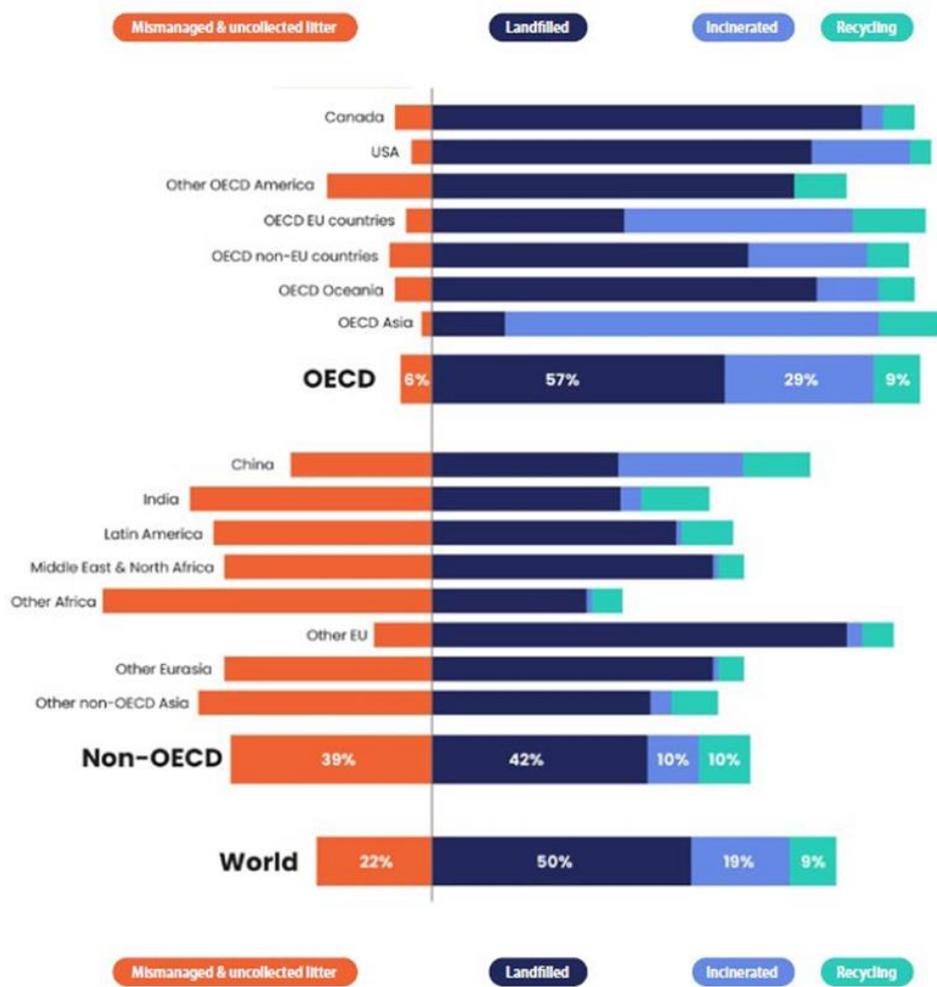
Mismanaged plastic waste is the main source of macroplastic leakage. In 2019 alone, 22 Mt of plastic materials leaked into the environment.

Macroplastics account for 88% of plastic leakage, mainly resulting from inadequate collection and disposal.

Microplastics, polymers with a diameter smaller than 5 mm, account for the remaining 12%, coming from various sources such as tyre abrasion, brake wear or textile washing. In 2019, only 9% of plastic waste was recycled, while 22 % was mismanaged

Source: «Global Plastics Outlook Economic Drivers, Environmental Impacts and Policy Options», OCSE, 2022 https://read.OCSE-ilibrary.org/view/?ref=1128_1128022-i5crhacc6w&title=Global-plastics-outlook-highlights

The current plastics life cycle is far from circular (see Figure).



3.1 The carbon footprint of the plastics lifecycle is significant (OCSE, 2022)

Beyond the hazards posed to the marine and terrestrial environment as well as to humans, plastics are also a substantial contributor to global greenhouse gas emissions. In 2019, plastics generated 1.8 Gigatonnes (Gt) of greenhouse gas (GHG) emissions – 3.4% of global emissions – with 90% of these emissions coming from their production and conversion from fossil fuels.

Furthermore, airborne microplastics have been found in remote regions, including the Arctic, where they may contribute to accelerated warming by absorbing light and decreasing the surface albedo of snow.

