



Scalable full-cycle marine litter remediation in the Mediterranean: Robotic and participatory solutions

SeaClear2.0

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Title: SeaClear2.0 stakeholder workshops

Co-design Activities for Tackling Marine Litter - Stakeholder Workshop in Dubrovnik, Croatia

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The SeaClear2.0 Stakeholder Workshops

Identifying site-specific issues and co-designing realistic, locally applicable solutions are essential steps in effectively tackling marine litter across Europe and the Mediterranean. As part of the SeaClear2.0 project, ISOTECH Ltd is implementing its DeCyDe-4 decision support method in a series of participatory workshops with stakeholders in eleven countries (including non-EU neighbours). These workshops aim to map local sources and drivers of marine litter and develop targeted, site-specific solutions to address this issue.

Stakeholder Workshop in Dubrovnik, Croatia

The workshop held in Dubrovnik, Croatia on 10 June 2026, was the ninth in the SeaClear2.0 series of stakeholder workshops. It brought together 20 stakeholders from 12 organisations, representing public authorities, academia and research institutions, and civil society organisations active in environmental protection, waste management, local development, and maritime affairs.

Local Insights: Marine Litter Challenges in Dubrovnik

The first objective of the workshop was to engage the participants in a discussion on the main gaps and needs that are contributing to marine litter creation in the wider Dubrovnik area. The identified issues reflect a combination of governance gaps, particularly as it regards waste management, infrastructure limitations, behaviour patterns and external pressures. The list that follows presents the identified gaps/needs, from most to least important, as ranked by the stakeholders:

1. Single-Use Plastics from overtourism: Dubrovnik receives more than 4 million overnight stays annually. This seasonal tourism pressure generates large quantities of single-use plastic waste, increasing the risk of littering in coastal and marine environments. The stakeholders noted that the majority of these are plastic bottles, however, cleanup and monitoring activities frequently identify ice cream cups/lids and other single-use plastic items in the coastal and marine environment. Tap water is potable in Dubrovnik; however, tourists are not aware, and no efforts are implemented to inform them. The stakeholders noted that bottled water is an important source of income for touristic enterprises; therefore, this lack of communication to tourists is convenient. Furthermore, while a Deposit Refund System (DRS) is operational throughout Croatia, covering plastic drink bottles, aluminium cans, and glass bottles, a lot of this waste is not captured by the system. The reasons are discussed in point 2 below.
2. Ineffective waste collection system: As mentioned above, a Deposit Refund System is operational in Croatia, which accepts plastic (PET), aluminium and glass beverage containers over 0.20 L of volume. The deposit is set at 0.10 euro per container. Supermarkets and stores larger than 200 square metres are obliged to accept these containers and issue either a refund or a voucher redeemable at the store. The stakeholders noted that there are two main issues with the DRS in Croatia. The first is the very low deposit, which is not enough to incentivise the return of the containers by most of the Croatian population. Tourists are generally not aware of the existence of the DRS, and in any case,

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are unlikely to return their beverage containers. Furthermore, the stakeholders noted that there is a scarcity of collection points, especially in the historic part of the city and in touristic areas, which inconveniences anyone interested in returning their containers. Moreover, stakeholders noted that in some local authorities in the wider Dubrovnik area, pay-as-you-throw schemes are in operation for residual waste. It is not uncommon for people to illegally dispose of their waste in nature to avoid paying for their waste collection.

3. Insufficient control of waste: the stakeholders stated that there is a lack of control regarding how waste is managed, which is directly linked to the lack of sufficient and suitably trained personnel within the relevant public services. Waste is often improperly separated in the municipal recycling bins. The stakeholders noted that this is because there are neither regular controls – manual or automated – nor suitable repercussions for those who fail to correctly separate and dispose of their waste. It was also noted that insufficient tracking and control of industrial and commercial waste results in illegal waste dumping.
4. Insufficient waste management infrastructure at small ports: the Dubrovnik Neretva County hosts over 50 ports, most of which are small. Many of these ports receive waste from small boats and mini-cruise vessels. However, they do not have the necessary infrastructure to be able to separately collect the waste that is being delivered.
5. Waste from mini-cruisers: mini-cruisers, vessels that undertake short, daily cruises in the Dubrovnik Neretva County area, allowing tourists to visit the nearby islands, are a significant source of litter, according to the stakeholders. The International Maritime Organization's MARPOL regulations require vessels to collect waste produced on board in separate bins and to record the amount of waste that they dispose of and the receiving port. Due to their size and operational characteristics, many mini-cruisers are subject to less stringent reporting and waste management requirements than larger vessels, creating potential gaps in oversight and accountability. This, coupled with the insufficient waste management infrastructure at small ports (point 4 above), contributes to marine litter pollution in the area.
6. Accidental loss of aquaculture waste: shellfish farming, particularly for mussels and oysters, is a very large industry in the area. Tubular nets, used to grow mussels and oysters, are often lost into the marine environment when they accidentally break, contributing to plastic and microplastic pollution.
7. Lack of available and free infrastructure for collecting end-of-life fishing gear: stakeholders noted that there is a lack of available infrastructure for collecting end-of-life (EoL) fishing gear at ports. One of the quoted reasons is the fear that, as there is limited control over what goes into each bin, the bins for fishing gear will be used to dispose of other types of waste. Furthermore, it was noted that where bins are available, fishermen are required to pay a fee to dispose of their gear, which can act as a disincentive for the proper management of EoL fishing gear.
8. Ineffective waste management contracts: public authorities use subcontractors for the management of waste. Very often their contracts do not require them to separately collect waste. This is an important loophole, which results in the mixing of waste and consequently a reduction in the quality and value of recyclates. The stakeholders also noted that this causes the public's mistrust in the way in which their waste is managed, and disincentivises them from properly sorting their waste.
9. Transnational waste: waste from the Neretva River washing up in the sea around Dubrovnik, as well as waste that enters the Adriatic from neighbouring countries, were considered by the stakeholders

