



From Source to Sea

– informing decisions to tackle plastic pollution

Plastics pollution is a pervasive and complex social problem. It is a result of linear economies, abundant disposable products and packaging, poor waste prevention and management, and human conduct. The responsibilities are spread across multiple sectors and so there is no simple solution. Plastics pollution also represents a loophole in resource efficiency that could be addressed by moving towards a more circular economy, not only making our environment healthier but also allowing communities to flourish.

Plastics in the environment - risks and impacts

Oceans play a crucial role in the regulation of the Earth's climate. They are important for transport and more than half of the world's population depend on them for multiple resources, including food. Marine plastics pollution is a growing problem: approximately 8 million tonnes of plastic enter the planet's oceans each year and we expect the production of plastics to quadruple by 2050.

Marine and freshwater plastics have serious impacts on wildlife, coastal and river communities, and the economy. The risks for human health are still unclear but there is cause for concern. Plastic waste takes a long time to degrade in aquatic systems and so it tends to accumulate and fragment into smaller and smaller particles that can be mistaken for food and ingested by a range of organisms, including tiny organisms such as zooplankton. In this way, plastic particles and associated toxic substances can enter the aquatic food chain. Elsewhere, in our cities, plastics pollution is affecting the quality of surface water and blocking drainage systems, and it may even be a vehicle for the spread of waterborne diseases.

Plastic debris is a human health issue

Knowledge and tools for policy - and decision-makers

Where are measurements most effective and how can we put science at the best service of policy? We know that good decision-making depends on presenting complex information in easily understandable and transparent ways.

We develop knowledge on the basis of data, model and information systems so that we can provide technical advice about plastics pollution that is relevant for management purposes throughout the world. That effort targets not only the levels and impact of plastics pollution but also how plastic waste can be generated on land and washed off into the sea through rain and rivers. We draw on our knowledge and models to develop integrated approaches that take complexity and the interaction with our environment into account, allowing for more realistic estimates and the simulation of different scenarios.

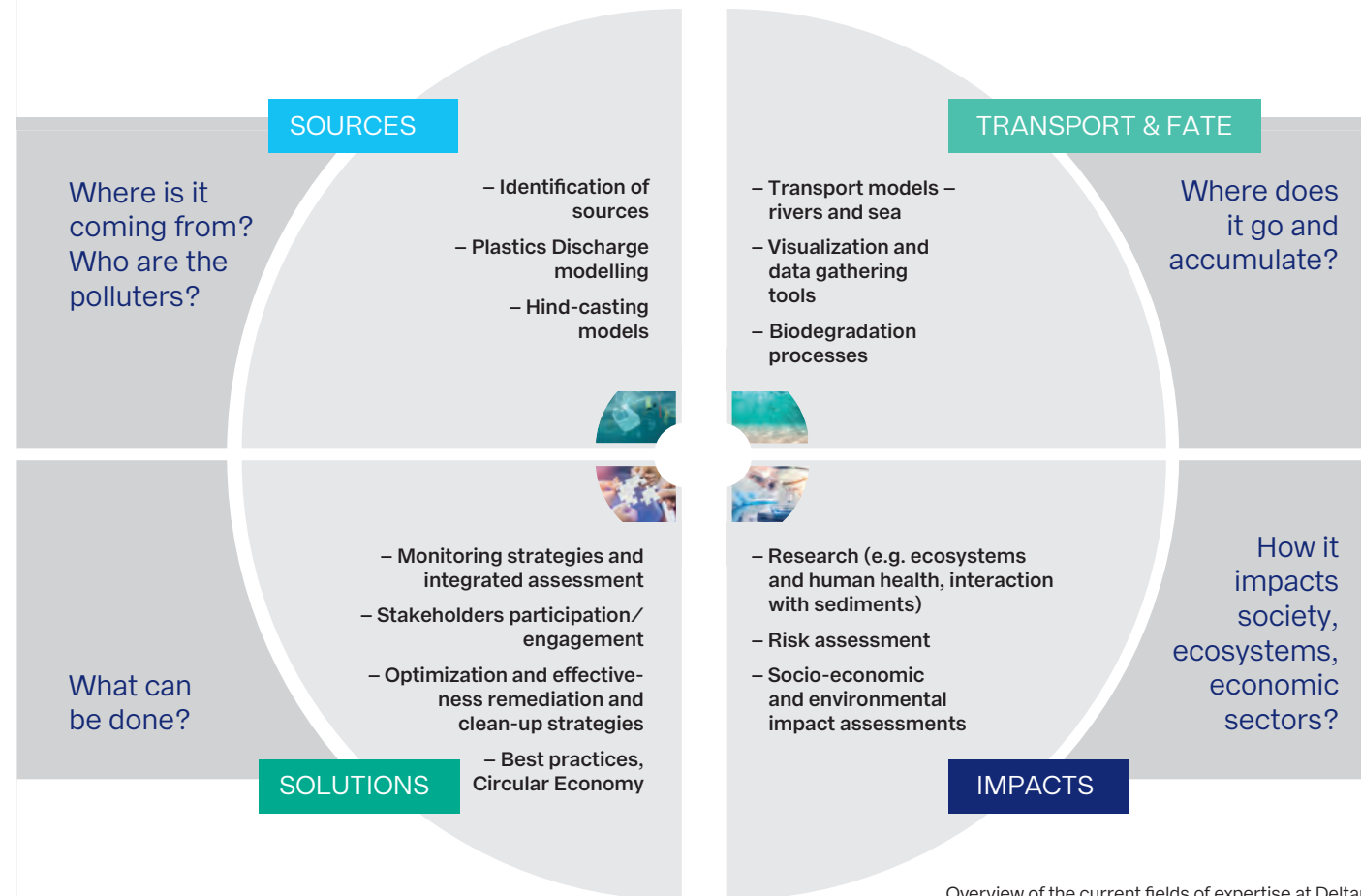
Understanding the impact on ecosystems and livelihoods

