UNEP

VALUING PLASTIC

The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry

Citation: UNEP (2014) Valuing Plastics: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry.

This publication is a contribution to the Global Partnership on Marine Litter (GPML). UNEP acknowledges the financial contribution of the Ministry of Foreign Affairs, Norway toward the GPML and this publication.

KLIMA- OG MILJØDEPARTEMENTET

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), as Secretariat for the GPML, the Plastic Disclosure Project, its parent organisation Ocean Recovery Alliance, and Trucost have collaborated and co-funded this publication.

Thank you to the project contributors (Alice Sireyjol Trucost, Anna Georgieva Trucost, Sarah Wainwright Trucost, Apurvee Haridwaj Trucost, Siddartha Joshi Trucost, Steven Bullock Trucost, Chaoni Huang Trucost, Amudha Gunasekaran Trucost, Bindhya Manoj Trucost); **methodology reviewers** (Chelsea Rochman Aquatic Health Program University of California Davis, Mark Browne National Center for Ecological Analysis & Synthesis University of California Santa Barbara, Heather Leslie Institute for Environmental Studies VU University Amsterdam); **editorial reviewers** (Vincent Sweeney UNEP, Heidi Savelli UNEP, Tessa Goverse UNEP, Elisa Tonda UNEP, Aihnoa Carpenter UNEP, Doug Woodring Ocean Recovery Alliance, Emily Utter PDP, Erik Floyd PDP, Pua Mench PDP, Nathaniel John Maynard PDP, Conrad MacKerron As You Sow, Saskia van Gendt Method Home, James Ewell Green Blue, Leila Munroe NRDC, Darby Hoover NRDC, Ben Ridley Credit Suisse, J.Robert Gibson City University of Hong Kong, Antony Wood AK Partners, Jill Boughton W2Worth Innovations, José Miguel Friz Valor Sustentable Chile).

Author: Julie Raynaud (Trucost), **Editor:** James Richens (Trucost), Andrew Russell (PDP),
Designer: Rebecca Edwards (Trucost)

ISBN: 978-92-807-3400-3

Job Number: DEP/1819/NA

Division of Environmental Policy Implementation

VALUING PLASTIC

The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry

ABOUT UNEP

Established in 1972, the United Nations Environment Programme is the voice for the environment within the United Nations system. UNEP acts as a catalyst, advocate, educator and facilitator to promote the wise use and sustainable development of the global environment. UNEP's Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was adopted by the international community in 1995 and "aims at preventing the degradation of the marine environment from land-based activities by facilitating the realization of the duty of States to preserve and protect the marine environment."

ABOUT THE GLOBAL PARTNERSHIP ON MARINE LITTER

The Global Partnership on Marine Litter (GPML) is a new global partnership that acts as a coordinating forum, bringing together diverse organizations working in the same field and encouraging governments, non-governmental organizations, scientists and academics to collaborate on marine litter issues. The new partnership, led by UNEP, was announced in June 2012 at a launch event during the Rio+20 conference in Rio de Janeiro. It builds on the Honolulu Strategy and seeks to protect human health and the global environment by the reduction and management of marine litter as its main goal. To join or learn more about the GPML visit www.gpa.unep.org or contact the secretariat (UNEP/GPA) at gpml@unep.org

ABOUT PLASTIC DISCLOSURE PROJECT

The Plastic Disclosure Project asks organisations to measure, manage, disclose and benefit from more sustainable use of plastic. It seeks a world in which plastic adds value for consumers and businesses without negatively impacting the environment. The PDP requests annual reporting regarding the production, use, handling and management of plastic and plastic waste by organisations. By measuring the amount of plastic that flows through an organisation, efficiencies can be gained in cost and waste reduction, new design, new materials, and better recycling. By reviewing how the material is managed, organisations can recognise risks and seize opportunities that their competitors may miss. By disclosing, organisations demonstrate leadership, and attract benefits in employee engagement, supplier management, customer loyalty, and access to capital. Initially designed for large corporates, institutions such as hospitals, universities, government offices, stadia, clubs, facilities, events, sports associations and teams participate and benefit. Interested parties are welcome to contact PDP at info@plasticdisclosure.org.

ABOUT OCEAN RECOVERY ALLIANCE

Ocean Recovery Alliance is a not-for-profit organisation based in Hong Kong and California. It is focused on bringing innovation, technologies, creativity and collaborations together to address some of the challenges that face the ocean and our broader environment. The Ocean Recovery Alliance has three global projects focussed on plastic waste issues, namely the PDP and Global Alert - both of which were announced as Clinton Global Initiatives; and the Plasticity Forum - a creative discussion on how to harness plastic in new ways, both "pre" and "post" consumer use.

ABOUT TRUCOST

Trucost has been helping companies, investors, governments, academics and thought leaders to understand the economic consequences of natural capital dependency for over 12 years. Our world leading data and insight enables our clients to identify natural capital dependency across companies, products, supply chains and investments; manage risk from volatile commodity prices and increasing environmental costs; and ultimately build more sustainable business models and brands. Key to our approach is that we not only quantify natural capital dependency, we also put a price on it, helping our clients understand environmental risk in business terms.

CONTENTS

FIGURES AND TABLES

MESSAGE FROM UNEP

It is estimated that 10 to 20 million tonnes of plastic is finding its way into the world's oceans each year, costing approximately US$13 billion per year in environmental damage to marine ecosystems. This includes financial losses incurred by fisheries and tourism as well as time spent cleaning up beaches.

The total natural capital cost of plastic used in the consumer goods industry is estimated to be more than US$75 billion per year. The cost comes from a range of environmental impacts including those on oceans and the loss of valuable resources when plastic waste is sent to landfill rather than being recycled. The most significant upstream impact is greenhouse gas emissions released from producing plastic feedstock, which is responsible for almost a third of the total natural capital costs.

Oceans are critical to sustaining life's natural support systems. They contribute to the livelihoods, culture and well-being of communities around the world. They also play a vital role in the global economy by providing food and a source of income for millions of people. Yet, with a fast-growing world population, the production of waste continues to increase faster than the efforts to curtail it and prevent it from degrading the environment. More waste means more marine litter; and one of the main types of marine litter is plastic debris.

About 280 million tonnes of plastic is produced globally each year and only a very small percentage is recycled. As society has developed new uses for plastic, the variety and quantity of plastic items found in the environment, and this includes the marine environment, has increased dramatically. Once in the ocean, plastic does not go away: it fragments, eventually breaking down into smaller pieces known as microplastics, and acts as a vector for chemicals such as persistent organic pollutants that may be transferred into the food chain upon ingestion by marine organisms. Transported by ocean currents, few places around the globe have not been infested by this material.

Proper measurement, management and disclosure of information on the use and disposal of plastic will help companies to optimize its use and reduce its end-of-life impacts by fully incorporating environmental management within their business frameworks.

Forward-looking companies can improve their management of plastic by, for example, cutting costs through their more efficient use, developing "closed loop" business models that recover the resources locked up in plastic, and winning customers by creating sustainable products. Good management of plastic could save consumer goods companies up to US$4 billion per year.

Valuing Plastic: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry is a highly informative publication on the valuation of plastic that allows us, for the first time, to put a figure on the costs companies would incur if the damage caused by waste plastic was included in their accounting. The report highlights the urgent need for businesses to measure, manage and disclose information on their annual use and disposal of plastic, as many companies already do with carbon emissions. It also provides a series of recommendations for companies that are designed to help ensure a sustainable future for plastic.

The report additionally provides companies with guidance on how to achieve the same economic output with fewer inputs and less waste, leading to greater cost savings; all of which can further expand the global economy in years to come.

Through the Global Partnership on Marine Litter and other relevant initiatives, UNEP is committed to working with all stakeholders to reduce the influx of waste into the ocean and to prevent plastic from getting into the environment in general. Progress on plastic pollution will require companies to work in partnership with other stakeholders. This includes collaborating with governments to develop effective legislation and waste management infrastructure, especially in developing countries.

I encourage all involved parties, particularly businesses, to fully digest the findings of this report and consider appropriate actions aimed at implementing the recommendations in order to save money, boost profits and reduce the impact of plastic waste on the environment.

Achim Steiner

UN Under-Secretary General and Executive Director, UNEP

MESSAGE FROM PLASTIC DISCLOSURE PROJECT

Andrew Russell, Director, Plastic Disclosure Project

The Plastic Disclosure Project (PDP) is delighted to share the findings in this report.

The findings reveal concerning impacts to natural capital stemming from plastic use in the consumer goods industry. The true impacts are likely to be much more severe, as the report calculates only those that can be quantified. As science catches up with plastic use, the magnitude of impacts omitted or conservatively assessed will surely increase.

Moreover, this report highlights the risks and opportunities that plastic poses to business. The objective is to help companies respond to these challenges and become more sustainable businesses.

There is an opportunity at hand for businesses to act before legislators, consumers, investors, and community and activist NGOs force action, eroding business value. Sustainable use of plastic, as with many other resources, makes good business sense.

Business opportunities will be unique from company to company. Reviewing how plastic and its waste are managed; the design of products or packaging, including its recycled content or recyclability; and reducing the impacts of plastic on operations, communities and society at large, can unlock previously unrecognised benefits.

Such benefits are often good for business, for example, saving input costs and recovering value from waste; customer loyalty, such as preferred products and enhanced brand value; employee engagement; community satisfaction, and improved access to capital.

The failure of a business to consider these benefits and/or to demonstrate action on these issues may bring about negative impacts. Regulatory risk, reputational damage and loss of competitive advantage are all very real threats.

Companies in plastic intensive sectors theoretically have the most value-at-risk, and greatest opportunities ahead of them. Yet all companies are in a position to mitigate risks and seize opportunities in relation to proactive plastic management. Indeed, PDP recommends that all organisations measure and manage their ‘plastic footprint’.

Disclosure is an important step towards sustainable plastic use. This can be accomplished through a standalone declaration, or as part of a sustainability report. Such action demonstrates an organisation’s commitment to the issue and demonstrating year-on-year progress.

Whether a company chooses to formally sign on to the Plastic Disclosure Project, or follow its guidance informally, we ask companies to become more aware of their plastic footprint. Measure it, consider the implications and explore better management practices.

We hope this report is a clarion call for action on plastic, and that it compels organisations to take action.

We wish to thank UNEP, Trucost, all the contributors and reviewers, and the Oak Foundation for their support.

MESSAGE FROM TRUCOST

Dr. Richard Mattison, Chief Executive, Trucost

This is an exciting time for Trucost, the world's leading natural capital valuation company, to be working with the Plastic Disclosure Project (PDP) and the UN Environment Programme. Plastic is an essential material for many businesses, yet its environmental impacts cannot be ignored. Nor would any responsible company want to.

This report lays the foundations for the Plastic Disclosure Project's drive to convince companies of the need to disclose information on their annual use and disposal of plastic. Trucost's analysis demonstrates a sound business case for disclosure as the first step on the road to making companies' use of plastic environmentally sustainable.

This business case includes a range of risks and opportunities for intensive users of plastic. For the consumer goods sector, protecting brand reputation is crucial and plastic is an issue that presents significant reputational risk. There are also bottom-line benefits from cutting the costs of excessive packaging and turning plastic waste into a useful resource.

Yet plastic is just one of a host of environmental issues that companies must cope with alongside climate change, water scarcity and air pollution. Of course companies should measure and report data on plastic, just as they already do on these other impacts. But how can they make sense of this blizzard of information? How can they turn it to their advantage?

Companies need a single tool that measures environmental impacts in an integrated way together with other business issues. This is where natural capital valuation comes in. As demonstrated in this report, the technique enables companies to put a financial value on a range of impacts, including plastic, so environmental management can be fully embedded within the business. Investors can also use it to assess their exposure to environmental impacts through the equity they own in companies.

One of the most important insights revealed by natural capital valuation in this study is the 'value at risk' in consumer goods companies. This is the proportion of revenue that could be lost if companies are held accountable for the damage caused by plastic use and disposal.

Toy manufacturers have the highest plastic intensity in the consumer goods sector, at 48 tonnes of CO_2 equivalents per US$1 million revenue, due to their use of plastic in products. As a result, they have the highest value at risk at 3.9% of annual revenue. This would wipe out the profits of several companies if they had to pay the full cost of environmental damage caused by plastic. That is a finding that should make the chief financial officer sit up and take note.

Companies can also use natural capital valuation to identify 'hotspots' of pollution or resource use in their supply chains. This report shows that sectors such as retail and food have the highest supply chain plastic intensity, while soft drinks and personal products have the highest plastic-in-packaging intensity. This analysis can be used by companies to target efforts to optimise plastic use and reduce end-of-life impacts.

We all urgently need to address the issue of irresponsible production, consumption and disposal of plastic. I encourage businesses to embrace the Plastic Disclosure Project's ethos of measuring, managing and disclosing their plastic use; and welcome the businesses interest in using natural capital valuation to weigh their impacts on the environment.

EXECUTIVE SUMMARY

This research was conducted by natural capital analysts Trucost on behalf of the Plastic Disclosure Project (PDP). It was supported by the United Nations Environment Programme and the Global Partnership on Marine Litter (GPML).

OBJECTIVES

Plastic is one of the most useful and important materials in modern society. Life without the vast range of products and technologies it enables is almost unthinkable. Plastic preserves and protects food and medicine helping us lead healthy lives. It is used to make electronic devices like computers and smartphones that bring people together, and it helps make transport more fuel efficient through its use in vehicles. The versatility and low price of plastic compared with alternatives is reflected in the rapid growth of the market for the material.[1,2]

But the environmental impacts of plastic cannot be ignored. Concerns are growing about its impact on the world's ecosystems. Marine wildlife is particularly vulnerable, and harmed through entanglement and ingestion of plastic. There is a risk of microscopic particles of plastic transferring toxins into the food chain. Fields, streets and beaches are increasingly littered with plastic bottles, bags and other trash. Plastic manufacturing processes use non-renewable resources, such as oil, and release greenhouse gases into the atmosphere contributing to climate change. In addition, the use of chemical additives in plastic may be hazardous to human health. All of these impacts are gaining increased attention from stakeholders such as non-governmental organisations (NGOs), international institutions, governments, and the general public.[3,4,5,6]

The objective of this report is to help companies manage the opportunities and risks associated with plastic use. It articulates the business case for companies to improve their measurement, disclosure and management of plastic use in their designs, operations and supply chains. In order to provide a sense of scale, the report sets out to quantify the physical impacts of plastic use translated into monetary terms. This metric can be seen as the current value-at-risk to a company, should these external impacts be realised internally through mechanisms like strengthened regulation, loss of market share, or increased price of raw materials and energy. This metric can also be used to help understand the magnitude of the opportunities, and the tangible benefits to stakeholders, including shareholders, of using plastic in an environmentally sustainable way.

METHODOLOGY

The use of plastic causes environmental and social impacts. For example, incinerating plastic at its end-of-life has associated air pollution impacts. Applying 'natural capital valuation' allows these impacts to be expressed in monetary terms, reflecting the scale of damage caused. The overall value or 'natural capital cost' gives an indication of the financial cost to companies were they to internalise impacts associated with their current practices. These costs can also be factored into business and investment decision making.

In order to quantify the natural capital cost of the impacts of plastic, the high-level methodology follows six steps: sector selection, plastic use quantification, scope and boundary selection, impact quantification, and natural capital valuation and application.

As with any innovative research, there are some limitations. For instance, while the upstream impacts of producing plastic feedstock are included, the impacts of the manufacturing stage are excluded due to their diversity. Downstream impacts, in particular of plastic waste reaching the ocean when littered, are likely to be underestimated due to the absence of robust data and scientific research, for example around the impact of microplastics.

Finally, this report looks at plastic in isolation. It was beyond the scope of this study to identify alternatives, and contrast the impacts of plastic with each of these alternatives. For example, the reduced greenhouse gas emissions due to lighter transport of plastic bottles, or the high reuse rates and low toxicology of glass are not considered here.

RESULTS

The analysis identifies a range of risks and opportunities facing companies that are intensive users of plastic. Institutional investors are also exposed through the shares they own in these companies as well as the project finance they provide. Pension funds, for instance, have a fiduciary duty to protect the value of their investments.

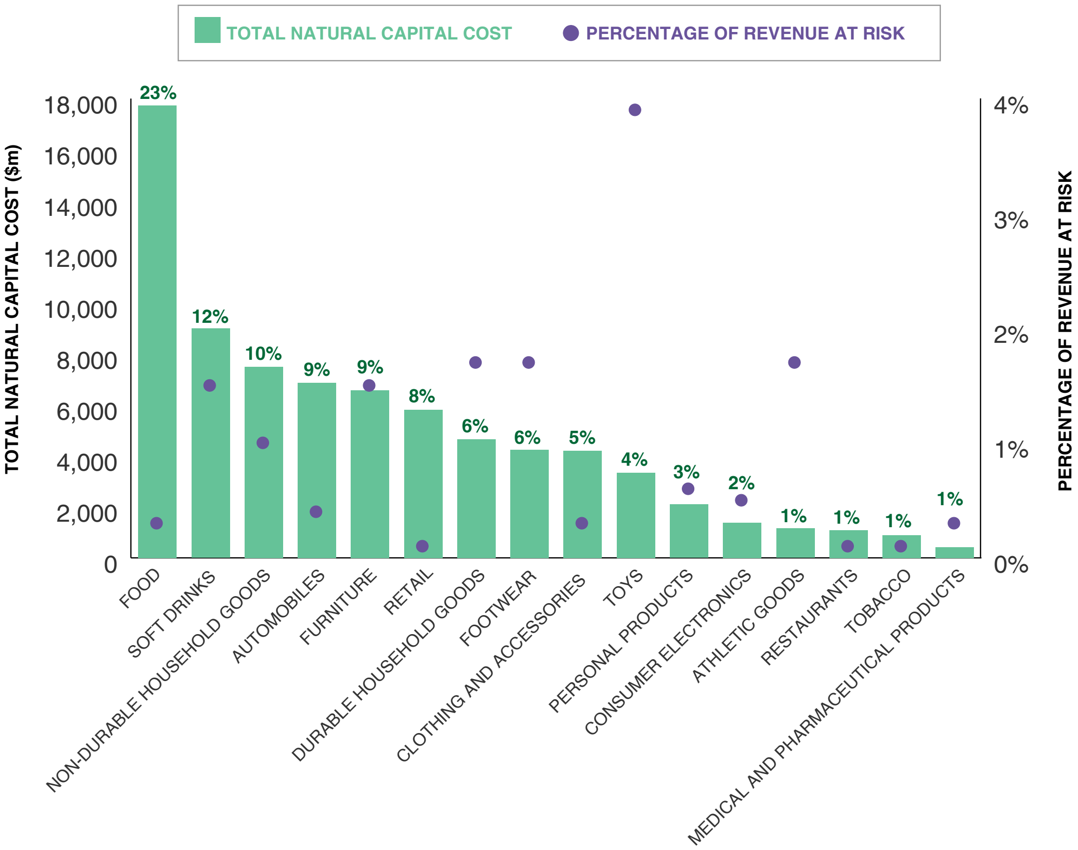
Risks include the impact of tougher environmental legislation such as bans on disposable plastic bags, carbon pricing schemes and chemicals regulation, damage done to the reputation of brands targeted by campaigners over their association with plastic litter, clean-up costs and disruption to the plastic supply chain caused by resource scarcity and price volatility. Opportunities include cutting costs through more efficient use of plastic, developing new revenue streams through ‘closed loop’ business models that recover plastic as a useful resource, and winning customers by demonstrating more sustainable products.

The research identifies where plastic is used most intensively by focusing on 16 consumer goods sectors where plastic is commonly used. The data is presented by sector, and divided into the plastic used directly within products and packaging, and indirectly within their supply chain. This information provides valuable insights to help companies focus their efforts to manage plastic.

The toy, athletic goods and durable household goods sectors use the most plastic in products per US$1 million revenue. The soft drinks, personal products and pharmaceutical sectors are among the most intensive users of plastic in packaging. The retail, restaurant and tobacco sectors use the most plastic per $1m revenue in their supply chains. This could be explained by their position down the supply chain and their reliance on the agricultural sector.

This research then analyses the exposure of companies to these risks and opportunities by expressing quantities of plastic used as a natural capital cost. The results show that the total natural capital cost of plastic used in the consumer goods industry is over $75bn per year. Broken down by sector, food companies are by far the largest contributor to this cost, responsible for 23% of the total natural capital cost (see figure 1).The results also show each sector’s natural capital intensity – or its natural capital cost per $1m of annual revenue. The toy sector has by far the highest intensity, at 3.9% of revenue.

FIGURE 1: TOTAL NATURAL CAPITAL COST AND INTENSITY OF SELECTED SECTORS



Corresponds approximately to over 80 million tonnes of plastic. Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodologies available in appendices 3 and 4 of this report).

$75bn

The natural capital cost of plastic in the consumer goods sector per year

These findings hold significant impacts for companies. On the one hand, companies in the food, soft drinks and non-durable household goods sectors have the largest natural capital costs in absolute terms and thus are more likely to face reputational and legislative risks from their association with the environmental impacts of plastic, especially litter from packaging. On the other hand, companies in the toy, athletic goods and footwear sectors have the highest natural capital intensity, meaning that a higher proportion of their revenue is at risk. Economic, reputational, legislative and other risks, or missing related opportunities, could extract significant value from these businesses if they had to internalise the full cost of their plastic use impacts.

The research compares the natural capital cost of plastic for sectors depending on the longevity of the product they make. Companies in sectors such as food and non-durable household goods, which make disposable plastic products and use plastic packaging, may face

$13bn

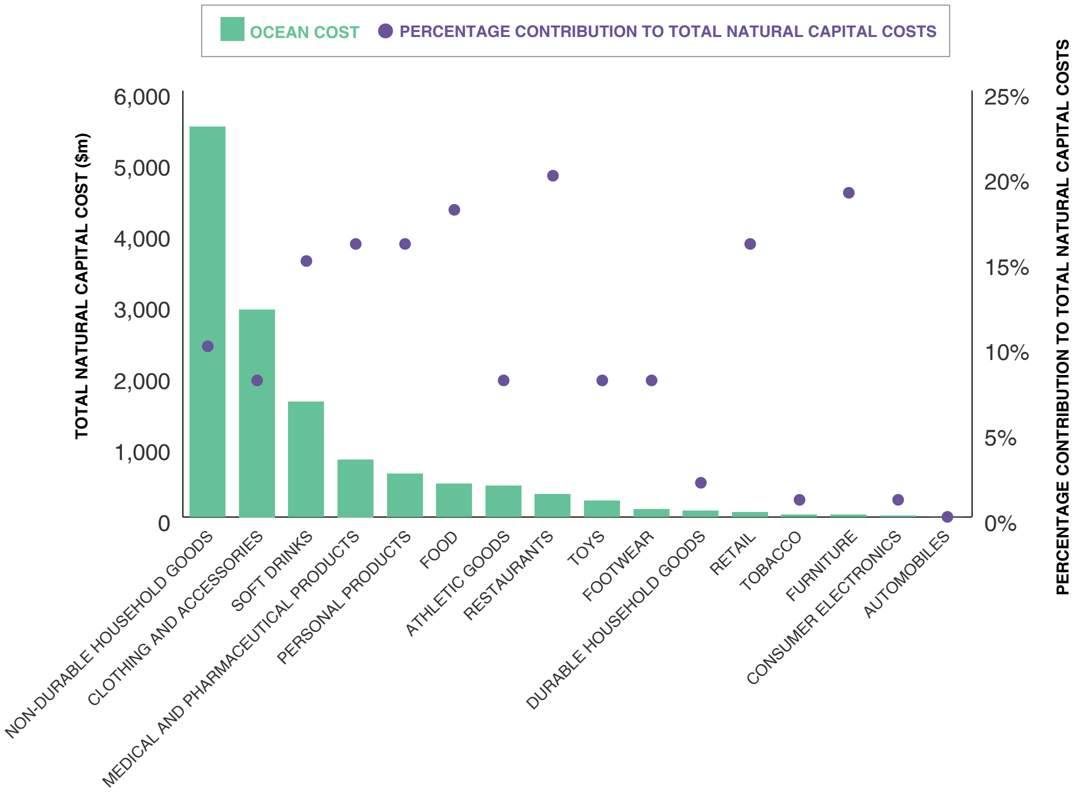
The total natural capital cost to marine ecosystems of plastic littering per year

much higher risks than those in sectors such as cars and athletic goods where products have a much longer lifetime. This is because the use of plastic in these instances may not seem efficient, given the durability of the material and the short service life of the product and packaging types they manufacture.

The research drills down into and assesses the main quantifiable impacts of plastic use in products and packaging. It relies upon the best available research to date. However, because of the nascent science in this field, several known or suspected impacts could not be fully assessed. This is particularly true regarding downstream impacts, i.e. impacts relating to littering and disposal.

With current knowledge, across all consumer goods sectors, over 30% of the natural capital costs come from greenhouse gas emissions released upstream in the supply chain from the extraction of raw materials and manufacturing of plastic feedstock. The most significant downstream impact is marine pollution, which has a natural capital cost of at least $13bn (see figure 2). This study is the first to apply natural capital valuation to impacts of plastic on the marine environment. Trucost supplemented its existing modelling techniques by gathering and analysing academic studies on the impact of plastic on marine ecosystems. Impacts include economic losses incurred by fisheries and tourism as well as time spent cleaning up beaches.

FIGURE 2: TOTAL NATURAL CAPITAL COST OF PLASTIC IN THE OCEAN ($) AND PERCENTAGE CONTRIBUTION TO TOTAL NATURAL CAPITAL COST PER SECTOR



Total natural capital costs corresponds approximately to over 80 million tonnes of plastic. Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodologies available in appendices 3 and 4 of this report).

The impacts of plastic vary around the world, based on background conditions and management practices. Companies face higher natural capital costs if they purchase or treat plastic at its end-of-life in Asia as opposed to North America, Europe or Oceania. This is due to higher pollution intensity levels of manufacturing in Asia and its lack of adequate waste management facilities. The finding is of concern given the growth in Asian economies. A limitation of this study is that transboundary waste trade has not been taken into account. The downstream, or end-of-life, natural capital costs of certain regions, such as Oceania shipping part of its waste to other countries, may thus have been underestimated.

This study focuses on plastic impacts in absolute terms, not in comparison to any alternatives. However it should be noted that recent studies commissioned by plastic manufacturers associations, such as the American Chemistry Council (ACC) and Plastics Europe, suggest that there are significant benefits (in terms of energy used and greenhouse gas emissions) associated with the use of plastic (mainly in packaging) such as reduced food waste and lower fuel use in transportation.[11,12] Similarly, this report suggests that current recycling and energy recovery practices save consumer goods companies around $4bn per year. The emphasis should not be on systematically moving away from plastic but rather in using it in an efficient and environmentally-sustainable way.

$4bn

The amount saved by consumer goods companies through good management of plastic, through recycling for example.

Over a quarter of these savings were generated through initiatives in the food sector and 17% in the soft drinks sector.

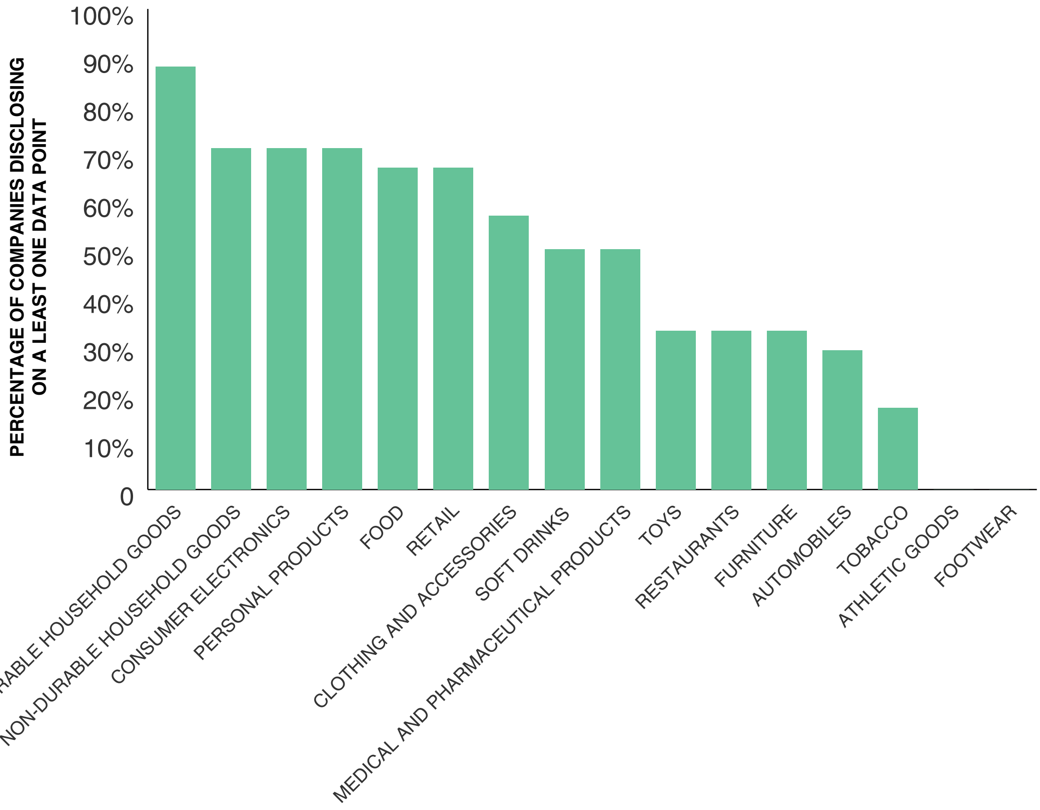
Good management of plastic, through recycling for example, saves consumer goods companies $4bn per year. Over a quarter of these savings were generated through initiatives in the food sector and 17% in the soft drinks sector.

The research assesses the largest publicly-listed companies of each of the 16 target sector by revenue - 100 in total. Each company's plastic usage is estimated, using industry data, modelling, and any disclosures specific to that company. The report contains 16 analyses that offer sector-specific results and company-level insight.

The research also shows whether companies disclose information on plastic. Due to low disclosure levels, most of the data has been modelled and should only be considered indicative of the magnitude. As the impacts of plastic gain more prominence, companies may be expected by their stakeholders to improve rates of disclosure. For example, this information is useful to inform institutional investors interested in protecting the value of their investments. Asset managers could engage with these companies to find out how they plan to manage the risks and opportunities of plastic.

Levels of disclosure on plastic are poor. Only around half of the 100 companies assessed reported at least one item of quantitative data on plastic (see figure 3). Disclosure rates vary widely with no companies in the footwear and athletic goods sectors reporting any useable quantitative data points, compared with 88% of firms in the durable household goods sector and 71% in the personal products sector. Quantitative data points span from total quantity of plastic used per year by the company to tonnage of plastic saved due to one recycling initiative; data coverage varies widely and is often poor. Even when a company is classified as a "discloser", it may mean that this company disclosed only one data point with limited coverage. Disclosed data was used in the research where available.

FIGURE 3: PERCENTAGE OF COMPANIES THAT DISCLOSE ON AT LEAST ONE DATA POINT



Trucost calculations derived from companies' public disclosures (full set of references and methodologies available in appendices 3 and 4 of this report).

Currently, there is no correlation between a sector's disclosure rate and its plastic intensity or absolute natural capital cost due to plastic. This means that sectors which face the most significant risks to their revenues from legislation, competition and consumer demand regarding plastic need to consider being more transparent about how they are managing the potentially material issue. It also suggests that disclosure may be more driven by external factors, such as legislation and reputation, rather than an internal understanding of risks and opportunities.

Levels of disclosure on plastic are

POOR

Of the 100 companies assessed, less than

HALF

reported one or more items of relevant quantitative data.

RECCOMMENDATIONS

Based on these findings, the research makes a series of recommendations to companies.

Taking action to reduce the risks of plastic while benefiting from the opportunities first involves raising the awareness of a company's executive board. The findings of this research provide the information needed to build a business case for the board to sanction action. The research recommends that companies establish a strategy to reduce the impacts of plastic, including setting targets with deadlines.

Companies can mitigate plastic-related risks and take advantage of the opportunities by improving their measurement, management and disclosure of plastic. Initially, this means measuring and reporting their use of plastic, as many companies already do with carbon emissions and other environmental impacts. Best practice frameworks to support companies in doing this in a standardised way include the Plastic Disclosure Project.

In order to properly identify the risks and opportunities, and manage these properly, this study recommends that companies greatly improve the quantity and quality of the information they gather and report on plastic. Relevant data includes the tonnage of plastic used in a company's operations and supply chain. This figure could be broken down into different types of plastic, such as polyethylene terephthalate used in drinks bottles and polystyrene used in hamburger boxes, as well the amount of recycled plastic or bio-plastic used (although bio-plastics do not always provide an environmentally-positive alternative to conventional plastics). Companies could also disclose how plastic is used in products and packaging. Reporting on the fate of plastic at the end of its life is relevant, such as whether it is disposed of to landfill or incineration with or without energy recovery, or whether it is recycled or reused.

By publicly reporting on plastic management, companies can demonstrate to stakeholders including governments, investors and campaign groups that they take their environmental responsibilities seriously. Companies that move quickest to report are most likely to gain credit by being seen as a leader on the issue.

In the longer term, progress on plastic is likely to require companies to work in partnership. The research recommendations identify a range of organisations and suggest broad areas for collaboration. This includes working with governments to develop effective legislation and waste management infrastructure, especially in developing countries. Innovation often requires a range of participants along the supply chain to work together, possibly with an official body acting as coordinator. Companies could also support research institutions in their efforts to deepen our understanding of the impacts of plastic in the environment.

An example of identified action is to reduce the weight of plastic used in products and packaging through improved design. Companies could also switch to using recycled plastic and form joint ventures to ensure sufficient supplies. In addition they could investigate the potential of bio-based plastic, although there is much uncertainty about its benefits and impacts. Users of plastic could engage with suppliers on issues such as phasing out hazardous substances.