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as important contributors to the marine litter issue in Dubrovnik. It was also noted that the geographic positioning of Dubrovnik and the hydrological conditions in the area, result in waste accumulating in the surrounding waters.

Further to the gaps and needs identified above, the stakeholders recognised that a key problem is the lack of an environmental culture and behaviour, which results in widespread littering. The stakeholders agreed that this is a horizontal issue that should be addressed through extensive education and awareness-raising activities, targeted to several audiences including the general public and industry.

Co-development of Solutions to Effectively Address Marine Litter in Dubrovnik

Dubrovnik stakeholders identified single-use plastics by overtourism and inefficient waste management as the two most important marine litter contributors in Dubrovnik. Following the identification and prioritisation of the main challenges, stakeholders, guided by the expert facilitator, co-developed and evaluated four potential solutions to address each of these two gaps/needs. The evaluation of the solutions was undertaken using the DeCyDe-4 multicriteria assessment developed by Dr Xenia I. Loizidou and Dr Michael I. Loizides, as reported in Loizidou et al., 2021.¹ The stakeholders evaluated the identified solutions across the criteria of 'Effectiveness' and 'Implementation'. The sections that follow present the outcomes of this evaluation. The numerical results of the multi-criteria assessment appear in Figure 1.

Addressing Single-Use Plastics Produced by Overtourism

To address this challenge, stakeholders identified the following solutions (ranked in terms of effectiveness and applicability):

- Install more water refill stations: while some water fountains are available in the city, these are not enough, specifically in the most touristic parts. Installing more water refill stations, where clean, cooled water is offered to the city's visitors, free of charge, would help minimise the use of single-use plastic bottles.
- Involve HoReCa and tourism authorities in promoting reusable alternatives: the role of hotels, restaurants and cafeterias in informing tourists about the fact that the city's water is potable and encouraging them to use reusable bottles is crucial and was identified as a very important solution by the stakeholders. Reusable water bottles, and sustainable alternatives to other single-use plastics, including for example ice cream spoons, could be promoted by the tourism industry as part of their corporate social responsibility schemes and their contribution to the city's sustainability.
- Expand the network of Deposit Refund System (DRS) return points, particularly in tourist hotspots and the historic city centre: this was identified as an important solution to ensure that residents and tourists alike are incentivised to return their water bottles at designated points.
- Increase the deposit amount for the DRS: stakeholders noted that the current deposit amount, set at €0.10, is not sufficient to incentivise and encourage residents or tourists to return their empty water

¹ Loizidou, X.I., Orthodoxou, D.L., Loizides, M.I. *et al.* A community-based approach for site-specific policies and solutions on marine litter: the example of Paphos, Cyprus. *Environ Syst Decis* **41**, 33–44 (2021). <https://doi.org/10.1007/s10669-020-09786-9>

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bottles. Increasing this deposit to at least €0.25 would provide a sufficient incentive for returns. This would also ensure that any bottles inappropriately disposed of would be collected by informal collectors, as they would have a more significant value.