3.2 The energetic dimension

(e.g. energy consumption for production (per tonne), energy consumption for reuse (per tonne))

Energy consumption for plastic production:

To produce one tonne of plastic requires 900 litres of oil, 180 cubic metres of water and 14 thousand kilowatt-hours of energy.

Energy consumption for recycling:

For one tonne of recycled plastic, on the other hand, it takes 2 tonnes of used plastic, one cubic metre of water and 950 kilowatt-hours of energy. [Il Sole 24 ore:

https://st.ilsole24ore.com/art/rapporto-sviluppo-sostenibile-05-nov/2013-11-04/viaggio-fabbrica-riciclo-plastica-182746.shtml?uid=ABPbqQb&refresh_ce=1]

4. THE RECENT REGULATORY FRAMEWORK: ESSENTIALS

This section discusses the most recent policies to reduce the consumption of single-use plastics and incentivise the reuse of plastics.

We also analyse Italian regulation and policies identified in the regulatory framework, adopted tools and modes of action, and economic resources committed to the 3Rs reuse, recovery, and recycling.

The Environmental Code is a set of regulations of the Italian Republic concerning the environment, issued by Legislative Decree No 152 of April 3 2006. The Consolidated Text was initially divided into five parts, 318 articles and 45 annexes; two more parts (Fifth-bis and Sixth-bis) were subsequently added to these so that its structure is subdivided as follows:

part One (Art. 1-3-sexies) - Common provisions and general principles;

part Two - Procedures for Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Integrated Environmental Authorisation (IPECC);

part three - Rules on soil protection and combating desertification, protection of water against pollution and management of water resources;

part four - rules on waste management and reclamation of polluted sites

part five - rules on air protection and reduction of emissions into the atmosphere;

part five-bis - provisions for particular installations;

part six - rules on the protection of the environment from damage;

part six-bis (Art. 318-bis-318-octies) -penalty provisions for administrative and criminal offences in the field of environmental protection.

Part four of the environment code, as indicated in Article 177, regulates "waste management and the reclamation of polluted sites in implementation of EU directives on waste, hazardous waste, waste oils, used batteries, packaging waste, polychlorinated biphenyls (PCB), landfills, incinerators, electrical and electronic waste, port waste, end-of-life vehicles, medical waste and waste containing asbestos".

Article 183 paragraph I specifies that waste means any substance or object which the holder discards, intends to discard or is required to discard" while waste management means:

"The collection, transport, recovery and disposal of waste, including the control of these operations, as well as the control of landfills after closure."

Furthermore, Article 178 adds that such waste management must 'be carried out following the principles of precaution, prevention, proportionality, accountability and cooperation of all those involved in the production, distribution, use and consumption of goods from which the waste originates, following the principles of national and Community law, with particular reference to the Community polluter-pays principle'.

In sum:

Communication from the European Commission's European Strategy for Plastics in the Circular Economy, COM(2018) 28 final, producers shall, voluntarily and on a trial basis from January 1 2019, until December 31 2023:

- (a) adopt separate collection and recycling models for plastic tableware from fossil sources with increasing rates of reintroduction of secondary raw materials into the production cycle;
- b) produce, use and compost tableware made from biopolymers of plant origin;
- (c) use biopolymers, with a focus on domestic sources of supply, on a massive scale and as an alternative to fossil-sourced plastics for the production of disposable tableware by December 31 2023'.

Future challenges: European Union

Between efficiency, effectiveness and sustainability

(n. 849/2018/Ue, 850/2018/Ue, 851/2018/Ue e 852/2018/Ue)

The basic principles are: firstly, prevent waste creation, repair and recycle products, and finally, energy recovery through waste-to-energy plants.

Landfilling is the last resort: by 2035, it must not exceed 10 per cent of total waste.

All member states have two years to transpose the framework directive, which envisages recycling at least 55% of municipal household and commercial waste by 2025, rising to 60% in 2030 and 65% in 2035.

In particular, as far as plastic is concerned, the target is to recycle 50% of it by 2025 and 55% by 2030.

In line with the UN Sustainable Development Goals (SDGs), the package also includes reducing food waste: -by 30% by 2025 and -by 50% by 2030.

What about employment? Even with employment risks in specific sectors, the overall impact on employment would be positive: stricter environmental legislation could translate into greater competitiveness for companies, which would also benefit from the innovative drive in all sectors due to the need to redesign materials and products to make them 'circular.'

