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Conceptual note on the waste indicators

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Introduction

This note aims to open the discussion on the use of proper indicators that will link marine litter (ML) and municipal solid waste management (SWM). The overall vision is to create a conceptual framework that will serve as the basis for studying how Marine Litter is related with the existing Solid Waste Management activities in countries and especially in coastal areas. Such a framework is necessary for the creation of more representative and meaningful indicators, as well as for the adjustment of the ones that ae already in use.

The general view of the note is that there is a need to build further on the work that has already been done, taking into account the experiences gained, the linkages between marine litter and waste management, as well as the scientific evolution of the waste indicators. The main scope of the author is to identify the improvements required in order to have indicators that will be:

- Better describe and reflect the linkages between SWM and ML
- Representative of the recent findings on ML quantities and composition
- Linked with the shift to Circular Economy (CE)
- Suitable for decision makers and decision takers

In addition, the indicators should cover the general criteria that have been set in the recent meeting in Copenhagen[1]. They must:

- Be simple, straight-forward, concise, easy to interpret,
- Be issue specific yet relevant to all countries,
- Build on existing indicators process in the region to ensure full use of existing information and data,
- Provide realistic and representative baseline of the current situation,
- Contribute to a balanced DPSIR distribution,
- Provide a comprehensive, yet non-exhaustive coverage of the priority areas,
- Allow for periodic review and update in line with future developments.

The structure of the note is as follows.

A. Solid Waste Indicators in use

B. Experiences gained

C. Marine Litter and Solid Waste Linkages

D. Understanding the Informal Sector

E. Circular Economy

F. The evolution of waste indicators

G. Proposed Indicators

H. Linkages with the SDGs

[1] Cécile Roddier-Quefelec, Review of H2020 indicators - Group Work, 1st ENI SEIS II South Support Mechanism Regional workshop on indicators 17-18 May 2017, Copenhagen, Denmark

A. Solid Waste Indicators in use

The current indicators in use by H2020 are:

IND 1 - Municipal waste generation

IND 1.A Municipal waste composition

IND 2 - Collected and treated municipal waste

IND 2.A Number, type and location of landfills

The proposed core NAP indicators in the recent meeting in Copenhagen (with their numbers) are the following[2]:

11. Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities

12. Share of recycled, landfilled and incinerated municipal waste with respect to collected amount

13. Amounts / trends of ML washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution, and where possible, source

14. Index of coastal eutrophication and floating plastic debris density

15. Share of existing illegal solid waste dumpsites on land that have been closed (in past 10 years) with respect to the total number

In the same meeting, there were two key-suggestions.

a. To expand IND2 to integrate the core NAP indicator 12: "Collected municipal waste and share of treated (recycled, landfilled, and incinerated) municipal waste with respect to collected amount", and
b. To make core NAP indicator 15 a sub-indicator to IND2 or a new indicator: "Share of existing illegal solid waste dumpsites on land that have been closed (in past 10 years) with respect to the total number"

It is important to notice that in the Horizon 2020 Mediterranean report[3], there are several other indicators in use, as follows.

- Municipal solid waste generation (MT/year)
- Municipal solid waste generation per capita (kg/year)
- Municipal solid waste generation (g/USD)
- Organic material (%)
- Collection rate (%)

[2] Stavros Antoniadis, Indicator processes at UN Environment/MAP Core NAP follow-up indicators, 1st ENI SEIS II South Support Mechanism Regional workshop on indicators 17-18 May 2017, Copenhagen, Denmark

[3] Horizon 2020 Mediterranean report, EEA Technical report No 6/2014

- Openly dumped (%)
- Sanitary landfilled (%)
- Recycled (%)
- Composted (%)
- Number of open dumps
- Number of sanitary landfills
- Investment projects on solid waste
- Institutions in charge of policy and planning
- Private sector involvement

Interestingly, the last three indicators (investments, institutions and private sector involvement) concern non-technical but rather administrative and policy issues related to SWM.

The following table presents the distribution of the used indicators according the DPSIR framework.

Table 1: The distribution of the indicators in use according the DPSIR framework

INDICATORS	Drivers	Pressures	State	Impacts	Responses
IND 1 - Municipal waste generation IND 1.A Municipal waste composition		X			
IND 2 - Collected and treated municipal waste IND 2.A Number, type and location of landfills		X	X		
NAP 11: Proportion of urban SW regularly collected and with appropriate final discharge out of total urban waste generated by cities		X	X		
NAP 12: Share of recycled, landfilled or incinerated municipal waste with respect to collected amount			X		
NAP 13: Amounts /trends of marine litter washed ashore and or deposited in coastlines, including analysis of composition, spatial distribution and where possible, source			X	X	
NAP 14: Index of coastal eutrophication and floating plastic debris density			X	X	
NAP 15: Share of existing illegal solid waste dumpsites on land that have been closed (in past 10 years) with respect to the total number			X		

Here are some comments regarding the table above.

- The indicators in use do not involve any indicators related with Drivers and Responses. From this point of view, this is a gap that should be covered. Important

drivers like the plastic consumption and the tourism industry are rather ignored.

- A serious problem is that the indicators proposed do not reflect the most important pollutant, namely the plastic that is dominant in marine litter.

- There is a question regarding the geographical coverage of the indicators. Calculating the indicators on a national level is not representative of the pressures on beaches and the seashore, as this is mostly due to the contribution of the areas around seashore and beaches and usually a smaller percentage comes from inner parts due to transportation by rivers and wind mechanisms.

- It seems necessary to granulate further the linkages between waste management and marine litter in order to identify more suitable indicators.

B. Experiences gained

The summary of the recent meeting in Copenhagen[4] provides good insights regarding the experiences and the views related to the use of the current indicators. Here are the main remarks from the Summary Report (column 1) together with some comments (column 2).

Table 2: Insights from the meeting in Copenhagen

INSIGHTS	COMMENTS
IND 1: Municipal waste generation and composition should remain. However, countries expressed their concerns on the lack of data on waste generation as the indicator is currently based on estimation. The country representatives expressed the need to have project support to develop waste survey and update production coefficient. As regards composition, the participants stressed the need to have data on plastics reaching the sea (using existing marine litter projects).	1. The concerns are right, especially because a lot of the estimations in place are not made in a similar way, with common assumptions and methodologies, and common definitions. Besides the necessary surveys, there is another way to cross-check the results by adjusted them using the much more reliable and accountable economic statistics like the GDP/cap etc. 2. There is definitely a need to measure and monitor plastics as they are the most important element of ML
The participants proposed to split IND 2 and consider collection and treatment separately (i.e. Municipal waste collected; Municipal waste treated). As regards waste treatment, special reference should be made to the type of treatment. Suggestion was made to integrate the NAP common indicator 12 (and SDG 12.5.1) "Share of recycled landfilled and incinerated municipal waste with respect to collected amount". New indicator could be labelled as Municipal waste treated, by type of treatment (recycle, landfill, incineration) and share of treatment with respect to collected amount.	1. It seems that mechanical biological treatment and composting are missing from the proposed typology of treatment. 2. Usually, collection efficiency is measured separately from treatment and disposal – the reason is that in many cases there is regular waste collection but uncontrolled disposal. 3. Do we have a clear definition on recycling? Do we consider informal recycling systems too? This is a very crucial issue for the area under consideration where informal recyclers play a very important role.
There was a suggestion to consider having a separate indicator on recycling. Under this indicator, specific information can be requested for plastics (e.g. share of plastics recycled with respect to the total amount of waste recycled).	Recycling is necessary to be measured as a separate indicator, especially for plastics. However, besides a common definition, we need to consider other elements like reuse, energy recovery and waste prevention, if we want to have a complete picture.
The existing H2020 sub-indicator "number, type and location of landfills" should be a separate Indicator "Number, type and location of landfills". Under this indicator, the NAP common indicator 15 could be a sub-indicator "share of existing illegal solid waste dumpsites on land that have been closed (in the past 10 years) with respect to the total number. Some countries expressed concerns about data availability for this indicator.	There is a need to clarify what is a sanitary landfill and what is a dumpsite. Sanitary landfills are considered legal and safe disposal options because they involve specific operational procedures, anti-pollution works, and environmental monitoring. Dumpsites are uncontrolled disposal sites, with no environmental protection. The problem is that in many Mediterranean countries we have an intermediate solution, usually called "engineered landfill" (in contrast with sanitary). I believe that the number of dumpsites in coastal areas is straightforward linked with the ML quantities.

[4] Summary Report V.3, 13/06/20171st ENI SEIS II South Support Mechanism Regional workshop on indicators 17-18 May 2017, Copenhagen, Denmark

The countries supported the idea of having an indicator on waste collection efficiency. In this respect, the use of NAP common indicator 11 was suggested for further consideration "Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated by cities". Again, some countries raised the issue of data availability and estimation for waste generation.	There is a need to paint the full picture of waste flows and see where are the most important leakages – collection efficiency is an important factor, but the usual problem is to answer what happens with the non-collected waste. In addition, imagine a case where the collection efficiency might be 100% and then the collected waste is brought to a dumpsite nearby a river or the seashore.
Countries confirmed the usefulness of having waste indicators at coastal level, which require sound statistics of population in coastal areas.	I believe this is a very important point. National figures say very few things for the leakages of waste that is transformed to ML. What we mainly need is to map the coastal cities and their performance, to assess their leakages and provide them suggestions for improvement. The geographical scale in which monitoring and indicators will be applied is a crucial and urgent issue.
Regarding marine litter, the countries expressed concerns on data availability to properly develop indicators, indicating that further work is needed. It was suggested to consider the NAP common indicator as well 14 (SDG indicator 14.1.1) "Index of coastal eutrophication and floating plastic debris density". The country representatives questioned the geographical scale to be applied for marine litter.	The link with the SDGs is a very important point. In addition, we must consider the necessity to link the indicators with the Circular Economy concept, which means to move from the waste view to the resources perspective. This means that we must consider not only waste, but also Production and Consumption patterns, for a meaningful analysis.

C. Marine Litter and Solid Waste Linkages

Marine litter is a challenge of planetary scale and implications. It is necessary to develop a more integrated perspective regarding ML. ML is not simply related to SWM and recycling, it is a result of a systemic failure, with the following four key-parameters:

(I) The continuous growth in use of thousands of different forms of plastics in each and every aspect of our daily lives.

(II) Poor or absent solid waste management services and infrastructure (mainly in the Med South), and insufficient monitoring & law enforcement (mainly in the Med North).

(III) Problematic and vulnerable markets for secondary plastics, resulting in poor and very fragile incentives for material recovery.

(IV) Lack of a systemic and in-depth understanding of:

- The technical challenges and the restrictions of material properties and the flows of plastics.
- The effects of social consumption patterns and littering behaviours on solid waste generation.
- The impacts of unplanned tourist developments and of the fishing industry.

The plastic production & consumption, the lack of waste & recycling infrastructure and enforcement, (especially in coastal areas), the problematic markets for secondary materials and the touristic activities should be considered as Drivers of ML. Here are some key-remarks about it.

Plastic production and consumption

It is widely accepted and documented in depth that the growing quantity of plastic production drives the rising quantities of plastic waste on our land and in our rivers and seas. Given that most plastics do not truly degrade but rather gradually break down into ever more numerous smaller particles, last year's plastics remain this year's problem, and a problem for potentially hundreds of years into the future.

In addition, plastic leakages into our oceans create a global problem. Plastics and plastics pollution do not respect borders. Plastic, plastic products, secondary raw material plastic and some waste are traded globally, and marine litter crosses continents in ocean currents, meaning the responsibility falls on all countries to act.

The problem is particularly important for single use plastics that are becoming one of the most important sources of plastic pollution and ML. Items such as bags, bottles and straws present a physical danger for marine life.

Plastics production has increased twentyfold since 1964, reaching 311m tonnes in 2014. It is expected to double again in the next 20 years and almost quadruple by 2050. Despite the growing demand, just 5% of plastics are recycled effectively, while 40% end up in landfill and a third in fragile ecosystems such as the world's oceans[5].

[5] Ellen McArthur Foundation, 2016, The New Plastics Economy

It is estimated that more than 150 million tonnes of plastics have accumulated in the world's oceans, while 4.6-12.7 million tonnes are added every year. It is broadly assumed that approximately 80% of marine litter is due to land-based sources[6].

If you face the problem form another point of view, plastic pollution can be prevented by applying the waste hierarchy to the plastic economy in order to drastically upscale the reduction, reuse and recycling of plastic waste. So, this is a clear link between ML and Circular Economy, where Circular Economy approaches can be considered as a proper Response to ML.

Next figure presents the current flows of packaging materials, as a typical example of the current linear flows of plastics.