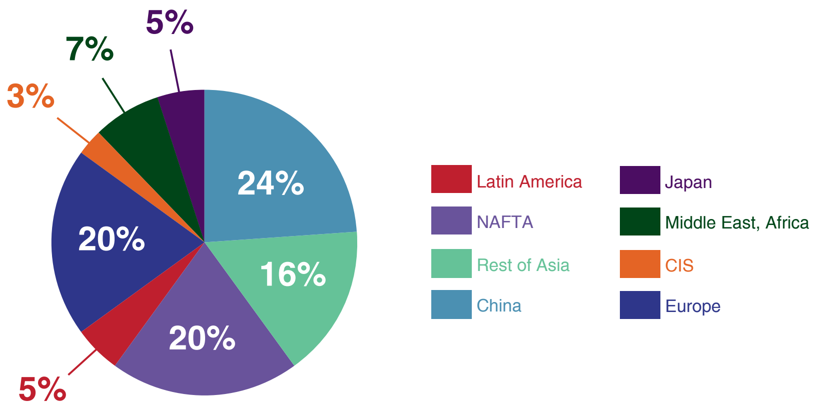
The research includes several case studies of companies striving to implement good practice on plastic management, including Lush cosmetics, electronics companies Apple, Dell and Hewlett Packard, and soft drink company Coca Cola, as well as awareness-raising initiatives working through innovation to collect and reuse oceans plastic (e.g. Interface and Method).

KEY RECOMMENDATIONS FOR COMPANIES:

- Raise awareness of the risks and opportunities of plastic at executive board level.
- Measure plastic use in products, packaging, operations and supply chains and publish the results in annual reports and, for example, through the PDP.
- Commit to reducing the environmental impact of plastic and set targets with deadlines to ensure this goal is achieved.
- Innovate products and processes to increase resource efficiency and recycling of plastic.
- Collaborate with governments to develop legislation to facilitate sustainable management of plastic, such as through extended producer responsibility and waste management infrastructure, especially in developing countries.
- Support data collection and further research into the impacts of plastic, especially in the marine environment, in partnership with academic institutions and conservation groups.

Plastic is an all-encompassing word referring to a family of synthetic materials. While this report refers to plastic in general, there are different types of plastic with a range of different properties and applications, from polyethylene terephthalate in soft drink bottles to acrylonitrile butadiene styrene in toys. Table 7 in Appendix 2 highlights this diversity.

FIGURE 4: PLASTIC PRODUCTION PER REGION, 2012



Based on PlasticsEurope data [1]

Plastic's strength, low weight and malleability makes it the preferred option for a range of applications such as cars, window frames, smartphones and packaging. The versatility and low price of plastic compared with alternatives is reflected in the rapid growth of the market for the material in a context of increased consumerism and drive for convenience. Plastic production has increased by 8.7% year on year from 1.7 million tonnes in 1950 to 288m tonnes in 2012. China is the world's biggest producer, accounting for almost a quarter of output.[1] Consumption is forecast to increase, with regions like Asia leading the growth.

Plastic has many social benefits. Plastic packaging keeps food fresh and safe for human consumption and prevents food waste. Plastic helps save lives through a wide range of medical applications such as packaging for pharmaceuticals and manufacturing healthcare equipment. There is also large potential for future applications in renewable energy generation and improving transportation.[2] In addition, the plastic industry makes an important contribution to employment. In 2012, the European plastic industry employed more than 1.4m people and earned revenues of €300 billion (or $390m), according to Plastics Europe.[1]

Studies commissioned by the plastic industry have found that plastic can help reduce some environmental impacts. A study commissioned by Plastics Europe found that if other materials were used instead of plastic in packaging, the packaging mass would on average increase by a factor of 3.6 and greenhouse gas emissions by a factor of 2.7 or 61m tonnes of $C0_2$-equivalent per year over the full life cycle, in particular during the use phase through decreased food losses and fuel use in transportation.[12] The same study commissioned by the American Chemistry Council (ACC) found that the use of plastic for packaging applications in the United States had a greenhouse gas emissions benefit over other materials of 75.8m tonnes of $C0_2$-equivalent per year and a cumulative energy demand benefit of 1,110bn MJ.[13] While these figures depend on a number of assumptions and could be debated, they illustrate the point that plastic has some benefits for the environment, in this case compared to using other packaging materials.

Despite these positives, plastic has a range of negative environmental and social impacts throughout its lifecycle which must be properly managed. Negative impacts include the use of chemicals which can potentially escape in the environment and harm local populations, customers and workers, the aesthetic, health, economic and ecological impacts of plastic litter, and the consumption of non-renewable petroleum products as an ingredient and fuel in manufacturing.

OBJECTIVES OF THE REPORT

Good management of plastic across its lifecycle from production to end of life is lacking in many businesses and places around the world. By measuring and understanding plastic and its associated impacts, businesses can identify context-specific measures to maximise the benefits of the material while decreasing its negative consequences. The first step on the road to good management of plastic is for companies to measure, elaborate and implement appropriate management plans, in collaboration with other stakeholders.

Disclosure underpins any robust plastic management strategy. While some companies can choose to act but not report publicly, reporting is a central transparency, communication and collaboration tool. Reporting targets and achievements reassure stakeholders about the transparency of a company's approach and add credibility to an overall company's sustainability programme. It is also useful as a communication tool, in order to keep stakeholders updated on the progresses made. By extension, disclosure may trigger collaboration, by supporting the identification of common areas of interest and challenges.

The objective of this report is to demonstrate the business case for plastic measurement, disclosure and management by quantifying the risks of plastic to a company's activities. The use of plastic causes environmental and social impacts that can be expressed in monetary terms to reflect the scale of damage caused – the 'natural capital cost'. Natural capital encompasses natural resources such as clean air and water, and environmental services such as food and climate regulating services. Economic activity depends on these resources and services; however, they are not often factored into corporate accounting.

Natural capital valuation translates physical environmental impacts, such as tonnes of plastic reaching the ocean, into a monetary value. Put simply, it puts a price on pollution and use of resources. This allows companies to make informed decisions, for instance, over how best to reduce their environmental impacts, or whether to invest in new equipment and what technology to use. It serves as a representation of the value-at-risk to a business through its plastic use.

In particular, the report:

- Identifies the main impacts of plastic use within 16 consumer goods sectors.
- Maps the plastic supply chain upstream and downstream from raw material extraction, manufacturing and use to the end of its life.
- Assesses the plastic-related natural capital cost and intensity of the largest puclicly-listed companies per sector, 100 in total.
- Estimates the impact of companies' plastic use based on disclosure from public sources and data modelling in the absence of company disclosure.
- Highlights the natural capital benefits of more sustainable use of plastic, such as recycling.
- Presents three case studies of business excellence in plastic disclosure and management.
- Provides recommendations for companies.

The next section highlights the impacts of plastic, followed by a discussion of the business case for the proper management of plastic and natural capital valuation as a useful tool to assess risks and opportunities.

THE ENVIRONMENTAL AND SOCIAL IMPACTS

Approximately 4% of oil production is used as feedstock and another 4% is used to fuel the plastic manufacturing process as well as other resources such as natural gas, water and chemicals.[2] Extracting and processing these raw materials into plastic feedstock generates carbon emissions and other air, land and water pollutants. Plastic pellets from the manufacturing process may also enter the waste stream and the ocean in the form of microplastics, which are small particles of plastic with a maximum diameter no greater than 5mm. Microplastics are easily ingested by sea life, and now even outweigh plankton in some areas of the high seas.[3] Initiatives from the plastic industry to tackle this issue include Operation Clean Sweep which promotes the better handling of plastic pellets at the manufacturing stage.[14] Finally, there is an opportunity cost associated with the use of these non-renewable resources which may not be available to future generations.

Impacts may also arise from chemical additives used in manufacturing plastic items. Chemical additives are added to plastic feedstock in order to enhance their performance, in terms of strength and heat resistance for example. These include fillers, plasticisers, stabilisers, flame retardants and colourings. Some of these substances are toxic, bioaccumulative, and persistent in the environment. These substances can leach out of plastic into the environment, affecting the health of wildflife.[2] Some additives are also of concern to human health. An example is the potential leaching of bisphenol A from plastic containers into the food it contains. Another is the possible migration of flame retardants from plastic computer enclosures into dust that humans breathe. Workers can also be exposed to additive leachate during the manufacturing stage. For example, trimethlytin chloride due to the use of methlytin stabilising agents in PVC products is linked to the increased risk of developing kidney stones in workers in the United States and China.[15]

Plastic presents further risks and costs once it is thrown away at the end of its life. Globally, between 22% and 43% of plastic waste is disposed of in landfills, where the resources it contains are wasted. Landfill sites can blight local communities due to their undesirable nature and by using up valuable space. If plastic is mixed with other materials, sorting the waste to collect useful materials becomes more complex, costly and dangerous. Some plastic waste goes to incineration – up to 21% in developed countries where most incineration plants are designed to generate energy. However, generating such energy from these waste plants is in some cases inefficient, requires pollution abatement to control air emissions, and the incinerator ash is classified as a hazardous waste.

Waste management, while necessary and better than littering, is costly and wastes resources that could be put to good use through recycling. Inadequate waste management is expensive to society and often not internalised by businesses. Collection costs range from $20 to $250 per tonne depending on the region, while landfill costs $10- $100/tonne and incineration with energy recovery $40-200/tonne.[8]

According to the World Bank, the quantity of waste and related cost is likely to double by 2025.[8] With many countries un-prepared to handle this increase, waste and resource management will be an increasingly important issue in the years to come for companies, particularly those who operate across borders. Plastic is one of the toughest waste streams to handle, and though the weight of plastic waste might not be as big as that of other materials, its durability and volume often account for a large proportion of a country's waste issues.

The highest profile impact of waste plastic is when it is littered. Once littered, it is costly to recover and becomes a multigenerational problem due to its long degradation time. Although it is typically only considered an eyesore, its impact is felt throughout our communities, environment and increasingly the ocean. Litter has an impact on land use, transport, animal and human health, safety, flooding, community spirit and clean-up costs. It often makes its way to the ocean over time, due to its light weight and durability, blown by the wind or via rivers and drains. While there is much uncertainty about the extent of the problem, a report by the United Nations Environment Programme (UNEP) estimates that 6.4m tonnes of litter enter the ocean every year – some eight million items every day.[5] This figure is likely to be an underestimate as the underlying research was published in 1975. Other studies suggest between 10m and 20m tonnes a year.[16,17]

Plastic is the most common type of marine litter, comprising up to 80% of total waste in marine litter surveys. Most (over 80%) comes from land-based sources, with marine-based activities such as shipping, cruise lines and fishing accounting for the remainder.[5] Studies show that levels of litter in the ocean are increasing in spite of efforts to control the problem. Industry bodies, businesses, governments, civil society and international institutions are recognizing the magnitude of the issue and the need to tackle it. As an example, many joined UNEP's Global Partnership on Marine Litter (GPML) and the global plastic associations have signed a declaration to develop solutions to marine litter.[18]

Over two thirds of plastic litter ends up on the seabed with half of the remainder washed up on beaches and the other half floating on or under the surface, according to a report from UNEP.[5] Over time, ocean currents drive plastic waste on the surface of the sea together into vast 'ocean gyres' such as the 'North Pacific Gyre', which has been nicknamed the 'Plastic Vortex' or the 'Great Pacific Garbage Patch'. In reality, these gyres are more like a soup than a patch.[19] Even the great depths of the ocean are polluted with plastic. Researchers using a remotely operated underwater vehicle to explore an area of seabed covering less than 1% of Monterey Bay in surface recorded over 380 pieces of plastic debris, with similar findings in the Mediterranean and North Sea.[20,21,22]

Plastic litter in the ocean kills, injures and harms wildlife. Larger items such as plastic bags, plastic strapping for packages and abandoned fishing gear can strangle marine animals. Bottle caps, plastic cutlery, pens and cigarette lighters can be ingested and harm animals through internal damage and starvation. There has been a 40% increase in the number of species reported to be affected by ingestion and entanglement between 1997 and 2012, across all marine debris types. Of 319 publications reviewed in the same 2012 report, the majority of reports (76%) described encounters with plastic debris as opposed to other types of material.[6] Ingestion of microplastics may also have severe impacts on wildlife. In addition to intentionally manufactured microplastics, microplastics are created as larger items of plastic break down in the environment. Other microplastics have been deliberately designed for use in products, such as facial scrubs, and cannot be caught in sewage treatment works before they are discharged into the sea.[23]

Plastic waste found in the marine environment can potentially leach chemicals into the environment as well as attract and communicate hazardous chemicals from the ocean to wildlife. For example, plastic waste in the Pacific Gyre has become contaminated with persistent bioaccumulative toxic pollutants (PBTs) including polychlorinated biphenols.[19] PBTs are chemicals which degrade slowly in the environment and as a consequence accumulate in the tissues of organisms. Due to its chemical characteristics, plastic absorbs PBTs present in the ocean.[24,25] Marine life then receives a concentrated exposure to PBTs, when the marine plastic is consumed, building up the food chain to potentially reach humans.

Plastic waste in the ocean has a direct economic impact. The Asia-Pacific Economic Cooperation (APEC) estimates that the cost to the tourism, fishing and shipping industries was $1.3bn in that region alone. For example, vessel damage can be caused by plastic waste becoming snarled up in a ship's propellers.[26] In Scotland, the approximate economic cost of marine litter is £17m per annum, or $28m per annum.[27] Local authorities have to bear the cost of cleaning up plastic litter from beaches. In the UK, the annual costs are put at $24m.[28] In the US, communities on the west coast spend more than $520m per year to curtail litter.[29] Another study found that closing a Lake Michigan beach could cost as much as $ 37,030 per day.[30]

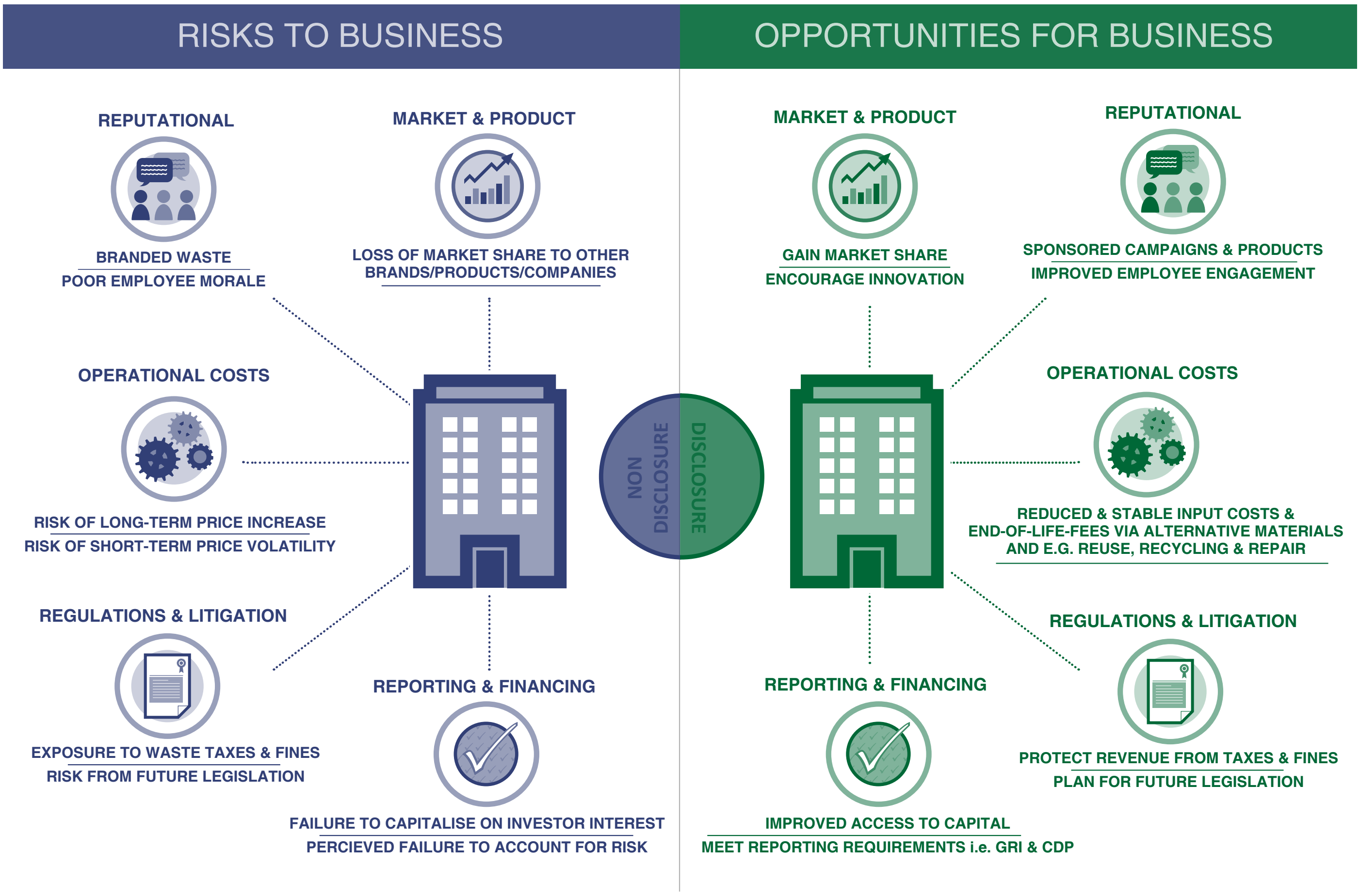
THE BUSINESS CASE FOR MANAGING PLASTIC

In spite of the impacts described in the previous section, compared to climate change, awareness of the environmental impacts of plastic is low among most companies. Yet the case for addressing emerging risks and seizing opportunities is strong and growing. Many of the challenges of plastic could be addressed by improving management of the material across its lifecycle. This does not mean companies should stop using plastic. But there is a case to use less plastic through improving efficiency. There is also a case for making much better use of waste plastic through reuse and recycling.

Major risks and opportunities can be grouped in five categories: operational costs, innovation in products and processes, regulation and litigation, reputational, and investor interest. These risks and opportunities are dynamic and may vary depending on the region, industry sector and over time. As science on the impact of plastic develops further, these risks may acquire a higher profile among external stakeholders. Where there are risks, there are opportunities which businesses can turn to their advantage.

Measurement and disclosure underpin any effective management strategy to mitigate risks and realise opportunities associated with environmental impacts. Measurement is vital so that companies have accurate information on the performance of their business. And disclosure builds trust with stakeholders within the business, supply-chain, government, financial markets and conservation. Plastic is no exception. Just as for carbon, greenhouse gases, water and forestry, businesses can improve their own sustainability by measuring, managing and disclosing their "plastic footprint".

FIGURE 5: BUSINESS RISKS AND OPPORTUNITIES RELATED TO PLASTIC MANAGEMENT



CUTTING COSTS AND IMPROVING EFFICIENCY

There is an increasing amount of evidence that companies which proactively manage environmental issues have better financial performance. A Style Research study found that the top 20% of developed country carbon-efficient companies outperformed the rest of the market.[31] A Harvard Business School study, using a sample of 180 companies, found that companies which voluntarily adopted sustainability policies more than 15 years ago significantly outperformed other companies over the long-term in the stock market.[32] Similarly, a study from Goldman Sachs shows that companies with better environmental, social and governance performance generate higher cash returns, higher incremental returns year-on-year and less volatile return on capital.[33]

One reason is that such companies tend to be more efficient; cutting energy consumption leads to lower energy bills as well as lower carbon emissions. Another is that they are perceived to be better managers and custodians of the environment by their stakeholders. Additionally, they demonstrate that they are in tune with their stakeholders' needs, including their "social license to operate", which de-risks the company in the eyes of investors.

Better management of plastic can help companies decrease their direct costs and reduce the risk of price increases. While plastic is a comparatively cheap material compared to alternatives, there are likely to be many opportunities to cut costs from using plastic more efficiently. Most types of plastic are petroleum-based products that also rely on fossil fuels to provide energy for the manufacturing process, making them vulnerable to price volatility as oil and geopolitical balances shift. In addition, depending on its grade, the price of recycled plastic is less that of virgin plastic. Companies that do not know how much plastic they use will be unaware of these potential savings.

INNOVATION IN PRODUCTS AND PROCESSES

Thinking more innovatively about plastic could create opportunities for companies by designing more sustainable products. For example, although recycling plastic in each community is to a large extent dependent on infrastructure and available technology, the use of recycled content in products today is viable in a vast range of products. The percentage of recycled content used comes down to one of economies of scale, availability, consumer perception, and understanding that such material can be effectively substituted for virgin grade product. Product design has a part to play by enabling plastic products to be reused or easily dismantled so that the resources they contain can be put to good use rather than sent to landfill or incinerated.

Innovative production processes could also be considered, reducing costs and improving supplies of raw materials. Concerns around the quality and quantity of recycled plastic have led companies to implement in-house recycling systems. For example, Interface's ReEntry process allows the company to recycle a higher quantity of post-consumer material while achieving lower contamination rates. The process constitutes a real innovation in the sector, with the lowest embodied energy than any other recycling system in the carpet sector.[34]

Companies that act first are usually the ones to profit most. Cosmetics company Lush benefits from its campaign asking people to bring back items to recycle by increasing customer foot fall in its stores. Replenish multi-surface cleaner, which is sold in concentrated form for dilution at home, results in 90% less plastic, oil and CO_2 emissions than a pre-mixed cleaner. The product has achieved double-digit market share and international reward recognition not simply because of its environmental credentials but because of its innovative design and ability to deliver a quality product at a lower cost.[35]

REGULATION

As concern about the impacts of plastic on the environment and human health grows, so does pressure on policymakers to introduce tougher regulations. Companies that produce or consume large quantities of plastic, but which fail to prepare for tighter controls, are exposed to risks such as lower sales due to restrictions or bans on products and packaging, or chemicals used in their manufacture. For example, there have been concerns over the use of bisphenol A (BPA) used widely in hard, clear plastic commonly found in food and drink containers. Canada was the first country to declare BPA toxic in 2009. From March 2011, the European Commission banned the use of BPA in plastic feeding bottles, followed by the US in 2012.[36]

There is an increasing range of global and national legislation covering the environmental impacts of waste including plastic. An important focus is preventing damage done by marine litter in the world's oceans.

Historically, marine pollution has been addressed by regulating disposal of waste at sea, for example, with the *1972 Convention on the Prevention of Marine Pollution by Dumping of Waste and other Matter (with its London Protocol) and the 1973 International Convention for the Prevention of Pollution from Ships (Annex V of MARPOL).*[37] However, these initiatives do not address the impact of plastic litter which enter the sea from land and is said to account for over 80% of plastic waste in the marine environment.[5] The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) has had marine litter as one of its priority source categories since 1995. The GPA is implemented at the regional level by the Regional Seas Conventions and Action Plans, several of which have Protocols on Land-based sources/activities of pollution.[38] More stringent legislation is likely to be introduced at national levels to control land-based sources of plastic pollution. This could affect not only users of plastic but the entire plastic supply chain.

In March 2011 the Fifth International Marine Debris Conference (5IMDC), organised by the UNEP and the National Oceanic and Atmospheric Administration, contributed to the development and subsequent finalisation of a global framework strategy to prevent and manage marine litter. The 'Honolulu Strategy' identified several areas of focus, including helping develop, strengthen and enact legislation, improving regulatory frameworks, and promoting best practice among industry. Emphasis was also put on market-based mechanisms.[39] In 2012, representatives of 64 Governments and the European Commission emphasized the importance of the Honolulu Strategy in the Manila Declaration on Furthering the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). They also recommended the establishment of a Global Partnership on Marine Litter (GPML) which was launched in June 2012. UNEP GPA provides the Secretariat. UNEP's marine litter related activities also feed into the workplan of the UNEP-led Global Partnership on Waste Management. This ensures that marine litter issues, goals and strategies are tied to global efforts to reduce and manage waste. The GPML seeks to protect human health and the global environment by the reduction and management of marine litter as its main goal.

In March 2013, the European Commission published a green paper seeking views on how to tackle the problem of plastic waste as part of a review of waste legislation to be completed in 2014.[16] Despite a number of European Union (EU) laws directly pertaining to packaging where plastic use is most prominent, there appears to be an ongoing realisation that plastic is under-regulated. The commission stated its intention to introduce more legislation in the near future.

In a resolution agreed by Parliament in January 2014, members of the European Parliament stressed that plastic waste is damaging the environment due both to weak enforcement of EU legislation on waste and the lack of specific EU laws on plastic waste. Among their aims is to ban the most hazardous plastic and certain types of plastic bags by 2020, and to introduce specific and binding targets for recycling, the economic potential of which is said to be largely unexploited.[40]

Plastic bags are one of the most obvious sources of pollution and are the subject of national legislation in many countries. In November 2013, the EU Commission published proposals to amend the EU packaging waste directive by requiring member states to reduce consumption of lightweight plastic bags using measures such as taxes, national reduction targets or bans. A number of EU countries such as Italy, as well as China and South Africa, have already banned some types of plastic bags. In 2014 the European Parliament called for a ban on single use plastic bags by 2020.[40] Ireland has a plastic bag tax, with Belgium, England, Germany, Spain and Norway following suit. In the United States, more than 17 states have passed ordinances banning plastic bags in several hundred municipalities.[41]

Similar activity is likely regarding microplastics. These are small plastic particles, either directly used in products such as cosmetics, or broken down from larger plastic pieces which can be swallowed by marine wildlife causing harm and potentially transferring toxins into our own food chain. Mounting concern over this issue is likely to result in more stringent regulations already proposed in New York and passed in California.[42,43,44]

REPUTATION

The risk of damage to corporate and brand reputation is one of the main reasons why companies should take early action on managing their plastic footprint. Brand valuation studies have found than in certain cases, brand accounts for over 70% of the total value of the company.[45] Environmental campaign groups often call for consumer boycotts of well-known brands to raise awareness about an issue, such as Greenpeace's campaign against Coca-Cola's opposition of container deposit taxes aimed at stimulating recycling in Australia. As part of the campaign, the organisation emphasised the wildlife damage caused by plastic bottles though organised protests outside the company's headquarters, boycotts of the product, and negative social media campaigns.[46]

In the past, campaigns portraying a corporation's negative impact on biodiversity have been known to threaten profitability. A recent example is the high profile 2010 Greenpeace campaign against Nestlé's palm oil sourcing practices using flagship brand Kit Kat as target, which resulted in Nestle changing its policy and severing contracts with its major palm oil producer Sinar Mas. Greenpeace then campaigned against HSBC who eventually dropped their investment in Sinar Mas.[47,48]

In the age of social media, images of plastic litter washed up on a beach or linked to the death of whales and dolphins can spread across the world in seconds. Although in many cases brand origin is unidentifiable, the potential for negative publicity on plastic in general could affect companies. Other times, brand origin is identifiable. #Litterati social media photo campaign encourages users to photograph litter before disposing of it and share the image on Instagram. The resulting "digital landfill" is expected to be used to work with communities and large corporations to prevent litter.[49] Another example includes the Plastic Soup Foundation's "Beat the Bead" application which allows the user to know whether there are microplastic within the product they are about to buy.[50]

By using social media and other communication tools, companies can demonstrate they are part of the solution to these problems. For example, in 2012 a group of California elementary school students gathered more than 90,000 signatures on a petition asking marker pen company Crayola to "make its mark" on recycling its used products. Crayola initially responded that it had no way to do so. The campaign inspired a competitor, Dixon Ticonderoga, to launch its own program for recycling used marker pens. The publicity and potential loss of business led to Crayola to announce its own recycling programme for used plastic markers.[51,52]

INVESTOR INTEREST

There is growing interest among investors in how companies manage environmental risks and opportunities. For instance, the UN's Principles for Responsible Investment (PRI) has some 1,200 signatories among asset owners and investment managers which collectively control almost $35 trillion.[53] Its members are committed to incorporating consideration of environmental, social and governance issues into their investment decisions.

The investor-led CDP (formerly the Carbon Disclosure Project) has had enormous success encouraging companies around the world to disclose their carbon emissions and plans to reduce them. Its climate change program is backed by 722 investors with $87tr in assets under management. In 2013, 81% of the world's 500 largest stock-exchange listed companies reported to the CDP. The CDP has widened its efforts to encourage disclosure on other issues such as water, forests and supply chain impacts.[54]

A survey commissioned by the Plastic Disclosure Project found strong interest among investors in encouraging companies to disclose their plastic consumption. Almost 90% of those surveyed said they would support the Plastic Disclosure Project including respondents from

HSBC, BNP Paribas, Credit Suisse, Bank of America, JPMorgan and First State Investments and others. Together they control assets worth some $5.8tr.[55] Companies can demonstrate leadership and engage with investors by proactively disclosing on their plastic use before they are asked to do so.

THE CONCEPT OF NATURAL CAPITAL AS A TOOL TO ASSESS RISKS AND OPPORTUNITIES

Plastic use has impacts associated with it, depending on how well it is understood and managed. These impacts can potentially translate into risks, or opportunities, to businesses. In order to understand the potential magnitude of these risks and opportunities, this report uses a technique called “natural capital valuation”. This technique translates physical impacts into a monetary figure, which expresses the potential value that companies would have to internalise if they were held accountable for their impacts. As such, natural capital valuation helps assess the magnitude of the financial risks and opportunities faced by companies.

Natural capital is the term used to describe the renewable and non-renewable natural resources that companies rely on to produce goods and deliver services. Businesses depend on natural assets that are non-renewable (e.g. fossil fuels and minerals), as well as renewable ecosystem goods and services, such as freshwater, timber and a stable climate. Business decisions around site operations, supply chains and products drive the use of natural resources. The capacity for renewable natural resources to regenerate over time affects the availability of stocks. Their ability to absorb unwanted by-products of production such as pollution and waste is limited. But the value of access to land, clean air and plants that provide critical inputs such as food, energy and fibre is usually excluded from financial accounts.

Business activities such as extraction and production can damage natural capital and cause economic costs that are largely external to market prices. Increasing environmental degradation and resource depletion combined with growing demand are highlighting the need to value natural capital. Companies need to improve the way they manage annual flows of natural capital to reduce economy-wide costs. To do this, they need to understand sources of value and risk. Measuring physical flows of resource use, pollution and waste provides a starting point to evaluate which ecosystem goods and services businesses depend on.

Natural capital valuations convert physical impacts measured in terms of cubic metres of water used or tonnes of plastic entering the marine environment into a monetary value, expressing the damage caused to the environment and society. Valuation is essential to understand the true value of environmental assets, according to an authoritative study by The Economics of Ecosystem and Biodiversity (TEEB) initiative. It says that despite uncertainties, economic valuations of ecosystem services can improve decisions around risk management.[56] Trucost research for the PRI and UNEP Finance Initiative (UNEP FI) valued resource use, pollution and waste linked to the 3,000 largest publicly-listed companies at over $2tr in 2008.[57] In addition, several companies have already conducted and publicly disclosed environmental profit and loss accounts (EP&L) such as Puma, Becker Underwood and Novo Nordisk.

Applying economic valuations to these quantities is one approach that is gaining ground to strengthen decision-making and risk management. Initiatives such as TEEB and World Business Council for Sustainable Development (WBCSD) Guide to Corporate Ecosystems Valuation encourage businesses to evaluate natural capital so that decisions consider related financial risks and benefits. To make this possible, companies need to measure and report relevant information. In June 2012, 196 governments at the UN Conference on Sustainable Development committed to taking steps to encourage companies to consider integrating sustainability information into reporting cycles. Fifty-seven countries and the European Commission, along with 86 companies, backed an initiative to factor the value of natural assets such as clean air and water, forests and other ecosystems into business decision-making and national accounting.[58]

This approach to environmental economics and accounting underpins the methodologies used by Trucost in this report. The natural capital valuation of plastic impacts allows companies to:

- Understand the potential materiality of environmental impacts.
- Prioritise environmental issues to address in operations, supply chains and investments.
- Identify opportunities to reduce risk and optimise capital allocations and expenditure.
- Develop strategies to reduce the environmental impacts of plastic use.
- Build the case for monetary incentives to reduce environmental impacts.

In order to quantify the natural capital cost of these impacts, the methodology followed six steps: sector selection, plastic use quantification, scope and boundary selection, impact quantification, and natural capital valuation and application (see figure 6). Appendices 3 and 4 explains the methodology in more detail.

HIGH LEVEL METHDOLOGY

STEP 1: SECTOR SELECTION

Trucost focused its research on 16 consumer goods sectors that were likely to use large volumes of plastic in products and packaging (see table 1). Other sectors which are large users of plastic, such as agriculture, were excluded from the analysis but may be included in future research. For the description of each sector, please refer to Table 8 in Appendix 3.

