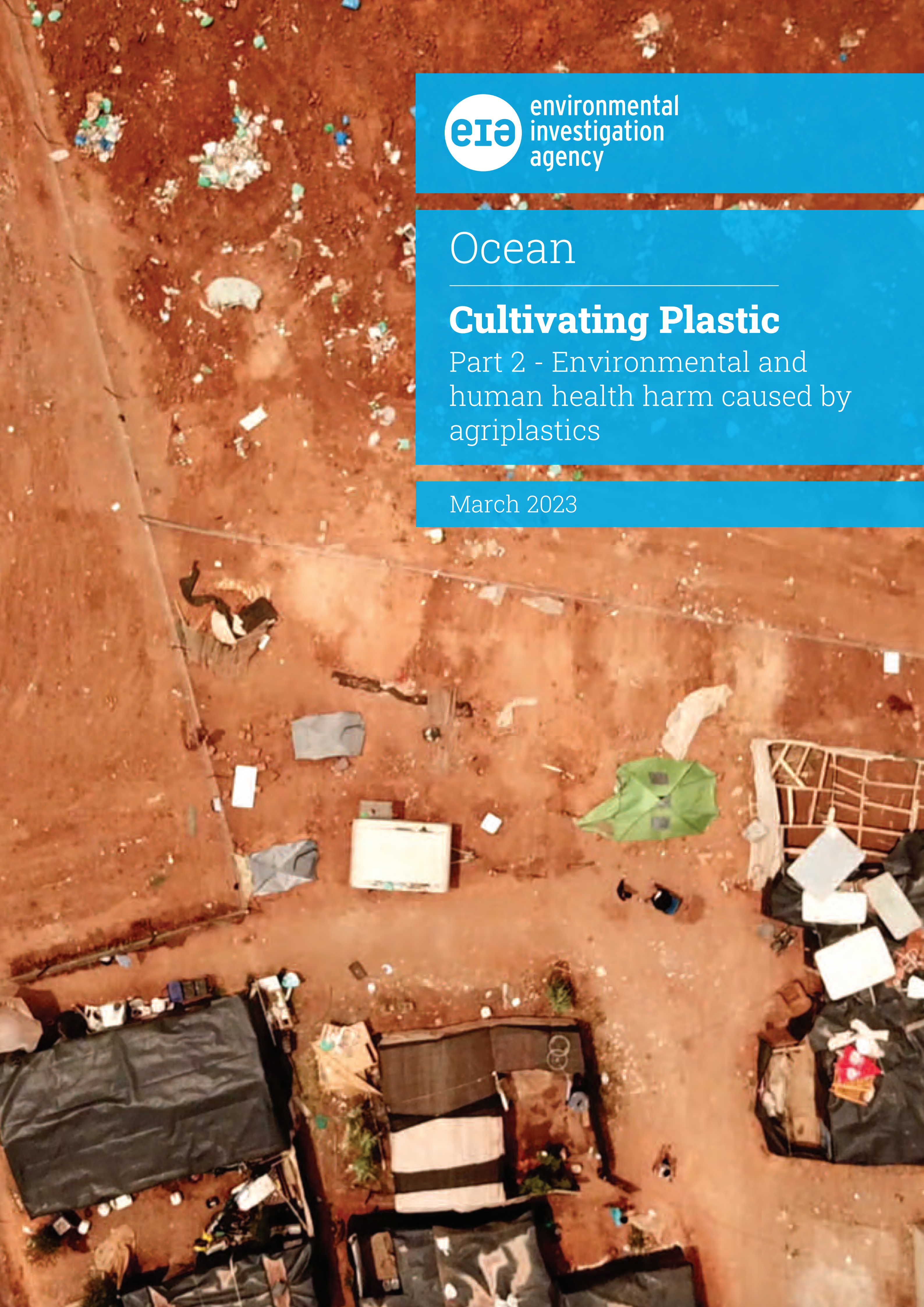

environmental investigation agency

Ocean

Cultivating Plastic

Part 2 - Environmental and human health harm caused by agriplastics

March 2023


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ABOUT EIA

We investigate and campaign against environmental crime and abuse.

Our undercover investigations expose transnational wildlife crime, with a focus on elephants and tigers, and forest crimes such as illegal logging and deforestation for cash crops like palm oil. We work to safeguard global marine ecosystems by addressing the threats posed by plastic pollution, bycatch and commercial exploitation of whales, dolphins and porpoises. Finally, we reduce the impact of climate change by strengthening and enforcing regional and international agreements that tackle climate super-pollutants, including ozone depleting substances, hydrofluorocarbons and fossil fuels.