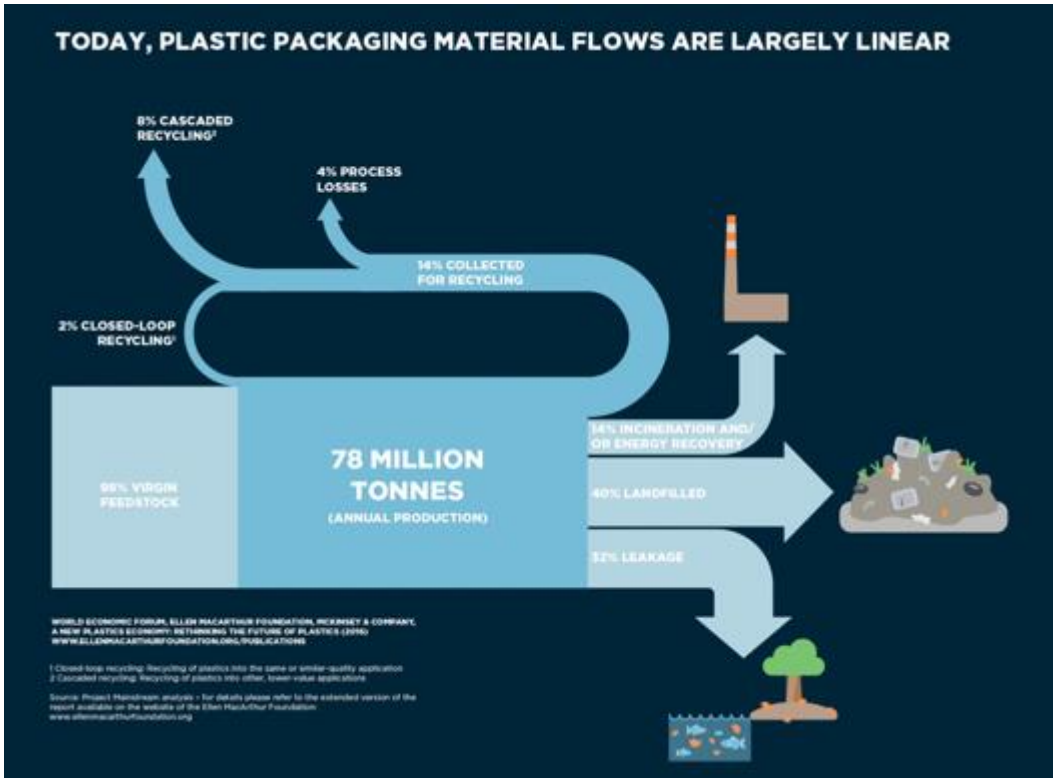


Figure 1: Plastic Packaging Flows (from the report The New Plastics Economy, Ellen McArthur Foundation, 2016

Linkages between SWM and ML

Can we control the sources of marine litter?

Most materials that go on to become marine litter could be effectively intercepted before entering aquatic environments by applying sound waste management practices.

Sound solid waste and resources management is the only major effective prevention because, on average, most marine litter originates from on-land activities, mostly because of unsustainable solid waste management practices.

Why intervene upstream at macro-plastic item level?

The bigger plastics waste items are a huge pool of future microplastics, as they degrade within the sea environment – after becoming small they cannot be effectively intercepted;

[6] Descriptor 10: Marine Litter, http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/index_en.htm

preventing the leakage upstream is the best place to act.

How does the solid waste management sector relate to interception points at generation hotspots?

Major upstream preventative interception points at the sources and at hotspots relate to solid waste: ranging from direct uncontrolled dumping to concentrated littering hotspots of packaging plastic waste. The solid waste management and resources sector relates to all major sources and hotspots where interventions can be planned and implemented. The key land-based sources of marine litter are numerous and include plastics leaking into the environment as a result of: uncontrolled dumping of waste from municipal sources (organised and unorganised dumping, fly tipping and direct dumpling into rivers or at/by the sea; littering by members of the public (e.g. through tourism, major public events, or in in busy areas of cities); limited escape of plastics from existing waste management activities during transport, handling, treatment or disposal. Sustainable solid waste management has a role also in controlling other major sources and hotspots: wastewater treatment related flows, if effectively intercepted at treatment plants, are also eventually handled as biosolids in solid waste treatment plants; and control of maritime sources of marine litter (fisheries, shipping sectors (including cargo and leisure), recreational activities) also depends on provision of convenient and affordable solid waste management collection facilities.

How can we know that relevant policies are suitable and work?

Polices to combat and eradicate marine litter can be effective only if they are informed by the challenges around developing sustainable solid waste and resources management systems across the world – monitoring (indicators) need to be suitably linked to waste and resources management evidence. There is still considerable uncertainty around the detailed flows (sources, pathways, transformations and final fate (sinks)), especially at local/ regional level. This gap in knowledge affects our ability to devise effective mitigating policies. However, no policy will be effective if it does not build upon the knowledge and challenges relating to implementing sound waste management practices in different parts of the world and localised to the socioeconomic and cultural specificities. And to monitor progress, proactive and upstream indicators will be needed – not just identifying concentrations of microplastics but measuring solid waste management performance and major solid waste flows that need to be intercepted. To achieve this, cross-sectorial collaboration will be fundamental.

So, what to do?

Immediate Actions

We need to significantly reduce the 'leakage' of plastics into the environment by intervening at the source: the generation point. This will require action to:

A. Close dumpsites and provide appropriate waste treatment and disposal facilities for all communities. It is estimated that over 3 billion people globally still do not have access to appropriate disposal facilities.

B. Prevent uncontrolled dumping by providing collection services for all. Dumping of wastes causes significant environmental, social and economic impacts, particularly for low income communities. These needs to be provided as a matter of urgency.

C. Prevent littering. Waste items dropped by people 'on the go' or at major events/ gatherings are a key source of plastics that escape into the marine environment. Reducing littering will require proactive engagement with communities, public awareness-raising, and an enhanced understanding people's needs and behaviours.

D. Working with the maritime sector to establish effective take-back systems for recovering waste and recyclable materials from the fishing, shipping and touristic activities.

Mid-term actions

Capturing and enhancing the value of waste plastics. Action on this issue will need to include developing effective collection systems that maximise and stabilise the value of secondary plastics, considering the social and market particularities of each and every municipality and region.

Properly functioning markets. We need a fundamental move away from the current push markets (i.e. collecting more waste for recycling than markets require) to pull markets, driven by sufficient demand. We need to address issues associated with global supply chains and social and environmental justice, and reverse the often-unfair competition with primary raw materials. These changes are needed in the medium term, so that littering/dumpling and therefore wasting used plastics becomes unthinkable. Better data and information sharing on waste and recycled materials at all stages of their use and end-of-life cycle can enable properly functioning, stable markets for secondary plastics.

Thermal recovery. There will be considerable part of plastics that, after first use or cascades, may remain or become unsuitable for a genuinely sustainable materials recovery. It is important that the energy value of this fraction is captured through efficient and well-operated energy from waste plants or quality assured solid recovered fuels.

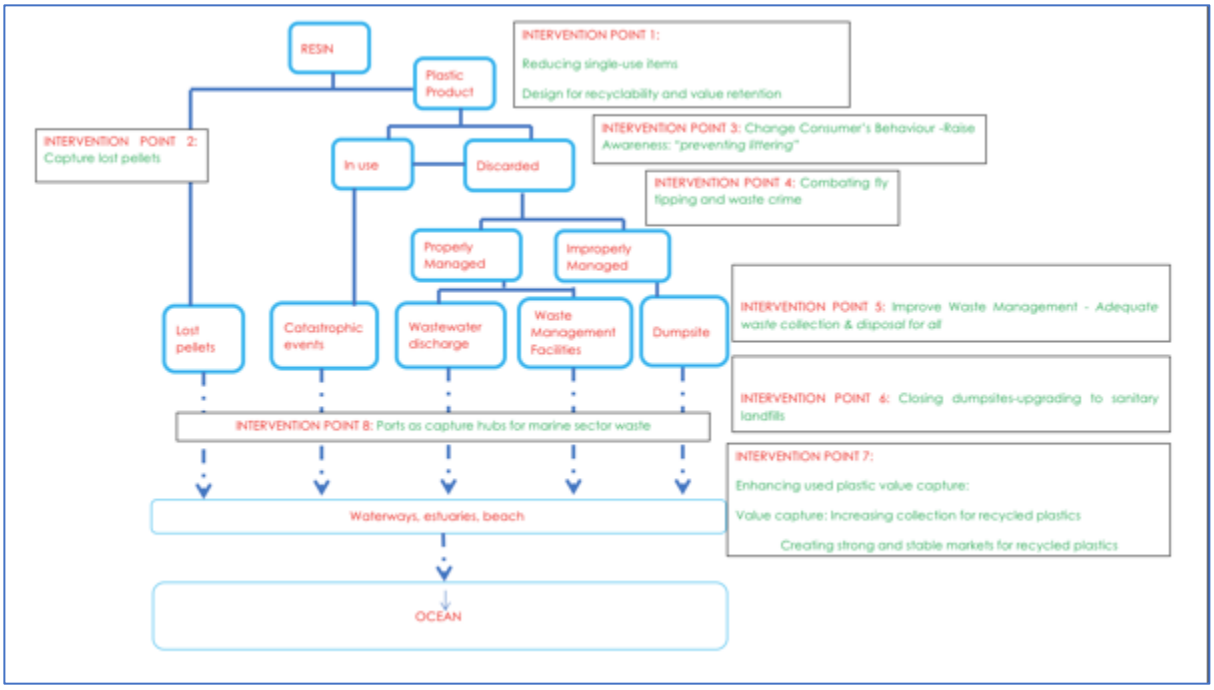
Long-term actions

A step-change from the linear use of plastics to a sustainable and proven circular and cascading system is needed. We need to move from the current situation, where most plastics are used once - with much of this material escaping the system - to a system based on the principles of sustainable and effective circularity and cascading, and clean material cycles, where the use of plastics is minimised and those that are used are collected and cycled back into the system as valuable raw materials and energy. This will require action on many fronts. The generic case has been widely made, but a more detailed and operationalised approach needs to be developed to being about the step change that is needed.

We need to address the issue at the very beginning: Innovate and invent at the materials and processing level. Priority actions could include reducing (i.e. rationalising) single-use items as a matter of priority and developing materials and designing products for recyclability and value retention after the use phase. This requires also a new innovation model that goes beyond cost-effectiveness, functionality during useful life time, and narrowly de ned utility needs to one that incorporates complex value. This will require a radical shift from today's practices, based on a cross-sector and intra-disciplinary scientific collaboration.

Next page presents schematically the linkages and the necessary intervention points between ML and SWM.

Figure 2: Linkages and Intervention Points between ML and SWM[7]



The role of Informal Recyclers Sector (IRS)

There is increasing consensus among all stakeholders and experts that the informal sector in general, and the IRS in particular, should not and, in fact, cannot be ignored while attempting to improve waste and resource management systems in developing countries. Accumulating evidence suggests that these activities can be beneficial to formal municipal waste and resource management, in addition to providing a livelihood to around 0.5% of the urban population. Specifically, informal sector and micro-enterprise recycling, reuse and repair systems achieve considerable recycling rates—often 20–30% wt. in low-income countries. They are also entirely market driven with their only income coming from selling the collected segregated, and often reprocessed, materials and can, thus, save local authorities around 20% or more of what they would otherwise need to spend on waste management, representing many millions of dollars per annum in large cities.

However, persistent factual and perceived issues with the activities of the informal sector, such as occupational and public H&S, child labour, uncontrolled pollutant flows, untaxed activities, association with crime and political collusion, and incompatibility with the image of a modern city result in poor inclusion/integration into official systems, despite the long-standing efforts of external support organisations, such as international donors and non-governmental organisations (NGOs). There is a major opportunity for win–win solutions—building recycling rates, protecting and developing people's livelihoods, addressing the negative aspects of current informal recycling on health and the environment, and reducing costs to the city of managing its wastes - if the informal sector can be included more successfully within an integrated and sustainable waste management system.

Over the last 10 years research has tried to account, analyse, comprehend and propose

[7] ISWA Task Force on Marine Litter, September 2017

solutions to address the key challenges related to the integration/inclusion/formalisation of the informal recyclers, considering waste management, material flows, and socioeconomic, governance and business aspects. Such interventions are described variously as aimed at the 'integration', 'inclusion', 'formalisation' or 'legalisation' of the IRS.

The linkages between IRS and ML have not been studied in full detail, but there is a lot of evidence that the IRS has a positive contribution to ML prevention. More about the informal recyclers are detailed later in the relevant chapter.

Secondary markets for recyclable plastics

From an environmental economics perspective, marine litter arises, like other waste or pollution problems, through market failure. In the case of ML, the most important problem is the vulnerability and the complexity of the plastic scrap market.