FIGURE 6: HIGH-LEVEL METHODOLOGY STEPS

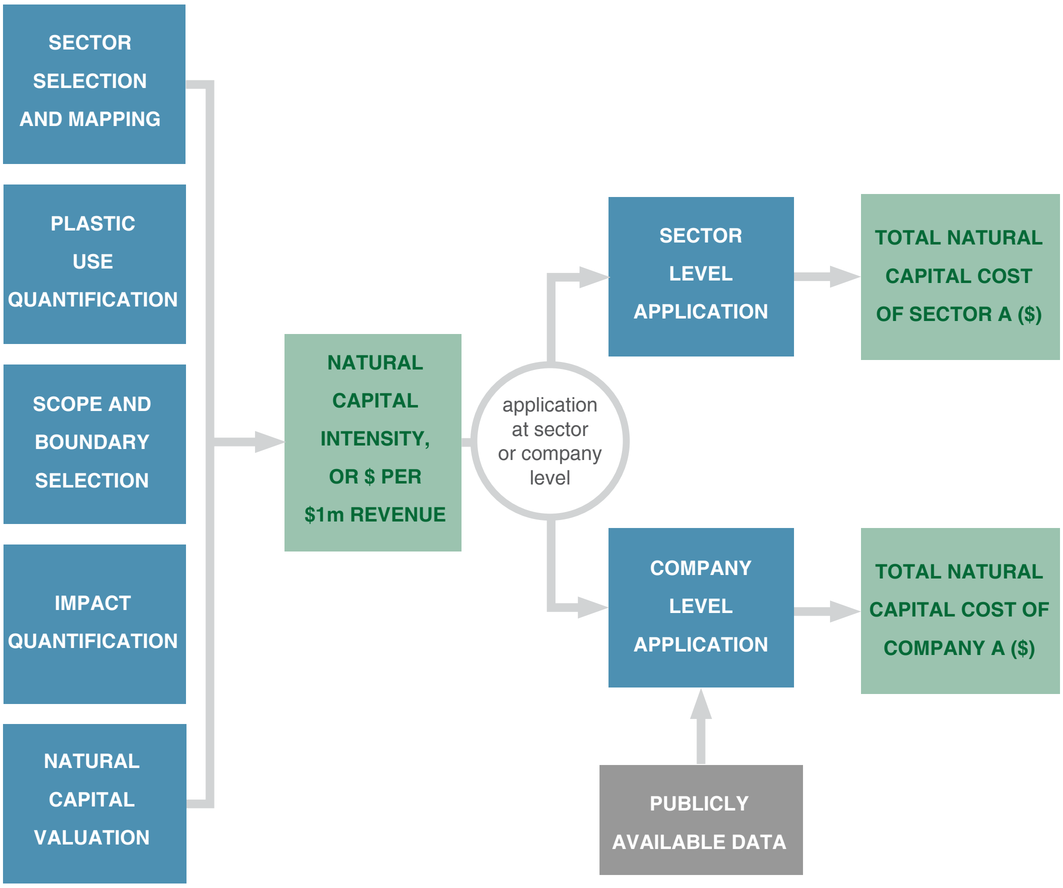


TABLE 1: SECTOR SELECTION

Food	Personal products
Soft drinks	Durable household goods
Tobacco	Consumer electronics
Furniture	Automobiles
Clothing and accessories	Athletic goods
Footwear	Toys
Non-durable household goods	Retail
Medical and pharmaceutical products	Restaurants and bars

STEP 2: PLASTIC USE QUANTIFICATION

Trucost calculated the tonnage of plastic used in the consumer goods sector based on its expenditure in key plastic manufacturing industries. This gave the plastic intensity, expressed as tonnes per $1m of revenue, for each of 16 sectors. The amount of plastic was categorised into three types:

- Plastic-in-product includes plastic used in products such as a child's plastic toy or a polyester T-shirt.
- Plastic-in-packaging includes plastic used as packaging such as carrier bags and shampoo bottles.
- Plastic-in-supply-chain includes plastic used by suppliers such as bags containing fertilizer used by farmers supplying the food sector. Trucost calculated the volume of 'plastic-in-supply-chain' to put the first two categories into perspective but did not calculate the related natural capital cost.

STEP 3: SCOPE AND BOUNDARY SELECTION

After modelling the plastic intensity of each sector, the next step was to calculate the associated environmental impacts. Trucost set boundaries on both the lifecycle stages and impacts to be included in order to create an achievable project. Impacts across the lifecycle of plastic were considered including the extraction and processing of raw materials into plastic feedstock and the end-of-life fate of waste plastic. Some lifecycle stages had to be excluded for practical reasons, such as the plastic product manufacturing, outbound transportation and any impacts during the use of plastic products.

STEP 4: IMPACT QUANTIFICATION

Trucost quantified the environmental impacts associated with plastic use using lifecycle analysis techniques. The analysis draws on numerous official sources such as the US Toxic Release Inventory and Plastics Europe eco-profiles.[59,9]

Impacts include greenhouse gas emissions, water abstraction, air, water and land pollutants from the extraction of natural resources to their conversion into plastic feedstock. However, it excludes the future cost to society of exploiting non-renewable resources which may not be available to future generations. It also excludes occupational hazards linked to the use of chemical additives.

Trucost also quantified the environmental impacts associated with plastic at the end of its life depending on the waste management route used, such as landfill, recycling, littering, and incineration with and without energy recovery. Data came from official sources such as US Environmental Protection Agency, the World Bank and Eurostat.[8,10,11]

Impacts include greenhouse gas emissions, water abstraction, air, water and land pollutants from the extraction of collecting and treating plastic waste. They also include the end-of-life impact of chemical additives in plastic leaching into the environment, the loss of amenity caused by litter, the economic cost of litter to the marine industries and the ecological cost linked to the loss of species. Other impacts have been excluded, such as the waste of recyclable resources, the impact of microplastic and the effect of hazardous chemicals once in a marine environment.

Appendix 3 explains in more detail inclusions and exclusions in the scope and boundary selection and impact quantification phase.

STEP 5: NATURAL CAPITAL VALUATION

Natural capital comprises stocks of resources, such as water and clean air, and services such as climate regulation and food provision. Businesses depend on natural capital to be able to operate and provide goods and services to society. Yet this is rarely accounted for in a company's financial accounts. Natural capital valuation provides a way to quantify in monetary terms natural capital risks and dependencies.

There are many benefits from natural capital valuation. For instance, using a common monetary unit enables companies to compare the significance of different impacts. It can also be used to measure the success of programmes to reduce impacts, such as diverting waste from landfill to recycling. It also enables a company to create an environmental profit and loss account for its business which can be integrated into its mainstream financial account. By comparing a business's annual natural capital cost to its annual revenue, a company's management can understand the risks it faces if tighter regulation or consumer demand forces it to pay these costs. This knowledge can encourage companies to take early action to reduce these risks by cutting environmental impacts.

Trucost calculated the natural capital cost by converting the physical quantities of different types of environmental impacts, such as tonnes of particulate matter, into a monetary cost and adding them together. The natural capital intensity is the sum of all the natural capital impacts expressed in monetary terms per $1m revenue.

STEP 6: APPLICATION

The valuations were applied at both the level of the consumer goods sector and the individual company.

At the sector level, Trucost calculated the total natural capital cost of plastic use by the consumer goods sector. The total natural capital cost is the total natural capital intensity for that sector, multiplied by its aggregate revenue.

For individual companies, Trucost selected the 100 largest stock exchange listed consumer goods companies and calculated the natural capital cost of plastic for each one. Where these companies published quantitative data on plastic use and disposal of adequate quality and scope, it was used in place of modelled data.

LIMITATIONS

There were a number of limitations to the research. One example is in deciding what life cycle stages to include. While the upstream impacts from manufacturing plastic feedstock (granules or fibres) were included, as were the downstream impacts from end-of-life plastic, the impacts from manufacturing finished products and packaging, and transporting and using those products and packaging, were excluded. This is because of the great complexity required by such an analysis. A single product may comprise hundreds or thousands of components made from different materials including plastic. This makes the modelling of product manufacturing at a sector level too uncertain. In addition, some impacts were excluded, such as the end-of-life impact of microplastic. A detailed discussion of the other limitations can be found in appendices 3 and 4.

VALUING THE IMPACTS OF PLASTIC ON THE OCEAN

This report is the first time that the environmental and societal impacts of plastic in the ocean have been assessed using natural capital valuation. Plastic pollution has a range of impacts on marine wildlife including small particles of plastic being eaten by fish and seabirds, or larger plastic items entangling larger creatures such as seals, fish and marine mammals. Concern over these impacts is growing, but they are difficult to quantify.

To conduct this research, Trucost supplemented its modelling techniques by compiling, analysing and aggregating academic studies on the impact of plastic on marine ecosystems. Impacts included the economic losses incurred by fisheries, aquaculture and tourism. The time spent by volunteers cleaning up beaches was also considered. Finally, Trucost valued how much society would be willing to pay to prevent species loss through plastic ingestion and entanglement.

RESULTS

This section provides a general overview of the results and is organised along six key questions:

- Which sectors are the most plastic intensive?
- What is the magnitude of the natural capital cost?
- What are the most significant impacts?
- Where do these impacts happen?
- What is the state of disclosure?
- What are the potential benefits of good plastic management?

The last section provides a summary of the key findings. The sector-specific results section (appendix 1) disaggregates overall results into sector-specific results.

WHICH SECTORS ARE THE MOST PLASTIC INTENSIVE?

‘**Plastic-in-product**’ includes the quantity of plastic directly used in the product, as well as any losses that were incurred during the manufacturing process. An example is the plastic used in the bumper of a car or a polyester t-shirt. **‘Plastic-in-packaging’** includes the quantity of plastic directly used in the packaging of the product, as well as any losses that were incurred during the manufacturing and packaging stage. This covers items such as plastic bags and films, as well as water and shampoo bottles. **‘Plastic-in-supply-chain’** includes the quantity of plastic used indirectly by consumer goods businesses via their supply chain but is neither destined to be in the final product nor in packaging.
For example, this includes the plastic containers of fertilisers applied in the agriculture sector, in the supply chain of the food sector; and the plastic in a toy, and its packaging, in the supply chain of a retailer where the item was sold. Trucost calculated ‘plastic-in-supply-chain’ to put the first two categories into perspective but did not calculate the related natural capital cost.

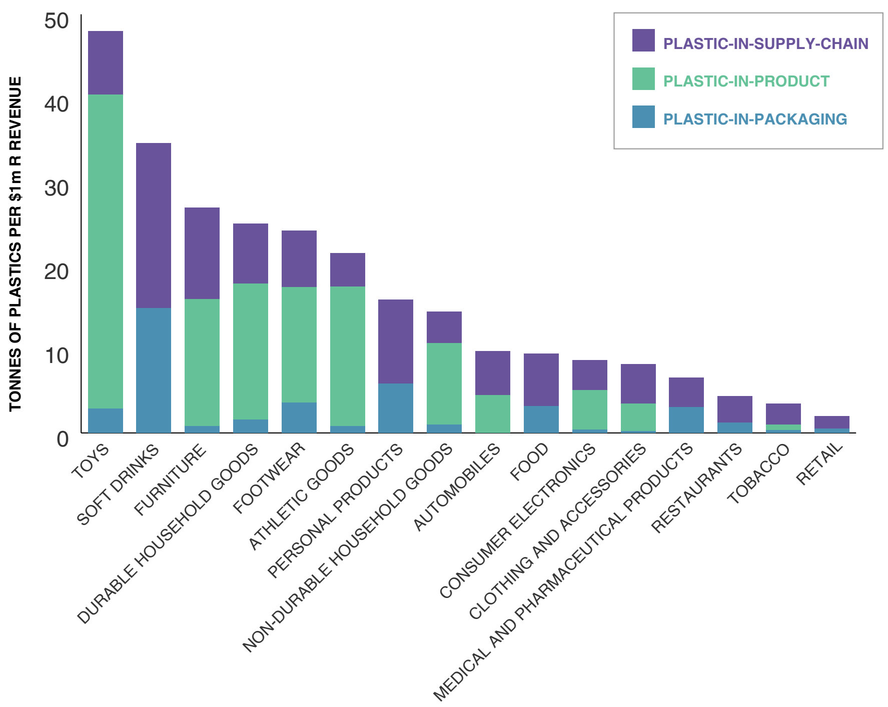
Overall, the global weighted average of plastic-in-packaging used in the consumer goods industry is 2 tonnes per $1m revenue; of plastic-in-product 2 tonnes per $1m revenue; and of plastic-in-supply-chain 4 tonnes per $1m revenue. This indicates that for every $1m in revenue in the consumer goods industry, 8 tonnes of plastic are consumed. These figures hide large sector-specific variations. Figure 7 and table 2 display the estimated tonnage of plastic used per $1m revenue, or plastic intensity, broken down between plastic-in-packaging, plastic-in-product and plastic-in-supply-chain for each of the 16 sectors.

Direct plastic intensity comprises plastic-in-product and plastic-in-packaging, but excludes plastic-in-supply chain.

The toy sector has the highest total direct plastic intensity, at 40 tonnes per $1m revenue, while the retail sector has the lowest, at 500 kg per $1m revenue. Plastic-in-packaging constitutes the main proportion of direct plastic intensity in the soft drinks, personal products, food, medical and pharmaceutical, restaurants and retail sectors. In particular, the soft drinks sector has the highest plastic-in-packaging intensity, at 15 tonnes per $1m revenue. Plastic-in-product is the larger proportion of total direct plastic intensity for all other sectors. In particular, the toy sector has the largest plastic-in-product intensity, at 38 tonnes per $1m revenue, followed by the athletic goods and durable household goods.

Sectors with the highest supply-chain-plastic intensity in relation to the total plastic intensity are the retail (75%), restaurants (72%), tobacco (70%) and food (66%) sectors – meaning that companies operating in these sectors may need to pay attention to plastic used in their supply chains. The retail and restaurant sectors are located further down the supply chain compared to others. Their low direct intensity is because it only includes packaging added to the product in the shop, such as carrier bags. This explains the low intensity of the sector's direct operations and proportionately larger plastic-in-supply-chain intensity. The retail, restaurants, tobacco and food sectors are also significant users of agricultural commodities in their supply chain, which has been recognized as a plastic intensive sector. As highlighted by Plastics Europe, agriculture contributed 4.2% to the overall plastic demand in Europe in 2012.[1]

FIGURE 7: PLASTIC INTENSITY PER SECTOR (TONNES PER $1M REVENUE)



Trucost calculations based on input-output modelling techniques (full methodology available in appendix 3 of this report)

TABLE 2: PLASTIC INTENSITY PER SECTOR (TONNES PER $1m REVENUE)

SECTOR	PLASTIC-IN-PACKAGING	PLASTIC-IN-PRODUCT	PLASTIC-IN-SUPPLY-CHAIN	TOTAL
Toys	2.9	37.5	7.6	48.0
Soft drinks	14.9	-	19.7	34.6
Furniture	0.8	15.2	10.9	26.9
Durable household goods	1.6	16.2	7.2	25.0
Footwear	3.6	13.8	6.8	24.2
Athletic goods	0.8	16.7	4.0	21.5
Personal products	5.9	not estimated	10.0	15.9
Non-durable household goods	1.0	9.7	3.8	14.4
Automobiles	0.0	4.5	5.3	9.9
Food	3.2	-	6.3	9.5
Consumer electronics	0.4	4.7	3.6	8.7
Clothing and accessories	0.2	3.3	4.7	8.2
Medical and pharmaceutical products	3.1	-	3.5	6.6
Restaurants	1.2	-	3.2	4.4
Tobacco	0.3	0.7	2.5	3.5
Retail	0.5	-	1.5	2.1

WHAT IS THE MAGNITUDE OF THE NATURAL CAPITAL COST?

The use of plastic causes environmental and social impacts that can be expressed in monetary terms to reflect the scale of damage caused – the 'natural capital cost'. As explained in the methodology and appendices 3 and 4, natural capital encompasses natural resources such as clean air and water, and environmental services such as food and climate regulating services. Economic activity depends on these resources and services; however, they are not often factored into corporate accounting. By putting a monetary value on environmental resources and services, companies can understand their dependency on natural capital and factor it into business strategy. For example, the production of plastic produces greenhouse gases, which contribute to climate change, which may have severe societal and economic repercussions. By calculating the quantity of greenhouse gases generated by the production of plastic, and putting a dollar value on each tonne of greenhouse gases in relation to its impact on climate change, these impacts can be factored in corporate decision making.

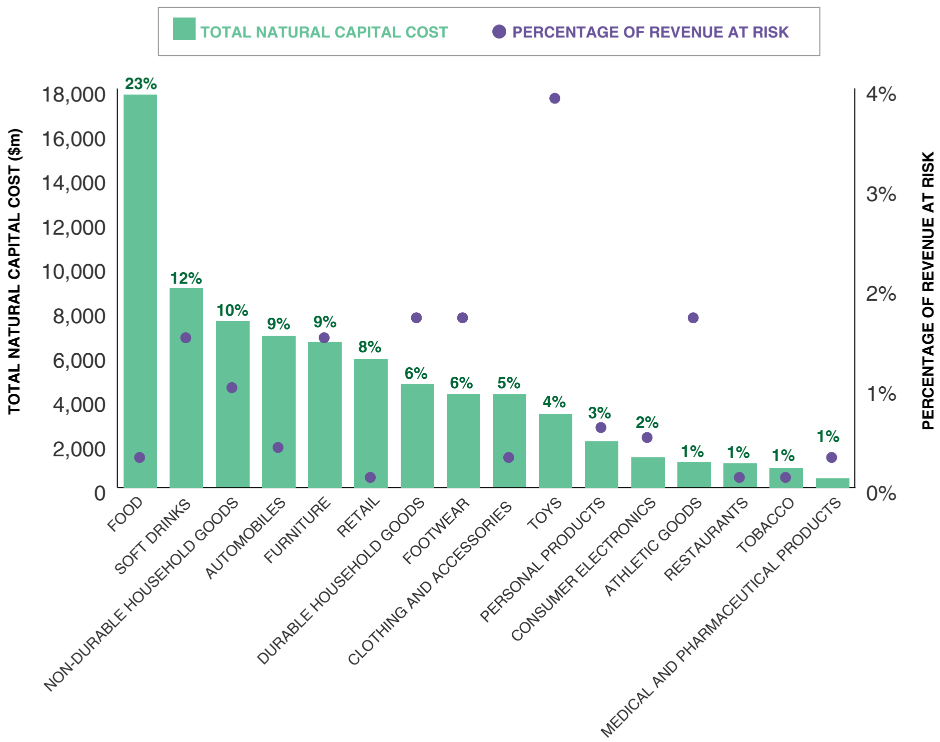
As part of this report, only the natural capital cost of direct plastic use has been quantified. This means that the natural capital cost associated with plastic-in-supply-chain has been excluded, for lack of data. In addition, certain potentially significant impacts have been excluded, such as the impacts associated with microplastics. Science has yet to catch up for these impacts to be included these in the analysis.

Figure 8 highlights the total natural capital cost of direct plastic use in 2012 for each sector. Purple circles display the natural capital intensity, or total natural capital cost per $1m revenue, from plastic use for each sector. The percentage figures indicate the percentage contribution of the sector to the total natural capital cost of the consumer goods industry.

The overall natural capital cost of plastic use by the consumer goods industry is over $75bn. While the toy sector has the largest natural capital intensity, at 3.9% of revenue, or $39,000 per $1m revenue, it is one of the smaller contributors to the overall total natural capital cost at just 4%. The food sector has one of the lowest plastic intensities, at 0.3%, but a total natural capital cost of $18bn and contributes 23% to the overall consumer goods natural capital cost. The soft drinks sector is the second larger contributor (12%), at $9bn, followed by the non-durable household goods sector, at over $7bn (10%).

The sector-specific results section (appendix 1) provides a sector-specific breakdown and commentaries of these figures.

FIGURE 8: TOTAL NATURAL CAPITAL COST ($) AND REVENUE AT RISK (NATURAL CAPITAL INTENSITY) PER SECTOR

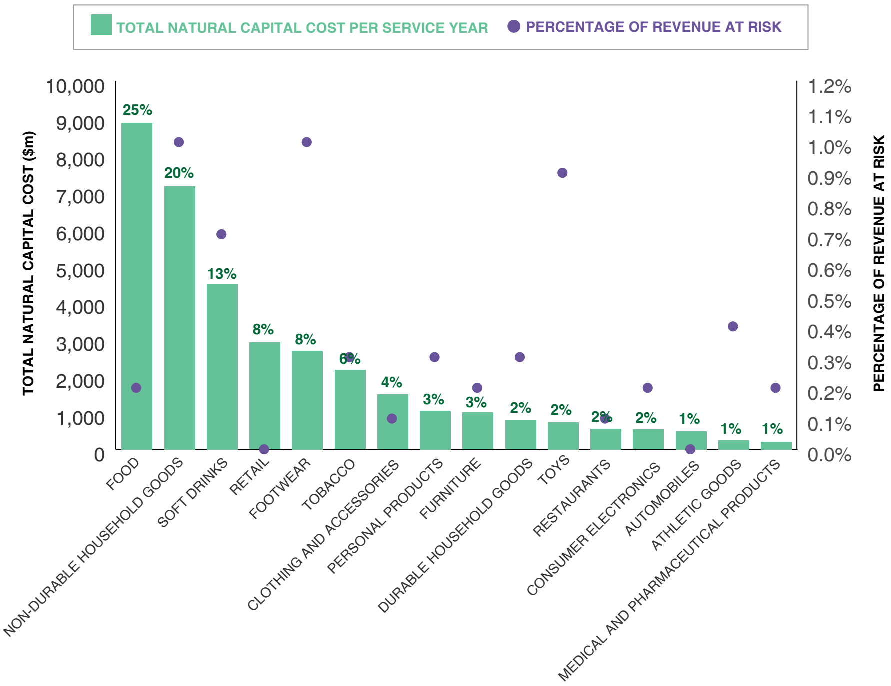


Corresponds approximately to over 80 million tonnes of plastic. Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

Depending on the type of product manufactured, the service life of plastic will vary. For example, cars have an average service life of 12.5 years, compared to short-lived products such as non-durable household goods or packaging. In order to take into account the durability of the products and packaging manufactured, Trucost divided the total natural capital cost of each sector by the average service life of the main product manufactured within that sector. The result is a normalized figure per sector.

The overall total natural capital cost per service year is $35bn. Figure 9 displays the total natural capital cost and intensity per service year for each sector. The total natural capital cost of the food sector per service year is $9bn – equivalent to 25% of the total natural capital cost of the consumer goods industry per service year. The non-durable household goods sector is the second larger contributor (20%) and has a total natural capital cost per service year of $7bn, followed by the soft drinks (13%) and the retail sector (8%).

FIGURE 9: TOTAL NATURAL CAPITAL COST ($) AND REVENUE AT RISK (NATURAL CAPITAL INTENSITY) PER SECTOR, NORMALIZED BY SERVICE YEAR



Corresponds approximately to over 80 million tonnes of plastic.Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

TABLE 3: TOTAL NATURAL CAPITAL COST ($) AND NATURAL CAPITAL INTENSITY

SECTOR	TOTAL NATURAL CAPITAL COST ($M)	TOTAL NATURAL CAPITAL COST ($M) PER SERVICE YEAR	REVENUE AT RISK (NATURAL CAPITAL INTENSITY)	REVENUE AT RISK (NATURAL CAPITAL INTENSITY) NORMALIZED BY SERVICE YEAR
Food	17,700	8,900	0.3%	0.2%
Non-durable household goods	7,500	7,100	1.0%	1.0%
Soft drinks	9,000	4,500	1.5%	0.7%
Retail	5,800	2,900	0.1%	0.0%
Footwear	4,200	2,700	1.7%	1.0%
Tobacco	900	2,200	0.1%	0.3%
Personal products	2,100	1,000	0.6%	0.3%
Clothing and accessories	4,200	1,500	0.3%	0.1%
Furniture	6,600	1000	1.5%	0.2%
Durable household goods	4,700	800	1.7%	0.3%
Toys	3,300	700	3.9%	0.9%
Consumer electronics	1,400	600	0.5%	0.2%
Restaurants	1,100	500	0.1%	0.1%
Automobiles	6,900	500	0.4%	0.0%
Athletic goods	1,100	200	1.7%	0.4%
Medical and pharmaceutical products	400	200	0.3%	0.2%

Total and per service year natural capital cost and intensity are both useful to understand the long term risk of plastic mismanagement. External stakeholders such as governments, pressure groups and research institutes are more likely to focus their regulatory and advocacy efforts on sectors which are responsible for the larger proportion of plastic-related impacts, especially when the products or packaging are short-lived. These efforts could lead to tougher regulation or campaigns targeting high-profile brands.

Total natural capital intensity represents the percentage of revenue of each sector that is at risk if the impacts of plastic mismanagement had to be internalized by companies. The larger the natural capital intensity, the larger the revenue at risk. Hence, while the food sector might be a focus for regulators and other stakeholders, its total natural capital intensity is one of the lowest in the consumer goods sector, with only 0.3% of its overall revenue at risk.

Natural capital cost as a percentage of economic costs is another useful metric for businesses. The economic cost includes the cost of buying plastic, and the cost of treating it after its disposal, either through recycling, landfilling or incineration with and without energy recovery. On average, the total natural capital cost of plastic use is 52% of total economic costs. Depending on the sector and region, end-of-life economic costs are usually not incurred by businesses. When only considering the upstream natural capital cost as a percentage of plastic prices, the potential cost increase is 44% on average. This means that if the upstream impacts of plastic were paid for in full by businesses, the price of plastic would by 44% higher on average.

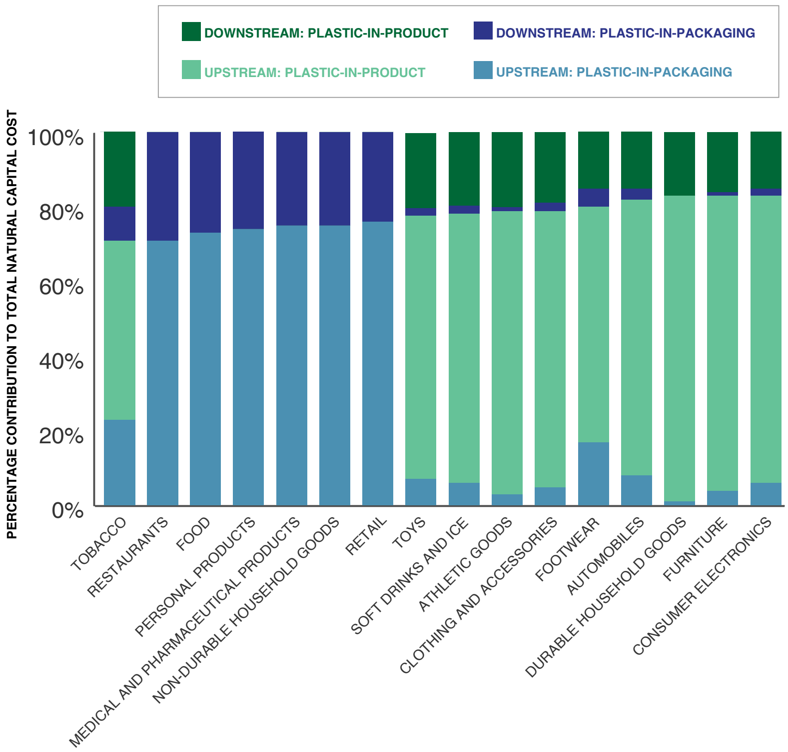
WHAT ARE THE MOST SIGNIFICANT IMPACTS?

Over 75% of the known and quantifiable impacts associated with plastic use are located in the upstream portion of the supply chain across all sectors. 'Upstream' refers to impacts generated from the extraction of raw materials to the manufacturing of plastic feedstock. 'Downstream' refers to impacts generated once the product has been discarded by the consumer. While this depends on the sector, type of plastic and application, upstream impacts have been studied in a more complete and consistent way than downstream ones, hence leading to data inconsistency and potential underestimation, especially in the downstream portion of the supply chain.

Figure 10 illustrates the variation among sectors. The tobacco sector has the largest downstream impact, at 29% of its total impact. This is mainly due to the impact of plastic used in cigarette filters which are often littered after use. At the other end of the spectrum, the consumer electronics sector has the lowest downstream impact as a proportion of total impact (17%), mainly due to recycling initiatives in North America and Europe.

The sector-specific results section (appendix 1) provides a sector-specific breakdown and commentaries of these figures.

FIGURE 10: UPSTREAM AND DOWNSTREAM IMPACT DISTRIBUTION



Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

Measures put in place to better manage plastic often have a consequence on upstream and downstream impacts at the same time. For example, lightweighting decreases both the upstream and downstream impact through material reduction, provided that recycling rates can be maintained. Similarly, increasing the recycling rate at the end-of-life may have a positive impact on the availability of recycled content, either to the business itself through closed-loop recycling, or to other businesses. A direct implication is that initiatives and measures could be more focused on the way plastic is used (in packaging or product) rather than a lifecycle stage in particular.

Table 4 highlights the total natural capital cost of products and packaging as a percentage of total natural capital cost. This gives an indication of where there is the most potential to reduce plastic intensity. These results are particularly useful for sectors that use both plastic in product and packaging. For example, 68% of the tobacco sector's total natural capital cost is attributable to plastic in product, rising to 91% in the non-durable household goods sector. Companies in this sector have focused recent improvements on packaging, when higher benefits could have been be achieved by focusing on products.

TABLE 4: TOTAL NATURAL COST PER SECTOR SPLIT BETWEEN PRODUCT AND PACKAGING, UPSTREAM AND DOWNSTREAM

SECTOR	PRODUCT				PACKAGING				TOTAL
	UPSTREAM	DOWN-STREAM	TOTAL	%	UPSTREAM	DOWN-STREAM	TOTAL	%	
Food	-	-	-	0%	13,000	4,700	17,700	100%	17,700
Soft drinks	-	-	-	0%	6,800	2,100	9,000	100%	9,000
Non-durable household goods	5,300	1,500	6,800	91%	500	200	700	9%	7,500
Automobiles	5,600	1,100	6,800	99%	100	<100	100	1%	6,900
Furniture	5,200	1,000	6,200	95%	300	100	300	5%	6,600
Retail	-	-	-	0%	4,400	1,400	5,800	100%	5,800
Durable household goods	3,500	700	4,200	89%	400	100	500	11%	4,700
Footwear	2,700	600	3,300	79%	700	200	900	21%	4,200
Clothing and accessories	3,100	800	3,900	93%	200	100	300	7%	4,200
Toys	2,400	700	3,100	93%	200	100	200	7%	3,300
Personal products	-	-	-	0%	1,600	500	2,100	100%	2,100
Consumer electronics	1,100	200	1,300	92%	100	<100	100	8%	1,400
Athletic goods	900	200	1,100	95%	-	<100	100	5%	1,100
Restaurants	-	-	-	0%	800	300	1,100	100%	1,100
Tobacco	400	200	600	68%	200	100	300	32%	900
Medical and pharmaceutical products	-	-	-	0%	300	100	400	100%	400

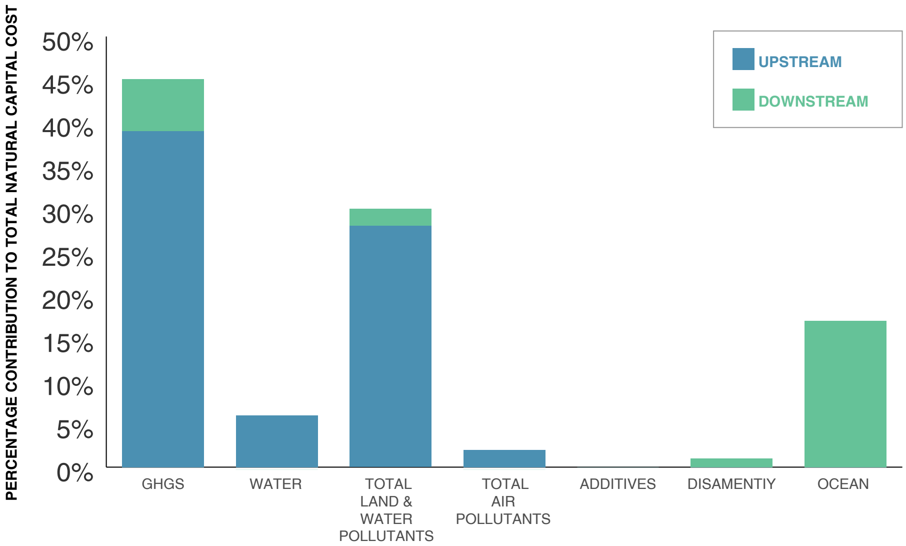
Understanding the distribution of the total natural capital cost by impact is useful to identify which specific initiative or measure may have the most beneficial impact. For example, if the main contributing impact to the total natural capital cost of plastic in a sector is upstream greenhouse gases, companies should further investigate this area to find a way to reduce these emissions. Figure 11 and 12 provide a weighted understanding of the materiality of different impacts.

The model used in this report suggests that the most significant impact of plastic-in-packaging is greenhouse gas emissions generated during the extraction and processing of raw materials to make plastic feedstock, followed by land and water pollution. The impact of littered plastic packaging reaching the ocean at the end-of-life is a significant contributor. As the downstream impacts, especially littering impacts, of plastic are more studied, the relative order of magnitude is likely to change.

The model also suggests that upstream emissions of greenhouse gases are also the most significant impact for plastic-in-product, followed by land and water pollution. The model used in this report assumes very few plastic products end up in the ocean; hence the ocean impact of plastic products is significantly less than that of packaging. Additive leachate at the end of the product's life is also a significant issue.

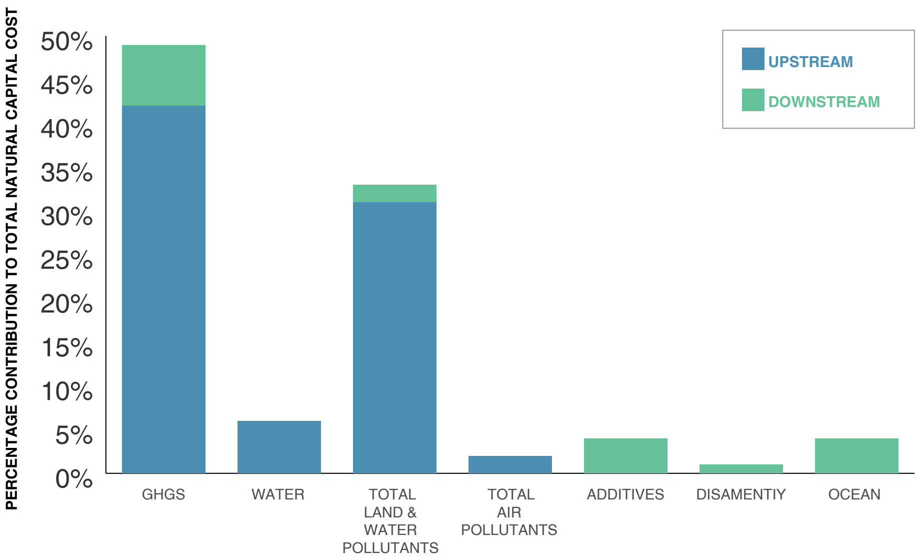
The sector-specific results section (appendix 1) provides a sector-specific breakdown and commentaries of these figures.

