



Socio-Economic Assessment of the Costs of Marine Litter

Marine litter is increasingly recognized as one of the major global environmental problems. The empirical evidence base assessing the extent of these problems worldwide is growing fast. However, remarkably few studies exist that have investigated the social costs of beach litter. Beach clean-up costs are, for example, monitored sporadically. Moreover, the social costs of marine litter include more than the financial clean-up costs of debris washed ashore. Beach litter is perhaps most visible and directly affects public recreational experiences, and is easiest expressed in monetary terms as the financial expenditures of cleaning up beaches, but the damage and associated social costs of marine litter also extend to other sectors such as residential property values affected by the presence of litter, the fishery sector where litter damages nets and more broadly marine ecosystems, that suffer as a result of the litter ending up in seas and oceans. The estimation of these latter damage costs to marine ecosystems and the services they provide is fraught with difficulties, not least because of our currently limited understanding of the physical impacts of marine litter on the marine ecosystem structure and functioning, let alone how the fragmentation and accumulation of marine litter in the food chain affects human health. Any integrated economic assessment of the social damage costs of marine litter crucially depends on such scientific understanding.

An economic welfare analysis ideally compares the costs of measures to prevent litter to enter the marine environment with the economic damage and clean-up costs of marine litter. Due to a lack of data and information, not least because of a fundamental lack of knowledge in many cases about the causal relationships between pollution sources and their impacts on the environment and humans, we are still quite far from being able to carry out such welfare analysis in a consistent and systematic manner. The main conclusion in this report is that despite increasing interest in marine litter still remarkably few studies exist that investigate their social costs. The case studies presented in this project task aim to add to the limited empirical evidence base of the costs of marine litter. These costs consist on the one hand of the clean-up costs of beach litter or floating litter in ports. The costs of marine litter consist on the other hand also of the environmental damage costs to marine ecosystems and marine living organisms and through existing food chains increasing risks to human health.

Four case studies are presented in this project task, each using a different research methodology. However, within every single case study where possible the same research methodology was used across different European member states to enable cross-country comparisons. The four case studies and their main outcome are summarized below.

Beach clean-up costs in selected municipalities of the Netherlands and Italy

The first case study surveyed municipalities along the Dutch North Sea and Italian Adriatic Sea using the same semi-structured telephone and email interview protocol to collect data and information about beach litter monitoring. In none of the municipalities regular monitoring takes place. The survey elicited the different types of litter found on beaches and the costs of cleaning up the litter on beaches and highlighted the differences in available data and information supplied by municipalities. This makes a comparative analysis both within and between countries very difficult. Expressing the annual beach clean-up costs in a comparable unit such as per ton per year, we furthermore find enormous variation (€25-3810 per ton per year), suggesting that there exist significant differences in the cost-effectiveness of the

manual and mechanic clean-up methods. However, we are unable to explain this variation, also not when linking these costs to the presence of garbage bins for example although these are expected to lower costs substantially. The study concludes that there is an urgent need for more reliable and consistent data points for more municipalities over a number of years to filter out for example potential weather impacts, including a set of common explanatory factors, such as beach length, number of garbage bins, number of visitors during peak and off-peak season, and more detailed descriptions of the clean-up activities, including or excluding transport of beach litter and waste disposal.

Clean-up costs of floating litter in the Port of Barcelona

The second survey was carried out in one of the largest ports in the Mediterranean Sea (Barcelona) and consisted of collecting, identifying and tracing the sources of floating debris in the port area. Data on the abundance of floating marine litter is equally scarce and not monitored regularly. This hampers the identification of preventive management measures to effectively tackle this problem. Besides collecting floating debris, also the collection costs were estimated and based on the identified sources possible future waste prevention measures and their costs for comparison with the clean-up costs. Not knowing the origin of marine litter makes it hard if not impossible to identify cost-effective measures to target the sources of pollution. Therefore this second survey collected and traced the sources of floating debris in the port area. Most of the litter appeared to come from tourists visiting the harbour. The estimated costs of waste prevention was compared with the annual costs of more than 300 thousand euros to clean-up approximately 35 thousand kg of floating litter every year. The latter is equal to a unit cost of €8,900 per ton per year for an area just under 4 km², which is many times more than the clean-up costs of the beaches included in the first survey. Implementing (more) preventive waste management measures such as placing more garbage bins or patrolling the area for littering is expected to substantially reduce these clean-up costs.

Marine litter problem perception and willingness to pay for clean-up in Bulgaria, Greece and the Netherlands

In the third survey 785 visitors to 6 urban beaches in Bulgaria, Greece and the Netherlands along the coastlines of the Black Sea, Mediterranean Sea and the North Sea were interviewed in person using the same questionnaire, and asked about their perception of beach litter, how beach litter affected their beach experience, and whether they would be willing to volunteer in beach clean-up actions or pay local entry fees and municipality taxes for beach clean-up. Actual or potential clean-up costs can be directly compared to this estimate of willingness to pay (WTP) to assess the economic welfare effects of clean-up actions in a cost-benefit framework. The study is unique because it is the first to assess the social costs of marine debris washed ashore and litter left behind by beach visitors along different European coast lines. Public WTP is on average and in absolute terms significantly higher in Bulgaria than in the Netherlands and Greece. However, in relative terms compared to the beach visitors' average annual income levels, the estimated WTP values are slightly higher in the Netherlands (0.01%) than in Bulgaria (0.07%) and lowest again in Greece (0.003%). In the Netherlands public willingness to contribute in kind as a volunteer in beach clean-up actions is also highest. Moreover, WTP is higher for litter left behind by beach visitors than for litter washed ashore for which they probably feel less responsible, and for plastic bags and bottles than for glass bottles and cigarette butts. WTP is lowest for fishnets and ropes. These latter results suggest that although cigarette butts were mentioned as most frequently encountered beach litter in all three countries, visitors prioritize the clean-up of larger plastic bags and bottles over these smaller cigarette butts.

Potential impacts of marine litter on the fishery sector

The fourth and final case study focuses on the potential impacts of marine litter on the fishery sector. The European fishery sector generates more than 7 billion euros annually and the main interest here was to assess, based on the available scientific knowledge and evidence, the potential impact of fragmented (micro)plastics on fish stocks and hence the economic value they generate every year, as an indicator of the potential economic damage costs of marine litter. A new 3D-modelling technique was applied to first assess the potential exposure of key fish species to micro plastics and the subsequent impacts on the fishery sector in the North Sea. This case study illustrated most evidently the need for integrated environmental-economic impact assessment procedures to assess the socio-economic costs of marine litter. The estimation of the potential economic damage costs of plastic particles in European seas to the European fishery sector depends crucially on the validity and reliability of underlying scientific models, linking exposure to micro plastics to the risks to fish and human health. The latter is essential in order to be able to assess the share of fish that can and cannot be marketed without posing any health risks. The economic damage estimates range between more than 100 million euros to over 2 billion euros, illustrating the enormous scientific uncertainties underlying the damage assessment. These values should therefore not be given much weight given our currently very limited understanding of the impacts of marine plastics on fish stocks and human health.