Most of the economic value of plastic packaging is lost after a short first-use cycle, and new plastic products contain less than 10% of recycled material, most of which is used in PET and HDPE bottles. Although there is significant opportunity for growth, decentralized waste pickers struggle to compete economically against virgin plastic processing facilities. Product designers in many industries around the world generally prefer virgin feedstock given its current lower cost and greater versatility compared to recycled feedstock. In some cases, there may be challenges to using recycled plastics for food contact and pharmaceutical packaging.

On average, only 10-20% of plastic waste in the focal geographies is profitably recycled, primarily by waste pickers. This small market of high-value plastics operates profitably with minimal if any funding support in developing (but not developed) economies, though often with narrow margins tied to commodity oil prices[8]. On average, only 8% of the world's plastic products contain recycled feedstock, primarily polyethylene terephthalate (PET).

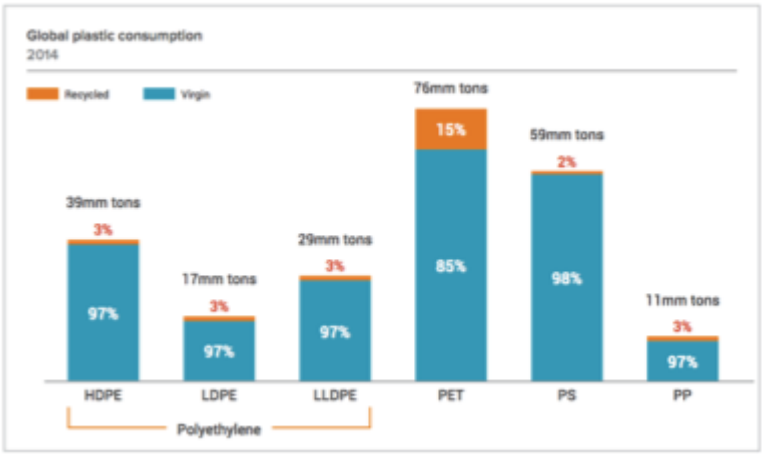


Figure 3: Recycled content in global plastic production[8]

Recycling operations depend profoundly on production and consumption. A shift in plastics production from the West to Asia has occurred: 40% by weight of world production is now in Asia, with 20% each in Europe and North America - China is the largest individual country at 24%. The drivers were increasing local demand and lower costs - mainly labour, but also lower environmental and health and safety costs, due to the initial absence of regulations

[8] The Next Wave – Investment Strategies for plastic free seas, Ocean Conservancy 2017

and/ or their implementation in both manufacturing and reprocessing. This regional shift also drives the demand for used plastics.

Much of the remaining, low-value, plastic waste (e.g., single-use food service and medical packaging, thin lm convenience items, and sophisticated packaging designs that are difficult to disassemble) does not yet have sufficient value in local markets to justify its collection given current virgin material prices and the existing waste management infrastructure in these regions.

The annual volume of globally traded waste plastics is around 15 Mt, less than 5% wt. of the new plastics production in 2012. Such a small percentage suggests that to-date international trade is a minor means to extract their resource value. Europe collectively is the major exporter, with the world's top 5 country exporters being Hong Kong SAR (re-exporting imported material to China), USA, Japan, Germany and the UK. The top world importers are: China at $6.1B and its SAR Hong Kong at $1.65B, followed by the USA, the Netherlands and Belgium. Plastic scrap flows from Western countries with established collection systems mainly to China, which dominates the international market, receiving around 56% wt. of global imports.

Europe (EU-27) collectively exports almost half of the plastics collected for recycling (3.4 Mt, worth of €1.7B), corresponding to 12% of the entire post-consumer plastic waste arisings. Europe depends entirely on China to absorb its exports (at least 87% of European exports end up in China). ASEAN countries (e.g. Vietnam, Malaysia and Indonesia) re-export reprocessed imports and domestically collected plastic scrap to China.

As a global market, plastic scrap has an inevitably complex market, vulnerable to disruption, as seen when prices crashed for secondary raw materials during the 2008-9 financial crisis and the 2013 GFO. Key factors are[9]: Oligopsony, especially for Europe, with China the main global importer; prohibitions relating to export / import of waste; susceptibility to virgin raw materials and fuel cost fluctuations; 'reverse haulage' logistics; high search and transaction costs; inconsistency of container loads sought by shipping lines; difficulty to quality control the exports; material quality information asymmetry between buyers and sellers – lack of transparency at the end of supply chain. The recent ban that China announced in recyclables imports, from 1/1/2018, is expected to create further problems worldwide and destabilise, at least temporarily, the current markets for secondary plastics[10].

Crude oil and natural gas prices govern the price of virgin plastics. Virgin plastics are commonly derived from fossil fuel derivatives from crude oil refining (cracking) or natural gas processing, as well as through the fermenting sugars of different bio-based feedstocks to yield chemical intermediates. It is produced in sophisticated plants in large volumes. Recycled plastics, in contrast, are produced in small, decentralized batches, using low-technology processes. Not surprisingly, recycling plastic waste can cost more than producing virgin plastics at low crude oil prices. In fact, at oil price levels below $40-50/bbl, the private plastic recyclers struggle to compete, and processing innovation stagnates. This is especially challenging given the historically unstable and currently low price of oil. Volatile oil prices are likely to be a major challenge, and solutions must be implemented that remain viable even if oil prices change.

[9] ISWA, 2014, Global Recycling Markets for Plastics: a story for one player -China

[10] China's Ban on Recyclables: Beyond the obvious, A. Mavropoulos, 2018, http://www.iswa.org/home/news/news-detail/article/chinas-ban-on-recyclables-beyond-the-obvious/109/

Next figure shows 15 years of oil pricing versus key recycling prices. From mid-2003 to mid-2011 the oil and recycling markets were in a healthy equilibrium. Mid-2011 saw the advent of significant recycling market disruptions, including a severe oversupply of PET due to overbuilding PET plant capacity (mid-2011 to late 2012) and the implosion of natural gas prices (early 2013 to late 2014). Also in play were the downstream effects of China's Green Fence program, which decreased the number of contaminated recyclables being imported into China, thereby temporarily interrupting recycling markets. Starting in late 2014, the traditional relationship between recycling and oil prices was restored.

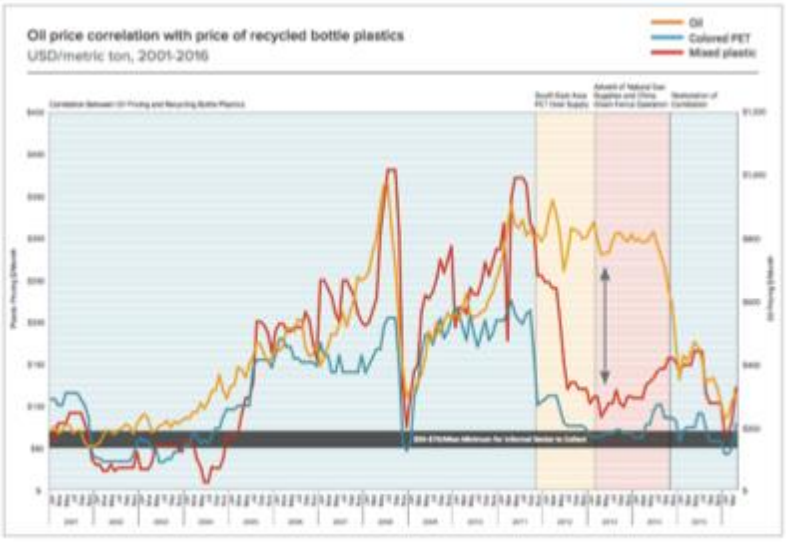


Figure 4: Oil price and recycled PET price[11]

Tourism and ML

Several studies have documented that ML, especially in islands and high touristic coastal areas, is directly linked with tourism and re-creational activities. In many cases, the greatest source of ML from publically accessible islands was tourist-related, with this source also influencing debris loads on nearby uninhabited islands[12].

Unsurprisingly, a considerable fraction of ML stem from tourism and recreational activities. These include not only smoking related items but packaging items such as food wrappers, caps/lids, plastic bottles, beverage cans, etc. The amount of litter during the tourism high season greatly increases, as several surveys show. Indicatively, the results from a study carried out on 32 beaches on the Balearic Islands[13] show that during the summertime recorded debris doubles in relation to the amounts recorded during the low season and seem closely related with beach use. Also, in this study, cigarette butts were the most abundant items, accounting for up to 46% of the objects recorded during the high tourist season.

In Baltic Sea, it has been found that touristic and re-creational activities contribute at least 34% of the ML[14].

[11] Ocean Conservancy 2017, data acquisition from "*Petroleum & other liquids*" US Energy Information Administration, 2016, "*Global Waste Management Outlook*", UNEP – ISWA 2015, "*Let's Recycle*", 2016, and Index Mundi, 2016
[12] Wilson, Verlis, 2017 The ugly face of tourism: Marine debris pollution linked to visitation in the southern Great Barrier Reef, Australia, Mar Pollut Bull. 2017 Apr 15;117(1-2):239-246
[13] JRC, 2016, Identifying Sources of marine Litter
[14] MARLIN, 2013

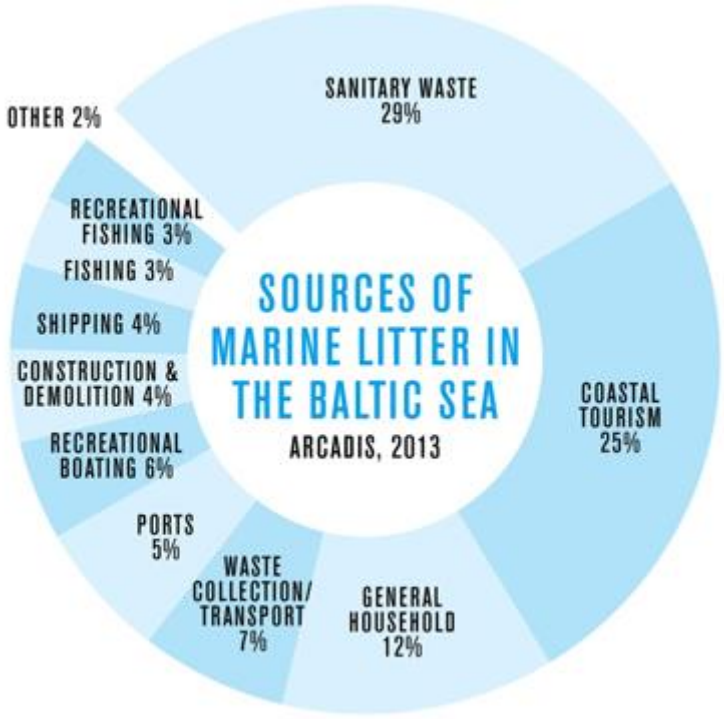


Figure 5: ML son Baltic Sea

The problem is of high importance in the Mediterranean Sea.

The Mediterranean Sea occupies some 2.5 million km^2 and it is an enclosed sea with only one opening for water exchange, the 14 km-wide Strait of Gibraltar. In the strait, surface water flows into the Mediterranean Sea and deeper water flows out. The water exchange rate of the Mediterranean is estimated to be 80-100 years to renew only the mass of surface water. It goes up to 7000 years if we consider the entire volume[15].

This sea is bordered by 18 countries, where more than 142 million people inhabit its coastal regions. The north-western shores of the sea are heavily populated and highly urbanised, while its southern coast is sparsely populated. Along the Mediterranean coast there are almost 600 cities, more than a thousand ports, several production plants and 200 gas power plants. In addition, major shipping lanes are found in the Mediterranean sea.

Multiple human activities cause various interlinking pressures that often have cumulative impacts on the Mediterranean coastal and marine environment. The key drivers of the main pressures that have been identified in the State of the Mediterranean Marine and Coastal Environment Report[16] include: population growth, intensified industrial activities including offshore explorations, shipping, (over)fishing, and mass tourism.

Tourism was identified as the most important sector in the Mediterranean, resulting in the most job-creation region-wide, with 3,3 million direct jobs and 8,5 million total jobs in and

[15] Legambiente, 2010, Retrieved from http://www.legambiente.it/temi/natura/mediterraneo

[16] UNEP/MAP, 2012, State of the Mediterranean Marine and Coastal Environment . - Barcelona Convention, Athens.

over 250 billion EUR generated in coastal Mediterranean areas[17].

The Mediterranean basin, if considered as a single area, is by far the largest global tourism destination (see next figure), attracting almost a third of the world's international tourists (306 million out of 980 million worldwide) and generating more than a quarter of international tourism receipts (190 out of 738 billion Euro worldwide)[18].