FIGURE 11: PLASTIC-IN-PACKAGING NATURAL CAPITAL COSTS COMPARED



Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

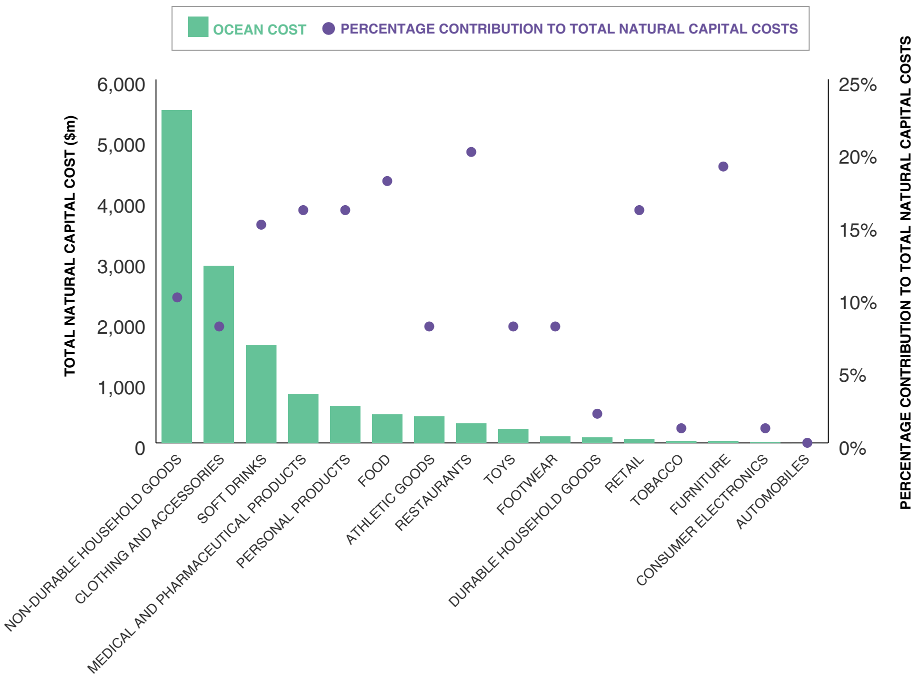
FIGURE 12: PLASTIC-IN-PRODUCT NATURAL CAPITAL COSTS COMPARED



Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

The total weighted natural capital cost of plastic on marine ecosystems is $13bn. Understanding the natural capital cost of plastic ending up in oceans is an area that has seldom been included in end-of-life analysis. Nevertheless, it contributes a non-negligible part of the total end-of-life and total lifecycle impacts. On average, the impact of plastic on marine ecosystems accounts for 17% of total lifecycle impacts. There are large variations across sectors, from 20% in the restaurant sector to less than 1% in the automobile sector. This percentage rises to 42% on average when calculated as a percentage of end-of life impacts only.

FIGURE 13: TOTAL NATURAL CAPITAL COST OF PLASTIC IN MARINE ECOSYSTEMS ($)



Total natural capital costs correspond approximately to over 80 million tonnes of plastic.Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

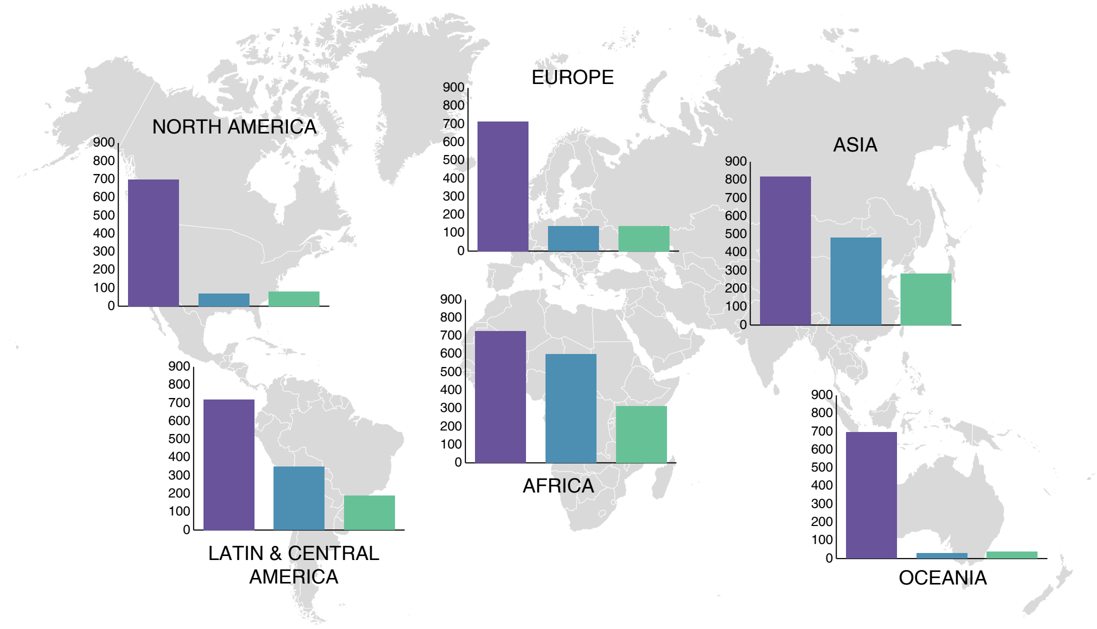
WHERE DO IMPACTS OCCUR?

Impacts vary across regions based on waste management infrastructure, local geographical conditions and the size of the consumer goods industry. Collection and recycling rates vary across regions affecting the types and quantity of pollutants emitted and the portion of plastic ending up as litter or in marine ecosystems. Local conditions influence the magnitude of the impact – for example, emitting one tonne of pollutants (e.g. to manufacture plastic feedstock) in a populated region (e.g. Asia) has a higher natural capital impact than emitting the same tonne of air pollutants in a sparsely populated region. These variables will therefore influence the natural capital intensity of producing and disposing of plastic. Finally, the larger the sector in one particular region, the larger the total natural capital cost.

Understanding regional variations in natural capital intensity of plastic use and disposal may be useful for companies to decide where to focus their efforts geographically. For example, efforts could be focused where local infrastructure is poor and emissions have a larger impact. Figure 14 highlights upstream and downstream geographical regions. Figure 15 highlights the total natural capital cost of plastic per sector in different regions. It should be noted that transboundary trade and shipping of waste has not been taken into account. These figures are based on the assumption that a tonne of plastic bought in North America has been manufactured in North America. Similarly, plastic waste disposed of or littered in Oceania is assumed to be treated in Oceania. This may underestimate the impacts of disposing plastic waste in region where it is likely to be shipped to another region.

Sourcing plastic in Oceania and North America is likely to be the best option in terms of natural capital, while sourcing in Asia the worst. This is of concern given that plastic production is increasing rapidly in Asia. Companies that purchase more plastic in Asia are likely to increase their exposure to natural capital risk. In addition, disposing of and treating plastic-in-packaging and plastic-in-product in Asia has one of the largest natural capital intensities, so increased sales in this region of the world are likely to increase companies' exposure to natural capital risk unless companies take steps in improving local waste collection and recycling infrastructure. In contrast, disposing of and treating plastic-in-packaging in Europe, Oceania and the United States have lower natural capital cost than disposing of and treating plastic waste in other regions.

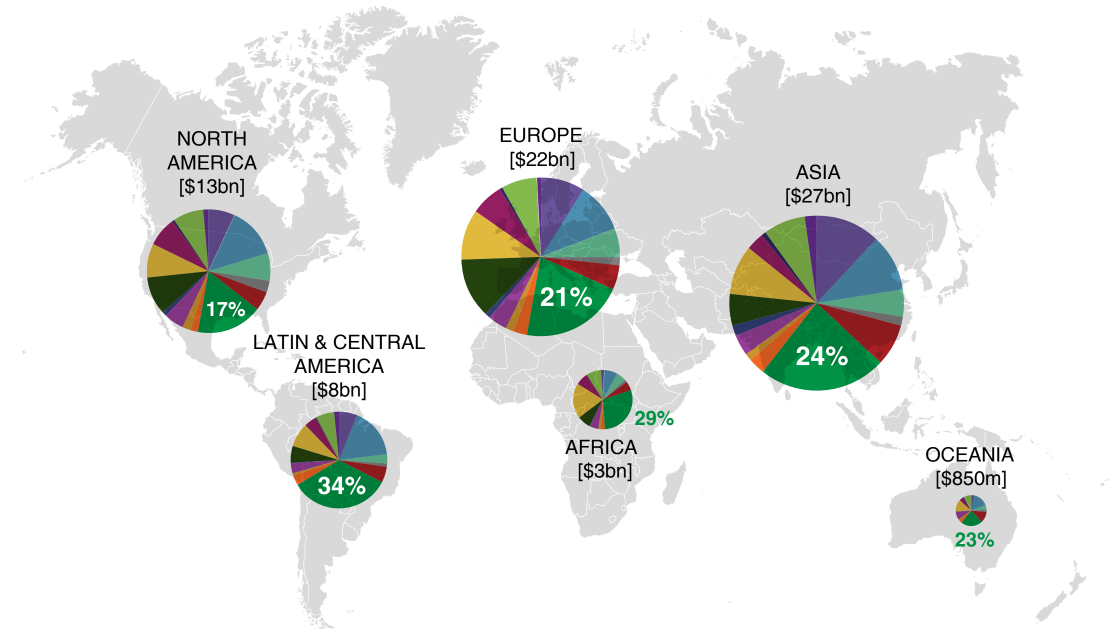
FIGURE 14: NATURAL CAPITAL INTENSITY DISTRIBUTION ($ PER TONNE OF PLASTIC)



UPSTREAM | PACKAGING DOWNSTREAM (WEIGHTED AVERAGE) | PRODUCT DOWNSTREAM (WEIGHTED AVERAGE)

Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

FIGURE 15: DISTRIBUTION OF NATURAL CAPITAL IMPACTS, BY BUSINESS SECTOR



AUTOMOBILES | SOFT DRINKS AND ICE | CLOTHING & ACCESSORIES | CONSUMER ELECTRONICS

DURABLE HOUSEHOLD GOODS | FOOD | PERSONAL PRODUCTS | ATHLETIC GOODS | TOYS

TOBACCO | FURNITURE | NON-DURABLE HOUSEHOLD GOODS | FOOTWEAR

MEDICAL AND PHARMACEUTICAL PRODUCTS | RETAIL | RESTAURANTS

Corresponds approximately to over 80 million tonnes of plastic. Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

WHAT IS THE STATE OF DISCLOSURE?

Measurement is the first step towards good management. What is measured can be managed. Disclosure is central to good management – whether on the plastic footprint, the targets, and achievements. As outlined in the introduction, reporting ensures transparency, accountability and collaboration.

Out of the 100 companies analysed, approximately half disclose useable quantitative information on plastic. Disclosure has been assessed on the following quantitative indicators: total or partial volume of plastic, percentage of recycled content and bio-based materials, upstream initiatives that have resulted in materials savings, downstream initiatives and take-back programs. To be "usable" the data provided needed to be clear as to coverage and granularity of application. Many companies disclosed both quantitative and qualitative data that could not be integrated within the calculations.

Disclosure rates vary from 0% in the athletic goods and footwear sector to 88% in the durable household goods sector. Types of disclosure vary depending on the sector. The durable household goods, consumer electronics and automobile sectors are more likely to report on take-back schemes, while the retail sector discloses the quantity of plastic bags saved. Most companies in the sample disclose qualitative information as well. While these levels of disclosure may appear high at first sight, disclosure is understood here in a broad way. Any type of quantitative disclosure that could be used to assess the impact of plastic use of each company has been counted as "disclosure".

Table 5 lists the companies assessed within the framework of this report and the primary sector to which they were mapped. Information on specific disclosure and sources can be found in Appendix 5.

TABLE 5: COMPANIES ASSESSED

SECTOR	COMPANY
Athletic goods	Amer Sports, Anta Sports, Jarden Corporation, Peak Sport
Automobiles	Daimler, Fiat, Ford, General Motors, Nissan, Toyota, Volkswagen
Clothing and accessories	Fast Retailing, Gap, Hanesbrands, Hennes & Mauritz, Inditex, Kering, VF Corp
Consumer electronics	Apple, Canon, Hewlett Packard, LG Electronics, Ricoh, Samsung, Sony
Durable household goods	Arcelik, Electrolux, Husqvarna, Indesit, Makita, Panasonic, Seb, Whirlpool
Food	Danone, Kellogg, Meiji Holdings, Mondelez International, Nestle, Pepsico
Footwear	Asics, Belle International, Daphne Holdings, Salvatore Ferragamo, Stella Holdings, Tod's
Furniture	Ekornes, Fortune Brands Home and Security, Interface, Legget & Platt, Mohawk, Samson Holding
Medical and pharmaceutical products	Abbott Labs, Johnson & Johnson, Merck, Novartis, Pfizer, Sanofi
Non-durable household goods	Clorox, Colgate Palmolive, Kao Corp, Kimberly Clark, Procter & Gamble, Reckitt Benckiser, Svenska Cellulosa
Personal products	Avon, Beiersdorf, Estee Lauder, L'Oreal, Natura Cosmeticos, Unilever, Shiseido
Restaurants	Bidvest Group, Compass, McDonalds, Sodexo, Starbucks, Sysco
Retail	Carrefour, Costco, CVS Caremark, Kroger, Tesco, Walmart Stores
Soft drinks	Britvic, China Huiyuan Juice, Coca Cola Company, Dr Pepper Snapple, Lotte Chilsung, Uni-President, Tingyi, Want Want China
Tobacco	Altria Group, British American Tobacco, Imperial Tobacco, Japan Tobacco, Philip Morris, Reynolds American
Toys	Hasbro, Hornby, Mattel

Trucost found no robust correlation between disclosure rates and the natural capital intensity of each sector's plastic use or its total natural capital cost, suggesting that disclosure is not yet driven by a clear understanding of risks and opportunities faced by companies. On the other hand, sectors with higher disclosure rates seem to be exposed to regulatory or reputational pressures. For instance, the durable household goods and consumer electronics sectors, with disclosure rates of 88% and 71% respectively, are covered by the EU directive on waste electrical and electronic equipment and other equivalents. The retail and food sectors, with rates of 67%, have received considerable media attention around plastic waste. Reporting pressures thus appear to be driven mainly by regulatory and reputational considerations. This can change in the future as companies become aware of the risks and opportunities of plastic use measurement, reporting and management.

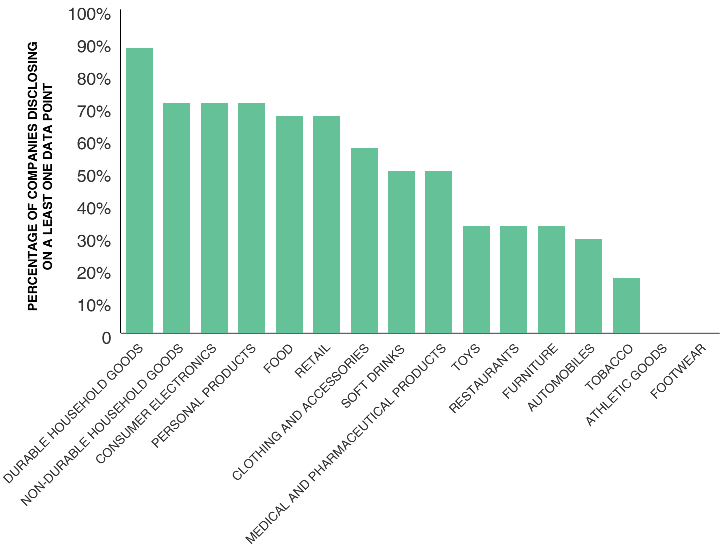
Table 6 and figures 16, 17 and 18 show the results of the disclosure analysis. 'Disclosure on at least one data point' is the percentage of companies in each sector that report at least one useable quantitative figure. 'Disclosure on quantity' and 'disclosure on recycled/bio-based/re-used content' refers to the percentage of companies that report at least usable partial information on the quantity of plastic used and its recycled/bio-based/re-used content. Average 'plastic' occurrences is the average number of times the word 'plastic' appears in reports published by companies in each sector (but does not include counts of related terms such as 'polymer').

The sector-specific results section (appendix 1) provides a sector-specific breakdown and commentaries of these figures.

TABLE 6: DISCLOSURE ANALYSIS

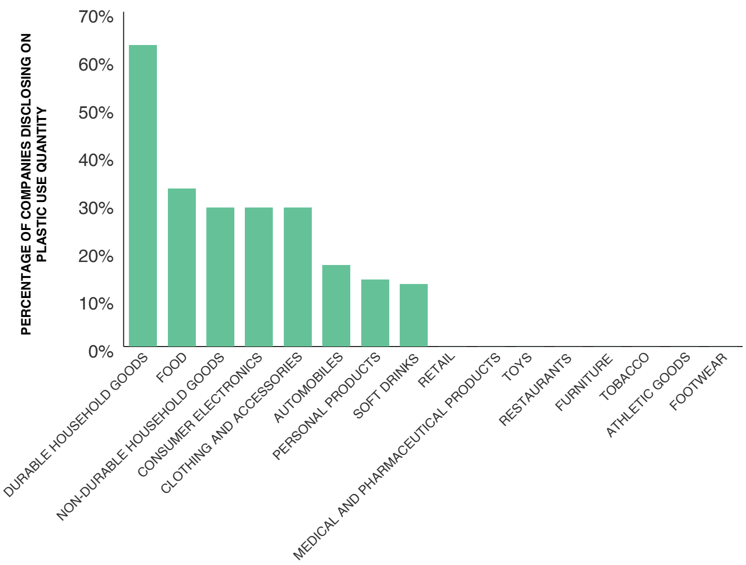
SECTOR	DISCLOSURE ON AT LEAST ONE USEABLE DATA POINT	DISCLOSURE ON QUANTITY	DISCLOSURE ON RECYCLED/ BIO-BASED/ RE-USED CONTENT	DISCLOSURE ON BOTH QUANTITY AND RECYCLED/ BIO-BASED/ RE-USED CONTENT	AVERAGE OCCURRENCES OF THE WORD 'PLASTIC' IN COMPANY'S DISCLOSURE	NUMBER OF COMPANIES INCLUDED IN THE DISCLOSURE ANALYSIS
Durable household goods	88%	63%	38%	25%	1	8
Non-durable household goods	71%	29%	43%	14%	1	7
Consumer electronics	71%	29%	43%	14%	2	7
Personal products	71%	14%	29%	0%	1	7
Food	67%	33%	50%	17%	2	6
Retail	67%	0%	0%	0%	2	6
Clothing and accessories	57%	29%	29%	0%	1	7
Soft drinks	50%	13%	13%	0%	1	8
Medical and pharmaceutical products	50%	0%	0%	0%	0	6
Toys	33%	0%	0%	0%	4	3
Restaurants	33%	0%	33%	0%	0	6
Furniture	33%	0%	17%	0%	1	6
Automobiles	29%	0%	14%	0%	2	7
Tobacco	17%	17%	17%	17%	0	6
Athletic goods	0%	0%	0%	0%	0	4
Footwear	0%	0%	0%	0%	0	6

FIGURE 16: PERCENTAGE OF COMPANIES DISCLOSING ON AT LEAST ONE DATA POINT



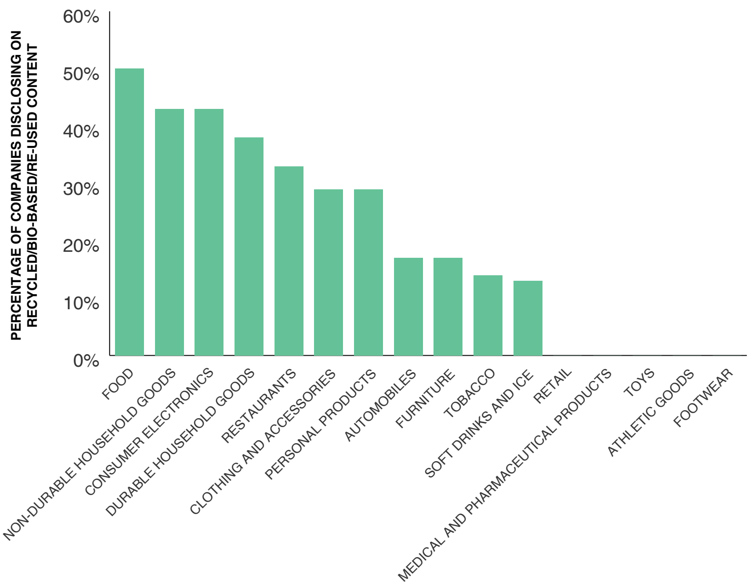
Trucost calculations derived from companies public disclosure (full set of references and methodology available in appendices 3 and 5 of this report)

FIGURE 17: PERCENTAGE OF COMPANIES DISCLOSING ON PLASTIC USE QUANTITY



Trucost calculations derived from companies public disclosure (full set of references and methodology available in appendices 3 and 5 of this report)

FIGURE 18: PERCENTAGE OF COMPANIES DISCLOSING ON RECYCLED AND BIO-BASED CONTENT



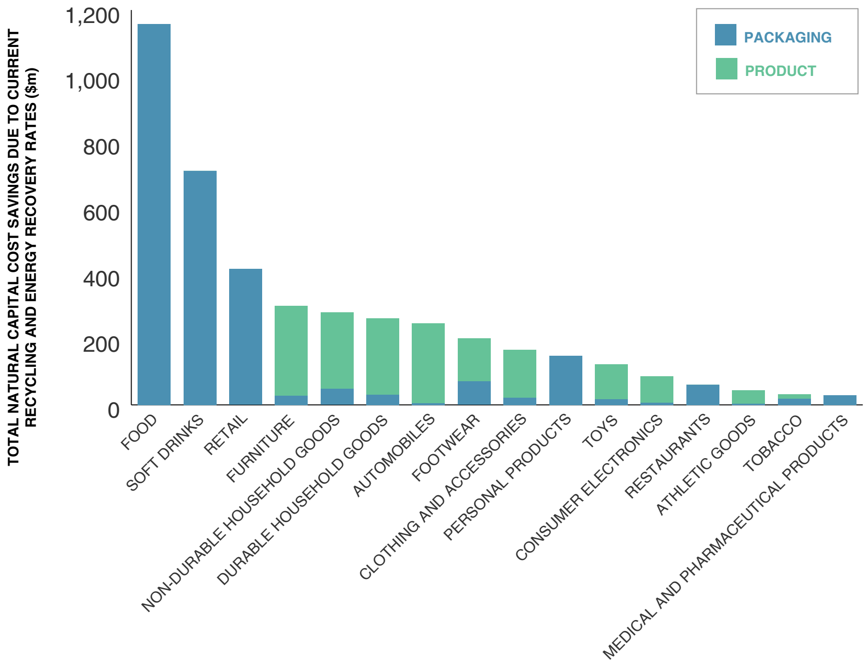
Trucost calculations derived from companies public disclosure (full set of references and methodology available in appendices 3 and 5 of this report)

WHAT ARE THE NATURAL CAPITAL BENEFITS OF GOOD PLASTIC MANAGEMENT?

Good management practices represent an opportunity for businesses that use plastic and can lead to substantial natural capital cost savings. The baseline figures presented throughout the report are based on impacts, and do not include the benefits of recycling or incineration with energy recovery at the end-of-life of products and packaging. Recycling benefits include the avoided impacts of the quantity of plastic that would have been produced if the recycled material had not been available, as well as the avoided impacts of where the plastic would have ended up (littered, landfilled) if it had not been recycled. Benefits of incineration with energy recovery include the avoided impacts of grid electricity production. Appendix 3 outlines the methodology used to assess these benefits.

Taking these benefits into account decreases the total natural capital cost from over $75bn to around $72bn. These waste management practices save $4bn a year. Figure 19 displays how this $4bn is split across sectors and products. Initiatives in the food and soft drinks sectors contribute 27% and 17% respectively to the total savings.

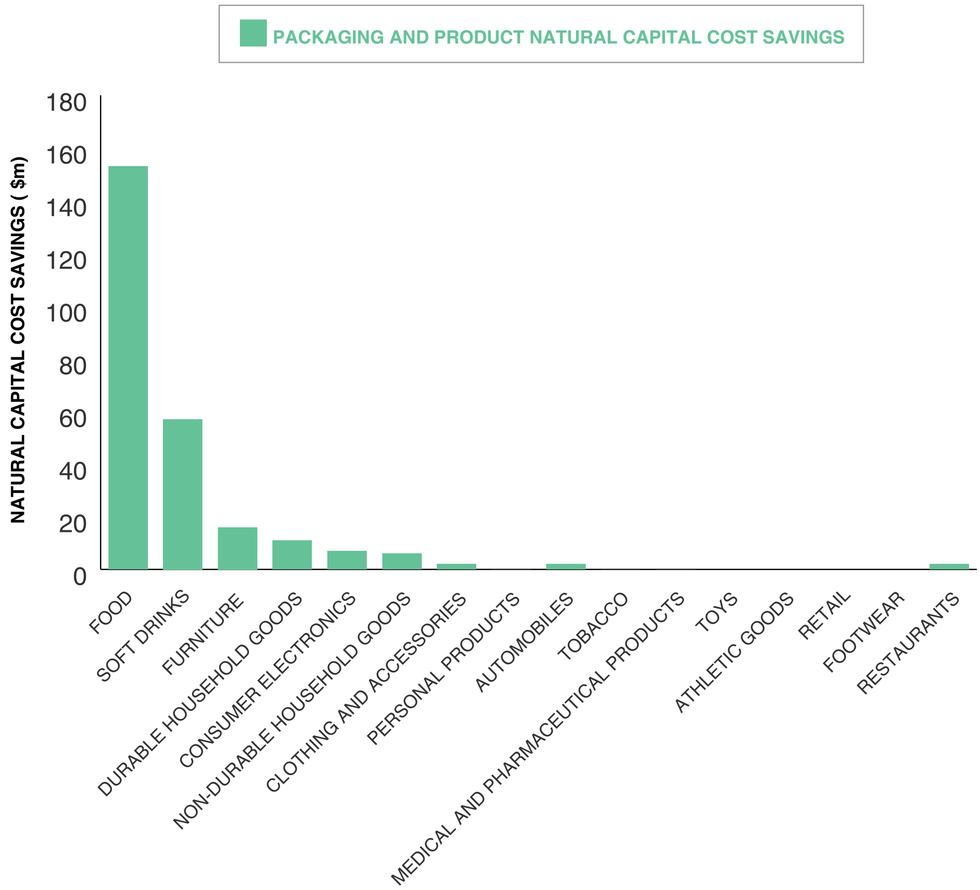
FIGURE 19: NATURAL CAPITAL COST SAVINGS DUE TO CURRENT RECYCLING AND INCINERATION WITH ENERGY RECOVERY RATE



Trucost calculations derived from, but not limited to, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3 and 4 of this report)

The same analysis can be carried out using company disclosures. Figure 20 shows the total natural capital cost savings that can be attributed to the use of recycled content in products and packaging for selected companies in each sector. These vary between zero and $153m in 2012. This data only takes into account companies that disclosed quantified savings, so is likely to be underestimated as many companies disclosed their use of recycled content in qualitative terms. The largest benefit is in the food sector with savings equivalent to $153m, or 8% of the natural capital cost of plastic, followed by the soft drink sector ($57m and 4% respectively) and the furniture sector ($16m and 24% respectively). No company in the toys, athletic goods, retail, and footwear or restaurants sector disclosed useable data on recycled content.

FIGURE 20: NATURAL CAPITAL SAVINGS DUE TO THE USE OF RECYCLED CONTENT



Trucost calculations derived from, but not limited to, companies' public disclosure, World Bank [7]; PlasticsEurope [8]; Eurostat [9], and the US EPA [10] datasets (full set of references and methodology available in appendices 3, 4 and 5 of this report)

SUMMARY

The global weighted average of plastic used by the consumer goods sector in their products and packaging, but excluding plastic used solely within the supply chain, is 2 tonnes per $1m revenue. This translates into a minimum natural capital cost for the consumer goods sector attributable to its plastic of over $75bn, with the food sector contributing 23% of this figure. When the lifespan of products and packaging is taken into account, the annualized overall natural capital cost of the consumer goods sector is $35bn, with the largest contributors being food (25%), non-durable household goods (20%), soft drinks (13%) and retail (8%).

Companies with the highest total natural capital cost are most likely to experience external pressures, such as legislation or scrutiny from the general public and non-profit organisation. Plastic use measurement, management and disclosure are thus particularly relevant for companies operating in the food, soft drinks, non-durable household goods, automobiles, and furniture sectors.

Natural capital intensity expresses the revenue-at-risk if the environmental impacts of plastic use had to be internalized by companies. The toys sector has the highest natural capital intensity, at 3.9% of its overall revenue, followed by the durable household goods, footwear and athletic goods sector (1.7%). Sectors with the lowest natural capital intensities are the retail, restaurants and tobacco sectors.

Companies with the highest natural capital intensity have the highest proportion of their revenue at risk if they had to internalize the costs linked to their plastic use. Plastic use, measurement, and disclosure are thus particularly relevant for companies operating in the toys, durable household goods, footwear and athletic goods sector.

On average, the total natural capital cost of plastic use is 52% of total economic costs. Over 75% of impacts are located upstream in the supply chain across all sectors and most are due to greenhouse gas emissions, followed by land and water pollution. At the end-of-life stage, the impact of plastic reaching marine ecosystems is the largest contributor – 17% of the total natural capital cost on average, or $13 bn. The non-durable household goods are the largest contributor to the overall ocean natural capital cost. Upstream impacts are better understood than downstream impacts, which have likely been underestimated as a result.

> When assessing what actions could be taken to better manage their plastic use, companies need to understand how these actions will impact the overall impact. The model developed for this report suggests that actions tackling upstream greenhouse gas generation and downstream littering are likely to have the most effect on the overall natural capital cost and intensity. The 'Fishing for Litter' case study in the next section provides insights on how to decrease marine litter impacts.

Impacts will vary across regions based on waste management infrastructure, local geographical conditions and the size of the consumer goods sector. Regions with the highest natural capital intensity – both upstream and downstream - are Asia, Latin America and Africa. With both production and consumption growing in these areas, companies' exposure to the risks of plastic is likely to grow, unless they take steps to improve production processes, waste collection, and recycling and recovery practices in these regions. A limitation of this report is that it does not take into account transboundary waste exchanges in its calculations.

> Companies could develop an understanding of where the plastic material is sourced and where it is disposed. Actions to decrease the impact of plastic use in these regions of the world where is it the highest will have the most effect on the overall natural capital cost and intensity.

The first step towards good management is measurement, because without measurement, it is impossible to properly manage. Disclosure of this plastic footprint is considered best practice. Out of the 100 companies analysed, approximately half disclose useable quantitative information on plastic. Disclosure rates vary from zero in the athletic goods and footwear sectors to 88% in the durable household goods sector. While this figure may seem high at first sight, "disclosure" here is understood in its broad sense and can comprise only one partial data point.

No correlation was found between natural capital cost, natural capital intensity, and rates of disclosure, suggesting that disclosure is not yet driven by a clear understanding of the risks and opportunities associated with plastic use. Sectors that disclose information on plastic use seem to be those that are most exposed to regulatory and reputational risks, rather than an understanding of the natural capital costs they face. This indicates that plastic is still a nascent issue, compared to others such as carbon. As companies improve their measurement, management and disclosure, a correlation could develop in their improved impact on natural capital.

> Companies could disclose better, both quantitatively and qualitatively, on their use of plastic. For example, the Plastic Disclosure Project provides guidance as to how to do this.

Plastic is a useful material with many benefits such as being lightweight and low cost. The main challenge is to properly manage the negative impacts of plastic and improve the positive aspects. Good management practices represent an opportunity for businesses that use plastic to achieve substantial natural capital cost savings. Recycling and incineration with energy recovery save $4bn in natural capital costs mainly due to initiatives in the soft drinks and food sectors.

> Once companies have taken action, they could evaluate and report on the progress achieved.

Appendix 1 provides sector-specific breakdown and analysis, including company-level analysis and case studies.

The next section details potential solutions and provides a roadmap for better plastic management and disclosure.

RAISING AWARENESS THROUGH INNOVATION: FISHING FOR LITTER AND THE LATEST USES OF OCEAN PLASTIC

A handful of companies are finding new and innovative solutions that increase the use of recycled plastic, clean up plastic litter from the world's oceans, and raise public awareness about the impacts of plastic.

Fishing for Litter programs were first developed in the Netherlands in 2000 by the North Sea Directorate of the Dutch Government and the fisheries association, and were expanded by Kommunenes Internasjonale Miljøorganisasjon (KIMO), the local authorities' international environmental organization. Since then, Fishing for Litter has grown in the North Sea region to include programs in Scotland, south west England and the Baltic Sea. The programs work to reduce marine litter by encouraging fisherman to collect the litter they 'catch' while fishing, and bring back to shore. The program works with ports and harbours to provide areas to deposit the trash, and with non-profit organizations and businesses to transfer it to recycling and waste recovery facilities.

Participation is voluntary and without financial compensation. Because the adverse impacts of marine litter on the fishing industry are widely understood, the program is fuelled by a desire to spread good operating practices. A study published in 2002 demonstrated that the UK fishing industry loses over €33m ($31m) a year due to marine debris. Research focusing on the Scottish Shetland fishing fleet found that marine debris could cost a vessel up to £30,000 ($45,000) a year.[7]

More than 210 boats in Scotland participate in Fishing for Litter, which operates in all Scottish ports. In south west England, eight harbours and 111 vessels participate.[60] Fishermen are important stakeholders in developing awareness of marine litter and practical ways to clean it up. Fishing for Litter's innovative approach to include fishermen along with non-profit organizations, businesses, government officials and harbours, facilitates and develops participatory multi-stakeholder awareness of the issue.

In 2011, the success of Fishing for Litter programs in the North Sea inspired EU commissioner for maritime affairs and fisheries Maria Damanakis to announce a similar plan in the Mediterranean. The fishing for plastic plan started in France and was later extended to Greece. This pilot project was coordinated by EU-level trade association the European Plastics Converters, in collaboration with the public-private foundation Waste Free Oceans (WFO) and the fishing industry.[63]

This initiative is the first program of its kind to pay fishermen through the European Fisheries Fund to recover litter, including plastic, and provides an extra source of income to fishermen while reducing pressure on fish stocks and cleaning up local fishing grounds. Fishermen who participate in this program use specially designed equipment to recover the litter, some of which is provided by the pilot project. The innovative multi-stakeholder partnership program promotes cooperation across sectors and raises awareness of the marine litter issue for the EU government and fisheries officials, the plastics and fishing industries, and non-government organizations like WFO.