Are we sure? [<https://eur-lex.europa.eu/legal-content/it/TXT/PDF/?uri=CELEX:32018L0851&from=EN>]

EU DIRECTIVE 2019/904: SINGLE-USE PLASTICS

The SUP Directive is one of the Union's responses to the worrying phenomenon of marine pollution, with plastics accounting for 85% of the marine litter found along coastlines (beach litter), on the sea surface and the ocean floor (marine litter).

"the objectives of this Directive are to prevent and reduce the impact of certain plastic products on the environment, particularly the aquatic environment, and on human health, and to promote the transition to a circular economy with innovative and sustainable business models, products and materials. "

From 2021, Member States prohibit the placing on the market of single-use plastic products for which there are alternatives on the market:

- 1) cotton swabs, except when they fall within the scope of Directive 90/385/EEC
- 2) cutlery (forks, knives, spoons, chopsticks)
- 3) plates;
- 4) straws, except where covered by Directive 90/385/EEC or Directive 93/42/EEC; 5) drink stirrers;
- 6) poles to be attached to support balloons, except for [...];
- 7) expanded polystyrene food containers, i.e. containers such as boxes with or without lids
- 8) beverage containers made of expanded polystyrene and their caps and lids
- 9) expanded polystyrene beverage cups and their caps and lids
- 10) products made of oxidisable plastics.

The date of entry into force of the plastics consumption tax, or plastic tax, is postponed to January 1 2023. This is stipulated in the 2022 Budget Law. The plastic tax should have already entered into force in July 2020. From 2023 onwards, a plastic tax of 0.45 euros per kilo of plastic will have to be paid.

This tax, set at 0.45 €/kg, is only due to the quantity of virgin plastic contained in MACSI and is therefore not due to plastic that comes from recycling processes. The establishment of this tax is consistent with SDGs 9, 11, 12, 13, and 14 of the 2030 Agenda.

4.1 THE PLASTIC TAX

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4.2 BIODEGRADATION AND COMPOSTING

Biodegradation can occur under very different conditions, depending on which the speed of the process may vary and the type of derived products obtained.

The use of compostable materials should be encouraged under strict conditions. According to UNI EN 13432:2002, the characteristics that a compostable material must have are as follows:

Biodegradability, i.e. the metabolic conversion of the compostable material into carbon dioxide. This property is measured using a standard test method: prEN 14046. The acceptance level is 90% (compared to cellulose) to be reached in less than six months.

Disintegrability, i.e. the fragmentation in the final compost (absence of visual contamination). Measured by a pilot scale composting test (prEN 14045). Samples of the test material are composted together with organic waste for three months. The compost is screened with a 2 mm sieve. The mass of the test material residues with a size > 2 mm must be less than 10% of the initial mass.

- Absence of negative effects on the composting process. Verified with a pilot-scale composting trial.
 - Low levels of heavy metals (below predefined maximum values) and no negative effects on compost quality (ecotoxicological effects on plant growth).
 - A plant growth test (modified OCSE 208 test) is carried out for this purpose. No difference should be shown with a control compost. Biomonitoring methods (Conti et al., 2011; Pino et al., 2010) using multivariate techniques (Conti et al., 2007) to obtain information about contamination levels in different ecosystems are well established. The use of plants to detect pollution levels (heavy metals, dioxins) in the vicinity of landfills or incinerators has been proposed (Van Dijk et al., 2015).
 - Other chemical-physical parameters that must not change after degradation of the study material: pH; salt content; volatile solids; N; P; Mg; K.
- The Italian Government is directing plastic manufacturers to replace fossil-based single-use plastics with biodegradable single-use plastics by 2023.

5. EFFORTS FOR A PLASTIC-FREE WORLD AND POLICY COHERENCE FOR A SUSTAINABLE DEVELOPMENT

Although five years have passed since the adoption of the 2030 Agenda, many countries have yet to organise themselves effectively to ensure the implementation of the Sustainable Development Goals (SDGs). Achieving the sustainable

development goals of the 2030 Agenda is a multidimensional and intergovernmental challenge.

It requires meaningful collaboration across all policy areas (horizontal coherence) and at different levels of Government (vertical coherence). The interactions and connections between the SDGs need to be identified, understood and managed. No country can act alone to do this: policy coherence is needed at the international level. Improving policy coherence for sustainable development is the theme of the High-Level Political Forum (HLPF), in which how resilient and sustainable social models can be created are analysed. At the recent HLPF meeting, the OCSE's (2019a) published Policy Coherence for Sustainable Development (PCSD) was reviewed. This report examines the actions that adhering countries will need to take to achieve sustainability goals. In particular, the report emphasises that the SDGs cannot be achieved by applying sectoral approaches, but only by adopting more integrated and coordinated approaches in planning and policy will positive results be achieved (Conti, 2020)

The different countries to achieve the SDGs must thus adopt an integrated management approach in which existing plans, practices and strategies are reorganised and integrated. The 2030 Agenda already invited governments to break out of traditional policy patterns and to develop and test new models based on greater participation and consensus achieved through coherent policies. In particular, SDG 17.14 calls on all countries to "strengthen policy coherence for sustainable development" (PCSD) as a key means of implementation (Conti, 2020).