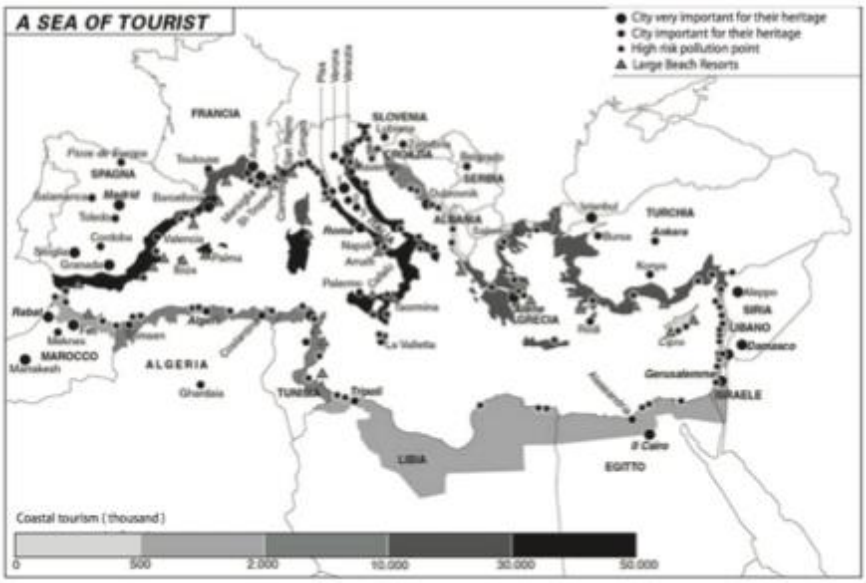


Figure 6: Coastal tourism in Mediterranean Sea[19]

It is forecasted that the Mediterranean region will reach 500 million of international tourist arrivals by 2030. In the Mediterranean area, most tourists come from Europe (81 %), while the amount of tourists coming from other areas such as America or Asia accounts for 12 %. It must also be noted that the Mediterranean is a growing market for cruise tourism[20].

Mass tourism results in pressures such as:

• Unsustainable coastal development and local disruption of circulation patterns. Human-made structures such as sandy-beaches and marinas change the hydrographical conditions, and intensify the pressures on a limited area of the coast.

• The increasing use of vessels / recreational shipping (i.e. cruise ships, water-sports, yachts etc.) is linked to pressures such as contamination from acute events (oil spills), marine litter, introduction of invasive species, and even marine noise.

• The irresponsible use of the coast and coastal waters increase the load of litter that ends up in the marine environment, harming the marine habitats and species, high percentage of which is endemic, and/or endangered[21].

[17] Plan-Blue, 2014, Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean, characterization and impacts of Fisheries, Aquaculture, Tourism and recreational activities, Maritime transport and Offshore extraction of oil and gas sectors. Technical Report, Valbonne.
[18] World Tourism Organization UNWTO, 2015, UNWTO Tourism Highlights
[19] Prepared by Limes in 2009, found in MED-Zero Plastic action plan
[20] MED-Zero Plastic action plan- Targeting the ML of the tourism industry in the Mediterranean Sea, January 2016
[21] Arcadis, 2015, MED II: Joint document of regional coordination of Programme of Measures in the Mediterranean Sea (Draft 1);

D. Understanding the Informal Sector

This policy brief aims to create a conceptual framework regarding the Informal Recyclers Sector (IRS) and its contribution to waste management and especially to resource recovery. This note is considered necessary to help the stakeholders involved in the Marine Litter prevention and management to understand the particularities of the Informal Recyclers and the way it is integrated in waste management and recourse recovery activities. The note also presents some first ideas about suitable indicators that can be used to describe the role and the contribution of IRS.

Defining the Informal Recyclers Sector

Solid waste recycling in many developing countries is generally carried out by the informal sector. This was true at some stage in the past, in what are now high-income developed countries. It is still the case in the low- and middle-income developing countries of Asia, Latin America and Africa, while informal recyclers have a strong presence in most of the Middle East countries too. The informal recycling sector (IRS) also persists alongside the 'modern', formal sector recycling in Central and Eastern Europe; in emerging economies, such as Malaysia (now officially a high-income country); and is even reappearing in Southern Europe, further amplified by the effects of considerable immigration influx combined with the current economic crisis.

Activities of the informal sector in waste management vary widely, ranging from groups organised in cooperatives providing door-to-door collection of either recyclates separated at source or of mixed waste which they then often sort, to individuals scavenging in open dumps, transfer stations and communal bins.

For this policy brief, we will use the following definition[22] of IRS: '*the Informal Recyclers Sector (IRS) refers to individuals or enterprises who are involved in recycling and waste management activities but are not sponsored, financed, recognised or allowed by the formal solid waste authorities, or who operate in violation of or in competition with formal authorities'*.

This definition is different to that of the informal sector in other contexts, where the term may be synonymous with the 'black economy'. Actually, in many countries informal sector waste and recycling workers and businesses can be, and often are, registered with the authorities and pay taxes; in this case, the definition of informality mainly relates to their lack of recognised status within the solid waste sector. Clearly, this definition does not include (organized) criminal activities, often evident in developed countries as, for example, the theft of valuable metals, nor does it address issues around the status/rights of illegal immigrants who have been reported to participate in informal sector activities in some countries.

[22] Wehenpohl G, Scheinberg A, Simpson M, Gupt Y and Kolb M (2007) *Economical impact of the informal sector in solid waste management in developing countries*. In: *11th International Waste Management and Landfill Symposium*, S. Margherita di Pula, Cagliari, Italy, 1-5 October, 2007. Padua: CISA, Environmental Sanitary Engineering Centre.

While informal activities are more prevalent in cities without separate collection for recyclables, they also take place in situations where such services exist, particularly in times of economic downturn. The effects of informal activities are quite different for the two situations.

For a more precise description, the informal waste and recycling sector in the cities is comprised of two distinct sub-sectors:

- An *informal service sector*, consisting of individuals and micro enterprise informal service providers (ISPs) earning fees for removal of waste, excreta, litter, and, more broadly considered, 'dirt'.
- An *informal valorisation sector*, consisting of individuals, co-operatives, and family and micro-enterprises - which functions as an extractive resource industry. The main activity of this sector is identifying and removing valuable materials from the waste stream and the places where waste accumulates, and valorising (extracting value added from) it.

There are several main forms of valorisation[23] in the informal private recycling sector, which can be found in different combinations in urban areas, as the following ones.

- *Personal or commercial reuse*: Using materials for household maintenance, including as food for persons or animals, or as household, agricultural, or business inputs. Second-hand shops and flea markets are examples of this.
- *Reuse with repair*: Repairing items and materials and marketing them.
- *Recycling*: collecting separately and/or identifying, sorting, processing, storing and trading materials into the global industrial value chain.
- *Organics valorisation*: collecting separately or sorting and processing kitchen, garden, commercial, agricultural and animal wastes and paper, and marketing it as animal feed or compost.

It is also important to notice that in many cases there is no clear border between formal and informal activities, but rather a grey-fuzzy zone of waste management and recycling that link formal and informal activities. The separation between the two sectors is challenged by an informal collaboration between the two, and the possible evolution of the informal sector may bring it into the sphere of the formal, because, when the informal sector gets organized either as cooperative or private companies it becomes formal[24]. Another example of the grey – fuzzy zone concerns the fact that in many cities informal recyclers are municipal workers involved in waste management activities. Under such circumstances, realities often even defy a clear distinction between formal and informal service providers Informal activities tend to intensify in times of economic crises when employment becomes difficult and in cases where imported raw materials are relatively expensive due to inflation or currency depreciation. While political and professional opinions differ about the

[23] Scheinberg, A., M. Simpson & Y. Gupt et al. (2010): *Economic Aspects of the Informal Sector in Solid Waste Management*. GTZ (German Technical Cooperation) and the Collaborative Working Group on Solid Waste Management in Low and Middle Income Countries (CWG), Eschborn, Germany.

[24] Axel Baudouin, Camilla Bjerkli, Frank Mugagga, Yirgalem Mahiteme and Zelalem Fanta Chekole, *Questioning the integration of the informal sector – The case of solid waste management*, Informalizing Economies and new Organizing Strategies in Africa, April 2007, Nordic Africa Institute, Uppsala, Sweden

desirability of informal activities, informal economic activities appear to constitute a very significant portion of the economy, accounting for as much as 60% of jobs among the urban population in some places[25]. It is important to realize that the informal sector is very heterogeneous and complex; it operates at various scales, from individuals and small family businesses to large and mighty enterprises.

The role of Informal Recyclers Sector

In recognition of its presence, the informal waste sector is examined here along the three sustainability domains – environment, economy and society. As is often the case, whichever sustainability domain is considered, there are two sides to every aspect. The conceptual framework for understanding the IRS is analysed in detail at the awarded paper "*An analytical framework and tool ('InteRa') for integrating the informal recycling sector in waste and resource management systems in developing countries*"[26].

Regarding the environment and resources, the benefits are evident in many cities. In some places, informal-sector service providers are responsible for a significant percentage of waste collection. For example, in Lusaka, Zambia, this is more than 30%. In many cities, the informal sector recovers, reuses or recycles valuable materials from waste and thereby contributes to sustainable resource management. On the other hand, due to the ubiquitous lack of both capital and knowledge at small recyclers, and without any agreements or cooperation with the authorities, working conditions are generally unsafe and unhealthy, and processing residues are often just crudely dumped, causing serious pollution, particularly in the case of e-waste recycling.

Regarding the economic aspect, in the absence of a formal recycling system, informal recyclers benefit cities directly, as they remove materials from the city and thereby save money that would otherwise need to be spent on waste collection, transport, and disposal, and in effect extend the use period of disposal facilities. Diversion of 10% or more of a city's waste is quite common, even according to official estimates. Also, as recyclers generate income for their families, their role helps alleviate poverty. In some instances, they generate substantial income, well above subsistence level. However, in places with a formal recycling system, where public or private waste companies have made investments and placed containers and other infrastructure for separate collection of recyclables, informal activities are often seen as unfair competition or outright theft, because they diminish the revenues of the formal companies without bearing any of the costs of the infrastructure. For example, due to a rekindled market interest in secondary materials, in European cities, individuals take materials of value from collection containers and sell them for their own financial gain[27]. The access to waste and, by extension, the competition for waste materials with market value are issues that directly impact on waste service providers. In Latin America, in 2009 the Constitutional Court of Colombia ruled in favour of

[25] UN Habitat (2003). The challenge of slums: Global report on human settlements. London: Earthscan.

[26] Costas A Velis, David C Wilson, Ondina Rocca, Stephen R Smith, Antonis Mavropoulos and Chris R Cheeseman *An analytical framework and tool ('InteRa') for integrating the informal recycling sector in waste and resource management systems in developing countries*, Waste Management & Research, 2012 30(9) Supplement 43–66

[27] Anne Scheinberg, Jelena Nesić, Rachel Savain, Pietro Luppi, Portia Sinnott, Flaviu Petean and Flaviu Pop, *From collision to collaboration – Integrating informal recyclers and re-use operators in Europe: A review*, 2016, Waste Management & Research 1–20

waste recyclers, guaranteeing their customary rights to access, sort and recycle waste and their legitimacy to compete in the waste recycling business.

The social aspect of informal work has received considerable attention from advocacy NGOs and social scientists, particularly through action research. In general terms IRS people[28]:

- They are recent migrants, often from the rural areas, or from neighbouring countries
- Child labour is common in the IRS, often working with their parents in family units, recovering materials, guarding them, sorting or cleaning them
- Women of all ages participate actively in the IRS. Sometimes women are forced into the IRS when their husbands die and they lack other sources of income
- Laid off workers comprise an important part of the IRS population
- Elderly individuals of retirement age that either do not receive pensions or the pensions they receive are insufficient for their needs
- Disabled individuals unable to find regular employment

Thus, the IRS population can be characterized as highly vulnerable, particularly women and children. Despite the millions of people worldwide that make a living in the IRS and their economic impact of several billion US dollars each year, it is still a neglected and understudied population.

With a few exceptions, authorities' attitudes are typically characterized as negative, ranging from disinterested and indifferent to harassing and outright hostile. One such exception is the Nansana Town Council in Kampala, Uganda, which has championed the promotion of MOUs between micro enterprises and local government as a means of achieving cost-effective waste management service delivery in Nansana District[29].

This attitude may also depend on the circumstances: waste pickers may be tacitly tolerated at a simple waste transfer site or a simple disposal site, but they get expelled when the site is upgraded into an engineered facility. A common complaint is that informal waste pickers tear bags or empty waste bins on the street in search of recyclable materials and leave a mess behind them. On the other hand, there are also examples in Brazil and the Balkans in which waste pickers contribute to the cleanliness of urban open spaces, if mutually beneficial agreements are made. In some countries, it has been reported that the public feels a certain degree of social connection with itinerant waste collectors taking old clothes and other reusable items or recyclables at their door, whereas they feel aversion towards waste pickers taking 'their' recyclables from street containers. This aversion can be very strong and waste pickers are often viewed, particularly by more affluent citizens, as 'dirty and suspicious'.