GhostNets Australia is an example of a fishing for litter-type organization that specifically targets fishing nets that have been abandoned, discarded or lost at sea. They can become entangled with other nets and marine litter, and can continue to accidently catch marine life at sea or on beaches. The Australian government funded the start of the program in 2004. The organization is now made up of over 22 indigenous Australian communities in the coastal areas of northern Australia, areas of west Australia, the Northern Territory and Queensland. The communities that recover these nets can either properly dispose of them, or convert them into artistic products, such as colourful baskets that are woven from the nylon threads of the fishing nets.[62] GhostNets Australia is a successful example of innovation employed by a diversity of stakeholders to reclaim highly destructive types of marine litter.

Interface is the world's largest designer and maker of carpet tiles.[34] In 2013, Interface introduced its Net-Works program to buy waste fishing nets from local Philippine fishermen of the Danajon Bank, an environmentally sensitive and ecologically diverse reef system that is one of only six double reefs in the world.[63] Many modern fishing nets are made of plastic nylon which will persist in the marine environment for an unknown period of time. With a density greater than water, discarded nets can sink to the ocean's floor and cause damage to fragile reefs and the surrounding marine life.

Interface's Net-Works program sets up community banking systems to pay fishermen and villagers to collect, clean, sort and sell-back discarded fishing nets. These villagers can invest the money earned through the Net-Works program in new financial opportunities including the creation of savings accounts, loans and micro-insurance. In collaboration with its business partner Aquafil, Interface converts the nylon from these nets into 100% ECONYL recycled nylon yarn, with the same quality and performance as virgin nylon yarn, to be used in their Net-Works blue ocean inspired carpet designs. The recycled nylon yarn is a blend of pre-consumer waste such as scraps from industrial processed nylon, and post-consumer waste such as the fishing nets.[63] With 27,000 kg of nets collected from 24 villages (4,460 people), Interface is planning to expand the program to other areas of the world.

Other companies are raising awareness about ocean pollution as well as utilising a new source of raw material by using recovered plastic in their products. Home care and personal products company Method uses 'ocean plastic' that has been collected by cleanup volunteers on the beaches of Hawaii to create post-consumer recycled blend plastic bottles for its

2-in-1 dish + hand soap.[64] The bottles are grey in colour, with tags attached explaining that the reason is because they are made with recycled ocean plastic.

UK-based cleaning and personal care company Ecover is using recycled ocean plastic in the production of its new 'ocean bottle'. This washing-up liquid bottle eliminates the use of fossil fuels in the supply chain, and replaces them with a combination of 10% ocean plastic, with the rest a combination of sugarcane and post-consumer recycled plastic.[65] They are the first company to create plastic from the combination of these three materials. Ecover sources ocean plastic through its partnership with the WFO and the North Sea Fishing for Litter programs.

Recycled plastic is also being used in clothing and fabric, such as by companies Patagonia and Nike. In 2010, Nike put recycled plastic clothing on the world stage when they produced kits for all of their World Cup teams from recycled plastic bottles harvested from landfills in Japan and Taiwan. Through the creation of these kits they removed the equivalent of nearly 13 million plastic bottles from landfills.[66]

In February 2014, musician and fashion designer Pharrell Williams announced his denim jeans clothing line, RAW for the Oceans. Williams, along with his company Bionic Yarn and clothing partner G-Star RAW, use recycled ocean plastic reclaimed from coastlines to produce the fabrics and yarn in the jeans.[67] Using fashion and popular culture, Williams is reaching a modern global audience, advancing innovation in the clothing sector, and making informed consumer choice a fashion statement.

ROADMAP FOR PLASTIC FOOTPRINT MANAGEMENT

Better upstream and downstream management of plastic will require collaboration between stakeholders. The first step is for companies to measure and report on plastic. This section describes how companies can report, and the role that other stakeholders can play in creating the conditions to support disclosure. It goes on to discuss how companies can manage the upstream impacts of their use of plastic. Finally, it highlights downstream solutions and challenges.

MEASURING, REPORTING AND MONITORING

Companies' measurement of plastic use can feed into mainstream reporting standards such as the Global Reporting Initiative and CDP.[54,68] The GRI enables companies to disclose plastic although the requirement is expressed in general terms. EN1 and EN2 indicators in the latest version of the guideline, GRI-4, require companies to report on the total weight or volume of materials used to produce and package products and the percentage of recycled input used. EN28 requires the percentage of reclaimed products and packaging materials for each product category to be disclosed. Similarly, understanding the carbon impact of its plastic consumption may feed into a company's disclosure to CDP on the scope 3 categories 'material sourcing' and 'end-of-life waste'. Additional reporting opportunities include the Sustainability Accounting Standards Board (SASB) and the International Integrated Reporting Council (IIRC).[69,70] Finally, the Plastic Disclosure Project provides a framework specifically on plastic reporting.

Integrating information on plastic use and its impact into annual sustainability and corporate social responsibility reports can help companies differentiate themselves in the marketplace and capture first-mover advantage by going beyond traditional issues such as carbon. Regulation and reputation are currently the main drivers of disclosure. External stakeholders could create the conditions amenable to greater measurement, disclosure and reporting. The Plastic Disclosure Project provides a platform for companies to report and demonstrate leadership on the issue of plastic, specifically by inviting them to disclose on the production, use, handling and end-of-life of this material in a standardised way. Companies and investors can then use this data to feed into product, supply chain and investment strategies.

Aside from commercial confidentiality issues, the main barrier to better disclosure and management appears to be a lack of transparency along the supply chain, all the way from raw material sourcing to end-of-life. While companies may have an understanding of their own material use, information on the plastic and chemicals embedded in items purchased from suppliers may not be readily available. This is particularly true of the use of additives in plastic, for example, in the clothing sector.[71] The Plastic Disclosure Project and other reporting frameworks provide a useful way to harmonize and compare data. However, this depends on companies taking the lead in engaging and monitoring their supply chain. One tool to do this is Material IQ, a comprehensive business-to-business online registry designed to provide in-depth sustainability information about materials, including chemical additives, used in a range of products and industrial sectors.[94] Another tool is the Plastic Scorecard, developed by BizNGO and Clean Production Action, which can serve as a mechanism to help businesses move to environmentally preferable types of plastic.[72]

Measurement is the first step towards understanding a company's use of plastic. With this information companies can identify the economic, environmental and social impacts of plastic consumption and make decisions on how to improve. Many of the companies in this research make use of lifecycle analysis, with some disclosing the results. For example, Apple and Interface make formal environmental product declarations linked to their main product categories, with the exact material composition and associated impact.[34,73] Industry bodies such as PlasticsEurope have published environmental profiles (or eco-profiles) for different types of plastics, from the extraction of raw materials to the manufacturing of plastic feedstock.[9] The next step could be to apply natural capital valuation in order to produce a single monetary figure which is easy to communicate to stakeholders and which can facilitate business decision-making by allowing different impacts to be compared.

Companies could collaborate with governments and research organisations to improve data on the downstream impacts of plastic related to waste management. The end-of-life fate of plastic products and packaging varies significantly depending on the geographical location, but minimal country-specific data for different types of materials exists. Very few countries apart from the US and EU member states disclose detailed data on the amount of plastic going to waste management. In addition, the amount of waste plastic going to different waste treatment routes such as incineration and landfill is rarely disaggregated, yet the social and environmental impacts of these two options vary significantly. This represents a challenge for companies that want to understand and take responsibility for their downstream impacts, but which operate in many different countries.

Companies could work with research institutions, campaign groups and others to improve their understanding of the environmental impact of littered plastic. At present there is only a limited understanding of the impact of plastic litter on the environment. While this research gathered the best available data to assess the end-of-life impacts of plastic, there are significant gaps in the information. Specifically, there are gaps in the understanding of dispersion routes for plastic litter, and how likely it is to be collected or enter the ocean. Experts also debate the quantity of plastic entering the ocean each year. Large uncertainties remain around degradation, leachate, and the toxicity of additives and de-adsorption rates of persistent bio-accumulative toxic substances. Similarly, the impact of microplastics is only starting to receive attention. In 2010, the UN's Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) established a working group on the subject and the UNEP's 2011 Yearbook identified it as an emerging issues.[74,75]

DISCLOSING PLASTICS

PDP PLASTIC DISCLOSURE PROJECT

The Plastic Disclosure Project is an initiative of the Hong Kong and California-based Ocean Recovery Alliance (ORA). Its supporters include the UN Environment Programme (UNEP) and the World Bank. The Plastic Disclosure Project participates in both of their related ocean programmes (UNEP's Global Partnership on Marine Litter, and the World Bank's Global Partnership for Oceans). Its mission is to encourage companies to report their performance on plastic management through an annual survey, much as the CDP (formerly Carbon Disclosure Project) has done with carbon.

Cosmetic company Lush was the first to disclose to the Plastic Disclosure Project. Ecologic Brands, Paragon Communications, AWP Painting, Seventh Generation, Method Home, PulpWorks, UC Berkeley, and San Francisco International (SFO) Airport are examples of other companies and institutions that participate in the Plastic Disclosure Project questionnaire.

Companies can disclose either through a questionnaire or in their own sustainability or integrated reports. The Plastic Disclosure Project is calling for collaboration with main reporting standards, such as GRI, Earth Check, the Sustainability Consortium and the Higgs Index in order to facilitate the reporting processes for companies and not overburden businesses with a plethora of inconsistent requirements.

The Plastic Disclosure Project provides a detailed reporting guideline, with the key quantitative questions highlighted below. Additional information can be found online at www.plasticdisclosure.org

What is the estimated use (in tonnes) of plastic in the company's operations and supply chain?

Companies may disclose plastic used in operation (or direct plastic use) as a minimum.

Companies may also disclose around the quantity and type of additives used. Additional questions include: What type and quantity of chemicals and additives have been used during the manufacturing process? What type and quantity has been released to air, land and water? What type and quantity remains within the product and packaging, and how likely is it to affect toxicity in the use and end-of-life phase?

Explain the calculation methodology employed.

Scope and boundary should be clear. If possible, additional information could be provided on the plastic content of parts purchased from external suppliers, for example, batteries, displays and keyboards.

What are the main types of plastic used in products and packaging, broken down by type and volume?

If possible, these figures may be disclosed both at the company and the product level, by sourcing location, as well as split between product categories and packaging (primary, secondary and tertiary).

Additional questions include: What proportion of raw material has been wasted during the manufacturing process and how it is handled? Is it sent to landfill, incineration without energy recovery, incineration with energy recovery, recycled in-house, recycled externally or re-used? This applies to both plastic-in-product and plastic-in-packaging. If possible, this information could be provided for plastic parts bought from external suppliers as well.

If recycled material is used, what percentage of the total material used is recycled or bio-based content?

If possible, this figure may be disclosed both at company and product level, and split between product categories and packaging (primary, secondary and tertiary). Information on the type of recycled and bio-based content could be provided, such as the type of recycling technology (mechanical or feedstock, for example) and the type of biomass used (corn or sugar-cane, for example).

What percentage of plastic used is biodegradable or recycled at end-of-life?

Is the organization aware of what happens to plastic used in its products and packaging after its use by customers? What percentage is disposed of in landfills or other disposal locations? How much is recovered as result of energy conversion (%) or recycling (%)?

Global data to be broken down between unmanaged waste and managed waste, landfilled, incinerated, incinerated with energy recovery, recycling, re-used, composted and other use (such as fuel conversion). Information on potential take-back programs such as quantity of products and packaging collected, type of materials recovered, and loss rates during the recovery process.

What percentage of plastic used is for short-user-life products or packaging?

This data point can help partially assess the efficiency of plastic usage.

PRODUCT AND PACKAGING DESIGN

The first and preferred upstream management option that is available to companies is reducing the weight of plastic products. There has been a trend, most apparent in the packaging industry, towards size reduction leading to a decrease in overall material intensity and operational cost reductions. For example, Dr Pepper Snapple Group has decreased its use of polyethylene terephthalate by 14m pounds (6m tonnes) in 2011 – or 31m (14m tonnes) pounds since 2007, saving the company $25m in costs.[76] Similarly, LG Electronics has reduced its use of packaging materials by 4.6% for new TV products and 20.1% for mobile phones in 2013, resulting in cost savings higher than $13m.[77] While laudable, these efforts are often offset by sales growth; how material use is decoupled from economic growth is unclear. Many other companies have set up goals for material reduction. Yet, apart from the EU packaging directive, very few regulations exist on material use reduction in most countries. Beyond anecdotal examples, it is often hard to evaluate the extent to which these voluntary goals are met.[78]

Another key trend is the continued growth in the market share of bioplastics, mainly in packaging and car components, forecast to be 20% per year globally.[79] Key drivers for biodegradable polymers include decreasing landfill capacity, pressure from retailers, consumer demand, and regulatory pressures on greenhouse gases, fossil fuel dependence and waste control. Challenges to the adoption of bioplastic include limited applicability until its functionality matches that of oil-based plastic, poor compatibility with existing equipment and end-of-life management systems, higher production costs, and a lack of detailed information on its environmental and social impacts. There are different types of bioplastic comprising materials that can either be bio-based, biodegradable or both, and each presents different social, environmental and business risks and opportunities.

Bio-based plastic is made from natural resources, such as starch or sugar, but may not necessarily be biodegradable. Examples of non-biodegradable bio-based plastics include bio-based polyethylene and polyester terephthalate. The bulk of market growth is projected to come from this family of products, from 12% in 2007 to 38% in 2011.[79] Debate exists around the environmental superiority of this material, and it is essential to draw adequate assessment boundaries to include potential impacts such as biodiversity loss, water consumption and fertiliser use. According to one review, most lifecycle analyses show that bio-based plastic is better than oil-based equivalents on aspects such as greenhouse gas emissions and fossil fuel consumption, but not necessarily for other impacts, such as eutrophication, manifested by algae blooms.[79] In addition, some bio-based plastics require land for production, which raises concerns over competition for land needed for food production. However, second generation plastic production from sources that do not compete with agricultural production, such as agricultural by-products including corn straw and waste sugar cane, is on the rise.[80]

Biodegradable plastic can be bio-based or oil-based and meet standards for biodegradability and compostability. Degradable or oxo-degradable plastics are usually oil-based plastics to which additives have been added to enhance the degradation, but do not meet biodegradability and compostability standards.[80] An example of bio-based and bio-degradable plastic is polylactic acid (PLA), which dominates the market. Confusion often stems from inadequate labelling and lack of consumer knowledge, leading to recycling stream contamination. Furthermore, these plastics have different degradation times and infrastructure needs, often requiring an industrial composter, rare in most of the world, to biodegrade as advertised. If they were littered by the public based on the assumption that they will soon biodegrade by themselves, they would have the same end-of-life environmental impacts as oil-based plastics. Stronger labelling requirements, educational programs and end-of-life sorting and monitoring are thus required to capture the benefits of this option. For example, NatureWorks proposes its own buy-back scheme to manage the recycling process themselves.[81]

Recycled plastic is gaining considerable attention across all industries. Treatment options include mechanical and feedstock recycling among others, and suitability differs across plastic types. Sorting remains a key issue. Due to the variety of plastic entering this waste stream, contamination may occur resulting in lower-grade, down-cycled materials, the price of which is approximately half that of new plastic.[82] In contrast, food-grade recycled PET (rPET) plastic, which is frequently used in packaging, is sold at a premium in most markets reflecting increased demand across multiple industries. The higher price also reflects problems with current processing technology which makes it difficult to remove contaminants, limiting supply.[83]

Reliability of supply has also been highlighted by several companies in the sample analysed. Solutions include closed-loop recycling of in-house waste or investment in end-of-life take-back programs. However, uptake remains limited. Similarly, environmental and human impacts have received recent attention when the process takes place in countries with less stringent regulations. China, for example, dominates the supply of recycled plastics. Attention has grown recently on the recycling practices of products with additives, such as consumer electronics, due to their potential health impacts when dismantled.

Chemical use in plastic has received regulatory attention due to the potential human health and environmental hazards across the lifecycle. While these substances play an essential role in improving the functionality of plastic, they can potentially be dangerous to workers during manufacturing and recycling processes, and to the general public through possible product leachate under certain circumstances. Several substances are covered and regulated by legislation, such as REACH in the European Union, while others have been banned such as PCBs in the US.[84,85] Many companies are taking steps to phase out toxic substances such as phthalates, brominated flame retardants and polyvinyl chloride.

Process innovation may help to tackle some of the issues associated with recycled plastic and bio-plastic, and lead to cost reduction while potentially generating additional revenue streams. Several companies are implementing internal guidelines and commodity purchasing plans for designers, product managers and buyers to help them develop more sustainable products and packaging, while making sense of all the information available. For example, Natura issued a guidebook in 2011 for the development of new products that includes increasing the use of post-consumption recycled materials and the choice of finishing to increase recyclability.[86] Similarly, Hasbro's sustainable packaging guidelines include information and an internal check list for designers and engineers to compare packaging options on criteria such as number of packaging layers and type of materials.[87]

Some companies are developing their own materials better suited to their specific requirements in terms of functionality, cost and supply availability. For example, in 2012 Ricoh and Shizuoka University developed a new type of PLA, polymerized at low temperatures, without the use of metal or organic solvents catalysts. According to Ricoh, this means the material can be produced in a safer and cheaper way without compromising on quality.[88] Another example is Sony's SoRPlas developed in 2011, which has 99% recycled content, the highest recycled material rate in the world according to the company's sustainability report. This was made possible by the development of a proprietary flame-retardant that reduces the proportion of additives to 1% of total content, thus allowing for a 99% recycled content rate compared with 60% in typical electronics devices made of recycled plastic.[89]

Some companies have put in place innovative processes, for example, to improve recycling technology. Interface's ReEntry process, launched in 2007, is an example of companies taking the lead to overcome traditional recycling barriers. This process has the lowest embodied energy of all recycling processes in the carpet industry while maximising the quantity of material recovered and minimising contamination.[34] Another example is Panasonic's resin-sorting system using near-infrared rays to overcome the issue of plastic mixture, enabling a purity of over 99% of sorted materials. This, along with optimizing the use of additives, has allowed extending the strength and quality of appearances of recycled plastics.[90]

END-OF-LIFE MANAGEMENT

The value of packaging sent to landfill in the US in 2010 was more than $11bn, with plastic accounting for more than 70% of this figure.[78] Plastic packaging has the highest recycling rate among plastic products, yet it is one the largest waste streams in US landfills and the most common material that ends up in oceans. Downstream waste management thus poses risks and opportunities from social, environmental and economic perspectives. Companies are taking voluntary steps to manage their end-of-life impacts, but these are often the low-hanging fruit and not necessarily the most significant from a social and environmental perspective. Regulations promoting extended producer responsibility are also being passed in key areas such as packaging and electronic waste. However, these mainly focus on increasing the overall recycling rate and may have a perverse effect on the management of plastic. As plastic is lighter than metal and glass, companies prioritize the recycling of these materials rather than plastic to meet the percentage required to be recycled. In addition, regulations are weaker in regions where consumption is growing.

Collection rates are inadequate in many countries. For example, this research estimates that 57% of plastic in Africa, 40% in Asia, and 32% in Latin America is not collected. These materials are either littered or burnt in the open, and eventually part of them make their way to the ocean. A 2013 research brief by Pritzer reviewed international instruments relevant to plastic marine litter and found that they have limited jurisdiction over major sources of plastic pollution, in particular land-based, and have limited enforcement standards and mechanisms.[37] The brief provides several recommendations on the key steps to tackle this problem through new conventions, amendments of actual law and the creation of an 'Ocean Friendly' certification program. One of the solutions appears to lie in creating a value for the most common types of plastic as an incentive for recovery and implementation of adequate collection and waste management structures to avoid plastic litter entering the environment in the first place.

After reduction, reuse is often seen as the next most preferable option. Avon, for example, has introduced refillable containers in its Mark Brand, which according to the company saves 0.15 pounds (0.07 kg) of materials at each refill.[91] More broadly, retailers are promoting the replacement of single-use plastic bags with reusable bags. These initiatives necessitate a change in consumer behaviour that is not always straightforward to achieve. In addition, they represent a change in the business model of companies, from product to solution thinking. In some instances, it is not clear whether the overall environmental and social benefit is positive or negative when taking into account the full lifecycle. Pouches are not easily recyclable and companies are investigating viable business models to manage the new types of waste generated, such as recovering some of the material and energy contained through incineration.

Despite all technological advances in the reclamation of plastic, an important proportion of the plastic waste stream cannot be mechanically recycled due to contamination, lack of markets, or inability to separate plastics. MBA polymers is an example of company that can recycle mixed plastics, however this is not yet common practice.[92] A new generation of conversion technology designed to manage non-recycled plastic using pyrolysis to convert plastic into oil and other fuels is becoming increasingly established in Europe and Asia.[93] One prominent player in the plastic to fuel field – British company Cynar – converts almost any kind of waste plastic by feeding it into a system where it undergoes liquefaction, pyrolysis and distillation at a 95% conversion rate.[94]

Pyrolysis is being investigated by several companies in the peer group. For example, in an effort to offer a practical solution to the problem of single-use sachet litter, Unilever investigated options to recover as much of the energy used in the manufacturing process. Through an assessment of waste-to-energy options it concluded that pyrolysis was the most promising, proving that turning sachets, pouches and other flexible plastic waste into fuel oil could be achieved at a viable cost.[95] Despite the greenhouse gas emissions associated with fossil fuels, it could be argued that the process is a possible alternative in that it offers a solution for difficult to recycle plastic such as bottle caps, appliance plastic and food packaging. The process is not suitable for polyvinyl chloride and polystyrene.[94]

Most companies have committed to operational waste reduction and recycling. Few companies, depending on their sector, have also implemented take-back programs for their own or different products. Regulations exist on overall recycling rates of certain products, such as the EU directives on end-of-life vehicles and waste electrical and electronic equipment. However, as discussed previously in this report, the focus on setting recycling rates using weight has often been to the detriment of plastic recycling because its lighter weight makes it a low priority compared with other materials such as metals. Further improving the recycling rate for plastic, as well as improving recycling processes and quality of plastic, could thus be a primary focus for companies and policymakers, particularly in a context where the supply of quality-recycled material does not meet demand.

RECOMMENDATIONS

Given the implications of plastic use for companies in the consumer goods industry, this research makes the following recommendations:

1. **Raise awareness at the Board Level** – Taking action to reduce the risks of plastic while benefiting from the opportunities first involves raising the awareness of a company's executive board. The findings of this research provide the information needed to build a business case for the board to sanction action.
2. **Measure your plastic footprint.** This research recommends that companies measure how much plastic they use in their direct operations, and ideally in their supply chain, as the first step towards understanding the implications of their plastic dependency. For companies in the consumer goods industry, the findings in this report could provide a useful initial assessment tool.
3. **Assess the risks and opportunities.** Once the plastic footprint is calculated, the next step is to identify the potential risks it poses in terms of emerging regulation, reputational damage and other factors. Companies will also benefit from assessing opportunities from improved plastic management such as cutting costs through efficiency gains, generating new revenue streams through 'closed loop' business models that recover useful resources locked up in plastic; and winning customers by demonstrating more sustainable products.
4. **Plan and implement a management strategy.** Once companies understand the implications of plastic for their business, they can set about developing a plan to address them. Companies can use the plastic footprint results to identify product lines, types of plastic, sourcing and end-of-life locations, as well as relevant environmental impacts that deserve further attention. To ensure the strategy is robust and effective, companies could include quantitative performance targets. Companies could use the disclosure to compare its performance with targets set in the strategy.
5. **Take action.** The management plan could include some or all of the following measures:
   - a. **Prepare your business for future regulation.** Recognize, commit publicly and push forward the agenda of extended producer responsibility policies and standards. This could help companies to achieve first mover advantage on future bans, taxes and regulations.
   - b. **Design products with the end in mind.** Consider the overall environmental and reputational impacts of products and packaging across the lifecycle and minimise the likelihood that materials will be littered or escape into the environment. This includes prioritizing environmentally preferable materials and chemicals, making use of tools such as Plastic Scorecard, Material IQ, lifecycle analysis and natural capital valuation. It also includes designing products and packaging to maximise recycled content, enable easy disassembly and recycling, and ideally, 'close the loop' on waste so that valuable materials avoid landfill and incineration without energy recovery and come back to industry as feedstock.
   - c. **Evaluate carefully any alternatives such as bio-based plastics or biodegradable additives.** Confirm, or disprove, their environmental and social superiority by conducting lifecycle assessments, natural capital valuation and other analyses.
   - d. **Label plastic clearly for tracking, public information and recovery purposes.** Proactively collaborate with industry and government to agree pragmatic labelling schemes. Particular care should be given to the labeling of biodegradable plastic that necessitates industrial composting facilities. In particular, the use of 'bio-based' and 'bio-degradable' claims could be regulated and a standard developed to identify plastic that biodegrade fully under natural conditions and in marine environments within an acceptable time frame.
   - e. **Participate in community reuse, recovery and recycling programmes.** Both economic and reputational opportunities exist in implementing and funding initiatives ranging from collection, recycling, take-back and used swap schemes. For instance, by supporting higher recycling rates, companies can develop new supply sources. When non-recyclable and non-reusable materials are still being used, companies may investigate other end-of-life routes such as incineration with energy recovery and waste-to-fuel options.

6. **Publicly disclose.** Companies would benefit from disclosing their plastic footprint, management plans and progress on an annual basis. The disclosure could be part of an existing sustainability/CSR report, following the Plastic Disclosure Project guidelines, or could be a separate Plastic Disclosure Project disclosure if preferred.

7. **Form collaborative partnerships with stakeholders, including suppliers, industry associations, academic bodies, governments and environmental protection organisations to promote industry-wide change and positive action.**

COLLABORATION

SUPPLIERS

Companies can engage with their suppliers to support them in measuring and managing their plastic footprint. This can promote a greater understanding of plastic use throughout the whole supply chain, sensitise suppliers to issues around plastic, and generate mutual benefits.

REPORTING INSTITUTIONS

Companies can engage with reporting institutions to ensure that the issues around plastic are recognised and included in reporting standards. Pushing for the harmonization of reporting requirements is particularly important in a context where companies are being asked to disclose on different platforms and issues.

RESEARCH INSTITUTIONS

Companies can partner with research institutions to derive valuable insights on plastic management in particular, at the plastic type and product level. In addition, there is a critical information gap on waste management routes and infrastructure at country level.

Companies could fund research and educational efforts to better understand the impact of plastic. Areas of particular interest include: consistent lifecycle analyses of bio-based, biodegradable and degradable polymers, including criteria such as food supply and water use; landfill and littered plastic leachate; quantity of plastic entering the environment per year and current concentration of plastic and additives; dispersion routes of plastic; deterioration rate of plastic in different environments and conditions; microplastic impact through ingestion and chemical effects; damage-oriented statistics on the impact of plastic to evaluate the extent of its impact; understand the toxicity impact of additives through the establishment of dose-response function curves, the probability of being released in different media and building up the food chain.

GOVERNMENTS

Companies can collaborate with governments, industry bodies and other institutions to encourage the extended producer responsibility agenda. Features of successful extended producer responsibility programs include: "Financed and managed by producers; aggressive recovery targets with enforceable penalties set by government for failure to meet goals; participation by all industries that produce waste streams with each producer contributing an equitable share to the program; transparent cost allocation; transparency in EPR collection and recycling data, including data from commercial service providers; applies to commercial, industrial, and residential packaging; industry-funded away from home collection, as well as curbside programs; sophisticated educational/promotional programs to ensure consumer participation; mechanisms to work synergistically with existing container deposit programs; levies and other market-based instruments; a focus on materials management and market development for all recyclables; provisions to reduce and phase out use of non-recyclable packaging and single-use items; no incineration – burning recyclable materials sends the wrong message to consumers and markets on materials conservation and efficiency."[78]

Companies can collaborate with industry associations (ACC, PlasticsEurope), institutions (UNEP) and governments to identify practical solutions to plastic issues. This particularly applies to international conventions covering marine litter. Companies and other stakeholders could support the development of new enforceable standards to reach the Rio+20 goal of "achieving significant reduction in marine debris to prevent harm to coastal and marine environments".

Companies can promote and support government, industry bodies and other institutions' focus on significant sectors and products by proactively looking for alternative material and/or design. This particularly applies to sectors that manufacture short-lived and plastic-intensive products, and a potential restriction on the use of hard-to-manage plastic, including microplastics.

INVESTORS

Companies can engage with the investor community to make the business case for good plastic management. Investors would benefit from considering effective management of plastic in their investment decisions through the use of natural capital valuation and initiatives such as the Plastic Disclosure Project.

GLOSSARY

TERM, ACRONYM OR ABBREVIATION	MEANING
Additives	Chemical substances added to plastic materials in order to enhance its properties, for example its resistance to heat or durability.
Benefit transfer	Technique by which an environmental value is transferred from one location to another.
Burden	Negative environmental impacts.
Credit	Positive environmental impacts.
Direct environmental impacts	Impacts from a company's own operations.
Downstream	Life cycle state once the product is discarded by the consumer.
Disamenity	Nuisance caused by noise, odour, presence of vermin, etc.
Environmentally extended input-output model	A model that maps the flow of inputs and environmental impacts through an economy.
Feedstock	Plastic granules or fibre before it is transformed into a finished product and packaging through different manufacturing processes, such as blow moulding or film extrusion.
Incineration without energy recovery	End-of-life treatment route which consists of burning plastic waste. Efficiency and environmental impact of incineration facilities vary globally. A global average has been used in this report and the word refers to a family of technologies rather than a specific one.
Incineration with energy recovery	End-of-life treatment route which consists of burning plastic waste to generate energy. Efficiency and environmental impact of incineration facilities vary globally. A global average has been used in this report and the word refers to a family of technologies rather than a specific one.
Indirect environmental impacts	Impacts from a company's supply chain.
Industry	Refers to the overall consumer goods industry.
Marine litter	Marine litter comprises items that have been deliberately discarded or unintentionally lost, and has reached oceans and beaches.
Microplastics	Microplastics refer to smaller pieces, less than 5mm in size.
Natural capital	The finite stock of natural assets (air, water, and land) from which goods and services flow to benefit society and the economy. It is made up of ecosystems (providing renewable resources and services), and non-renewable deposits of fossil fuels and minerals.
Natural capital cost	Expresses the impact to natural capital of processes and activities. Derived by multiplying the natural capital intensity by revenue.
Natural capital intensity and revenue-at-risk	Expresses the natural capital cost of all environmental impacts per million US$ revenue. This can be understood as a measure of risk – if all environmental and social impacts generated by plastic were to be paid for by businesses, this percentage of their total revenue would be at risk.
Natural capital valuation	The value to people from environmental goods and services. When no market price exists, it can be estimated in monetary terms by using environmental valuation methods. It is often a cost borne by third parties not taking part in the economic activity which generated it.
Normalised natural capital cost	Expresses the total natural capital cost weighted by the average service life of a typical product within the sector of interest.

Plastic	Synthetic material derived from petrochemicals. Can be classified in families depending on properties (see Appendix 2). When the word plastic is used in this report, it excludes bioplastic.
Plastic-in-packaging	Includes the quantity of plastic directly used in the packaging of the product, as well as any losses that were incurred during the manufacturing and packaging stage.
Plastic-in-product	Includes the quantity of plastic directly used in the product, as well as any losses that were incurred during the manufacturing process.
Plastic-in-supply-chain	Includes the quantity of plastic used indirectly by consumer goods businesses via their supply chain but is not destined to be neither in the final product nor in packaging.
Sector	Refers to individual sectors (soft drink, food, etc...) within the consumer goods industry.
Upstream	Life cycle stage spanning from the extraction of raw materials to plastic granule manufacturing.