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Front cover ©EIA: Agriplastic waste pollution on a farm. Agriplastic design, use and waste cause environmental and human health harm, and so concrete policy solutions are urgently required. .

Above: Agriplastic waste illegally dumped by a Spanish coastline. Agriplastic pollution is not limited to farmland, due to leakage and mismanagement (like dumping) agriplastics can pollute other environments, including marine ecosystems.

CONTENTS

Introduction

Published literature to date clearly outlines the widespread severity of the scale of this form of pollution, from its use and application to mismanagement at the end of life.

Agriplastics are used widely in agriculture to grow and store produce, yet peer-reviewed research on their impacts is still in its infancy. Despite this, published literature to date clearly outlines the widespread severity of the scale of this form of pollution, from its use and application to mismanagement at the end of life.

Another critical factor is the impact such pollution can have on human health, especially that of workers in close contact with agriplastics at their end-of-life, but also at varying stages of the materials' lifecycle from the point of production.

Above: Degraded plastic greenhouse covers. Agriplastic pollution doesn't just stem from when it becomes waste at the end of its life. Agriplastic degradation and breakage throughout use, as captured above, can then lead to plastic contamination of the surrounding environment and beyond. Plastic contamination of soils have been said to reduce crop yields in the long term.

Opposite page: Agriplastic left in the open environment. Agriplastic pollution is worsened by the fact that wide-scale collection of agriplastic waste is not common, and so waste is more vulnerable to mismanaged. This includes dumping of agriplastic waste.


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Environmental impacts

Agriplastic leakage into the environment causes physical, chemical and biological harm to soil, terrestrial, aquatic and marine life, ecosystems and ultimately - through trophic transfer - human health.[1]

The effects are often combined; examples of these impacts include:

Soil quality – Due to many factors, soil quality has been degrading over recent decades. One of the pollutants driving this is plastic contamination,[2] posing a major threat to soil health and fertility.[3] Terrestrial microplastic pollution is estimated to be up to 23 times higher than in the oceans,[4] with soil being a significant 'sink' for microplastics in that it is one of the main mediums in which they accumulate.[5]

Agriplastics have been shown to leak into and accumulate in soils.[6] This stems from both the breakdown of intentionally used agriplastics (e.g. plastic films used for mulching, drip lines, tree guards)[7] and application of agricultural products unintentionally contaminated with plastic (e.g. compost, sewage sludge, manure and through irrigation).[8] Soil contamination via agriplastic use is further exacerbated by agriplastic waste dumping and mismanagement, including burning and burying agriplastic waste on agricultural land.[9]

Plastic contamination can change soil properties, such as its density or how water collects and moves through it, subsequently impacting water availability and impeding the movement of essential elements in soil such as air, moisture, nutrients and soil biota such as micro-organisms, insects and worms.[10]

Plastics also change soil texture and composition, which also alters the level of water retention, permeability, pore structure and density, affecting the evaporation process of soil.[11]

Plastic contamination also has toxic effects due to the chemicals they contain, adsorb or transport. Adsorption includes POPs (persistent organic pollutants), pesticides, herbicides and heavy metals[12] and can change soil acidity (pH).[13] The impact of these plastic contaminants goes far beyond soils themselves, they also have been shown to have consequences on microbial activity, fauna, flora, human and other ecosystem health.[14]

Soil dwelling organisms – Both the toxic and physical impacts of plastics in soil can cause harm to soil biodiversity,[15] including microbial activity and soil-dwelling organisms.

Microplastic-driven changes in soil microbial biodiversity can impact key functions in ecosystems, such as nitrogen-fixing associations, which in turn impacts on plant growth and health.[16]

Studies have shown impacted fauna include not only soil microbiota that could enhance trophic accumulation, but also organisms that perform essential ecosystem services such as soil-dwelling invertebrates, fungi and plant-pollinators.[17] This includes species such as earthworms, nematodes, isopods and mites. Once ingested by soil organisms, plastics can affect their growth, reproduction, immunity and gut micro-organisms. Some additives in plastics, such as phthalates and bisphenol, can cause hormonal effects in some invertebrates.