Methodologically speaking, there are four dimensions of the IRS that must be studied to develop a sound understanding of its role. Three of them are considered as *primary interfaces* between the informal recyclers and the outside world, namely their interfaces with:

[28] GIZ, *Recovering resources, creating opportunities Integrating the informal sector into solid waste management*, 2015
[29] UNEP-ISWA, 2015, Global Waste Management Outlook

(A) the formal SWM system from which the informal sector obtains materials for recycling;
(B) the materials and value chain into which those materials are sold and which therefore provides their primary source of income; and
(C) society as a whole, including various aspects relating to the acceptance of their activities by society.

The fourth category of possible interventions is different from, and underpins, the others, facilitating the conditions which enable actions under the three interfaces to be successful. It concerns the organisation and empowerment of the informal recyclers. The next graph presents the conceptual framework for understanding and describing IRS.

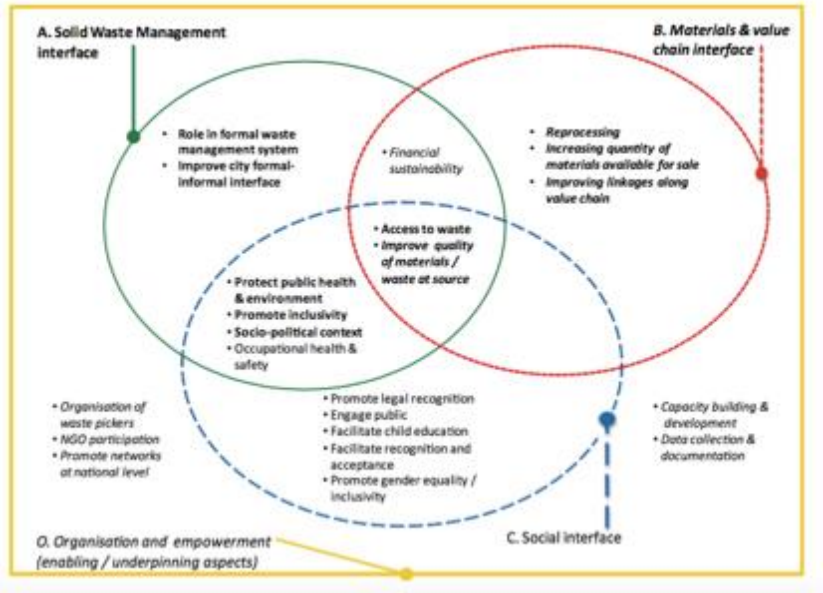


Figure 7: Overall analytical framework and typology of interventions, showing the interdependencies[30]

Measuring the activities of Informal Recyclers Sector

It is by definition difficult to estimate the contribution of informal activities, because IRS have no inherent reason or obligation to keep records, or may simply not be capable. In addition, official performance data do not cover informal systems; statistics do not reflect the big picture in low-income countries. Therefore, for waste management planning or monitoring purposes it is of paramount importance to obtain data on informal systems.

Different stakeholder groups with varying interests have diverse motivations with respect to obtaining data on informal sector activities in waste management. These motivations might be driven by rational considerations, for example a local authority might be interested to know the amounts informally collected in order to obtain a complete picture on waste generation. On the other hand, motivations could have emotional components rooted in competition, fear or compassion. In addition, the enabling conditions vary in different

[30] Costas A Velis, David C Wilson, Ondina Rocca, Stephen R Smith, Antonis Mavropoulos and Chris R Cheeseman *An analytical framework and tool ('InteRa') for integrating the informal recycling sector in waste and resource management systems in developing countries*, Waste Management & Research, 2012 30(9) Supplement 43–66

geographical regions meaning that the motivation to obtain data on informal sector performance can be different between low- and high- income countries.

However, there are certain tools and methodologies to assess their contribution to recycling. In any case, it must be stressed that there is a real need to recover data about IRS and use it in several different levels, as the table below shows.

Table 3: Different data requirements regarding IRS[31]

Stakeholder	Data required
National level authorities e.g. ministry of environment, labour or social affairs	**Policy making and enforcement** e.g. national environmental plans, achievement of recycling goals; tax circumvention, transfer payments and minimum wage policies etc.
Local level authorities regional governments, city administrations, municipal waste departments	**Monitoring and planning of waste management systems** e.g. cost efficiency, material balances / recycling rates, environmental performance, collection efficiency, capacities of treatment and disposal plants; city master plans etc.
Waste management enterprises Recycling & manufacturing industry	**Competitive & inclusivity issues** amount and quality of materials collected by informal sector; material prices etc.
Individual pickers, waste picker associations, NGOs (local, regional, global) …acting as advocates for informal workers	**Improving efficiency / display unique selling points of informal systems** contribution to waste collection, recycling, hygiene; describing environmental benefits / cost savings; amounts & quality of collected materials important for manufacturing industry; describing livelihoods (income etc.)
Others (e.g. labour unions, chambers of commerce, banks, insurance companies, customs offices etc.)	**Minimum wage enforcement, industry support, loans, warranty issues, transboundary shipment etc.**

The table is not comprehensive and the interest of certain stakeholder groups to obtain data on informal sector performance is highly dependent on local specifications. For example, motivations might differ in a low-income country compared to middle or high-income countries or the stakeholder groups claiming to have a stake may vary depending on the region. One example is that formal waste management stakeholders in some cases simply neglect the existence of the informal sector in low-income countries, whereas in high-income countries where the waste management system is more advanced with respect to the recovery of recyclables and therefore informal workers might be faced as a competitive threat.

Changes to waste management systems, which are assumed to be more resource oriented might also interest other stakeholders, for example the private sector may be interested in setting up a value chain to procure recyclables. In these cases, datasets on informal activities should be extended to include more information about the reliability of the informal systems, viability and quantities amassed over time, quality of materials collected, prices and so on. This may be different from conventional solid waste management planning data.

[31] Roland Ramusch, *Key-Performance Indicators of the Informal Waste Sector*, 2014, ISWA-EXPRA workshop on Challenges to separate collection systems for different waste streams - barriers and opportunities

The following taxonomy has been proposed for the information related to IRS[32]. The information has been divided into five sections.

(A) Characterization of the informal sector: this section classifies by region and type (e.g. ranging from individual waste recycler to broker or middlemen), the number of people or families involved, gender and if they are registered/organised.
(B) Informal waste picking activities: this section mainly refers to materials and specialised types of activities, prices of materials, income generation, working hours, access to materials and the material flow (i.e. information about the value chain).
(C) Environmental and health problems caused by informal activities: deals with potential health and other risks, disturbances and environmental impacts associated with informal activities.
(D) Measures against informal sector: displaying potential types of measures against informal sector activities and the initiating stakeholders.
(E) Formalization of and support for the informal sector: deals with formalisation ideas applied and their degrees of success.

Working with data sets obtained from an extensive literature review (more than 100 journal papers, reports, studies, books and policy papers etc.), Roland Ramusch and his colleaguues in Boku University, were able to compile several Key-Performance Indicators related to:

- The size of IRS in different regions of the world;
- The collected amounts per day;
- The income related information;
- The Job creation potential.

Here are some of the most important results that provide useful insights for proper indicators and tools to be applied on a local national level for measuring the IRS.

- The proportion of informal waste workers can be estimated at approximately 0.6% (0.5–2%) of the total population in most of the urban areas in developing countries.
- Depending on the means of transport, daily collection rates amount to approximately 40–2000 kg for different materials.
- Informal systems may recycle up to 45% of the generated waste (in some specific cases even more).
- Per kg prices of materials collected may increase by a factor of 3 up the recycling hierarchy.
- Daily incomes of informal waste recyclers can be assumed to be between US$1 and US$15 (in some cases higher) and the ratio of income to minimum wage may be in a range from 0.7 up to 5.0.
- A rough estimate is that informal waste management systems generate 10–40 times more jobs than systems in an industrialized country.

[32] Roland Ramusch, Urlike Lange, *Role and size of informal sector in waste management – a review*, Proceedings of the Institution of Civil Engineers, Waste and Resource Management 166 May 2013 Issue WR2 Pages 69–83

The next graph presents the daily quantities collected and the daily distances travelled collected for different types of IRS.

Figure 8: Range of daily performance of IRS[33]

The next graph presents the job creation potential in IRS.

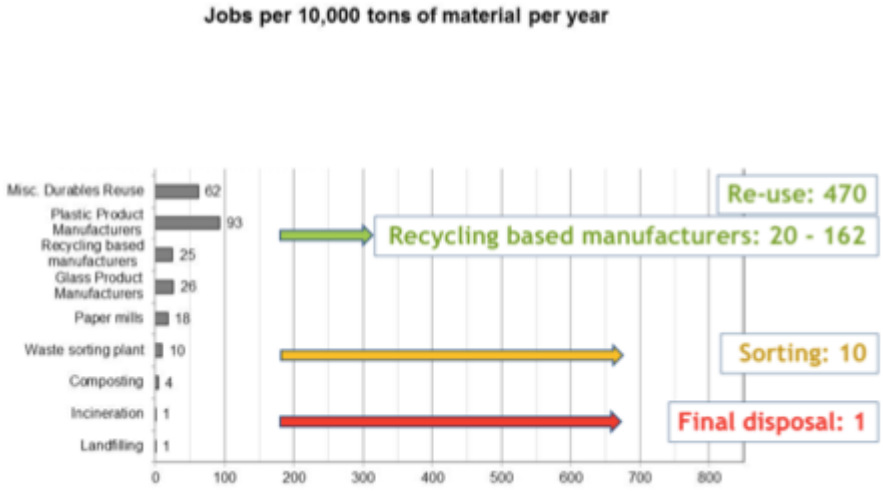


Figure 9: IRS potential job generation for different activities[34]

Developing proper intervention and policies

The inclusion of the informal sector in formal waste management is still a problematic and contested issue. However, starting from the premise that the informal sector is a significant stakeholder in waste management in many places, especially those where the formal SWM system struggles to provide good services to all their citizens, it is more valuable to work

[33] Roland Ramusch, *Key-Performance Indicators of the Informal Waste Sector*, 2014, ISWA-EXPRA workshop on Challenges to separate collection systems for different waste streams - barriers and opportunities

[34] Linzner R and Lange U, *Role and size of informal sector in waste management – a review*, Proceedings of the ICE – 2013, Waste and Resource Management Volume 166: 15.

with the existing favourable practices and use them for the benefit of the system than to put effort, already strained capacities and limited resources into dismantling them and starting from scratch to develop new systems. The position and the role of informal sector is particularly important to address when a city is establishing a formal separate collection scheme, either through public municipal or private business initiatives. The same holds for the preparation of long-term goals and strategic plans, including selection of technology for a city's SWM system.

The challenge for authorities is to support and promote the entrepreneurship, flexibility and productivity that characterize the informal sector, while striving to reduce the sector's negative aspects. Rather than criminalizing informality, such an approach would imply giving a mandate to the informal service providers, integrating them to work alongside the formal sector and thus incorporating them in the system. In some cases where public authorities have made attempts to involve the informal sector, they have faced resistance, for various reasons, one of them being that the economic situation may be better when operating informally, as the case of the city of Douala, Cameroon, illustrates. The government introduced legislation in 2014 that bans informal recycling and waste-picking activities and requires all waste pickers to register and pay taxes, which would increase government revenue from this growing economic sector. However, the result has been a decrease in waste collection and recycling in some neighbourhoods.

Opening a dialogue in order to better understand each other's roles and to negotiate responsibilities holds the potential for identifying common goals and interests as well as creating partnerships for the bene t of the entire community. For example, it is important to distinguish between waste pickers who work in the streets, waste pickers who work on dumpsites, and itinerant waste buyers who go door-to-door, actually paying householders (or household servants) for clean, source- segregated waste materials. Accordingly, the introduction of waste segregation at source would not only be likely to result in more and better materials but would also be an opportunity to develop an integrated system that successfully combines formal and informal actors, as experiences in Bangladesh, India, the Philippines and many other countries confirm. Latin American countries are particularly advanced in such efforts, including Argentina, Brazil, Colombia and Ecuador.

The potential positive impacts of informal sector integration show that measures to include this sector in waste management systems are necessary. Different levels and models of integration are possible and range from mere recognition of the informal workers by public authorities (e.g. provision of identity cards) to a complete formalization of actors as companies or co-operatives. When it comes to the question how to do this, several conditions have shown to be important for the successful implementation. These are for example the attention paid to the activities of informal waste workers in public policies, regulations, and procedures, the organisation of informal actors, the technical and managerial capacity these workers have as economic actors, and the networks they establish with formal companies and other institutions like providers of business or financing services.

Improving SWM systems can affect the IRS positively or negatively. It can lead to the elaboration and implementation of strategies which finally threaten or improve the income

generating activities that IS workers traditionally carried out. Strategies for improving SWM systems, however, can also support the integration of the IRS in the (formal) municipal SWM system and formally charge informal actors with SWM activities.