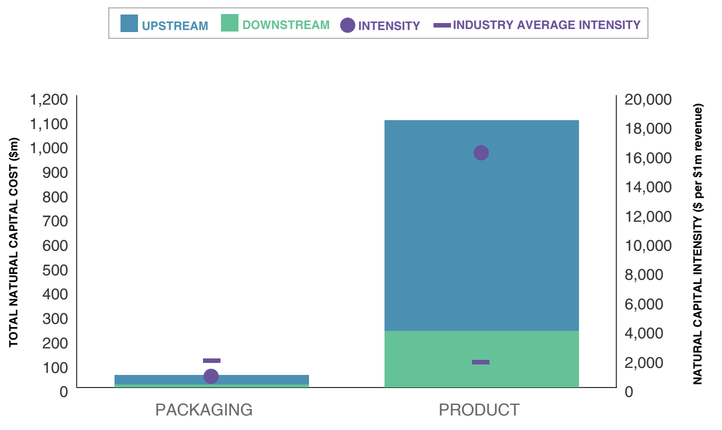
ACRONYMS

ACRONYM	MEANING
ACC	American Chemistry Council
Bn	Billion
CDP	Formerly the Carbon Disclosure Project
EP&L	Environmental Profit and Loss Account
EPR	Extended Producer Responsibility
EU	European Union
GPML	Global Partnership on Marine Litter
GRI	Global Reporting Initiative
IIRC	International Integrated Reporting Council
M	Million
NAICS	North American Industry Classification System
PDP	Plastic Disclosure Project
SASB	Sustainability Accounting Standards Board
T	Tonne
TEEB	The Economics of Ecosystems and Biodiversity
Tr	Trillion
UNEP	United Nations Environment Programme
UNEP FI	UNEP Finance Initiative
UN PRI	United Nations Principles for Responsible Investment
US	United States
WEEE Directive	Waste Electrical and Electronic Equipment Directive
WBCSD	World Business Council for Sustainable Development
$	US dollar

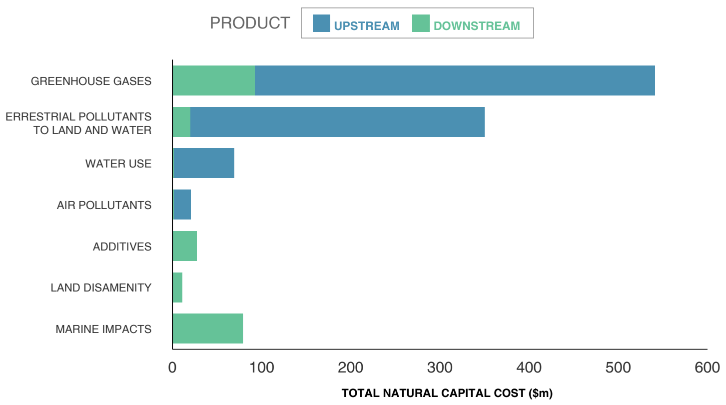
APPENDIX 1: SECTOR-SPECIFIC RESULTS

Plastic has permeated every domain of sports, from tracks, through clothing and shoes, to safety equipment such as helmets. The benefits of synthetic wear in sports are long established, as natural materials such as cotton consist of fibres that maintain moisture easily.[96] Polyester is the most widely used manufactured fibre in US apparel. Recent trends include apparel made of fibres from recycled plastic bottles (e.g. Coke, Nike, Patagonia).[97] Beyond this, plastic plays an important role in sports shoe designs, for example, the mid-sole can be made from ethyl vinyl acetate, providing lightweight cushioning, and polyester foam padding, providing extra flexibility to the insoles. Plastic materials are also used in most ballgames; tennis racquet manufacturers use plastics for the frame and strings because of their light weight and strength. Water vessels use advanced carbon plastics compounds for their greater flexibility, superior performance and faster production speed.[98]

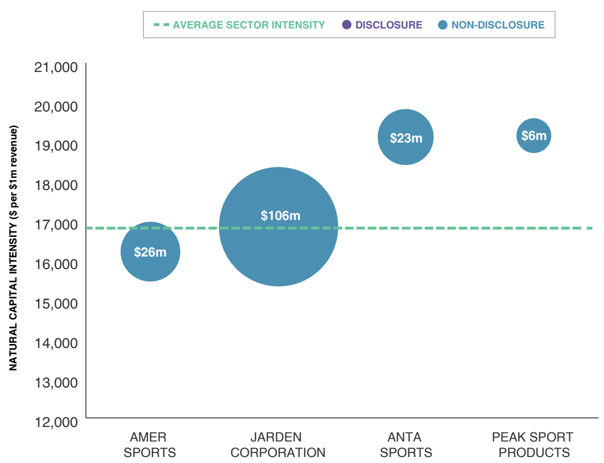
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the athletic goods sector is over $1bn per year, or 1% of the total natural capital cost of the consumer goods industry. The athletic goods sector has a modelled plastic-in-product and plastic-in-packaging intensity of 1 and 17 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 5% of the overall natural capital cost, while plastic-in-product accounts for 95%, mainly in the upstream stage. This amounts to a total natural capital intensity of $17,000 per $1m revenue, or 1.7% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is lower than that of the overall industry. However, the risk related to plastic-in-product is higher, meaning that on average the athletic goods industry is more at risk from plastic than other sectors



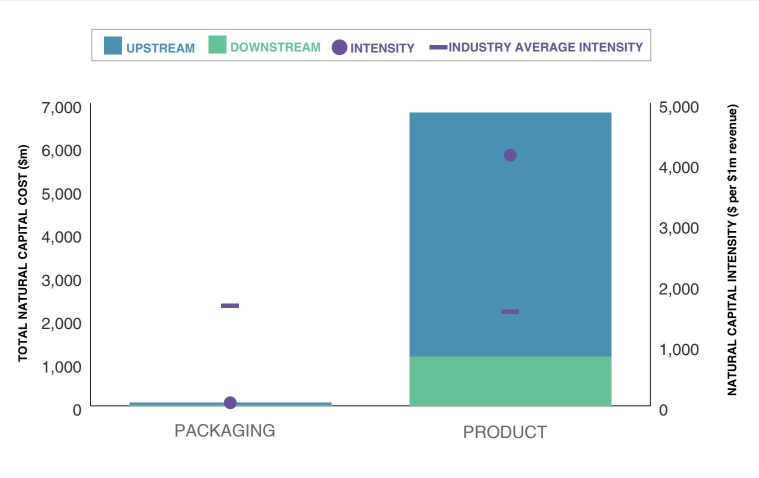
The figure on the left highlights the distribution of impacts for plastic-in-product. 79% of impacts are located upstream (or $870m) and 21% downstream (or $230m). The most significant upstream impact is greenhouse gas emissions ($450m), followed by land and water pollutants ($330m). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is $120m. Of these, the impact of littered products ending up in marine environments is the most significant. The impact of managed waste is lower, at $114m, with the emission of greenhouse gases the most significant.



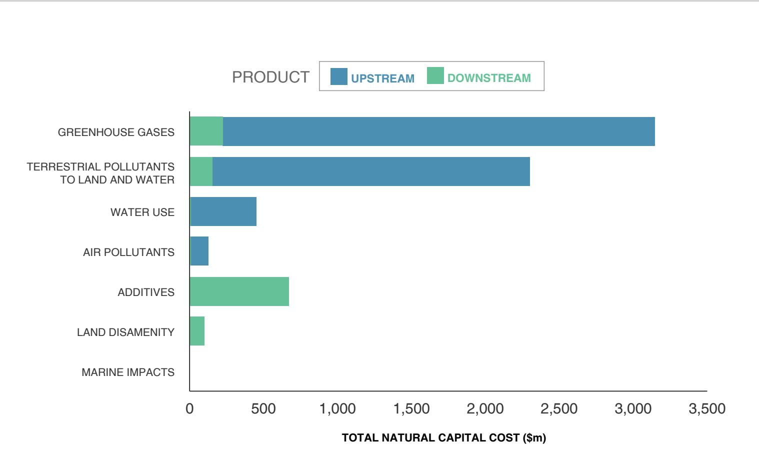
The figure on the left displays the estimated natural capital cost and intensity of selected companies. None disclosed useable quantitative data. All of the variation is thus attributed to type of products manufactured and sales location. Jarden has the highest natural capital cost of the peer group due to the type of product manufactured and higher revenue. As well as outdoor and sports goods, Jarden sells non-durable goods such as cutlery which have a higher intensity than the athletic goods sector. Amer Sports has the lowest intensity due to its sales being located mostly in Europe and the US.

Plastic is increasingly used in the automotive industry, from approximately 60 kilograms per car in the 1970s to around 150 kg at present. This is equivalent to around 10% to 15% of the total weight of a car, found in more than 2,000 parts.[99,100] Plastic presents numerous advantages such as improved durability, corrosion resistance, design flexibility and high performance at low cost. Several types of plastic are used in automotive manufacturing, ranging from polypropylene (28.6% by weight) to polyvinyl chloride (3.8%), mostly in the interior of the cars (52.5%), but also in the exterior and electric system.[100]

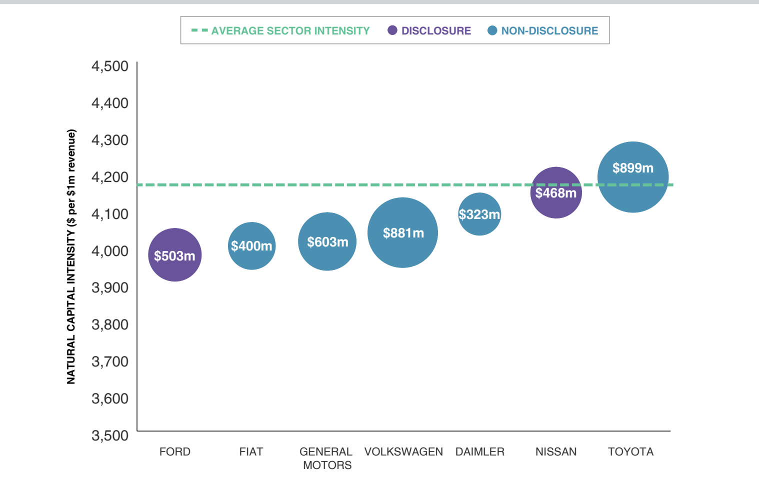
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the automobile sector is $7bn per year, or 9% of the total natural capital cost of the consumer goods industry. The automobile sector has a modelled plastic-in-product and plastic-in-packaging intensity of over 4 and less than 1 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 1% of the overall natural capital cost, while plastic-in-product accounts for 99%, mainly in the upstream stage (82%). This amounts to a total natural capital intensity higher than $4,000 per $1m revenue, or 0.4% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is significantly lower than that of the overall industry. However, the risk related to plastic-in-product is higher, meaning that on average the automobile industry is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-product. 83% of impacts are located upstream (or $5.5bn) and 17% downstream (or $1bn). The most significant upstream impact is greenhouse gas emissions ($3bn), followed by land and water pollutants ($2bn). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is $760m. Of these, the impact of chemical additives is the most significant ($660m). The impact of managed waste is lower, at $380m, with greenhouse gases the most significant.

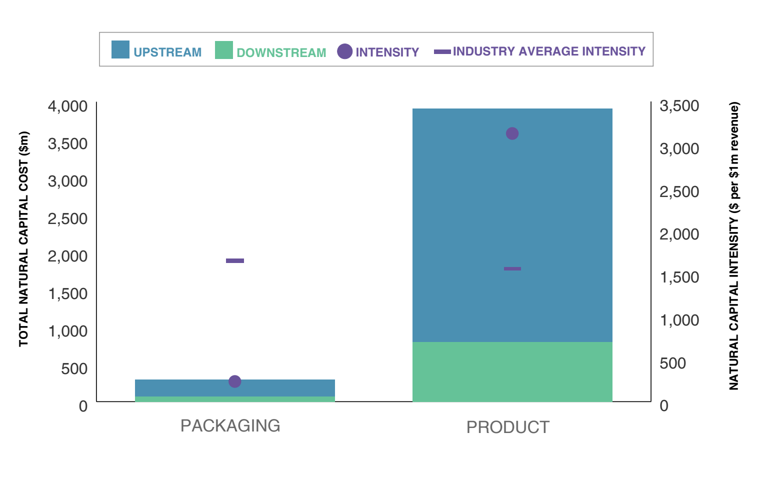


The figure on the left displays the estimated natural capital cost and intensity of selected companies. Three companies in the peer group disclosed useable data; all the rest is modelled. As such, any comparisons should be taken with care. Ford has the lowest overall intensity and Toyota the highest due to their geographical sales, as Ford sells more in the US and Europe, while Toyota's primary market is Asia. Toyota and Volkswagen have the higher total natural capital cost due to their high revenue. Nissan and Ford disclosed data points on use of recycled content that have been used to model their total natural capital cost. All other companies mentioned qualitative information that could not be integrated and are thus modelled.

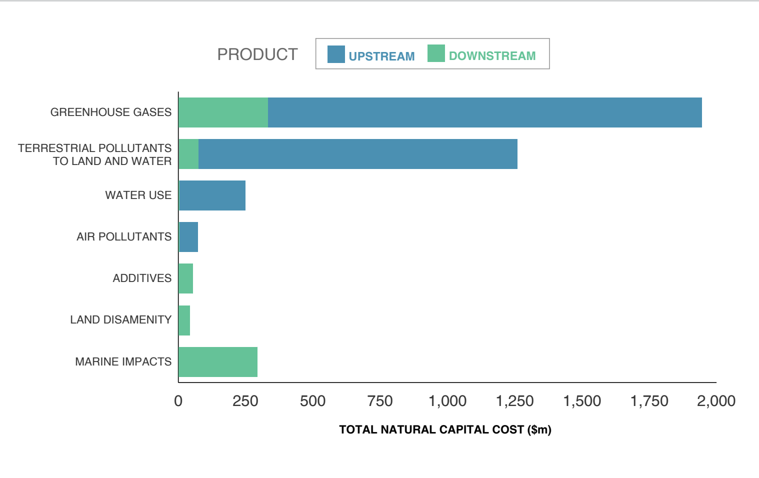
CLOTHING AND ACCESSORIES

Synthetic fibres make up over 60% of all fibres used in the clothing and accessories industry, as they are cheaper, more resistant and less prone to price volatility than natural fibers.[101] Acrylic, polyolefin and polyester account for approximately 98% by volume of total synthetic production, with polyester accounting for 60%.[102] Chemical additives have received considerable attention recently. For example, Greenpeace recently published a report highlighting the hazards related to the use of additives such as phthalates, organotins and antinomy in several large consumer brands.[71] These additives can also contaminate sewage water, along with fibres that easily break down into microplastics. One study estimates that over 1,900 fibres can be produced by a single garment, per wash.[103] Trucost was able to include the impact of additives in its natural cost model, but the wash out of fibres was excluded due to lack of adequate data.

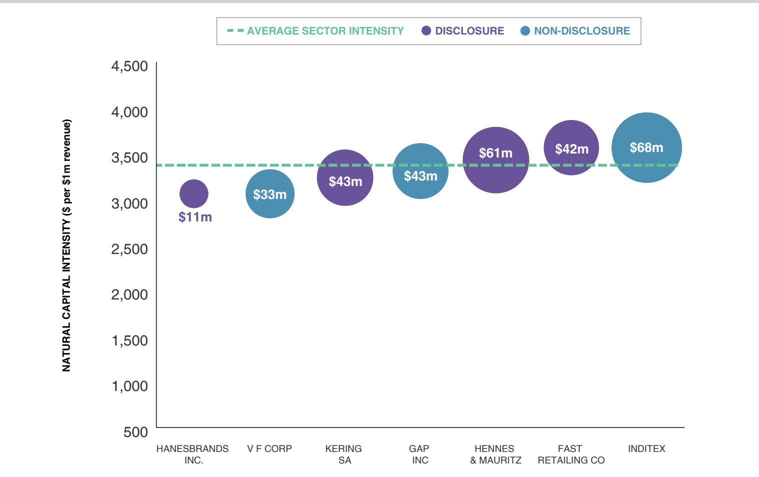
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the clothing and accessories sector is around $4bn per year, or 5% of the total natural capital cost of the consumer goods industry. The clothing and accessories sector has a modelled plastic-in-product and plastic-in-packaging intensity of 200 kg and 3 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 7% of the overall natural capital cost, while plastic-in-product accounts for 93%, mainly in the upstream stage (79%). This amounts to a total natural capital intensity higher than $3,000 per $1m revenue, or 0.3% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is lower than that of the overall industry. However, the risk related to plastic-in-product is higher, meaning that on average the clothing and accessories industry is more at risk from plastic than other sectors.



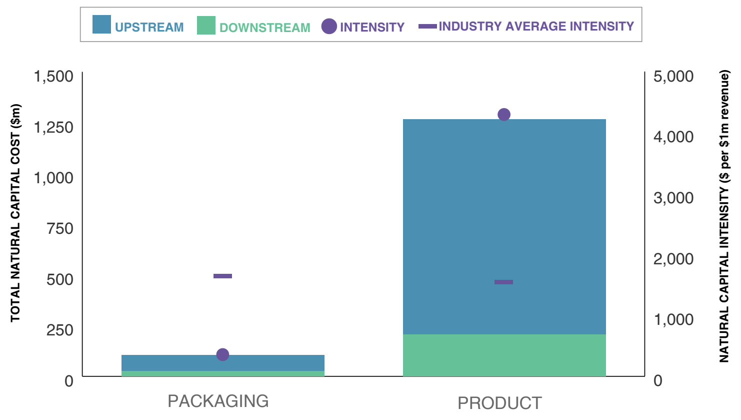
The figure on the left highlights the distribution of impacts for plastic-in-product. 80% of impacts are located upstream (or $3bn) and 20% downstream (or $800m). The most significant upstream impact is greenhouse gas emissions ($1.6bn), followed by land and water pollutants ($1.1bn). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is around $390m. Of these, the impact of littered products ending up in marine environment is the most significant. The impact of managed waste is marginally higher, at $400m, with the emission of greenhouse gases the most significant.



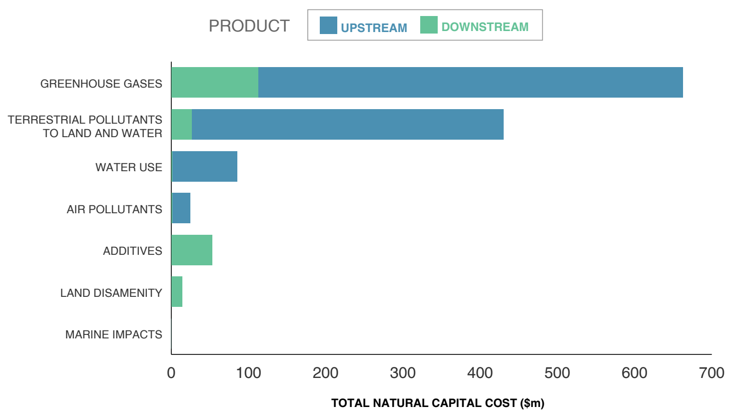
The figure on the left displays the estimated natural capital cost and intensity of selected companies. More than half of the companies disclose useable quantitative data – however, disclosure may be better at the brand level for most of the big groups such as VF, Kering and Fast Retailing. Fast Retailing has one of the highest intensities due to the larger proportion of its sales done in Asia. Hennes and Mauritz (H&M), Hanesbrands and Kering have low intensity due to the larger proportion of its sales done in Europe and its disclosed use of post-consumer polyethylene terephthalate in products and packaging. The natural capital valuation and intensity of luxury brands that use more cotton and leather may be overestimated. Most data points are modelled and as such any comparison should be taken with care.

The consumer electronics sector accounts for a large and varied part of total plastic demand from polyethylene to polyurethane – in Europe in 2012, 5.5% of total plastic demand came from the electrical and electronics sector.[1] Environmental and social issues pertaining to this sector are diverse and have received attention from stakeholders and policymakers in recent years, through the waste electrical and electronic equipment (WEEE) directive in the EU for example. Notwithstanding the upstream impacts of manufacturing plastic, the use of toxic additives such as flame-retardants have been highlighted, especially its related occupational hazards and downstream toxicity when recycled, incinerated, landfilled or littered. The following case study details specific issues and regulations, while highlighting examples of initiatives and disclosure from Hewlett-Packard, Apple and Dell.

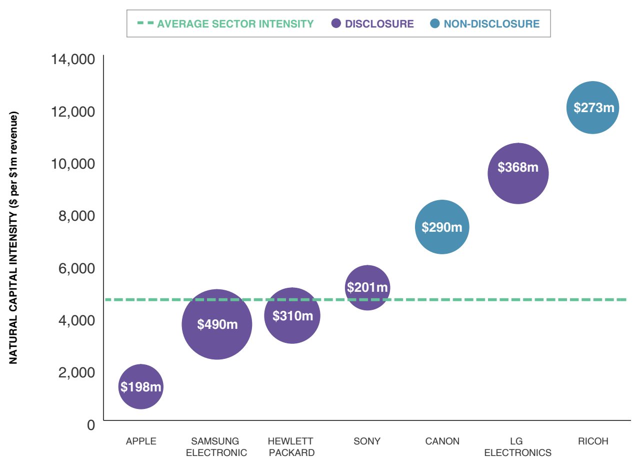
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the consumer electronics sector is over $1.4bn per year, or 2% of the total natural capital cost of the consumer goods industry. The consumer electronics sector has a modelled plastic-in-product and plastic-in-packaging intensity of 400 kg and 5 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 8% of the overall natural capital cost, while plastic-in-product accounts for 92%, mainly in the upstream stage (84%). This amounts to a total natural capital intensity higher than $4,000 per $1m revenue, or 0.4% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is significantly lower than that of the overall industry. However, the risk related to plastic-in-product is higher, meaning that on average the consumer electronics industry is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-product. 84% of impacts are located upstream (or $1bn) and 16% downstream (or $200m). The most significant upstream impact is greenhouse gas emissions ($550m), followed by land and water pollutants ($400m). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is $65m. Of these, the impact of chemical additives is the most significant ($52m). The impact of managed waste is higher, at $140m, with greenhouse gas impacts the most significant.



The figure on the left displays the estimated natural capital cost and intensity of selected companies. Variations are mainly due to differences in the type of product manufactured, countries of sale and disclosed data. Five out of seven companies disclosed usable quantitative data, and all disclosed qualitative information on plastic usage and disposal. Ricoh for example is active in developing new materials and processes and incorporating recycled content in their product – however, no quantitative data could be integrated within the model. The company's high intensity is mostly due to the type of product manufactured and its large proportion of sales in Asia. LG used 4,980 tonnes of recycled plastic in 2012, phased out PVC, brominated flame retardants and other additives from new products, put in place Green Packaging Design Guidelines in 2012 and is active in implementing take-back programs which collected 174,482 tonnes of e-waste.

CASE STUDY: CONSUMER ELECTRONICS I

The use of electronics is soaring across the world and for most manufacturers, environmental accountability is easier said than done. One common challenge facing the sector is the lack of visibility up the supply chain due many of the components they source being pre-manufactured. Firms also have difficulty sourcing recycled plastic due to the additives they contain. In contrast, manufacturers have much more control over packaging.

The increasing ubiquity of electronics coupled with the decreasing lifetime of devices means that e-waste is the fastest growing global waste stream.[104] According to the UN, the world's e-waste is expected to grow by 33% over 2012 to 2017.[105] Illegal exports of electronic waste to developing countries amplify the problem. For example, China is the world's primary dumping ground for global e-waste receiving shipments from the US, Europe and neighbouring Asian countries due to illegal loopholes in transboundary imports.[106] The situation is aggravated by the fact that many developing countries now produce large amounts of e-waste with some, like Indonesia, becoming net exporters of it.[107]

The way e-waste is managed has a crucial influence on the environmental impacts of used and discarded electronics. Certain toxic and hazardous materials contained in IT equipment are not only released from equipment during manual disassembly but during other recycling processes, for example when plastics are heated for recycling.[108] Consequently, e-waste recycling is associated with significant health hazards, which are exacerbated under the uncontrolled conditions prevalent in developing countries.

The 1992 Basel Convention is the best known initiative to attempt to impose restrictions on shipping e-waste to developing countries, with mixed results. In the EU, regardless of the fact that the Waste Electrical and Electronic Equipment (WEEE) directive banning the export of hazardous electronic waste to third-world countries has been in place since 2003, circumventing EU legislation remains a serious problem.[109] The revised 2012 WEEE directive aims to give EU Member States the tools to fight this more effectively. Other jurisdictions such as China have promulgated WEEE regulations too.

The United States presents a problematic compliance landscape. It tops the list of countries for total volume of e-waste generated each year, more than 80% of which ends up in landfills.[110] The lack of comprehensive federal regulation governing waste electronic equipment, partly due to corporate resistance to the NEPSI Initiative back in 2001, has prompted states to enact their own WEEE legislation resulting in an inconsistent patchwork of state requirements covering two thirds of US population. In this context it is very important that electronics manufacturers become more responsible and accountable for their own footprint.

The following provides an overview of the attempts at e-waste plastic management of three of the world's largest technology companies. Three companies have been selected to showcase a particular plastic management innovation in one of three areas – design, packaging and recycling - although the selection is not exhaustive and a more comprehensive review would acknowledge the efforts of many other electronics manufacturers.

APPLE

Electronics company Apple's compact products and packaging designs with highly recyclable aluminium enclosures lead the sector in material efficiency manufacturing innovations such as unibody construction which allows MacBooks and iPads to become thinner while being more resilient.[73] As an additional benefit the extensive use of aluminium material means that plastic use is greatly reduced in comparison to competitor brands.

Since 1995 when it phased out polyvinyl chloride in packaging materials, Apple has been working to improve the environmental performance of its products.[73] By 2002, it had phased polyvinyl chloride out of cables and other parts, as well as removing hazardous substances such as brominated flame retardants and heavy metals. The 2012 iMac has been redesigned to use two thirds less material than previous models. Apple's AirPort Express has an enclosure that contains bio-based polymers derived from rapeseed and recycled acrylonitrile butadiene styrene.

At the same time Apple sparks debate among the proponents of sustainable electronics for the fact that its product designs involve sticking its lithium polymer battery cells directly onto the aluminium unibody shell. There is some disagreement over the extent to which this inhibits recycling. Construction with screws could be more efficient for recycling processing, but this could compromise the slenderness of the products.[111]

Apple is one of the companies in the sector that publishes an environmental footprint for each of its products, including data on energy use, restricted substances and material use. Apple's 15-inch MacBook Pro with retina display contains 59g of plastic, compared with 738g of aluminium and 175g of glass. Apple also discloses the packaging materials used for the MacBook.[112] These include 23g of plastic and 241g of polystyrene in the retail box and shipping boxes, compared with 822g of cardboard and 296g of moulded fibre. Unfortunately, this could not be integrated within the calculations in this report due to the lack of aggregation in the data. Critics have raised concerns over the fact that Apple does not publish details over its methodology or aggregated material use.

DELL

In 2012, Dell achieved its long-term recycling goal to collect 1bn pounds of e-waste a full year ahead of schedule. More ambitious yet, as part of its 2020 Legacy for Good Plan, Dell has set the goal of recovering 2bn pounds of electronics and reusing more than 50m pounds of recycled-content plastics in its products by 2020. In 2009, against the background of a patchy regulatory framework, Dell became the first information technology company to prohibit the practice of shipping non-working parts or end-of-life equipment into certain developing countries.[113] It has also created the first of its kind e-waste recycling hub in East Africa by building a regional e-waste handling facility in collaboration with partners in Kenya. In addition to the environmental benefits generated by the hub's operation, the model has created important employment opportunities at the facility and across supporting logistics and collection networks, in part by converting informal e-waste 'pickers' into compensated and trained employees.[114,115]

Dell uses Ecovative's packaging grown from agricultural wastes and mushroom fungus into solid moulded packaging materials without the use of petrochemicals.[116] This mycelium-based molding is an alternative to polystyrene and polyethylene-based cushioning for its heavier product packaging, and has the added benefit of breaking down naturally and ability to act as compost. Dell is the first technology company to use this material for shipping. This is not the first environmentally sustainable material in Dell's track record however – in 2009 the company began using bamboo for electronics packaging and still uses it for some of its lighter products.

HEWLETT-PACKARD

Since 1992, computer and printer manufacturer HP's Design for Environment programme has been helping the company incorporate sustainability considerations into the design of its products, including the impacts of plastic.[117] The programme has led HP to introduce ways to make its products more recyclable by making it easier for them to be dismantled at end of life. Improvements include using common fasteners and snap-on features to avoid using glue or welds. Most HP products are 90% recyclable by weight.

HP is also working to close the loop on plastic waste from toner cartridges by taking back used cartridges for recycling. HP operates a free take-back scheme for used cartridges in 56 countries, and over the past two years, it has made 600m inkjet cartridges using recycled plastic. HP also uses recycled plastic to make new computers and printers. A quarter of the plastic used to make one of its new 2012 desk jet printers is from recycled sources. One of its new desktop PCs contains one third recycled plastic. In 2013, HP took this a step further by using recycled plastic from its own hardware recycling facilities to make acrylonitrile butadiene styrene. Recycled ABS makes up 5% of the plastic used to make the new HP Office jet Pro X printer.

For packaging, HP is shifting from plastic to paper and moulded pulp alternatives, which contain recycled content and are from certified sustainable forests. In some cases plastic has a lower carbon footprint, so HP uses expanded polystyrene or polyethylene which contains recycled plastic. HP also operates a programme called Green Screen to phase out use of hazardous substances in its products such as phthalates, as well as halogens, including brominated flame retardants and PVC. For instance, 96% of HP's Compaq notebooks are classified as low-halogen. Since 2007, more than 160 assessments have been conducted.

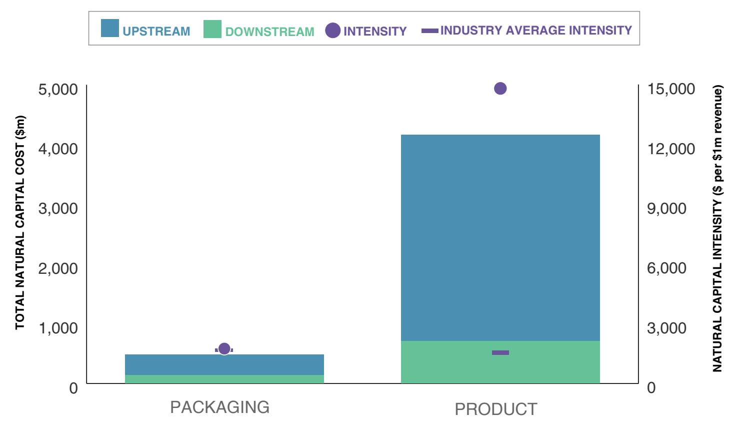
In 2012, HP published for first time data on the weight of materials it uses in PC and printer manufacturing, including plastic, normalised by revenue (tonnes per $1m) so it can measure performance.

Despite these initiatives, Greenpeace gives the company a low score with regards to its e-waste program and use of recycled plastic in products, because the company does not disclose the use of post-recycled plastic in its products nor has specific goals with this respect.[118]

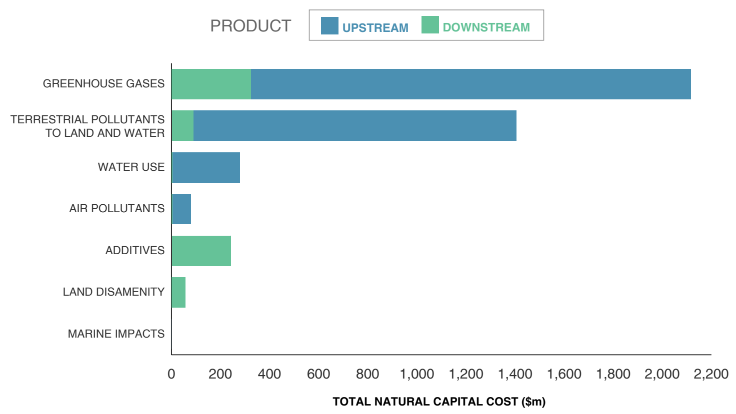
DURABLE HOUSEHOLD GOODS

The household durables sector includes products such as large and small household appliances, from toasters to refrigerators. Relevant environmental and social impacts are similar to the consumer electronics sector, as well as industry and policy initiatives. In particular, household appliances are also covered by the WEEE directive in the EU, stipulating that 80% and 70% of the weight of the collected large and small appliances should be recovered, with at least 75% and 50% recycled and the rest used as an energy source. The occupational hazards and downstream impact of additives has also received attention in the past year, and industry initiatives focus on phasing out and finding alternatives to these substances.

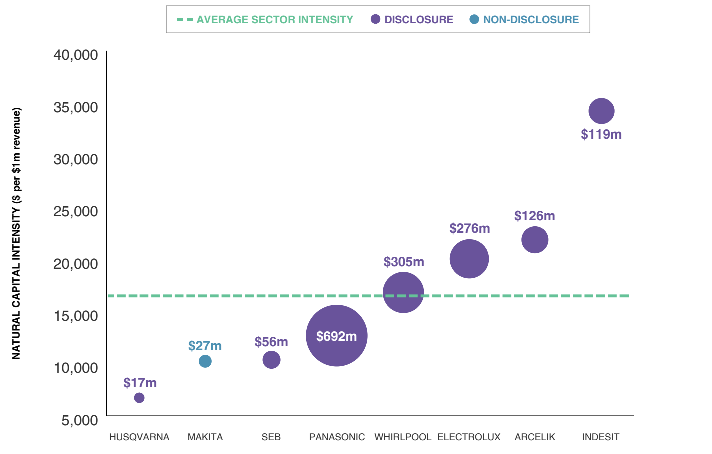
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the durable household goods sector is over $4.5bn per year, or 6% of the total natural capital cost of the consumer goods industry. The durable household goods sector has a modelled plastic-in-product and plastic-in-packaging intensity of 2 tonnes and 16 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 11% of the overall natural capital cost, while plastic-in-product accounts for 89%, mainly in the upstream stage (83%). This amounts to a total natural capital intensity higher than $16,000 per $1m revenue, or 1.7% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is lower than that of the overall industry. However, the risk related to plastic-in-product is significantly higher, meaning that on average the durable household goods industry is more at risk from plastic than other sectors.



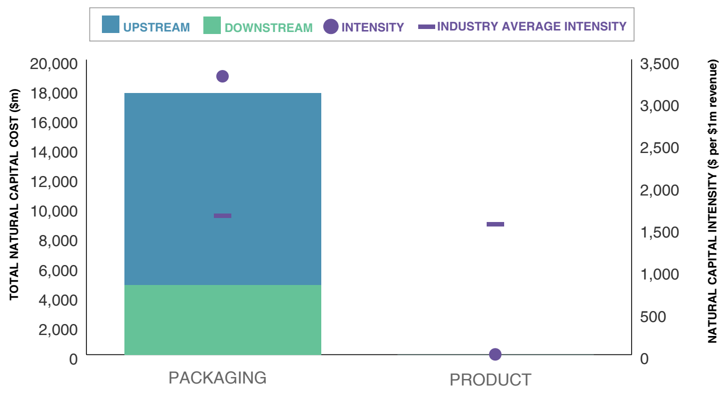
The figure on the left highlights the distribution of impacts for plastic-in-product. 83% of impacts are located upstream (or $3.5bn) and 17% downstream (or $710m). The most significant upstream impact is greenhouse gas emissions ($1.8bn), followed by land and water pollutants ($1.3bn). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is $290m. Of these, the impact of chemical additives is the most significant ($235m). The impact of managed waste is higher, at $410m, with greenhouse gas impacts the most significant.



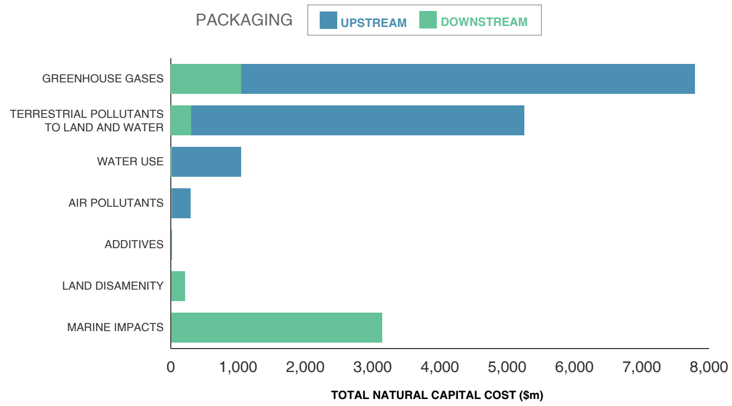
The figure on the left displays the estimated natural capital cost and intensity of selected companies. Most companies disclose quantitative information that could be used and all companies disclosed qualitative information. Indesit is one of the best disclosers, disclosing quantity of plastic use, percentage of recycled content and tonnes of packaging collected in Europe. Electrolux discloses quantity of plastic used and recycled content; Arcelik, Husqvarna and Seb information on plastic use; Panasonic percentage of recycled content; and Whirlpool packaging waste collection in Brazil. All the rest is modelled – as such, any comparisons should be taken with care.