Plant health and crop yield – Studies have shown that plastic contamination in soil negatively impacts seed germination and the height of plant shoots.[18] Soil property changes arising from plastic contamination (i.e. soil water evaporation, soil water infiltration, soil organic matter, soil available phosphorous) also result in reduced plant height, root weight[19] and plant health generally.[20] This includes microplastics altering soil structure, contributing to nutrient immobilisation and the transport of contaminants, including toxic chemicals, that can be absorbed by plants, however, research in this area is within its infancy.[21] Nanoplastics and microplastics can also be absorbed directly by plants and so enter the wider food chain.[22] Their accumulation in food chains and subsequent leaching of harmful substances, such as bisphenols and phthalates, into food during crop production is a matter of increasing concern.[23]


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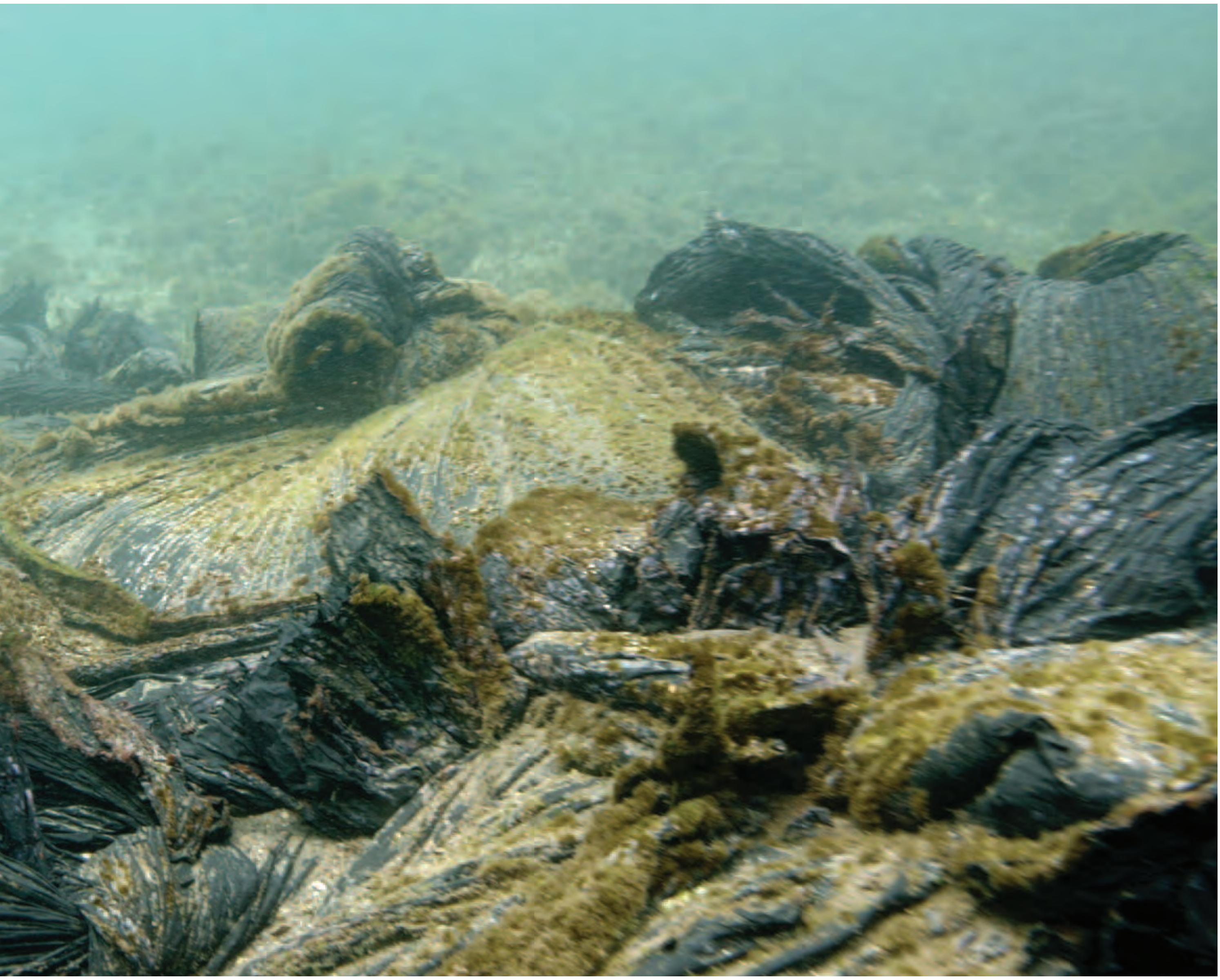
Microplastic contamination has also been shown to reduce crop yields; mulching film residues especially have been said to be a factor causing their decrease.[24] The exact reasons for crop yield reduction are unclear since the relationship between plastic and crop yield is not a simple one and depends on multiple factors, with further assessment needed.[25]