As the main characteristic of the informal waste sector is its "invisibility", one major element of strengthening informal sector integration consists of raising awareness of political decision-makers for the work and the possible contributions of the informal sector for an appropriate waste management system, as well as for the important aspects to consider when integrating them. Experience, especially from India and Brazil, clearly shows that the constitution of adequate legal structures and the process of informal sector integration go hand in hand. The adaptation of laws, regulations and bylaws at federal, state and municipal levels to the requirements of a successful integration process paves the way for further developments. [35] The next table presents the basic interventions available for IRS.

Table 4: Policy Interventions for IRS[36]

INTERVENTIONS	DESCRIPTION
Welfare Interventions	Focus on improving the socio-economic status of IRS and their families Based on the idea that waste pickers are poor, socially weak and without options
Rights based Interventions	Support groups of IRS and their families to claim labour or citizenship rights Build associations or unions to support them Providing ID cards or formal papers Main goal: occupational recognition
Technical integration – two sided	Create formal contracts or agreements between the service chain and IRS Semi-formal operations Reduce police harassment and blackmailing of IRS Registration of recycling activities, support to create small business units and enterprises
One sided formalization	Focus on zoning, legal rules, tax issues and support to achieve IRS compliance Eliminate illegal activities Becomes possible when the formal system is open to accept the compliance and there is space for IRS within the formal arrangements
Professionalization and access to financing	Focus on demand-driven support to informal recyclers for training, Health and Safety and improvement of their functioning as workers for enterprises Organize support for IRS professional activities Occupational recognition Capacity building and business skills support
Business to Business Intervention – Value Chain strengthening	Focus on economic development and job creation Work within the value chain to improve stability and predictability of earnings Leverage access to finance and storage for materials
NGO Recycling Projects	Prioritise job creation and/or improving socio-economic conditions for a small number of IRS Local importance and focus Provide access to more capital for infrastructure

In any case, it is important to build on the existing experiences from IRS integration and intervention policies before any specific policies are formulated. Here are some key-points that need to be considered by decision-makers (but they also require partnerships with other stakeholders like donors and NGOs, private enter- prises etc.):

- Analyse the informal solid waste management activities, its linkages to the formal solid waste management system and its impacts

[35] GIZ, *Recovering resources, creating opportunities Integrating the informal sector into solid waste management*, 2015
[36] GIZ, SWEEP-Net, *Valuing Informal Integration: Inclusive recycling in North Africa and Middle East*, 2015

- If significant informal waste management activities exist, foresee strategic measures for the inclusion of these activities in National Solid Waste Management Strategies, laws and regulations

- Involve representatives of the informal sector in local solid waste management planning processes

- Improve social recognition of waste recovery activities through communication campaigns, partnerships with NGOs and other actors to accompany informal stakeholders

- Facilitate the organisation and formal recognition of informal waste workers (through identity cards, associations, co-operatives, enterprises, etc.)

- Train informal stakeholders on health, environmental, technical and management aspects

- Provide information about recycling markets and prices to informal workers

- Create opportunities for resource recovery through the informal sector:

    - in waste collection systems (e.g. (separate) collection contracts for registered informal sector, buy-back or drop-o points for recyclable materials, partnerships or franchising systems with formal private sector)

    - on transfer stations or landfill sites (by providing sorting space and infrastructure, establishing agreements with waste pickers on recovery practices not disturbing landfill operation)

- Analyse feasibility of upgrading informal sector recycling and initiating new recycling activities

- Establish partnerships with the private sector to improve the informal sector's linkages to industrial value chains

E. Circular Economy and ML

Marine litter is an example of market and system failure, and like other environmental challenges policy intervention should play a central role. Citizens alone cannot be expected to change consumption patterns to reduce marine litter. Recognizing the difficulties which governments themselves face in implementing green public procurement policies, it is questionable if and how consumer choice alone can effectively reduce littering. Like other major environmental challenges, there is a need for "courageous" intervention by policy makers because as we all know "no environmental problem has ever been solved without a strong policy framework".

Plastics are an element of the economy, nested within society and the terrestrial and marine environments. Within this system there are flows of materials, particularly fossil-based plastics, with a number of leakage points leading to marine litter. Each leakage point has a range of impacts, both socio-economic and environmental. Next figure presets a generic flow-chart of the plastic flows, the Circular Economy and ML.

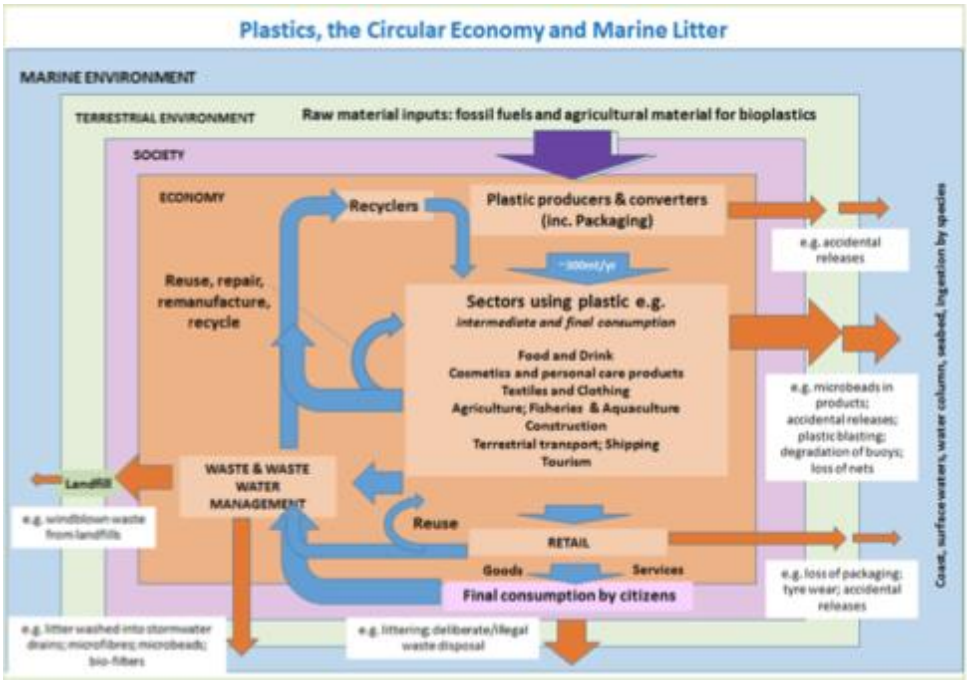


Figure 10: Plastic flows, Circular Economy and Marine Litter[37]

The conclusions of the whole scientific work around marine litter suggest that policy to address marine litter should focus on prevention[38].

The transportation - both vertically and horizontally in ocean columns - and fragmentation of plastic waste in the oceans means that seemingly innovative clean-up solutions, such as ocean buoys and plastic eating bugs, are likely to be inefficient in both practical and economic terms.

Further analysis by Imperial College London examines the potential effectiveness of floating buoys in collecting marine litter. The study shows that in order to maximise effectiveness, clean-up activities should be located next to sources in coastal areas such as the

[37] Ten Brink, P.; Schweitzer, J.-P.; Watkins, E.; Howe, M. (2016) Plastics Marine Litter and the Circular Economy. A briefing by IEEP for the MAVA Foundation.
[38] EU, DG for Internal Policies, EU Action to Combat Marine Litter, IP/A/ENVI/2017-02, May 2017

Mediterranean and East Asia. However, even optimum placement of clean-up activities is predicted to be able to collect just 31% of the 6% of plastic which is floating (~2% of the total of marine litter) – and consequently clean-up alone does not represent a solution[39]. Similar limitations can be seen in other "innovative" clean-up solutions.

Promoting clean-up activities distracts from opportunities for innovative and sustainable production systems[40]. Additionally, recycling alone cannot solve the problem, as many products need to be redesigned. Preventative measures save money and can support business innovation, and this needs to start at the design phase.

It is possible to target key intervention points in different economic sectors. For different sectors (e.g. retail, fisheries, tourism) it is possible to identify responsibilities (i.e. where the sector drives marine litter) and self-interest (i.e. where the sector is impacted by marine litter so can benefit from action), creating a dialogue for collective action.

Looking at different sectors, including waste management, fisheries and tourism, we can identify a range of impacts and actions[41]:

- Producer responsibility and consumer action – both producers and citizens have responsibility to act. In Europe alone 400 tonnes of plastic enter the ocean each year from personal care and cosmetic products. Other sources include food and beverage packaging and fibres from laundry. All leakages have health, safety, food chain and wellbeing impacts.
- Waste management – investments in waste management and waste water treatment infrastructure can help to address marine litter, particularly at the municipal level. In maritime sectors, improved port reception facilities are an important tool.
- Clean-up and trash for treasure – collecting marine plastics and turning them into new products provides a useful awareness raising tool, but such initiatives are not effective when scaled up.
- Fishing and aquaculture – nets, buoys and gear are all major sources of marine litter, both discarded accidentally and deliberately. There are also impacts on the sector including vessel damage, loss of catches as a result of "ghost fishing" by lost nets, and the reduced value of catches due to pollution.
- Tourism – this sector is a major source of marine litter, including recreational boating, hotels, cruise ships, and inadequate infrastructure to deal with seasonal influxes of tourists. Impacts to the sector include loss of aesthetic value, health and safety risks, loss of income and reduction in tourist numbers.

Overall, it can be seen that different sectors are simultaneously major sources of marine litter and also burdened by this form of pollution, meaning they have both a responsibility

[39] Dustin Benton, Green Alliance, Ocean clean-up? Why prevention is better than cure, EU workshop, Brussels, Wednesday 3 May 2017

[40] Heather Leslie—CleanSea Documentary: The Marine Litter Problem and What We Can Do About It? https://vimeo.com/206068041

[41] Patrick ten Brink, Institute for European Environmental Policy (IEEP), Measures to address marine litter, EU workshop, Brussels, Wednesday 3 May 2017

and a self-interest to act.

As the circular economy presents a number of different solutions for tackling marine litter in our oceans, including material reduction, design for end-of-life recyclability, green chemistry life-cycle analyses and the use of bio-based feedstocks whose biodegradability is confirmed in a range of real-world locations where the waste may end up, it is necessary to identify a way to put priorities between the different options. The priority solutions will depend on the country in question, but in general terms a preferential hierarchy should be followed where possible

The waste hierarchy can be applied to marine litter[42] - this will prioritize measures based on preventing and reducing the sources of marine litter (see below).

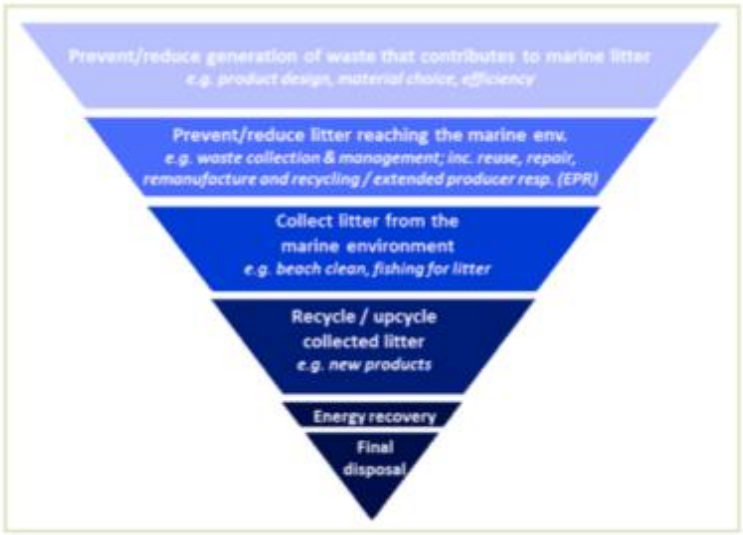


Figure 11: The ML Hierarchy for decision makers[42]

According the Institute for European Environmental Policy[43], the following circular economy tools should be integrated in policy making:

- Extended Producer Responsibility: Use EPR to avoid certain types of marine litter, most notably single-use packaging items.
- Research into product design to facilitate reuse, repair, remanufacture and recycling, and complement this by providing more information on the plastic composition of products.
- Bans for unnecessary and damaging products or activities where viable substitutes exist - e.g. plastic microbeads in cosmetics can be replaced by ground nut shells, marble particles or naturally-grown polymers, and plastic blasting in shipyards can be replaced by ultra high pressure water jets.
- Improved legislation: Provide clear definitions of polymers, waste and secondary raw materials. Manufacturers need to design their products and packaging to fit into existing recycling systems.