Packaging in the food sector serves a number of functions, including physical protection during storage and transportation, convenience, labelling and branding. Increased use at the detriment of other materials such as glass is driven by higher demands for packaged fresh food and ready-made meals.[119] From an environmental and social perspective specifically, the use of plastic packaging yields significant benefits such as reducing waste and extending the shelf-life of items. On the other hand, impacts include upstream and downstream pollution. In particular, food wrappers and containers are among one of the main items collected during coastal clean ups.[120]

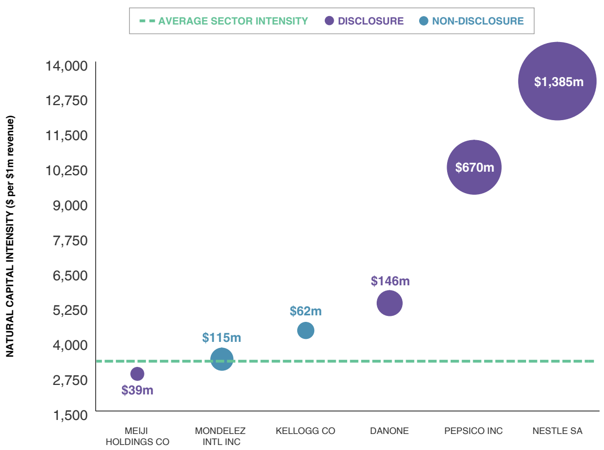
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the food sector is around $18bn per year, or 23% of the total natural capital cost of the consumer goods industry. The food sector has a modelled plastic-in-packaging intensity of 3 tonnes per $1m revenue. This amounts to a total natural capital intensity higher than $3,000 per $1m revenue, or 0.3% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is higher than that of the overall industry, meaning that on average the food industry is more at risk from plastic than other sectors.



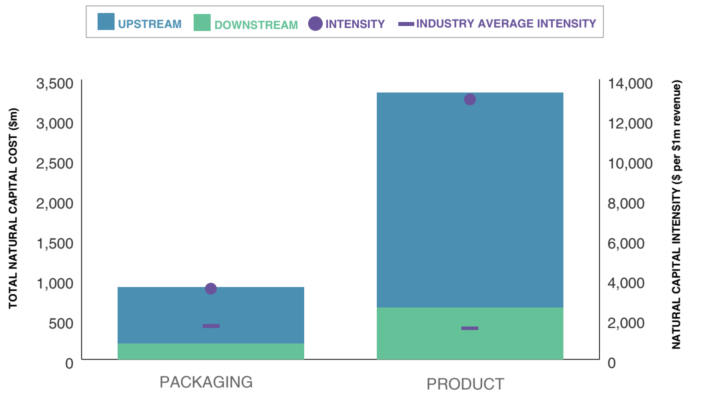
The figure on the left highlights the distribution of impacts for plastic-in-packaging. 73% of impacts are located upstream (or $13bn) and 27% downstream (or $5bn). The most significant upstream impact is greenhouse gas emissions ($6.5bn), followed by land and water pollutants ($5bn). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is around $3bn. Of these, the impact of littered products ending up in marine environment is the most significant. The impact of managed waste is lower, at $1.3m, with greenhouse gas impacts the most significant.



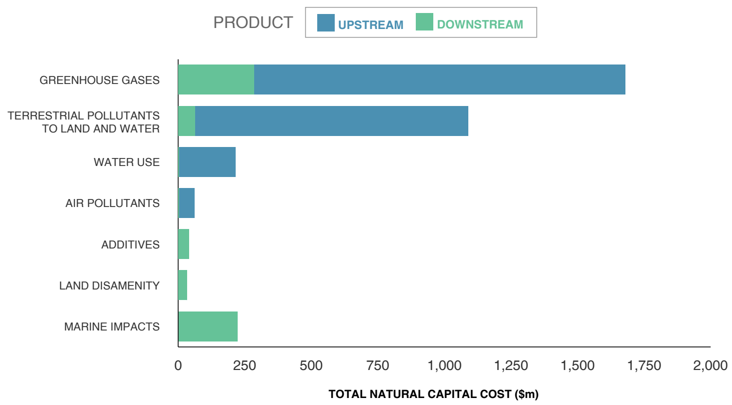
The figure on the left displays the estimated natural capital cost and intensity of selected companies. Four out of the six companies in the peer group disclose useable quantitative data. Nestlé has the highest intensity of the peer group and the best disclosure, reporting on both the quantity of packaging used and the quantity of recycled content. Nestlé and PepsiCo also operate in the soft drink sector, which has a higher plastic-in-packaging intensity than the food sector, hence their higher overall intensity. Meiji reports on the quantity of packaging used and has the lower intensity of the peer group, mainly due to its activities in the pharmaceutical sector. In addition to sectoral activities, variation can be explained by the geographical location of sales.

Global footwear sales have increased from 2.5bn pairs per year in 1950 to more than 20bn pairs of shoes currently.[121] The use of synthetic materials, plastic, rubber and adhesives has underpinned the proliferation of shoes that differ from traditional crafting techniques and biodegradable materials. Because less than 5% of shoes are currently recycled, this leads to significant material loss and landfill space, as some estimates suggest the average pair of shoes takes 1,000 years to degrade in landfill.[122] The main use of downcycled plastic shoes is in other applications such as rubber playground surfacing, insulation materials, and underlay products. In recent year's biodegradability or recyclability is a growing trend in shoe manufacturing, with bio-plastic, recycled plastic and organic or eco-friendly materials becoming a popular choice, with for example the PUMA Incycle shoe.[122,123]

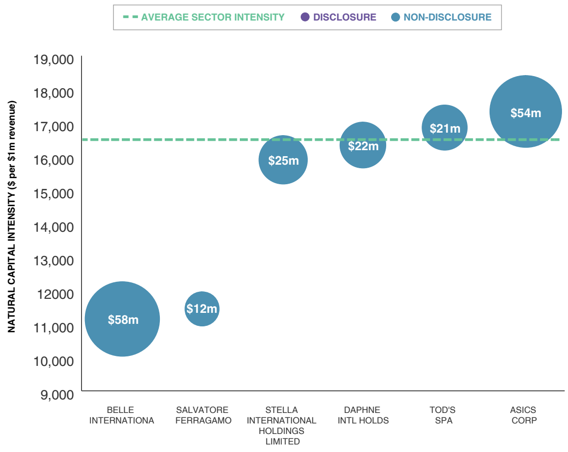
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the footwear sector is over $4bn per year, or 6% of the total natural capital cost of the consumer goods industry. The footwear sector has a modelled plastic-in-product and plastic-in-packaging intensity of 4 and 14 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 21% of the overall natural capital cost, while plastic-in-product accounts for 79%, mainly in the upstream stage (81%). This amounts to a total natural capital intensity higher than $16,500 per $1m revenue, or 1.7% of total revenue. Both the risk related to plastic-in-packaging, expressed by the natural capital intensity, and the risk related to plastic-in-product are higher than industry averages, meaning that on average the footwear sector is more at risk from plastic than other sectors.



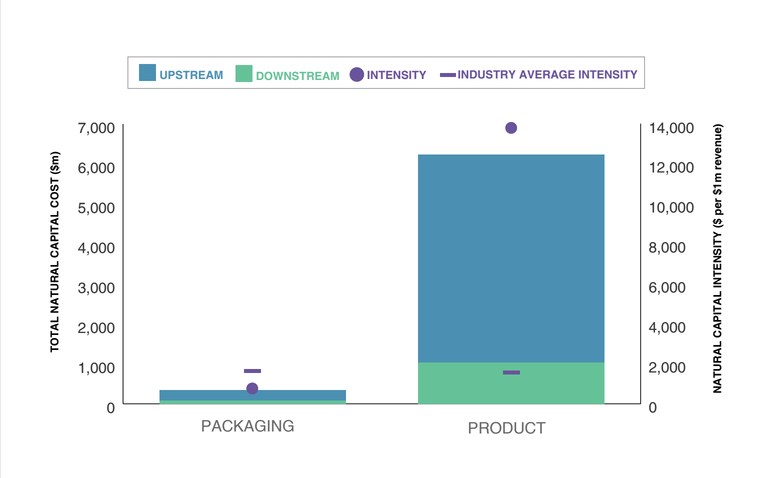
The figure on the left highlights the distribution of impacts for plastic-in-product. 81% of impacts are located upstream (or $2.7bn) and 19% downstream (or $645m). The most significant upstream impact is greenhouse gas emissions ($1.4bn), followed by land and water pollutants ($1bn). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is $300m. Of these, the impact of littered products ending up in marine environment is the most significant. The impact of managed waste is higher, at $350m, with the emission of greenhouse gases the most significant.



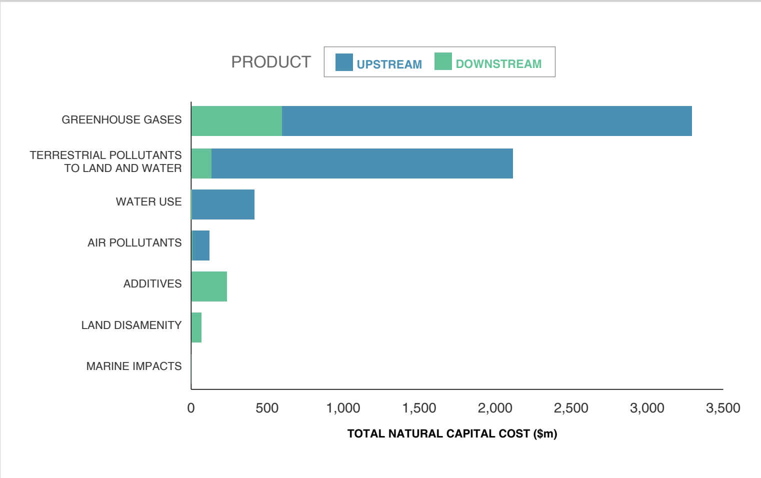
The figure on the left displays the estimated natural capital cost and intensity of selected companies. No company disclosed useable quantitative data points to include in the analysis. Variations can thus be fully explained by sector of operation and downstream sales location. For example, Belle and Salvatore Ferragamo also operate in the clothing sector, which has a lower intensity than the footwear sector. Asics has the highest natural capital intensity due to its large proportion of sales made in Asia – this figure may however be overestimated. Asics reports making use of recycled polyester and strives to design products in a way that allows repair and replacement of worn out parts.

Although wood has been a building material of choice for centuries, its deficiencies in terms of durability and deforestation have meant that over the last century plastic alternatives have gained increasing popularity, as well as recent movements towards reclaimed wood products. Plastic furniture is cost-efficient and needs less maintenance. Composites of wood and plastic make the product difficult to recycle. In the past, PVC has been widely used as alternative to wood. However, it has been proven to be one of the most toxic materials.[124] Beyond this, polyester is the most widely used manufactured fibre in the US in apparel and home furnishings, such as bed sheets, mattresses and curtains.[125] Many carpets are made up of nylon fibres with plastic backing. The contamination of different materials makes recycling a difficult option. Some innovative business models that minimise plastic use include Econyl, which produces nylon 6 polymers from 100% regenerated materials, and Interface, a leading producer of carpet tiles made from discarded fishing nets.[126]

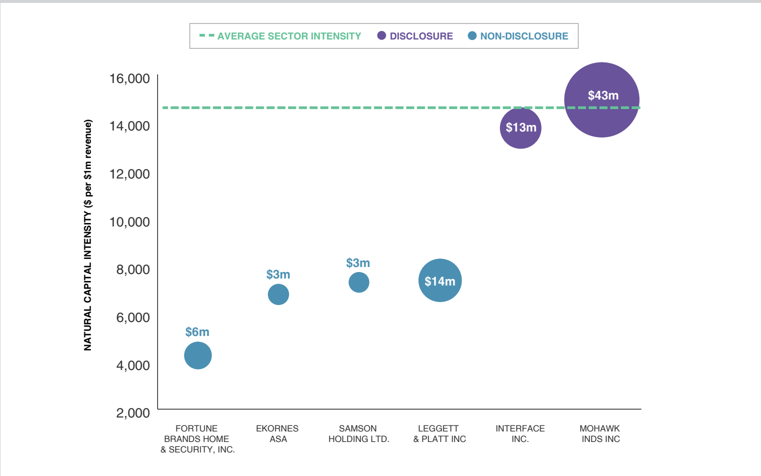
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the furniture sector is over $6bn per year, or 9% of the total natural capital cost of the consumer goods industry. The sector has a modelled plastic-in-product and plastic-in-packaging intensity of 1 tonnes and 15 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 5% of the overall natural capital cost, while plastic-in-product accounts for 95%, mainly in the upstream stage (83%). This amounts to a total natural capital intensity higher than $14,500 per $1m revenue, or 1.5% of total revenue. The risk related to plastic-in-packaging, expressed by the natural capital intensity, is lower than that of the overall industry. However, the risk related to plastic-in-product is significantly higher, meaning that on average the furniture sector is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-product. 83% of impacts are located upstream (or $5bn) and 17% downstream (or $1bn). The most significant upstream impact is greenhouse gas emissions ($2.7bn), followed by land and water pollutants ($2bn). Downstream, the impact of unmanaged waste from chemical additives, land disamenity and marine litter is $295m. Of these, the impact of chemical additives is the most significant ($230m). The impact of managed waste is higher, at $730m, with greenhouse gas impacts the most significant.

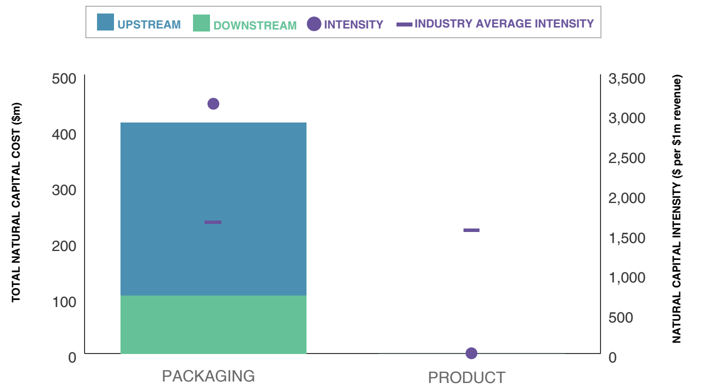


The figure on the left displays the estimated natural capital cost and intensity of selected companies. Two companies in the peer group disclosed useable quantitative data, both operating in the carpet and rug mill sub-sector, which is more intensive than other furniture sub-sectors. Interface discloses a 49% rate of recycled content and bio-based material use that could be integrated in the calculations. This company also makes public the results of lifecycle analysis conducted on its products; however, for lack of sales data, this could not be included. Interface is also known for its take-back programs, but no data was found on quantity of products collected. Mohawk discloses quantitative data on specific measures, for example, the diversion of more than 1bn pounds foam trim from landfill since 2006 to be used in their product range.

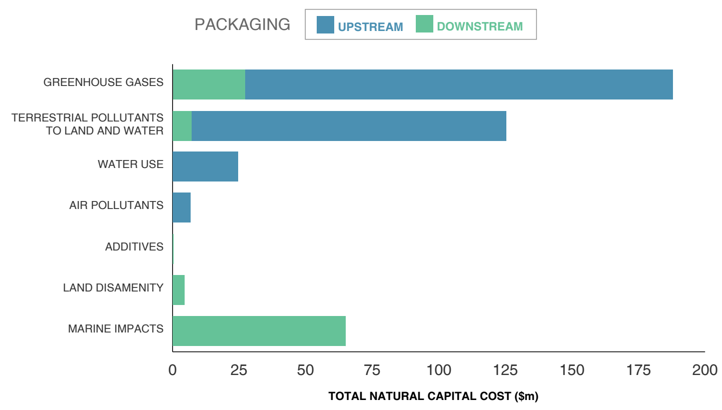
MEDICAL AND PHARMACEUTICAL PRODUCTS

This sector only includes medicine preparation and excludes medical appliances. Plastic packaging plays an important role in the preservation of medicine due to its exceptional barrier properties, light weight, low cost, durability, transparency and compatibility with other materials.[127] Plastic pill capsules release the active ingredients over a longer period of time. The most important impacts associated with medical packaging are related to upstream production and downstream disposal as some make their way into the ocean. Measures taken by the industry include material use optimization and reduction. For example, Merck has a goal of having 50% of its products with sustainable packaging features such as size reduction, use of renewable, recyclable or recycled content and implementation of take-back programs by 2020.[128] Similarly, Johnson and Johnson has environmental, health and safety standards which require all business units to evaluate all new products and product packaging for sustainable packaging improvements.[129]

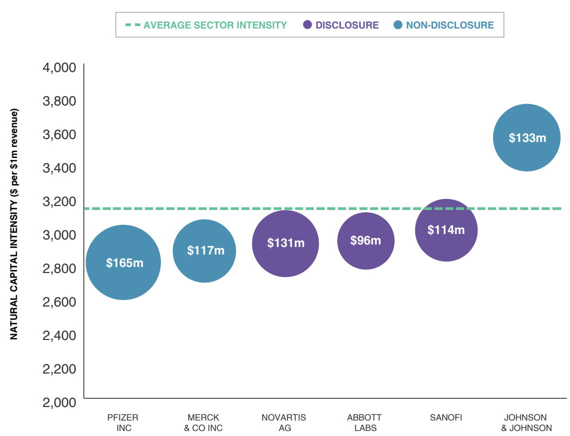
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the medical and pharmaceutical products sector is higher than $400m per year, or 1% of the total natural capital cost of the consumer goods industry. The medical sector has a modelled plastic-in-packaging intensity of 3 tonnes per $1m revenue. This amounts to a total natural capital intensity higher than $3,000 per $1m revenue, or 0.3% of total revenue. The risk related to plastic-in-packaging, expressed by natural capital intensity, is higher than that of the overall industry, meaning that on average the medical sector is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-packaging. 75% of the impacts are located upstream (or $310m) and 25% downstream (or $100m). The most significant upstream impact is greenhouse gas emissions ($161m), followed by terrestrial pollutants to land ($118m) and water use ($25m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $70m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $35m, with greenhouse gas impacts the most significant.

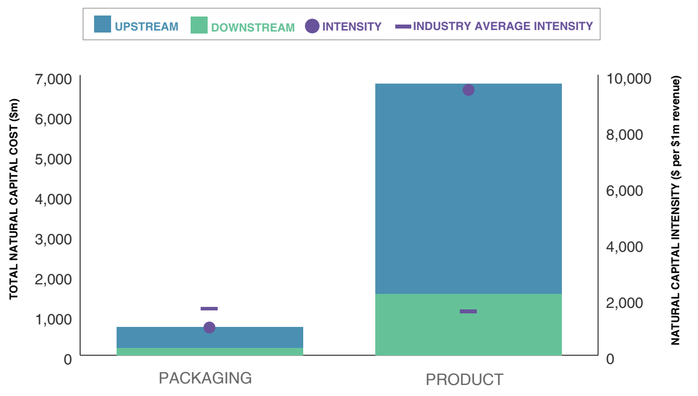


The figure on the left displays the estimated natural capital cost and intensity of selected companies. No company in the sample disclosed quantity of plastic packaging or recycled content percentage. Abbott Labs reported a 3.9% reduction in packaging used from 2007 to 2011, Novartis the amount of plastic film saved by a facility in Brazil, and Sanofi a 24 tonne reduction in PVC from an initiative in Hungary. Johnson and Johnson has the highest natural capital intensity due to its activities in the non-durable goods and personal product sector.

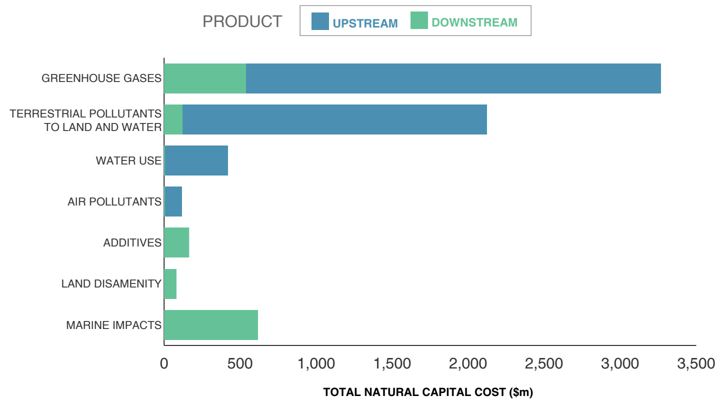
NON-DURABLE HOUSEHOLD GOODS

The non-durable household goods sector includes products such as cleaning products, razor blades and bin liners. Personal hygiene products are included in the personal product sector. This sector has one of the highest natural capital cost per service year, due to the short life span of products sold. Plastic used in non-durable household goods are not widely recycled – for example, while the average recycling rates of plastic in the United States is more than 8%, plastic in non-durable household goods are only recycled at 1.7%.[130] Companies are taking steps to address the lack of infrastructure. For example, Procter and Gamble assesses the recyclability of its packaging design prior to market launch in partnership with the Association of Postconsumer Plastic Recyclers.[131] Other key sectoral initiatives include lightweighting, incorporation of recycled and bio-based materials, and refills, which may help mitigate their environmental impact. For example, Colgate Palmolive provides eco refills for spray cleaners in Europe.[132]

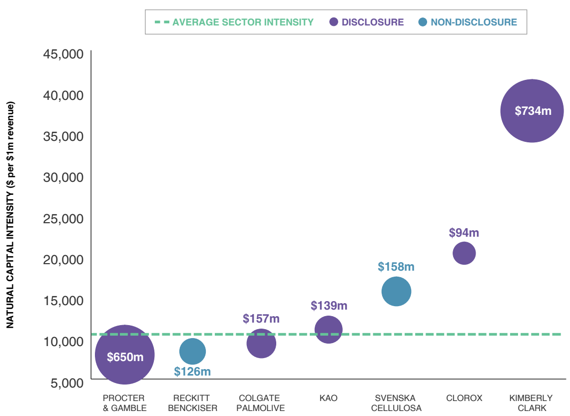
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the non-durable household goods sector is over $7bn per year, or 10% of the total natural capital cost of the consumer goods industry. The non-durable household goods sector has a modelled plastic-in-product and plastic-in-packaging intensity of 10 and 1 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 9% of the overall natural capital cost, while plastic-in-product accounts for 91%, mainly in the upstream stage (77%). This amounts to a total natural capital intensity higher than $10,000 per $1m revenue, or 1% of total revenue. The risk related to plastic-in-packaging, expressed by natural capital intensity, is lower than that of the overall industry. However, the risk related to plastic-in-product is higher, meaning that on average the non-durable household goods sector is more at risk from plastic than other sectors.



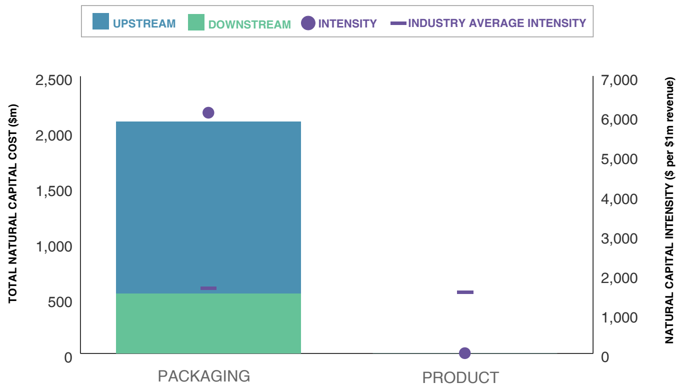
The figure on the left highlights the distribution of impacts for plastic-in-product. 77% of the impacts are located upstream (or $5.3bn) and 23% downstream (or $1.5bn). The most significant upstream impact is greenhouse gas emissions ($2.7bn), followed by terrestrial pollutants to land ($2bn) and water use ($416m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $860m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $670m, with the emission of greenhouse gases the most significant.



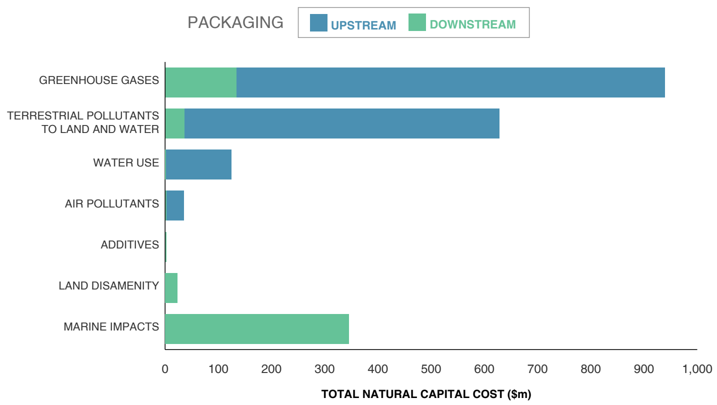
The figure on the left displays the estimated natural capital cost and intensity of selected companies. Most companies in the peer group disclose useable quantitative data to different extents – as such, any comparison should be taken with care. Kimberly Clark has the best disclosure of the sector, on both the amount of packaging and recycled content used; Kao discloses quantity of packaging; Procter and Gamble recycled content and other disclosing companies' quantitative savings through optimisation measures. Variations are mostly due to countries of sales and sector of activities.

Packaging is an important part of cosmetics as it must protect and preserve the product, be durable, enable efficient application, be distinctive and attractive, and simultaneously be designed to allow recycling or recovery.[133] Much of it ends up in landfill however, either due to contamination, unavailability of local recycling facilities, or to non-recyclability of the packaging. Some initiatives to deal with this include Aveda, which also recycles polypropylene caps through its 'Recycle Caps with Aveda' initiative, and Origins 'Return to Origins' recycling programme inviting customers to return packaging in exchange for a sample.[134] However, some of the barriers to wider adoption of refillable packaging include time constraints, shelf availability, extra staffing and logistical costs. Microplastics used in products are of particular concern as sewage treatment facilities are not designed to remove or break them down. They then find their way into the marine environment, resulting in concentrations of microplastics sometimes higher than that of plankton, and accumulate in the food chain. However, the impact of microplastic could not be included in the analysis for lack of data.

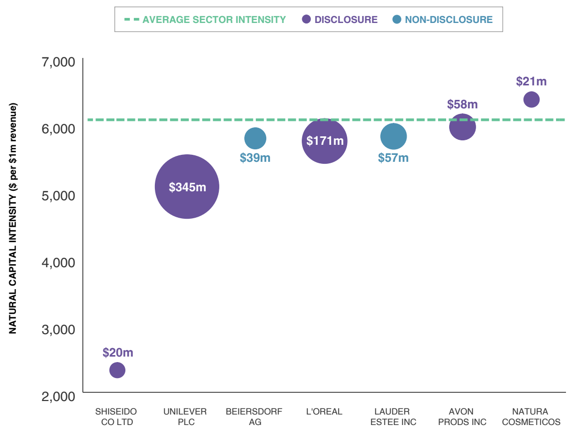
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the personal products sector is over $2bn per year, or 3% of the total natural capital cost of the consumer goods industry. The personal products sector has a modelled plastic-in-packaging intensity of 6 tonnes per $1m revenue. This amounts to a total natural capital intensity higher than $6,000 per $1m revenue, or 0.6% of total revenue. The risk related to plastic-in-packaging, expressed by natural capital intensity, is higher than that of the overall industry, meaning that on average the personal products sector is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-packaging. 74% of the impacts are located upstream (or $1.5bn) and 26% downstream (or $530m). The most significant upstream impact is greenhouse gas emissions ($805m), followed by terrestrial pollutants to land ($590m) and water use ($120m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $370m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $170m, with the emission of greenhouse gases the most significant.



The figure on the left displays the estimated natural capital cost and intensity of selected companies. Five companies in the sample disclosed useable quantitative data on materials savings due to light weighting initiatives, recycled content and quantity of packaging used. Shisheido is the only company that disclosed useable data on packaging usage; Natura and Unilever disclose it at a product level and this could not be integrated for lack of consolidated figure. Natura has the highest modelled intensity due to its high sales in Latin America; however, this figure is likely to be overestimated given the large sustainability efforts undertaken by this company.

Cosmetics company Lush was the first to disclose its plastic footprint and management strategy with the Plastic Disclosure Project in 2011, with its 2014 disclosure currently underway. The company stands out as having taken many positive steps towards minimising plastic use in all stages of its value chain, famously designing its products to eliminate or minimise the need for packaging. For example it has redesigned many traditionally liquid products into solid form, resulting in about 70% (62% in 2010/11) of its product range to require no packaging, hence the slogan “We prefer naked”.[135]

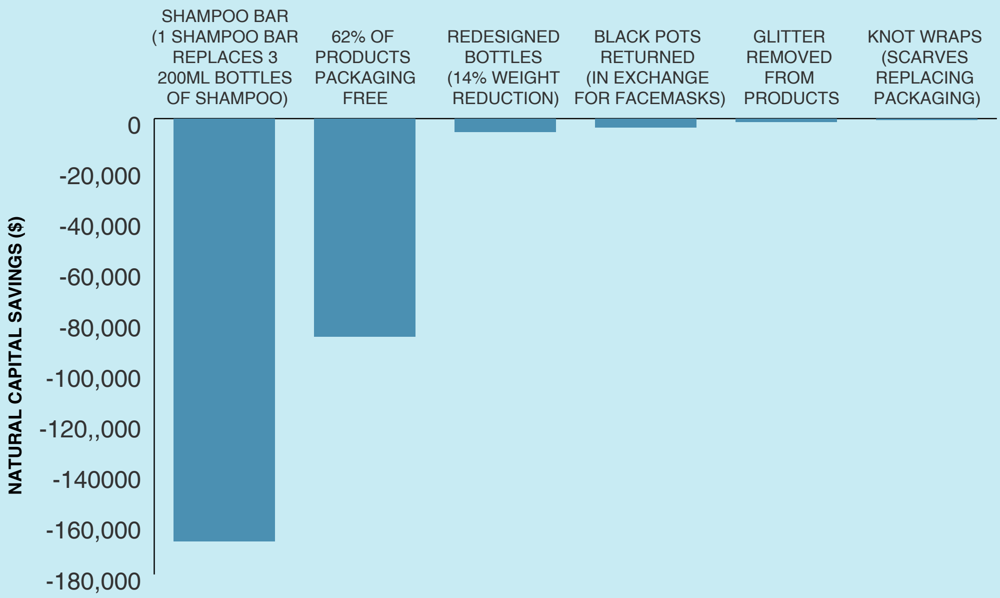
One such innovation – a solid-bar shampoo – removes the need for a plastic bottle. Lush says one shampoo bar provides up to 100 hair washes, the equivalent of three 200ml bottles of liquid shampoo. The company sells 1.9m shampoo bars per year, preventing the need for 5.7m plastic bottles. Lush has developed solid bar massage oil, bath bombs, deodorant, conditioner, toothpaste and henna hair dye. Shifting from liquid to solid-bar shampoo removes water from the product, cutting its weight and reducing transport emissions.[136,137]

Another example is Lush’s use of knot wraps to replace wrapping paper. Almost two thirds of the wraps are vintage scarves from the second hand clothes market, while the remainder are made from recycled plastic bottles or organic cotton. Lush sold almost 90,000 wraps in 2011, recycling 44,000 plastic bottles in the process.[138,139]

Where packaging is needed Lush favors using recycled material. Some 90% of its packaging is from recycled sources including all of its bottles, pots and carrier bags. In total, some 90 tonnes of plastics is saved per year, the equivalent of 800 barrels of oil. Lush is also developing closed loop systems for its waste. Facial toner bottles are made from high-density polyethylene recycled from containers used within the firm’s operations to transport fragrances. Pots, or small plastic containers for cosmetics such as cream and shampoos, are made from recycled polypropylene. Lush encourages customers to bring back empty pots to its stores by offering a free face mask if they return five pots. In 2011, some 250,000 pots have been brought back as a result. Lush is aiming to recycle these back into new pots. Bottle tops can also be brought back.

Trucost applied natural capital valuation to estimate the savings from Lush’s plastic reduction initiatives using its Plastic Disclosure Project disclosure in 2010/11. The total natural capital savings from plastic reduction amount to $263,273. The most important of these savings, over $160,000, relates to the fact that 62% of products are sold packaging free. $86,041 of these savings are associated with the sales of its solid bar shampoo. In 2010/11 Lush also redesigned its bottles, shaving 14% of the weight of a bottle, gave out 51,250 facemasks for the return of black pots, and sold 88,609 knot wraps 40% of which were made from recycled PET. These initiatives resulted in combined savings of $9,140.