Grazing, terrestrial animals – Terrestrial animals, both wild and domesticated, are exposed to plastics pollution largely from leakage as a result of their use within the agricultural sector.[26]

For instance, low density microplastics have been detected in 92 per cent of sheep faeces tested in south-east Spain, an area where intensive vegetable farming takes place.[27]

Macroplastic ingestion, entanglement and entrapment can cause both lethal and sub-lethal impacts.[28] Microplastic ingestion, its subsequent accumulation and associated toxicity when entering the food chain is a concern that needs to be researched further.[29]



Atmosphere – Microplastics can be dispersed in the air; a recent study estimates that five per cent of microplastics in the atmosphere originate from agricultural soils.[30]

Not only that, the open burning of agriplastic waste releases contaminants into the atmosphere, which also harm the environment and human health. These include persistent organic pollutants such as polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs), the release of which has been shown to be particularly high in the burning of PVC-based agricultural plastic waste.[31]

Water – Damaged, degraded or discarded plastic products from agriculture can leach into water resources in the form of macro-, micro- and nanoplastics.[32] Microplastics can be transported from agricultural lands to waterways via surface run-off and erosion and transported to groundwater through water permeation through soil.[33]

Lakes and fluvial networks (rivers and their tributaries) are major sinks of micro- and nanoplastics due to run-off from surrounding urban and rural landscapes.[34] Rivers and their tributaries transport plastic particles into larger bodies of freshwater, such as lakes and wetlands.[35] By entering water resources from agricultural fields, plastics can even contaminate drinking water.[36]

Aquatic and marine environments – Agriplastics can contaminate both fresh water and marine environments.[37] Entering these environments from agricultural fields, plastics can subsequently be ingested by wild freshwater species, including fish,[38] entering the food chain with potential health risks to biodiversity.[39]

The intensification of the agricultural industry and, specifically, the development of the intensive use of agriplastics around coastal areas has been proven to have a clear link with the increase in concentration of microplastics in marine ecosystems and organisms.[40]

Above: Black plastic mulch found off the Spanish coast. Dumping of agriplastic waste on coastlines and riverbeds means that macro-plastics can find their way into the marine environment, which can result in lethal and sub-lethal effects through ingestion and entrapment by marine wildlife.

Mismanagement (including illegal dumping), soil contamination and weather generate pathways through which agriplastics end up in waterways, rivers, estuaries and subsequently the ocean. They can be dumped or carried by run-off, winds, floods and currents.[41] Rivers represent the most important conduits for the transportation of anthropogenic litter to the marine environment,[42] where plastic waste[43] threatens marine biodiversity, including as microplastics.[44]

Plastics are found in coasts, mid-ocean gyres (large systems of rotating ocean currents) and depths of more than 6,000 metres.[45] It has been estimated that 70 per cent of plastic sinks to the seafloor[46] as a consequence of reduced buoyancy due to fragmentation, water movements[47] or colonisation by different organisms.[48] Interaction with marine species can occur at different stages of this path.[49]

Plastics also accumulate a complex mixture of chemical contaminants present in the surrounding seawater and serve as vectors adding to the cocktail of toxic chemicals already present from manufacturing. These include different additives such as plasticisers, antioxidants, flame-retardants and UV stabilisers and, in some cases, they make up a large proportion of the plastic product.[50] Agriplastics, such as mulching, can also be contaminated with phthalates and agrochemicals.[51] Plastic then serves to concentrate and transfer toxic chemicals from the ocean into the marine food web[52] and then into human diets.[53]

Studies that identify agricultural plastics specifically in the marine environment are currently few, but evidence is growing. For instance, a study published in 2022 found that 12 per cent of lightweight and six per cent of heavy weight riverine anthropogenic macro-litter, especially plastic, was agricultural in Sardinian rivers in Italy.[54] In 2018, researchers monitored inputs from the Adour River in south-west France to the ocean. Although they found higher quantities of agricultural tarpaulin (such as mulching film) and packaging inland, where agricultural tarpaulin and packaging made up seven per cent of inland litter composition, this could be due to the fact that those items may have been too fragmented when they reached the ocean to be identifiable.[55]