[42] Watkins, E., ten Brink, P., Mutafoglu, K., Withana, S., Schweitzer, J-P., Russi, D., Kettunen, M. and Gitti, G. (2016) Marine litter: Socio- economic study. A report by IEEP for UNEP.
[43] Institute for European Environmental Policy, Plastics Marine Litter and the Circular Economy, October 2016

- Economic incentives targeting consumption: Make greater use of economic incentives to make market signals part of the solution - i.e. ensure that plastic has a price and is therefore more widely recognised as a valuable resource – e.g. apply deposit-refunds to bottles, and charges/taxes to plastic bags, disposable cutlery, and other one-use items.
- Transparency and labelling: Improve transparency on the chemicals contained in plastics – to help with decisions on remanufacture and recycling. In addition, transparency on where personal care and cosmetic products (PCCPs) do and/or do not contain plastics. Explore the implications for additives such as flame retardants, plasticisers, pigments, fillers, and stabilisers.
- Waste management measures: Invest in waste collection infrastructure and services (at ports), waste management infrastructure and wastewater treatment facilities to avoid dispersion of litter into the marine environment - particularly in coastal areas or near rivers.
- Awareness-raising: Raise awareness among consumers to improve waste disposal (littering and waste separation), and also better inform purchasing habits to increase demand for sustainable substitutes - e.g. cosmetic products not containing microbeads (e.g. via Beat the Bead), multiuse bottles and bags, purchase of washing machines with filters.
- Fishing for litter: combined incentives to encourage action, and develop new products from waste. While this is not the most cost-effective of solution (efforts higher up the hierarchy are preferable), it can create interesting branding opportunities for manufacturers, raise awareness and contribute to reducing pressure on the marine environment in selective places.
- Improved implementation: In addition, there is a need for better implementation of existing legislation on the release of litter, from terrestrial sources and at sea – e.g. The MARPOL Convention, Waste Framework Directive, Directive on Port Reception Facilities, Water Framework Directive and, Marine Strategy Framework Directive.

In the context of the challenges outlined above and existing global commitments to simultaneously enhance the plastics economy, increase resource efficiency and reduce marine litter, a global roadmap is needed that includes a mixture of legal, voluntary, market based and informational measures across stakeholders to promote the transition to a circular and marine litter free economy. No environmental problem of this size has ever been effectively addressed without a solid legal framework, so the current heavy reliance on soft measures such as voluntary agreements needs to be augmented with formal policy measures and regulation.

The G20 have advocated for a global roadmap for action to address the life cycle of plastics and effectively valorise plastics in the economy whilst mitigating their environmental impacts[44]. This roadmap includes:

[44] G20 Insights, T20 Task Force Circular Economy: Circular economy measures to keep plastics and their value in the economy, avoid waste and reduce marine litter, 2017

1. Upstream measures: The G20 should support innovation, providing investment for the implementation of upstream solutions. Upstream and design led approaches to reducing plastic waste and pollution are cost-effective ways to implement the waste hierarchy. Without redesign many plastic products cannot be reused or recycled.

2. Consumption based measures: The G20 should create the right incentives for producers and citizens to dematerialise the plastics economy and decouple it from negative externalities. Information and economic signals should favour the most sustainable and resource efficient solutions. Market based instruments in particular can help to dematerialise the plastics sector.

3. Worldwide engagement in awareness of impacts and the need for social change: The G20 should act to increase both political and public awareness of the impacts of plastic pollution in the environment and on organisms, including humans, and the opportunities which exist in recovering the value of plastic as a resource through circular economy tools. The availability of data on the scale of the marine litter issue and of structural waste in the plastics sector has played a major role in driving the global agenda. Nevertheless knowledge gaps exist, particularly on impacts and costs, and the awareness of consumers remains low and needs additional support. Likewise, cases of best practice that illustrate the socio-economic and environmental benefits of action are increasingly showing that preventative measures are preferable to clean-up. Systematic investment in the research and evaluation of policy experiments is needed in order to identify and communicate good practice cases to catalyse action.

4. Measures to enhance and advance waste management: The G20 should support the development of effective waste management infrastructure to implement the waste hierarchy, upscale the cycling of plastics in the economy, and prevent leakage into the environment and organisms, including humans. The collection and sustainable management of waste are key to reducing the leakage of plastics into the environment. Major leakages of plastic waste into the oceans are attributable to poor waste management infrastructure in countries across the globe. In the context of the circular economy, waste management should cover municipal waste as well as industrial waste from a range of sectors. Cascading uses of plastic resources and industrial symbioses can maintain plastics' value within the economy. The required measures involve:

- Separate waste collection: Emphasis should be placed on moving away from landfill and energy recovery towards re-use and recycling. Separate municipal waste collection is a key element within this infrastructure, to make recycling a convenient option for citizens to deal with their waste plastics. Re- use opportunities in the plastic packaging sector, ranging from reusable B2B crates to refillable bottles for beverages and cleaning products.

- Waste management infrastructure and services: Direct investment in waste infrastructure is needed in all countries to increase the rate of recovery and reduce the leakage of plastics. Although landfilling should be the least-preferred option, investment in sanitary landfills is still desirable in countries where informal and unprotected landfills are a major source of plastic pollution.
- Export of plastic waste: In general, plastic waste should not be exported for disposal or treatment in locations with significantly lower treatment standards than the country of origin. Countries which export waste for recycling should have responsibility to assess and take into account the impacts of that trade. An estimated 15 million tonnes of plastic is traded per year as waste destined for recycling.
- Water treatment and waste water: Surface runoff, rivers and sewage waters are key pathways for marine litter, transferring significant volumes of material from land to sea. Measures to improve the quality of freshwater treatment and management, including stormwater, can help reduce transboundary flows of both larger plastic items and microparticles.
- Infrastructure for maritime and fisheries marine litter: Whilst terrestrial sources are the most important, an estimated 0.5 to 5.9 million tonnes of plastics enters the oceans from sea-based sources every year. Appropriate waste infrastructure at ports can reduce this flow of waste.
- Deposit refunds and extended producer responsibility (EPR): Producers should be made responsible for their products after the point of sale. Deposit refund and EPR instruments, which support the uptake, quality and economics of recycling, thus reducing marine littering, should be implemented. EPR schemes also encourage producers to design their products to be suitable for take-back and recycling.
- Clean-up and collection: Given the size of the oceans and the scale of the marine litter problem, clean- up activities are costly, largely ineffective and create an unhelpful illusion that upstream measures are not necessary. This is the case for macroplastic (i.e. visible to the eye) and microplastic pollution, both of which are pervasive in our oceans. The transfer of marine litter and microplastics to the ocean floor means that surface water clean-up activities do not target the bulk of the litter and are not a cost- effective solution. Whilst upstream measures should be preferred, clean-up may be a suitable last resort for addressing marine litter in limited zones such as urban areas, tourist beaches and ports where the litter causes severe social and economic damage.

F. The evolution of SWM indicators

In summary, statistics aim to convert raw data into useful information; indicators then help to transform that information into knowledge, which can then be used to make wise decisions.

Performance indicators provide a good basis for assessing the existing situation, carrying out a comparison and tracking changes or progress made over time. For indicators to be useful as a tool for decision makers and politicians, they need to simplify the potential mass of data by being selective, by focusing on the important elements rather than trying to cover all aspects. By doing so, the information the indicators present will be relatively easy to use and understand.

Unfortunately, compiling high quality data on waste and waste treatment has long been a challenge. The available estimates are diverse, not verified or reliable, and often rather outdated. Thus, transforming waste data into reliable waste statistics has proven difficult. Definitely, this situation reflects to Marine Litter Statistics too, in one or another way. Some of the major areas of concern are:

- Lack of standard definitions and classifications
- Absence of measurement and of standard methodologies for measurement
- Lack of standard reporting systems

Interest in performance indicators for solid waste management is long-standing. Researchers have examined the bias issues in the then-standard set of three benchmark indicators: waste generated per capita; proportion of waste being managed by different methods; and proportion of households with a regular collection service. They found that although solid waste planning is a multi-disciplinary field requiring information about the physical, environmental, social, and economic implications of a system, the environmental indicators in use for solid waste do not adequately inform decision-makers about all of these attributes. Therefore, the indicators do not facilitate a holistic approach to environmental planning and policymaking.

Similar indicators are still used as part of composite sustainable development indicators in cities, e.g. an example is the Global City Indicators Facility, which does promise an improvement in the current level of availability of comparable data as more cities sign up. Until recently, the best that the literature can offer on a worldwide basis is compilations of older data, of dubious comparability and often just at the national level.

There has been much recent attention to developing indicators for particular aspects of ‘modernising’ a solid waste management system. Most of the published research has focused on high-income countries, with only a few that have focused on developing countries. There is a long list of publications regarding indicators about:

- Waste prevention
- Zero waste management systems
- 3R (reduce, reuse, recycle) policies to transition from waste management to resource management

- Extended producer responsibility systems
- Tracking compliance with European Union requirements
- Rank the performance of US cities
- Recycling systems and selective collection for recycling
- Waste collection
- Comparing technologies for waste treatment, recycling and disposal

A notable recent attempt to develop benchmark indicators and apply them to the comparison of cities both North and South was the report prepared for UN-Habitat on the state of solid waste management in the World's cities.

The UN-Habitat work is not the only recent attempt to develop benchmark indicators to compare solid waste management systems in cities. Perhaps the most developed of these alternative approaches is the ten solid waste management indicators which are being tested in over 400 urban local bodies in the two Indian states of Gujarat and Maharashtra[45] as part of a 5-year project to develop and demonstrate a performance measurement framework for urban water and sanitation.

Despite the numerous efforts and sets of indicators that have been created, the global community still lacks common definitions and methodologies that will be applied to the waste sector providing a meaningful description of its complexity. There is a need for an integrated analytical framework capable to be easily understood fro decision makers and decision takers.

Such a tool is described in the recent UNEP – ISWA Global Waste Management Outlook[46]. According this tool, experience suggests that, for a system to be sustainable in the long term, consideration needs to be given to:

• All the physical elements (infrastructure) of the system, from waste generation through storage, collection, transport, transfer, recycling, recovery, treatment and disposal.

• All the stakeholders (actors) involved, including municipalities; regional and national governments; waste generators/service users (including industry, business, institutions and households); producers (those who put products on the market which become waste at the end of their life, including manufacturers, brand owners, importers and others in the supply chain); service providers (whether public or private sector, formal or informal, large or small); civil society and non-governmental organizations (NGOs) (which play a variety of roles, including facilitating the participation of other parties); international agencies; etc.

• All the strategic aspects, including the political, health, institutional, social, economic, financial, environmental and technical facets.

• The term *integrated waste management* has been widely used[47] with a variety of meanings, but often refers only to integration across the physical elements. The concept of

[45] CEPT University, 2010. Performance measurement framework for urban water and sanitation. Volume I: Approach and framework. Volume II: List of indicators and reliability assessment

[46] UNEP – ISWA, Global Waste Management Outlook, 2015, ISBN: 978-92-807-3479-9

[47] See UNEP's Governing Council Decision GC 24/5 (2007) and in GC 25/8 (2009)

Integrated Sustainable Waste Management (ISWM) which explicitly brings together all three dimensions, is gradually becoming the norm in discussion of solid waste management in developing countries.

The concept is described in brief in next figure.

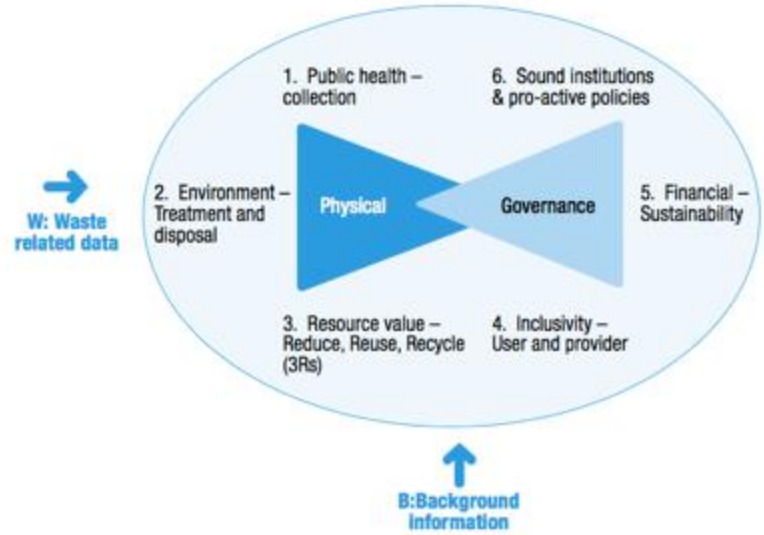


Figure 12: The Integrated Sustainable Waste Management Framework

It is strongly suggested using this framework for improving the ML indicators.

The first triangle (sometimes called also as "Hardware") comprises the three primary physical components (elements), each linked to one of the key drivers that are described. These provide the necessary infrastructure for solid waste management:

Waste collection: driven primarily by public health;

Waste treatment and disposal: driven primarily by environmental protection; and

The 3Rs – reduce, reuse, recycle: driven by the resource value of the waste and more recently by 'closing the loop' in order to return both materials and nutrients to beneficial use.