Plastics in water systems are potentially *toxic* for the environment and humans. In addition, the impact at the *ecosystem level* can have knock-on effects on important *socio-economic sectors* such as fisheries and aquaculture, leading to reduced yields or more contamination of products. In the European MICRO project, Deltares developed transport models for predicting hotspots of plastic particles in marine waters and sediment. That made it possible for us to assess the impact on the economy. We looked at how microplastics affect specific species such as snails and zooplankton, and economic sectors such as aquaculture and tourism. We have been developing the relevant models in the European *CleanSea* project.

Plastics can also affect bathing water quality or, when hygienic conditions are poor, further the spread of water-borne diseases. Plastic waste on beaches leads to huge clean-up costs to keep the coast attractive for tourism.

Targeted cleanup operations to improve water quality

A lot of plastic waste can be removed from waterways before it enters the sea. Using our numerical models for particle transport and our knowledge of river



Overview of the current fields of expertise at Deltares in the field of plastics pollution

processes, Deltares is advising the private sector about the best locations for removing waste from rivers. Our marine model of the coastal waters near the Japanese island of Tsushima (2016) has been used to help *The Ocean Cleanup* in their attempts to tackle the Great Pacific Garbage Patch.

We also use model simulations of particle transport to show where high concentrations of plastics occur and how these are transported on rivers and ocean currents. This makes it possible to identify the locations of the main “sinks” and hotspots. This knowledge can be used in monitoring strategies and for the cleanup and identification of impacted areas. For example, to improve the targeting of litter cleanup operations in preparation for the 2016 Olympic Games in Rio de Janeiro (Brazil), we developed an operational forecasting system to collect and process data about water levels and currents. This made it possible to



A simulation show how plastics are transported along the Dutch coast by tides and currents

produce real-time simulations and locate floating litter in Guanabara Bay.

Identifying sources to make informed decisions

The problem is not limited to the familiar plastic soup in our oceans (from the Arctic regions to the deep seas), seas, lakes, rivers and urban waters: plastic particles can be found everywhere in our biosphere, including the soil, the air and our food chain. Our D-Emission model can provide better quantitative data about how the generation of waste and subsequent management measures can lead to discharges of plastic waste into the environment, including rivers and the sea. In this way we link plastic waste to its sources.