Larger pieces of macroplastic debris from agricultural and other plastic sources can fragment and degrade into microplastics as they are weakened by ultraviolet (UV) radiation, chemical degradation, wave mechanics and grazing by marine life.[56]

A study of the coasts of the Iskenderun Bay, Türkiye (previously Turkey) (an agriculturally intensive region), found an average rate of 12.2 to 12.3 ± 3.5 pcs m^{-2} plastic contamination in 13 sample sites (a high amount). The majority of plastics (59.4 per cent) were smaller than 2.5cm, the type of plastic found most often was hard plastics (broken, fragmented, and deformed) at 59.8 per cent and greenhouse coverage films at 11 per cent.[57]

Below: Burning of stockpiles of agriplastic waste. Burning of agriplastic waste as a form of end-of-life treatment is still common across the globe – despite it having serious environmental and human health impacts. In many countries burning of agriplastic waste is illegal, however lack of enforcement means these bans are often not regulated or monitored.

Human rights and health

The lack of collection and recycling infrastructure means that burning agriplastic waste at end of its life has historically been common practice – and one that continues to the present.

In addition to the environmental harm this poses, workers and communities in close proximity of this burning waste are also exposed to toxic emissions, including dioxins, furans, mercury and polychlorinated biphenyls (PCBs).[58] This exposure increases their risks of contracting serious life-long respiratory, neurological and reproductive health conditions.

Providing some insight into the human health implications related to the use of agriplastics, is Umut Kuruüzüm PhD, an Assistant Professor of Development at the Department of Economics at İstanbul Technical University and researcher at the London School of Economics and Political Science, who has been conducting research and fieldwork in the Çukurova region of Türkiye.

The UK has a significant role in influencing global supply systems and plastic pollution, both by importing food from other regions and as a major exporter of plastic waste.[59] For instance, the UK imports a variety of different produce from Türkiye, which is also a major destination of UK plastic waste and thus the UK's impact on Türkiye with regards to the impact of plastic use is twofold.

For example, according to UN Comtrade data, the UK imports different varieties of fruit (grapes, apricots, melons, dates, citrus fruit), vegetables (cabbages, onions, tomatoes) and more from Türkiye. In 2021, Türkiye was the 11th largest sourcing country for melons (net imports standing at 1,269,257kg) and 7th largest sourcing country for tomatoes (net imports standing at 838,317kg). Furthermore, of the 482 million kg per year UK plastic waste that was exported in 2022, 18 per cent was shipped directly to Türkiye.[60]

Above: Agricultural workers in close contact with agriplastic waste in Türkiye. During the COVID-19 pandemic, vulnerable groups, including refugees and their children fleeing the war in Syria have become the agriculture sector's new cheap labour in Türkiye.

Wastecaping Away: Waste, pollution, and labour in the eastern Mediterranean coast of Türkiye - Umut Kuruüzüm PhD

The Çukurova, also known as the Cicilian Plain, is located on the watery delta of the Seyhan and Ceyhan rivers in Türkiye.

One of the world's most fertile deltas, Çukurova produces a wide variety of crops generating an agricultural market worth billions of US dollars that ensures both the livelihood and the food security of populations in the Middle East, Europe and the Caucasus. The delta has historically been heavily networked with waterways and irrigation canals interconnected with Çukurova's longest rivers, Seyhan and Ceyhan, which deliver freshwater resources and irrigate farmlands, linking the terrestrial landscape with the marine ecosystem in the north-eastern Mediterranean Sea.

With a thriving agricultural economy, the region has long served as a crossroads for seasonal farmworkers and their children who travel from Kurdish-populated areas in southeast Türkiye to harvest the abundant fresh crops from May to October each year.

During the COVID-19 pandemic, refugees and their children fleeing the war in Syria have particularly become the agriculture sector's new cheap labour supply concentrated in tent settlement areas, partly having substituted seasonally migrating Kurdish families. These workers and their children live year-round in tents nestled along the network of irrigation canals and motorways with no or limited access to safe and reliable electricity, drinking water, and sanitation. As a result of using contaminated water from irrigation waterways, workers and their children chronically suffer from gastrointestinal disorders such as diarrhoea, abdominal cramps, nausea, and vomiting. Despite being registered, children of these seasonal workers rarely, if ever, attend school due to lack of funds—or worse, being required to labour alongside their parents.