The second triangle (sometimes called as "Software") focuses on the 'softer' aspects of ISWM – the governance strategies:

Inclusivity of stakeholders: focusing in particular on service users and service providers;

Financial sustainability: requiring the system to be cost-effective, affordable and well financed; and

Sound institutions and proactive policies: including both the national policy framework and local institutions.

An integrated and sustainable waste management system must address all technical (infrastructure) and governance aspects to allow a well-functioning system that works sustainably over the long term.

In addition, the recent shift towards the Circular Economy (CE) concept, creates a need to examine further the linkages between waste management indicators and resource management.

Looking more generally, there has been extensive recent work to extend well-established national and international statistics on the financial flows associated with manufacturing and trade (i.e. the economy) to resource and waste flows, for example using Material Flow Accounting (MFA). MFA is now regularly practised by some member states of the EU and detailed national calculations have been available for several years for countries such as Austria, Denmark, Finland, Germany and the UK. In comparison with efforts in the EU, efforts to establish comprehensive MFA for the United States are more recent and to date less institutionalized. In the Asia-Pacific region, Australia, PRC, Japan and the Republic of Korea have been pioneers in developing an MFA system, and considerable work in the region has been done by UNEP[48,49].

For the time being, the focus of MFA is still on individual substances (e.g. cadmium flows), specific materials, or bulk material flows (e.g. steel and steel scrap flows within an economy). Using the concepts of MFA may also help in throwing some light on the present situation of transboundary movements of wastes. It is likely to take many years however for full national and international accounts that show the mass flows of both virgin and secondary raw materials, although some serious efforts are already in place.

There are very interesting approaches for developing new meaningful indicators that will link waste management with CE.

From the point of view of a company with a specific supply chain, the Ellen Mc Arthur Foundation has developed the Circularity Indicators Project, that aims to address this gap and has developed indicators that measure how well a product or company performs in the context of a circular economy, thereby allowing companies to estimate how advanced they are on their journey from linear to circular.

On a national level, CE has been widely discussed and practiced on a policy level in China. The Chinese central government has adopted CE as a national regulatory policy priority introducing numerous regulations to support and build its implementation. China was the first country to release nationally focused Circular Economy indicators so that objective and credible information on the status of CE implementation can be recognized. These indicators are valuable metrics for policy and decision-makers and can help achieve specific goals and outcomes.

Another important effort was recently made by France[50]. According the French approach, Circular Economy is divided in three areas, namely, Supply from Economic Stakeholders, Consumer Demand and Behaviour, and Waste Management. Performance monitoring takes place at every stage of the cycle; 4 indicators are applied to the early phases (extraction/use of resources and sustainable purchasing, eco-design, industrial and territorial ecology and the functional economy), followed by two indicators for the second Action Area (responsible consumption and extension of product lifespan), and two indicators for the end of the cycle (recycling). Finally, an indicator examining employment in the circular economy naturally addresses the cycle as a whole.

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[48] UNEP and CSIRO (2011). *Resource Ef ciency: Economics and Outlook for Asia and the Pacific* http://apps.unep.org/publications/pmtdocuments//pdf/Resource_Ef ciency_EOAP_web.pdf

[49] UNEP and CSIRO (2013). *Recent Trends in Material Flows and Resource Productivity in Asia and the Pacific* http://www.unep.org/pdf/RecentTrendsAP(FinalFeb2013).pdf

[50] MINISTRY OF THE ENVIRONMENT, ENERGY AND MARINE AFFAIRS, May 2017, 10 Key Indicators for Monitoring Circular Economy

There are other important efforts in place, however what is still required is to examine whether those indicator systems have actually had any significant results to government, industry, communities and other stakeholders. A clear identification of how these indicators have actually been applied and what are the experiences requires significant investigation. In any case the indicators can be used for benchmarking, improvement of environmental performance at multiple levels, identification of problem areas, cost-benefit analyses, policy direction, business investment decisions, and many other applications. But there is a need to further examine how these indicators can be integrated into methodologies for decision making and policy setting that allow for their effective implementation.

G. Proposed Indicators

Based on the previous discussion, the following improvements are proposed.

H2020

The current indicators in use by H2020 are:

IND 1 - Municipal waste generation

IND 1.A Municipal waste composition

IND 2 - Collected and treated municipal waste

IND 2.A Number, type and location of landfills

Proposed Changes

The IND 1 needs to be improved in order to reflect better the linkages with ML. Considering the importance of plastics in ML, the following changes are proposed.

IND 1 Municipal Waste Generation stays as it is. Special emphasis should be given to:

- Plastic Waste Generation per capita
- Touristic activities, and
- Coastal Areas.

So, I suggest the following structure.

H202O Indicators

IND 1 - Municipal waste generation

IND 1.A Municipal waste composition

IND 1.B Plastic waste generation per capita

IND 1.C % of population living in Coastal Areas / Total Population

IND 1.D % of Tourists / population living in Coastal Areas

Regarding IND 2, I propose a complete restructure as follows:

IND 2 – "Hardware" of waste management

IND 2.A Waste Collection

IND 2.A.1 Waste Collection Coverage: % households who have access to a reliable waste collection service.

IND 2.A.2 Waste Captured by the solid waste management and recycling system: % of waste generated that is collected and delivered to an official facility.

IND 2.B Environmental Control

Controlled treatment or disposal: % of the total municipal solid waste destined for treatment or disposal which goes to either a waste treatment facility (MRF, thermal, mechanical-biological) or sanitary landfill.

IND 2.B.1 % of waste that goes to uncontrolled dumpsites

IND 2.B.2 Number of uncontrolled dumpsites in Coastal Areas

IND 2.B.3 Quantities of waste going to uncontrolled dumpsites in Coastal Areas

IND 2.C Resource Recovery

% of total municipal solid waste generated that is recycled. Includes materials recycling and organics valorization (composting, animal feed, anaerobic digestion).

IND 2.C.1 % % of plastic solid waste generated that is recycled. Includes plastic recycled in formal and informal systems, both through source separation and MRFs.

Finally, I propose a new qualitative indicator IND 3 that will measure the "Software" of waste management in relation to ML. The indicator is described below.

IND 3 "Software" of waste management

IND 3.A Is there a National Plan for ML? (Yes or No)

IND 3.B Are there mandatory targets for source separation of plastics? (Yes or No)

IND 3.C Are there Extended Producer Responsibility obligations and schemes for plastics? (Yes or No)

IND 3.D Is there legislation to stop the use of single-use plastics? (Yes or No)

IND 3.E Is there a national plan to close the dumpsites within next 10 years? (Yes or No)

IND 3.F Is there a government budget for investments in waste management infrastructure for closing the dumpsites, reducing landfilling and promoting recycling and waste treatment? (Yes or No)

IND 3.G Is there a legal framework for the creation of waste management authorities by municipalities?

IND 3.H Are there waste management authorities in the Coastal Areas? (Yes or No)

IND 3.H Are there green procurement rules in place? (Yes or No)

IND 3.I Are there policies to support sustainable tourism? (Yes or No)

IND 3.J Are there eco-labelling and eco-design procedures? (Yes or No)

The next table presents the proposed H2020 indicators and their distribution within the DPSIR framework.

Table 5: Proposed H2020 indicators

INDICATORS	Drivers	Pressures	State	Impacts	Responses
IND 1 - Municipal waste generation		X			
IND 1.A Municipal waste composition		X			
IND 1.B Plastic waste generation per capita		X			
IND 1.C % of population living in Coastal Areas / Total Population	X	X			
IND 1.D % of Tourists / population living in Coastal Areas	X	X			
IND 2 – "Hardware" of waste management		X	X		
IND 2.A Waste Collection		X		X	
IND.2.A.1 Waste Collection Coverage: % households who have access to a reliable waste collection service.	X	X			
IND.2.A.2 Waste Captured by the solid waste management and recycling system: % of waste generated that is collected and delivered to an official facility.		X		X	
IND 2.B Environmental Control Controlled treatment or disposal: % of the total municipal solid waste destined for treatment or disposal which goes to either a waste treatment facility (MRF, thermal, mechanical-biological) or sanitary landfill.	X	X		X	
IND 2.B.1 % of waste that goes to uncontrolled dumpsites		X		X	
IND 2.B.2 Number of uncontrolled dumpsites in Coastal Areas	X	X		X	
IND 2.B.3 Quantities of waste going to uncontrolled dumpsites in Coastal Areas	X	X		X	
IND 2.C Resource Recovery % of total municipal solid waste generated that is recycled. Includes materials recycling and organics valorization (composting, animal feed, anaerobic digestion).	X	X			
IND 2.C.1 % of plastic solid waste generated that is recycled. Includes plastic recycled in formal and informal systems, both through source separation and MRFs	X	X			
IND 3 – Software of waste management This is a composite indicator that combines information regarding policies, governance, planning and regulations in waste management					X

Core NAP Indicators

The concept is to have the same all the H2020 indicators as core NAP indicators too. However, it is important to measure two more parameters that represent additional drivers for ML generation.

- The linkages between tourism and ML
- The existence of recycling markets and instruments

So, the proposed core NAP indicators are as follows.

Table 6: Proposed core NAP indicators

INDICATORS	Drivers	Pressures	State	Impacts	Responses
1. Municipal waste generation		X			
Municipal waste composition		X			
Plastic waste generation per capita		X			
% of population living in Coastal Areas / Total Population	X	X			
% of Tourists / population living in Coastal Areas	X	X			
2. "Hardware" of waste management		X	X		
2.A Waste Collection		X		X	
2.A.1 Waste Collection Coverage: % households who have access to a reliable waste collection service.	X	X			
2.A.2 Waste Captured by the solid waste management and recycling system: % of waste generated that is collected and delivered to an official facility.		X		X	
2.B Environmental Control Controlled treatment or disposal: % of the total municipal solid waste destined for treatment or disposal which goes to either a waste treatment facility (MRF, thermal, mechanical-biological) or sanitary landfill.	X	X		X	
2.B.1 % of waste that goes to uncontrolled dumpsites		X		X	
2.B.2 Number of uncontrolled dumpsites in Coastal Areas	X	X		X	
2.B.3 Quantities of waste going to uncontrolled dumpsites in Coastal Areas	X	X		X	
2.C Resource Recovery % of total municipal solid waste generated that is recycled. Includes materials recycling and organics valorization (composting, animal feed, anaerobic digestion).	X	X			
2.C.1 % % of plastic solid waste generated that is recycled. Includes plastic recycled in formal and informal systems, both through source separation and MRFs	X	X			
3. Software of waste management This is a composite indicator that combines information regarding policies, governance, planning and regulations in waste management					X

4. Tourism as a driver for ML	X				
% of GNI related to tourism in coastal areas & Islands	X	X			
International tourist arrivals in coastal areas & Islands	X	X			
Seasonal variation of accommodation occupancy (in %) in coastal areas & Islands	X	X			
5. Recycling Markets and Instruments	X	X			X
Source Separation Programs in coastal areas & Islands: % of waste recovered through source separation programs. Includes materials recycling and organics valorization (composting, animal feed, anaerobic digestion)	X	X			X
Private Sector Involvement: Turnover of private sector recycling companies	X				X
Extended Producer Responsibility schemes for packaging: % of recyclables / packaging waste collected by EPR schemes for packaging	X				X
Deposit systems for packaging: % of recyclables / packaging waste collected by deposit systems	X				X

H. Linkages with the SDGs

Waste management is linked or reflected to many different part of the SDGs. However, it is mostly reflected in the following SDGs.

Goal 3: Ensure healthy lives and promote well-being for all at all ages

- By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births
- By 2030, end preventable deaths of new-borns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
- By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases
- By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
- Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol
- By 2020, halve the number of global deaths and injuries from road traffic accidents
- By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes
- Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
- By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
- Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate
- Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all
- Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States
- Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

- By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
- By 2030, provide access to safe, affordable, accessible and sustainable transport

systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
- By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
- Strengthen efforts to protect and safeguard the world's cultural and natural heritage
- By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
    - Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities
- By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
- Support positive economic, social and environmental links between urban, per-urban and rural areas by strengthening national and regional development planning
- By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels
- Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Goal 12: Ensure Sustainable Consumption and Production Patterns

- Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries
- By 2030, achieve the sustainable management and efficient use of natural resources
- By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses
- By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
- By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
- Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
- Promote public procurement practices that are sustainable, in accordance with national policies and priorities
- By 2030, ensure that people everywhere have the relevant information and

awareness for sustainable development and lifestyles in harmony with nature
- Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production
- Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products
- Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities

Goal 14: Conserve and sustainably use the oceans, seas and marine resources

- By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
- By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
- Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels
- By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics
- By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information
- By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation
- By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism
- Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries
- Provide access for small-scale artisanal fishers to marine resources and markets
- Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources,

as recalled in paragraph 158 of The Future We Want

Goal 6: Ensure access to water and sanitation for all

- By 2030, achieve universal and equitable access to safe and affordable drinking water for all
- By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
- By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
- By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies
- Support and strengthen the participation of local communities in improving water and sanitation management