An equally important document of the OCSE (2019b) reports the recommendations to the adhering countries for the PCSD (Recommendation of the Council on Policy coherence for sustainable development). PCSD is defined in the cited documents (OCSE, 2019a,b) as:

"[...]an approach to integrate sustainable development dimensions into all decision-making at the national and international level. The objective, in the context of the 2030 Agenda, is to promote the integrated implementation of the Agenda through certain actions:

- (i) Promoting synergies between policy areas and maximising the benefits in economic, social and environmental terms;
- (ii) Balancing domestic policy objectives with the SDGs;
- (iii) Addressing cross-border and long-term impacts of policies, including those that could affect developing countries."

The 2019 edition of the PCSD (OCSE 2019a) picks up on these concepts by examining the efforts countries will need to make to address this challenge. Essentially, it identifies opportunities for countries to accelerate progress in this regard. This is no easy feat: it requires significant collaboration across all policy areas at the same hierarchical level (horizontal coherence) and across different levels of Government (vertical coherence).

In general, the analysis of coherence consists of two main steps:

- Assessment of external coherence.
- Assessment of internal coherence.

Internal coherence clarifies the operational link between the plan's actions and objectives and, at the same time, makes the decision-making process accompanying the drawing up of the plan transparent. It makes it possible to verify the existence of contradictions within the plan.

On the other hand, the assessment of external coherence investigates the compatibility of the general objectives and strategies of the plan/programme with the more general sustainable development goals established by Agenda 2030. The analysis of external coherence is usually divided into two dimensions

- vertical coherence: investigates whether the policy actions of a public body are consistent with the policy actions of hierarchically superordinate public bodies (national, subnational and local levels, e.g. the municipal strategic plan must be consistent and coherent with the superordinate regional, national and European strategy)

- Horizontal coherence: investigates whether the policy actions of a public body are consistent and coordinated with the policy actions implemented by bodies at the same hierarchical level (e.g. whether the strategic plan of the municipality of Rome is consistent with the strategic plan of the municipality of Latina, etc.).

Plastic waste management and policy coherence should be considered strictly intertwined levers for a broader integrated co-benefit-based decisional approach. Within this strategic area, five SDGs can be identified that interact strongly with each other:

- SDG 9 -Build resilient infrastructure, promote inclusive and sustainable industrialisation and support innovation;
- SDG 11- Make cities and human settlements inclusive, safe, resilient and sustainable
- SDG 12- Ensure sustainable consumption and production patterns;
- SDG 13- Take urgent action to combat climate change and its consequences;
- SDG 14-Conserve and sustainably use the oceans, seas and marine resources.

5.1 Pandemia effects

In 2019, a strong criticality occurred due to both the closure of commercial and production activities and the abrupt halt in the export of municipal waste. In 7 weeks of lockdown, the export of more than 16,000 tonnes of municipal waste was stopped.

In addition, the almost complete shutdown of the construction sector has severely reduced the use of the mechanically non-recyclable portion of packaging (Plasmix) as fuel in cement plants. This sector accounts for about 75% of Plasmix use.

These causes, combined with the saturation of the available capacity in domestic plants in the second two months of 2020, have caused, on the one hand, an increase in the portion of packaging waste destined for recycling in foreign plants (+27%, or 3,000 tonnes) and, on the other hand, an increase in the percentage sent to waste-to-energy.

The closure of several operating sectors that use secondary raw materials, the severe difficulties in handling goods and the reduced available capacity in the waste-to-energy plants also led, as a last resort, to an increase in landfilling (about 42,000 tonnes more than the previous year).

6. FINAL REMARKS: SUGGESTED LEVERS FOR A SUSTAINABLE PLASTIC WASTE MANAGEMENT

Although plastics' benefits to our society are unquestionable, there remains the troubling issue of their environmental impact.

Plastic waste management is acquiring critical importance in both public administration and corporate management, as well as at micro, middle and macro level of decision (Basuhi et al., 2021; Chen et al., 2020; Foschi and Bonoli, 2019).