Along with the capillary network of waterways and the influx of refugees, a recycling industry has recently sprouted in this landscape. Today, formal and informal recycling facilities, a chain of dealers and merchants, illegal practices, entrepreneurial activities, and improvisation proliferated along with the multiplication of informal, undocumented, and child labour. The expansion of the recycling industry in the area is undoubtedly linked to the overall growth of waste in our global economy, as well as waste trade and trafficking, primarily from the global north to the global south.

The region lies near Türkiye's largest port, Mersin, one of the busiest ports in the eastern Mediterranean Sea and a convenient stop for container ships traveling to East Asia via the Suez Canal. The region has been absorbing a large amount of plastic waste from all over Western Europe, particularly the United Kingdom, via this port. In 2020, about 40 per cent of the UK's plastic waste exports went to Türkiye, nearly half of which are either mixed plastic, styrene, or polyvinyl chloride (PVC)—materials that are neither readily or extensively recycled.[61] The circulation of globally traded waste contributed to the growth of the recycling industry, which operates through a mishmash of formal and informal work and labour practices, absorbing low-wage, vulnerable, and refugee, as well as child labour.

In addition to the growing amount of foreign garbage entering the region, the use of plastic in agriculture has rapidly increased recently in response to rising pesticide, herbicide, and gas prices as well as protection against unfavourable and unpredictable weather conditions. Based on our earlier field research in 2022, we found that a typical watermelon field in the delta requires at least 50 kg agricultural plastics per decare[62] (including mulching, drip irrigation pipes, and double low-tunnel film covers), while strawberry fields require up to 65 kg.[63] For a watermelon, melon or tomato field, a typical farmer disposes of an average of 75 pesticide containers per 100 decares of land every year. An average of 25 plastic fertiliser containers and 150 plastic fertiliser bags per 100 decares of land can be roughly added to the plastic load, making the amount of plastic waste and emissions even worse.

We also observed that agriplastics collected by refugees and seasonal agricultural workers, as well as their children, are widely used for cooking and heating in and around tents.[64] Burning mulch plastics in tent settlement areas for cooking and heating purposes by workers releases carcinogens such as dioxin and furan into air, water, and soil, posing a risk of respiratory illnesses, heart disease, reduction in cognitive and motor disabilities, and finally endocrine disruption. Inhaling plastic fumes and dust disproportionately affects women and girls (helping the mother) who cook in tent settlement areas, further degrading them now also chemically. Furthermore, the plastic and grass-mixed mulch waste piles can start fires in tent settlement areas. In the summer of 2021, for example, at least three fires broke out in one tent settlement, destroying tents and physically (further) displacing agricultural workers and Syrian refugees.

With the increased use of plastic materials in agriculture and the global trade and trafficking of waste, a recent capitalist wastescape on the Eastern Mediterranean Sea's coast is globally nurtured and governed. It not only pollutes the bionetwork, emits toxic risks, degrades the bionetwork, and accumulates anthropogenic risks, but it also contributes to the proliferation of informal work, child labour, refugee marginalisation, and feminisation of toxic poverty. This emerging wastescape is driven not only by local governmental regulations (or non-regulations) and geospatial landscapes, but also by worldwide waste politics, diplomacy, and our long-standing dependence on and consumption of plastics.
If change is demanded, our response should likewise be globally coordinated and networked.

Above: Stockpiles of agriplastic waste in Çukurova, Türkiye. Umut Kuruüzüm PhD has documented the burning of agriplastic waste by agricultural workers for heating and cooking, the burning of agriplastic waste releases chemical toxins which have serious impacts on human health.

Conclusion

The UN's 2022 declaration that everyone on the planet has a 'right to a healthy environment' underscores how human health and the environment are intrinsically linked.[65]

Agriplastic use and waste have been shown to pollute and impact the Earth's four environmental compartments – the atmosphere, hydrosphere, lithosphere and biosphere – in addition to that of human health. The impacts are both immediate and, crucially, can have long-term repercussions.

Any approaches taken to address the challenges related to agriplastic production, use and end-of-life collection and treatment must therefore be grounded in considering both environmental impacts and human health. Policy interventions and agriplastic alternatives should be designed inclusively with impacted workers and communities and take a rights- and health-based approach.

This is all the more pertinent given the world is facing a triple planetary crisis of climate change, biodiversity loss and pollution; the disproportionate impact on vulnerable and poor communities, many of whom are directly engaged in the supply of global food and resources, is only expected to intensify.

For more information

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