In several projects for the Dutch national government, Deltares has assessed the fate and transport of microplastics, identifying hotspots and indicators as a first step towards a monitoring programme. Deltares is also assisting the European Environment Agency (EEA) with the development of a set of Marine Litter indicators with a view to a more integrated assessment of the issue, and the prevention of plastic pollution.



River Citarum Indonesia, photo Deltares



Deltares has contributed to a study for the European Commission in which we estimated discharges of microplastics from major European rivers into the marine basins of Europe.

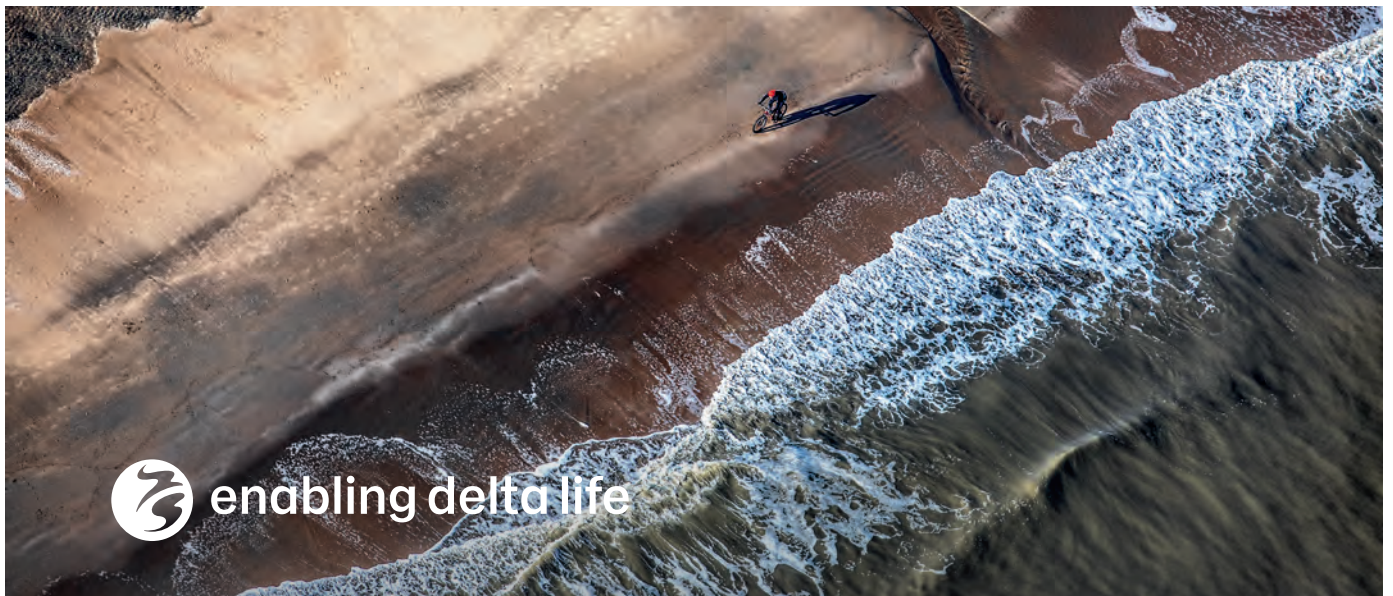
More recently, we led an assignment to support the Indonesian Coordinating Ministry for Maritime Affairs with the determination of a baseline for marine litter in Indonesia, which can also help to adequately measure their progress in the prevention of marine litter. We combine the D-Emission model with hydrological and

plastic plume modelling and use Indonesian datasets on waste management and from field measurements. In the project, which was financed by the World Bank, we have produced estimates of the discharges of plastic waste into the sea, mostly through rivers, from land-based sources.

More info:

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Deltares is an independent institute for applied research in the field of water, subsurface and infrastructure. Throughout the world, we work on smart solutions, innovations and applications for people, environment and society. Deltares is based in Delft and Utrecht.

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