The challenges that the various public and private decision-makers will have to face concern: the increase in the production and consumption rates of plastic materials, the ban on the export of waste to China and India, the lack of adequate infrastructures and the lack of awareness of consumers and producers (Wang et al. 2020; Huang et al. 2020; Paletta et al., 2019; Ciacci et al. 2017; Braunegg et al., 2004; OECD, 2001).

In the previous part of this paper, we have highlighted the main concerns related to plastic waste according to the more recent international studies and statistical reports: In this section, we would like to sum up the main levers that the policymakers could activate to face those concerns:

-the current plastics lifecycle is far from circular;

-mismanaged plastic waste is the main source of macroplastic leakage;

-significant stocks of plastics have already accumulated in aquatic environments, with 109 Mt of plastics accumulated in rivers and 30 Mt in the ocean;

-the carbon footprint of the plastics lifecycle is still significant.

In this section we would like to sum up the main levers that the policymakers could activate to face those concerns.

Firstly, in the post-COVID-19 pandemic era - during which the 2030 Agenda suffered a halt-it is necessary to shift from the scientific phase to the implementing phase of the 2030 Agenda (International Council for Science, 2022). This involves moving towards a more systemic view of the 2030 Agenda. The 17 SDGs and the related 169 targets are not independent silos. Instead, they should be viewed and managed as an intertwined network of goals and targets affecting each other by positive and/or negative feedback loops of interaction. On the one hand, the nature, strengths and impact of the feedback loops of interactions are context-specific. On the other hand, the outcomes depend on the policy options and strategies chosen at multiple levels of decision to pursue them. The awareness about the systemic nature of the 2030 Agenda is a cognitive, deep and valuable lever to promote the health and environment co-benefit -discussed in Sec. 2 of this paper- with respect to plastic waste management plays a relevant role.

Secondly, stimulating innovation for a more circular plastics lifecycle and a more sustainable plastic waste management, for example, by reducing the virgin material needed, extending the proper lifecycle of plastics and facilitating the recycling processes (OECD, 2022). Innovative models of plastic waste management could be conceived in terms of a digital platform. Digital platforms can immediately connect all the actors in the plastics supply chain via algorithms. Consistently with the policy coherence perspective, a digital platform would make it possible to overcome the traditional plastic waste management model by quickly connecting the various actors that characterise the plastics supply chain (citizens, communities, inventors, innovators, entrepreneurs, public institutions). Basically, through the infrastructure

of the platform, an ecosystemic approach of integrated management is implemented in which existing plans, practices and strategies are reorganised and integrated (Ronzon and Sanjuán, 2020; Simone et al., 2020; Barile et al., 2022). The digital platform dedicated to waste management includes all those involved in the plastics supply chain: the State (platform sponsor), the local authorities (platform provider), consumers (users) and producers and recyclers (complementors). The state is the owner of the platform and, as such, influences and coordinates all parties participating in the digital platform. The latter establishes the rules for participation in the digital platform and favors the integration of all parties adhering to it. The local authorities then flank the state as a point of contact between all the members of the digital platform. Among the remaining subjects, we also find consumers who can be both citizens and organisations and complementors, i.e., plastic manufacturing companies and companies involved in recycling and reuse.

Lastly, a third lever represents a coherent set of economic incentives and taxation. These levers aim, on the one hand, to boost the circular use of plastic and, on the other hand, to strengthen the internalisation of negative externalities. These third set of levers includes policies such as (OECD, 2021; OECD, 2015; European Commission, 2015):

- a) the extended producer responsibility (EPR): policies that aim to apply the polluter-pays principle by ensuring that producers, rather than municipalities and taxpayers, bear the financial burden of end-of-life waste treatment for their products.
- b) the deposit-refund schemes (DRSs): consumers pay a deposit at the point of sale of the product, while the refund is only received if the product is returned to an authorised recipient;
- c) banning or taxing single-use plastics;
- d) imposing recycled content standards;
- e) landfill and incineration taxes and pay-as-you-throw schemes.

RESUMO

Este artigo pretende revisar criticamente as preocupações e alavancas do setor de gestão de plásticos. Ressaltamos aqui a necessidade de integração perfeita entre todas as etapas (produção, consumo e reciclagem) da cadeia produtiva do plástico e o papel fundamental do Estado como promotor de políticas coerentes para o desenvolvimento sustentável. A conexão entre pandemia e o atual marco regulatório é amplamente discutida.

Palavras-chave: Resíduos de plásticos. Poluição plástica. Coerência política. Economia circular.

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