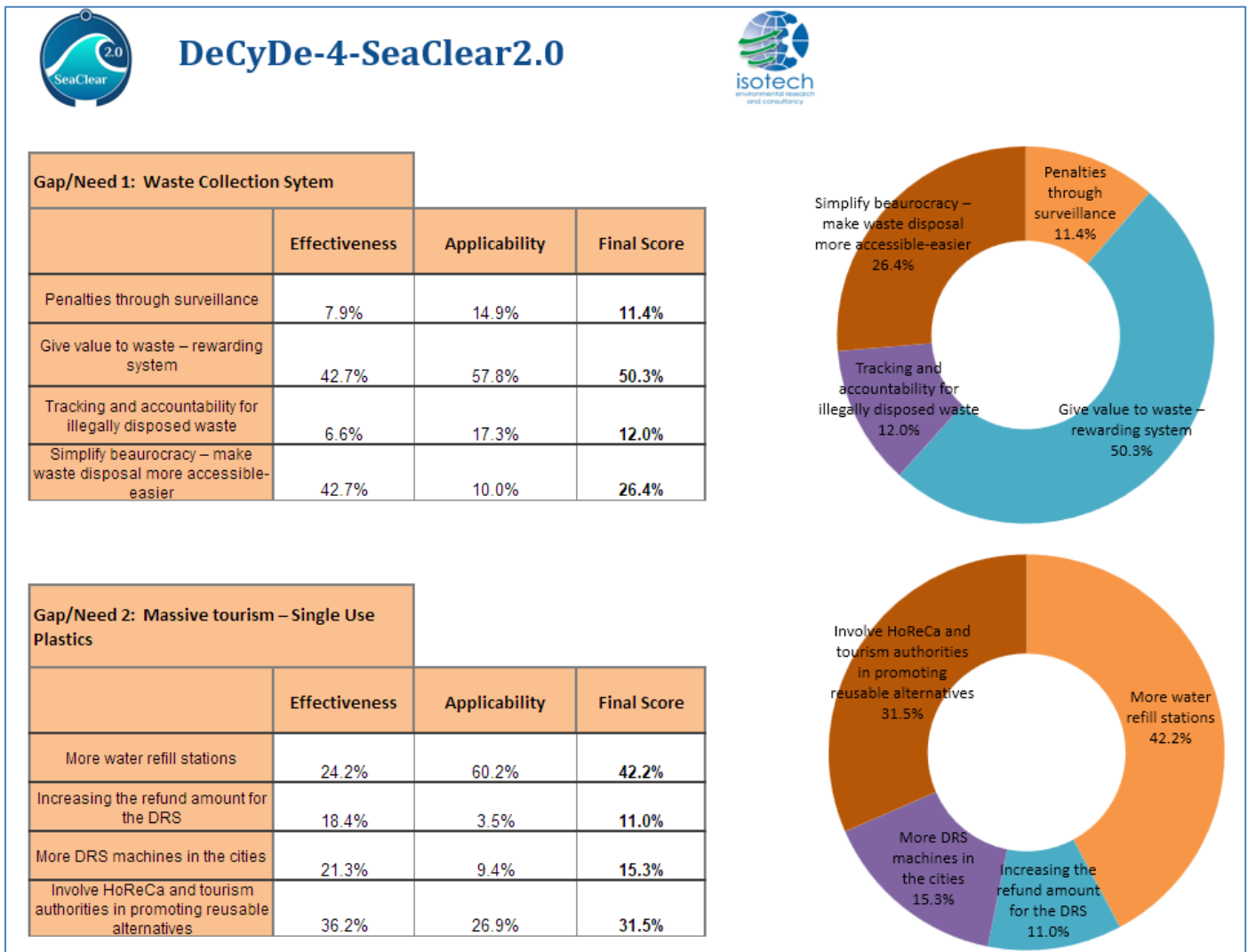


Figure 1 Results of the DeCyDe-4-SeaClear2.0 multicriteria assessment of the proposed solutions.

Overcoming the Current Inefficient Waste Management System

To address this challenge, the following four solutions were identified by the stakeholders, presented here from the most to the least effective and applicable:

- **Introduce incentives for waste separation and recycling - Give value to waste:** The current waste management system could be strengthened by introducing reward schemes and economic incentives that encourage households and businesses to properly separate and recycle waste.

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- Simplify bureaucracy: bureaucratic processes can be quite complex and challenging, making it difficult to navigate and properly follow the relevant rules and regulations. Simplifying the bureaucratic procedures and streamlining the processes of obtaining the relevant licenses, particularly for construction, would facilitate proper disposal and management of waste.
- Tracking and accountability for illegally disposed waste: the stakeholders noted that there must be a way through which waste movements can be tracked to ensure that the owners of illegally disposed waste can be identified and are made accountable.
- Penalties through surveillance: the fourth solution identified by the stakeholders was the imposition of penalties on polluters and on those who fail to properly separate and manage their waste. A smart surveillance system could be used to this end.

Conclusion

The Dubrovnik stakeholder workshop highlighted that marine litter in the region is driven by a combination of tourism-related pressures, shortcomings in waste management systems, infrastructure gaps, and behavioural factors. Participants identified single-use plastics generated by overtourism and inefficiencies in waste collection and management as the most pressing challenges requiring immediate attention. The solutions prioritised by stakeholders emphasise both preventive and systemic approaches.

A recurring theme throughout the discussions was the need to strengthen environmental awareness and foster a culture of responsible consumption and waste management among residents, visitors, businesses, and public authorities. Participants recognised that education and awareness-raising activities are essential enablers for the successful implementation of technical, regulatory, and economic measures.

The outcomes of this workshop will contribute directly to the broader SeaClear2.0 policy analysis and the White Paper that will be delivered towards the end of 2026, ensuring that the experiences and priorities identified in Dubrovnik inform scalable and impactful marine litter prevention strategies across Europe and the Mediterranean.

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