FIGURE 21: NATURAL CAPITAL SAVINGS FROM SELECTED LUSH INITIATIVES



One important issue on Lush's agenda has been its use of microplastic glitter in ten products. Starting with the Christmas line in 2012, Lush decided to replace these with alternatives including rice paper confetti, coloured mica, agar-based sparkles and popping candy, without losing any of the product functionality. This is a forward thinking decision considering the associated costs, both economic and to natural capital. The Plastic Disclosure Project was partially instrumental in Lush's move away from plastic beads and glitter, as it was through conducting its Plastic Disclosure Project disclosure that Lush recognised the magnitude of the issue and opportunity.[139]

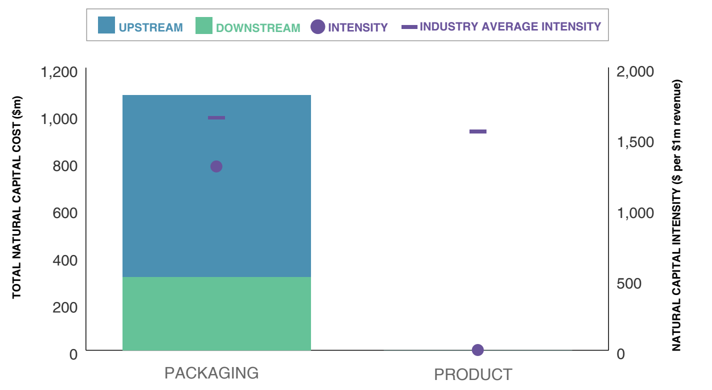
Prominent Dutch non-profit organization the Plastic Soup Foundation is also working to bring a halt to microplastic pollution in marine environments with their smartphone app for shoppers called 'Beat the Bead'.[50] Microplastics are plastic pieces less than 5mm long and an important type of marine litter. When used in products such as cosmetic scrubs, they can make their way into the sea where they have a detrimental effect. Research suggests that very small particles can be retained in the tissues of marine invertebrates and mussels, as well as having an elevated ability to absorb chemicals in the water due to the petroleum in the plastic and subsequently bioaccumulate in the food chain.[140] The small size of microplastic makes it difficult to study and model its environmental impacts but research in this field is growing quickly.

One campaign led by the Plastic Soup Foundation and other organizations contributed to Unilever's commitment in late 2012 to phase out the use of microplastic in all its personal care products by 2015. The company is currently investigating alternatives. Some other mainstream companies which have pledged to phase out microplastic by or before 2017 include L'Oreal, Johnson & Johnson and Procter & Gamble.[141] Increasingly suppliers have also started responding to the trend by launching biodegradable alternatives to plastic beads. For example, Koster Keunen offers sunflower and rice bran waxes in bead form as an alternative to plastic beads.[141] With their wide colour and size availability, they are suitable for a wide range of exfoliation applications. Other natural alternatives include ground almonds, oatmeal and pumice.

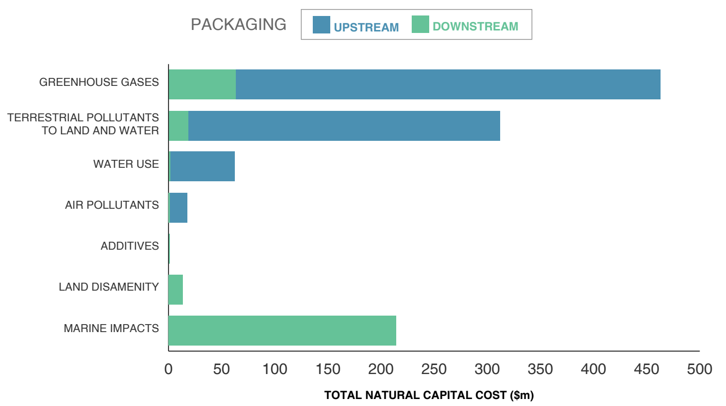
Overall, the combination of these market trends with increasingly evident scientific research and emerging legislative pressure – most recently through the California "Microplastic Nuisance Prevention Law" banning the sale and manufacture of products containing microplastics – implies a regulatory risk that companies might not have anticipated.[44]

Disposable food packaging prevalent in fast food and takeaway restaurants is typically made from plastic, paper, and other bio materials. The unique properties of plastic including insulation, light weight, hygiene, malleability, and cost-effectiveness compared to reusable packaging, make it a particularly popular choice for the foodservice industry. The main barriers to recycling plastic packaging are that it is considered contaminated and unfit for recycling unless cleaned and sorted, individuals eating fast food on the move rarely encounter dedicated waste collection services, as well as the challenge of raw material, collection and scrap costs.[142] Paper takeaway cups are least expensive and most widely used; however in the UK alone, an estimated 2.5bn disposable cups go to landfill every year because the plastic coating makes them difficult to recycle or compost.[143]

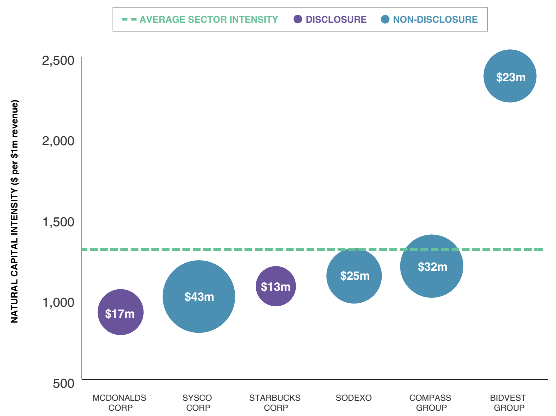
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the restaurants sector is over $1bn per year, or 1% of the total natural capital cost of the consumer goods industry. The restaurants sector has a modelled plastic-in-packaging intensity of 1 tonne per $1m revenue. This amounts to a total natural capital intensity around $1,300 per $1m revenue, or 0.1% of total revenue. The risk related to plastic-in-packaging, expressed by natural capital intensity, is slightly lower than that of the overall industry. Plastic-in-packaging only include 'shop-added' packaging.



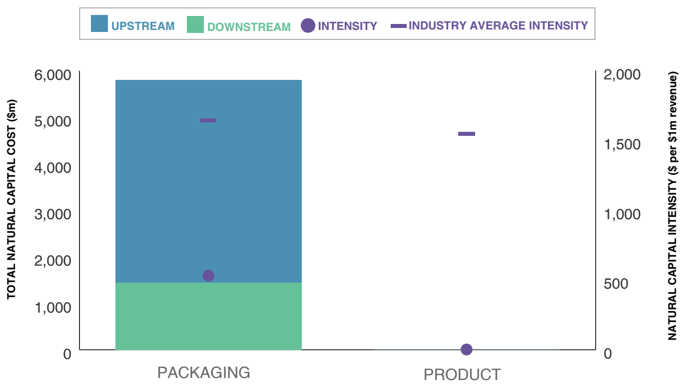
The figure on the left highlights the distribution of impacts for plastic-in-packaging. 71% of the impacts are located upstream (or $770m) and 29% downstream (or $310m). The most significant upstream impact is greenhouse gas emissions ($400m), followed by terrestrial pollutants to land ($295m) and water use ($60m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $230m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $80m, with the emission of greenhouse gases the most significant.



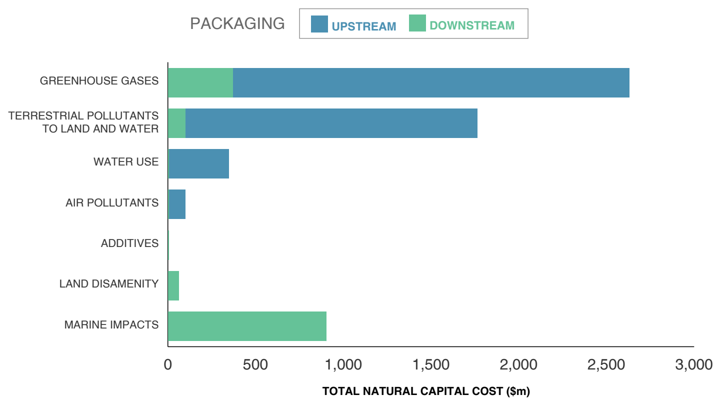
The figure on the left displays the estimated natural capital cost and intensity of selected companies. Bidvest has the highest intensity among the peer group due to its operations in the household goods sector, which has a higher plastic use than the restaurants sector. McDonalds has the lowest intensity, primarily due to its use of recycled content (28%). However, it should be noted that its natural capital intensity and cost is likely to be underestimated, as McDonalds is the world's largest distributor of toys. Starbucks has the second lowest intensity, due to its emphasis on reusable cups. In 2012, 1.5% or 35.8m beverages were served in personal tumblers. No useable quantitative disclosure was found on the other companies, which are all modelled. As such, all comparison should be taken with care.

Between 100 and 380bn plastic bags are used in the US every year, or 1,200 per resident. In 2010, 95.5bn plastic bags were placed on the EU market, 92% of them being single use. Plastic bags are the second most collected items during coastal clean-ups and can thus have significant environmental impacts.[120] As a result, several cities and countries have passed laws against the use of plastic bags. Bangladesh became the first country to ban thinner plastic bags in 2002 after they were found to have choked the drainage system during floods, soon followed but not limited to South Africa, Rwanda, China, India, cities in the US and Australia. The main focus of industry-led initiatives is twofold: reducing the use of plastic bags by suggesting alternatives and organising campaigns, helping suppliers reduce their own packaging and organising takeback programs for products such as batteries. For example, Walmart has already achieved a 35% reduction in plastic bags distributed since 2007, or 3.1bn bags.[144] Similarly, Carrefour saved 1,400m bags since 2009 and Kroger 1bn bags since 2008 through the selling of 4.8m reusable bags.[145,146] Furthermore, while this is not captured by the analysis, companies are implementing measures to reduce the consumption of plastic throughout their supply chain. Walmart for example has the ambition to be 'packaging neutral' through the use of recyclable, reusable, recycled and sustainably sourced packaging by 2025.[144]

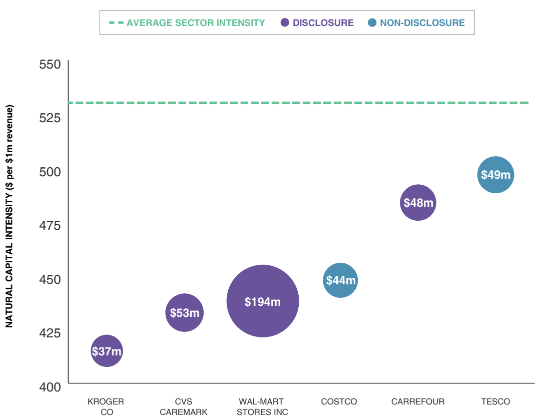
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the retail sector is around $5.8bn per year, or 8% of the total natural capital cost of the consumer goods industry. The retail sector has a modelled shop-added plastic-in-packaging intensity of 500kg per $1m revenue. This amounts to a total natural capital intensity around $530 per $1m revenue, or 0.05% of total revenue. The risk related to plastic-in-packaging, expressed by natural capital intensity, is lower than that of the overall industry.



The figure on the left highlights the distribution of impacts for plastic-in-packaging. 75% of the impacts are located upstream (or $4.4bn) and 25% downstream (or $1.4bn). The most significant upstream impact is greenhouse gas emissions ($2.3bn), followed by terrestrial pollutants to land ($1.7bn) and water use ($345m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $960m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $470m, with the emission of greenhouse gases the most significant.

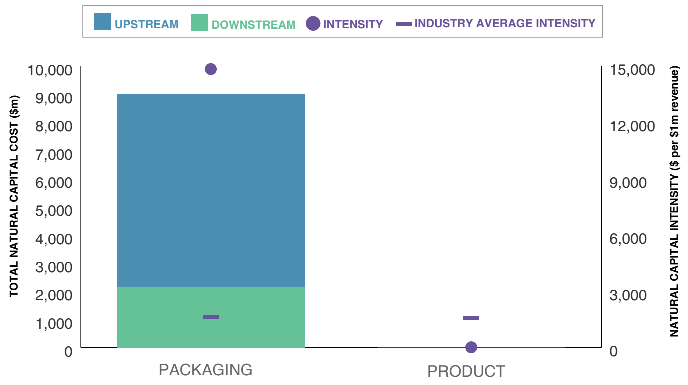


The figure on the left displays the estimated natural capital cost and intensity of selected companies. Kroger, Carrefour and Walmart Stores all disclosed useable quantitative data on plastic bags decrease. CVS Caremark and Kroger also disclosed some data on plastic recycled through in-house initiatives and voluntary takeback programs. Particularly interesting is Kroger's in-store Bag2Bag program, which consists of providing recycling bins to its customers for plastic dry-cleaning bags and plastic shrink-wrap, which collected 28m pounds of plastic in 2012.

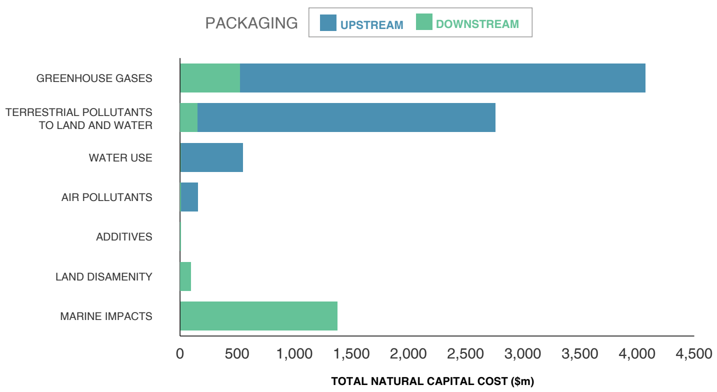
SOFT DRINKS

Soft drinks bottles are widely made of polyethylene terephthalate and polyethylene. There has been continual progress at lightweighting, improving recycled content (PET bottles are one of the most recycled items), and more recently, advances aimed at integrating bio-based content into the material make-up which could, depending on circumstances, reduce upstream impacts. However, bio-based content is not without debate, with some fearing it could be a threat to food production, concerns whether bio-based packaging can be treated in mainstream recycling streams, and activists raising concerns that having bio-based content could seduce consumers into believing the greater problem is solved. Because of its light weight, packaging easily makes its way to marine environments where it can cause harm through ingestion, especially when it breaks down into microplastic. According to Greenpeace, “a single one litre bottle could break down into enough small fragments to put one on every mile of beach in the entire world”.[147]

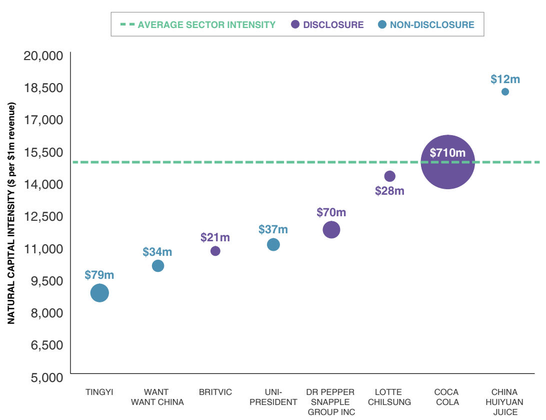
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the soft drinks sector is around $9bn per year, or 12% of the total natural capital cost of the consumer goods industry. The soft drinks sector has a modelled plastic-in-packaging intensity of 15 tonnes per $1m revenue. This amounts to a total natural capital intensity around $15,000 per $1m revenue, or 1.5% of total revenue. The risk related to plastic-in-packaging, expressed by natural capital intensity, is higher than that of the overall industry, meaning that on average the soft drinks sector is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-packaging. 76% of the impacts are located supstream (or $6.8bn) and 24% downstream (or $2.1bn). The most significant upstream impact is greenhouse gas emissions ($3.6bn), followed by terrestrial pollutants to land ($2.6bn) and water use ($540m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $1.5bn. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $6.7m, with the emission of greenhouse gases the most significant.



The figure on the left displays the estimated natural capital cost and intensity of selected companies. Coca-Cola has the largest total natural capital cost due to its high revenue; China Huiyuan Juice has the highest intensity due to its geographic sales in Asia (100%). Tingyi, Uni President and Want Want1 also operate in Asia; however, a little less than half of their revenue is generated within the food sector, which has a lower plastic intensity than the drinks sector, hence the lower overall intensity. Britvic, Coca-Cola and Dr Pepper all have end of life programs and partly operate in regions with packaging regulations, and thus have lower downstream intensity. Lotte Chilsung operates in Asia, but achieves the lowest downstream intensity thanks to its take-back program (91% of all sales).

CASE STUDY: COCA-COLA COMPANY I

As the world's largest beverage company, Coca-Cola is aware of the reputational and regulatory pressures it faces over plastic waste. Its iconic brand is one of its greatest strengths, but also a vulnerability that campaigners such as Greenpeace can exploit, as its recent YouTube video on seabird deaths caused by plastic bottles showed.[148] The original source of the row was a court case that Coca-Cola won to stop a container deposit scheme in Australia's Northern Territory – a programme that according to Greenpeace doubled recycling rates and ran successfully in South Australia for over 30 years. Yet according to Coca-Cola, it is one of the least efficient methods to increase recycling rates, with other methods being around 28 times more cost-effective.[149]

Ultimately, container deposits are linked to Extended Producer Responsibility (EPR), an increasingly prominent public policy and regulation, which promotes shifting financial responsibility for collecting and recycling used packaging from taxpayers to producers, leading to an internalization of end-of-life costs, creating an economic incentive for producers to adapt packaging and promote higher recyclability, and providing revenue to improve current recycling systems. In the US, EPR is successfully established for products such as batteries, carpet, electronics and paint. In the past, US companies generating a lot of packaging waste have shown little leadership in EPR. Corporate responsibility group As You Sow, which works with consumer brands to accept responsibility for recycling their packaging, says Nestlé Waters' advocacy of EPR for packaging in the US was the most important action taken by a company in the last decade on plastic because an optimized EPR system would reduce plastic loadings on land and in the ocean, and significantly increase recycling.[78]

Coca-Cola's sustainability programme features a range of targets to boost performance on sustainable packaging.[150] This includes a 2015 global target to recover the equivalent of half the plastic and metal it uses to make its products from a 2008 baseline, to source a quarter of its PET plastic from recycled or renewable sources by 2015, and to cut plastic use by reducing the weight of its bottles by 7% per litre of product by 2015 from a 2008 baseline. Investor pressure played an important role in securing these commitments: for example, As You Sow's shareholder dialogue and filing of proposals to encourage beverage and food retailers to assume responsibility for the collection and recycling of their containers. In 2009, Coca-Cola built the US's largest bottle-to-bottle recycling plant following several years of discussions with As You Sow on beverage container recycling.[151]

Progress on the 2015 goal has been hampered by a lack of available data as many emerging markets do not collect recovery data, although 2013 estimates suggest a current rate of 39%, increasing to 75% by 2020 for developed countries which already have well-developed waste management infrastructures. Coca-Cola is working with governments and industries in developing countries to help create waste collection and recycling systems so these targets can be achieved. It supports numerous litter prevention programs through The Coca-Cola Foundation.

To encourage recycling by motivating behaviour change, Coca-Cola has been working to invent creative ways to engage with consumers. EKOCYCLE, launched in July 2012 in collaboration with musical artist and producer will.i.am and other consumer brands, is an initiative dedicated to educating consumers that waste can be turned into recycled content for fashionable lifestyle products, such as Levi's 501 jeans, Beats by Dr. Dre headphones, New Era caps, Case-Mate iPhone cases, RVCA board shorts.[152] At the same time, the campaign has been criticized in that it does not educate consumers that the most efficient reuse of PET plastic is to make it into new Coke bottles. In addition it is notable that Coke has stalled on its binding recycled content goals for PET bottles, whilst some competitors have set binding targets.

Other notable campaigns include Happiness Recycled in collaboration with Zero Waste Sector, recycling at the London 2012 Olympic Games and during the Torch Relay, and addressing marine debris through collaboration with Ocean Conservancy with whom they launched the Trash Free Seas Alliance, a group of stakeholders seeking to end ocean trash. Coca-Cola also sponsors Ocean Conservancy's annual International Coastal Clean-up, the world's largest volunteer effort for ocean health, in which 500,000 volunteers remove plastic and other waste from beaches around the world.

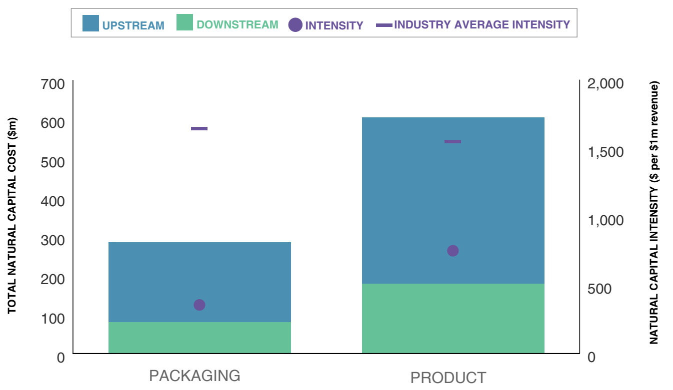
In 2009, Coca-Cola launched PlantBottle, a PET plastic bottle made from 30% renewable material. By the end of 2012, it had distributed some 14bn PlantBottles in two dozen countries, eliminating the need for 300,000 barrels of oil and cutting carbon dioxide emissions by 130,000 tonnes. In 2011, Coca-Cola licensed this technology to Heinz for ketchup bottles, and is also working with the Ford Motor Company where PlantBottle material will be used in the fabric interior of a Ford Fusion Energi.[153] The companies also work together with Nike and Procter and Gamble with the goal of creating a commercially scalable 100% plant-based plastic. To ensure that sustainably sourced feedstock is used to make the PlantBottle, the company has engaged with partners such as the World Wildlife Fund. However, although it has been designed to be compatible with recycling systems, the concern remains that PlantBottle may placate stakeholders, while Coke needs to continue to push forward a higher percentage of recycled and bio-based content. Moreover, Coca-Cola's target of sourcing a quarter of its PET plastic from recycled or renewable sources by 2015 has been criticised for amalgamating two distinctly different material sources into its goal and thus not fully committing to either one.

By 2012, 5% of Coca-Cola's packaging came from renewable sources. One challenge is scaling up sufficient supplies of recycled polyethylene terephtalate (rPET) to meet increasing demand. Currently, US PET reclaimers operate at less than 60% capacity, and according to As You Sow, lack of sufficient rPET supply is one of the reasons Coca-Cola could not meet its 10% rPET in bottles target by 2011.[151] To address this, Coca-Cola Enterprises in the United Kingdom has invested in a PET recycling facility through a joint venture with waste reprocessor ECO Plastics. The £15m investment more than doubled the amount of rPET available in the United Kingdom and enabled Coca-Cola to commit to recycling all PET bottles from the London 2012 Olympics venues and turn them back into new bottles within six weeks.

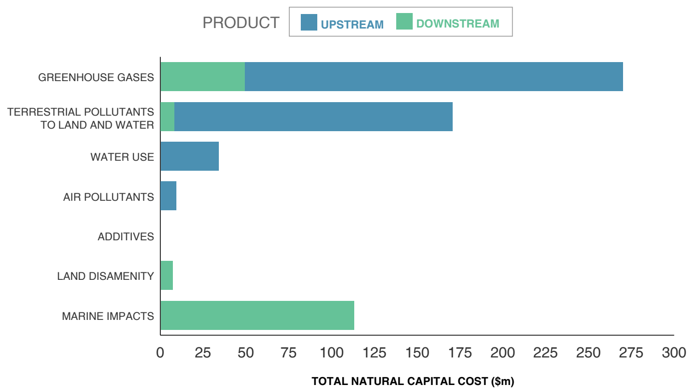
Coca-Cola's third key target to cut plastic use by reducing the weight of its bottles by 7% per litre of product by 2015 from a 2008 baseline was achieved for 85% of its packaging materials, including the lightest ever bottle for DASANI water developed by their bottling partner in Puerto Rico, which weighs 9.8 grams. Coca-Cola has joined the Ellen MacArthur Foundation in launching the Circular Economy 100, a three-year program aimed at facilitating projects promoting a global 'circular economy'. By 2015, participating companies are expected to identify and commit to new circular initiatives.[154]

Cigarette filters are made of a natural plastic called cellulose acetate and were introduced in the 1950s in order to decrease the toxic chemicals inhaled by smokers. Filters take between 1 month and 15 years to biodegrade depending on the receiving environment.[155,156,157] Studies estimate that more than 800,000 tonnes of butts litter the natural environment each year and are the single most collected items in coastal clean-ups. Main impacts include collection costs, disamenity, leachate of toxic chemicals and ingestion by local fauna.[158] Tobacco companies are taking steps against littering. For example, Imperial Tobacco supports several local initiatives to change consumer behaviour towards littering, such as the 'Keep Australia Beautiful' campaign.[159] Japan Tobacco rolled out a citizen participation clean-up campaign ('Pick up and you will love your city') initiative in 47 prefectures.[160] Reynolds American collected 2m cigarette butts in 6 months in partnership with Terra Cycle.[161]

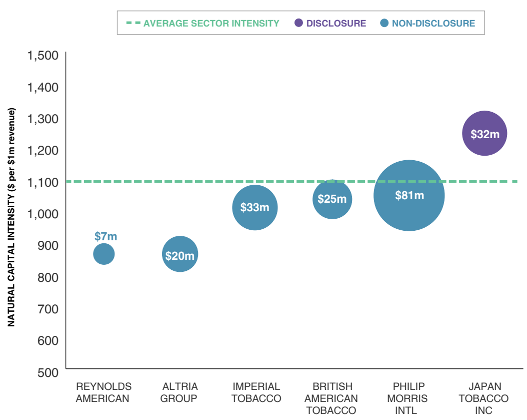
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the tobacco sector is around $890m per year, or 1% of the total natural capital cost of the consumer goods industry. The tobacco sector has a modelled plastic-in-product and plastic-in-packaging intensity of 700kg and 300kg per $1m revenue respectively. Plastic-in-packaging accounts for 32% of the overall natural capital cost, while plastic-in-product accounts for 69%, mainly in the upstream stage (66%). This amounts to a total natural capital intensity higher than $1,000 per $1m revenue, or 0.1% of total revenue. The risk related to both plastic-in-packaging and plastic-in-product, expressed by natural capital intensity, is lower than that of the overall industry.



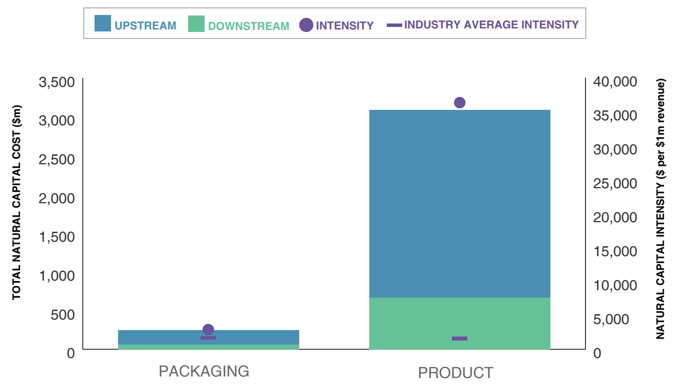
The figure on the left highlights the distribution of impacts for plastic-in-product. 70% of the impacts are located upstream (or $426m) and 30% downstream (or $180m). The most significant upstream impact is greenhouse gas emissions ($220m), followed by terrestrial pollutants to land ($160m) and water use ($34m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $120m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $60m, with the emission of greenhouse gases the most significant.



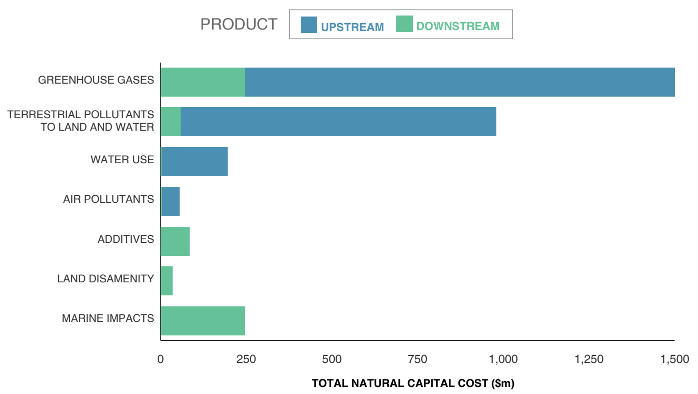
The figure on the left displays the estimated natural capital cost and intensity of selected companies. One company in the peer group disclosed data; all the rest is modelled. As such, any comparisons should be taken with care. Japan Tobacco has a higher total plastic intensity due to its activities in the soft drink sector. Imperial Tobacco, Reynolds American, and Altria Group have lower downstream littering impacts due to the larger proportion of their sales made in Europe and North America, where filters are more likely to enter waste treatment routes, leading to a lower overall intensity. Philip Morris has the highest total natural capital cost due to its higher total sales

The proliferation of plastic material in toy manufacturing took place in the 1950s, facilitated by its durability and malleability. In 1958 Lego patented its blocks produced from cellulose acetate, later replaced by acrylonitrile butadiene styrene polymer which was glossier, tougher and more ductile.[162] Pure plastic typically has low solubility in water and a low level of toxicity, although some plastic found in toys contains chemical additives and softeners which can be particularly toxic. For instance, brittle plastic such as polyvinyl chloride contains plasticizers to make them pliable enough for toys such as phthalates and Bisphenol A (BPA).[163] Traditional plastic toys are not widely recycled, and in the UK alone 8.5m new and usable toys are landfilled every year.[164]

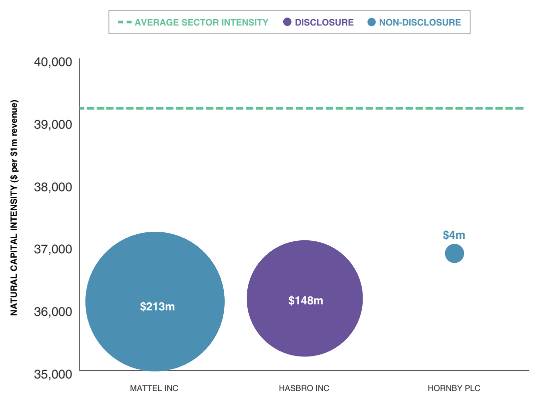
Results based on a combination of modelled and publicly disclosed data (third graph). Refer to Appendices 3 and 4 for the complete methodology. The study is NOT intended to compare companies performance due to limitations in methodology and scope.



The total natural capital cost of plastic use by the toy sector is over $3.3bn per year, or 4% of the total natural capital cost of the consumer goods industry. The toy sector has a modelled plastic-in-product and plastic-in-packaging intensity of 38 and 3 tonnes per $1m revenue respectively. Plastic-in-packaging accounts for 7% of the overall natural capital cost, while plastic-in-product accounts for 93%, mainly in the upstream stage (77%). This amounts to a total natural capital intensity higher than $39,000 per $1m revenue, or 4% of total revenue. The risk related to plastic-in-packaging and plastic-in-product expressed by natural capital intensity, is higher than that of the overall industry, meaning that on average the toy sector is more at risk from plastic than other sectors.



The figure on the left highlights the distribution of impacts for plastic-in-product. 78% of the impacts are located upstream (or US2.4bn) and 22% downstream (or $670m). The most significant upstream impact is greenhouse gas emissions ($1.3bn), followed by terrestrial pollutants to land ($920m) and water use ($190m). Downstream, the impacts from unmanaged waste from chemical additives, land disamenity and marine litter are $360m. Of these, the impact of littered products ending up in the marine environment is the most significant. The impact of managed waste is lower, at $300m, with the emission of greenhouse gases the most significant.



The figure on the left displays the estimated natural capital cost and intensity of selected companies. Only Hasbro disclosed a useable quantitative data point on plastic savings associated with the elimination of the use of plastic bags in which game instructions were wrapped. All other aspects have been modelled and variations can be explained by location of sale.

APPENDIX 2: TYPES OF PLASTIC

This table highlights the differences between several types of plastic.

TABLE 7: TYPES OF PLASTIC

SYMBOL / RIC CODE	PLASTIC NAME	PROPERTIES	COMMON USES
1 PET	Polyethylene Terephthalate	Clear, tough, solvent resistant, barrier to gas and moisture, softens at 80°C	• Soft drink and water bottles • Salad trays and other food containers • Synthetic fibres
2 HDPE	High Density Polyethylene	Hard to semi-flexible, resistant to chemicals and moisture, waxy surface, opaque, softens at 75°C, easily coloured, processed and formed	• Milk jugs and other containers • Laundry detergents and other household cleaning products • Shampoo bottles
3 PVC	Polyvinyl Chloride	PVC-U: Strong, tough, can be clear, can be solvent weld, softens at 80°C PVC-P: Flexible, clear, elastic, can be solvent weld	• Plumbing - pipes, fittings, window and door frames • Electric cables • Thermal insulation (PVC foam) and automotive parts
4 LDPE	Low Density Polyethylene	Soft, flexible, waxy surface, translucent, softens at 70°C, scratches easily	• Bread bags, frozen food and grocery bags • Most plastic film wraps • Some bottles
5 PP	Polypropylene	Hard but still flexible, waxy surface, softens at 140°C, translucent, withstands solvents, versatile	• Margarine containers • Microwaveable meal trays, lunch boxes • Garden furniture and outdoor carpets
6 PS	Polystyrene / Expanded Polystyrene	Can be clear, glassy, rigid, opaque, and semi-tough, softens at 95°C	• Rigid in disposable cutlery, CD cases • Foamed (Styrofoam) in food containers, egg cartons, protective packaging for electronic goods and toys, and building insulation
7 OTHER	Other (e.g. polycarbonate and polylactide)	Includes all other resins and multi-materials. Properties dependent on plastic or combination of plastics.	• Lids, medical storage containers, most baby plastic bottles • Electronics

APPENDIX 3: METHODOLOGY

This report has six steps:

1. **Sector selection and mapping** - Sixteen consumer goods and services sectors were selected.
2. **Plastic use quantification** – The plastic used in each sector was modelled using input-output modelling.
3. **Scope and boundary selection** – Scope and boundaries for impact quantification of plastic use were determined.
4. **Impact quantification** – Upstream and downstream impacts were quantified using input-output modelling and lifecycle analysis techniques.
5. **Natural capital valuation** - Natural capital valuations were applied to all impacts.

The output of the first five steps is an intensity figure – or impact per US$ million revenue.

6. **Sector-level and company-level application** – The intensity figure derived through the first five steps was applied at a sector level and company level to calculate total impact. At the company level, 100 companies were selected based on their modelled plastic use in their respective sectors. Further data was retrieved from public reports where available to produce an estimated plastic use figure for each company.

STEP 1: SECTOR SELECTION AND MAPPING

Input-output models map the flows of inputs through an economy and associated environmental impacts. Trucost's input-output model comprises 464 sectors spanning primary to service industries. Consumer-facing sub-sectors were selected as part of the scope of this study. All non-consumer facing sectors, such as agriculture, were excluded and may form part of future analysis. Out of Trucost 464 sectors, 75 consumer goods sectors were selected and aggregated into sixteen higher-level sectors based on two main criteria:

- **Type of product manufactured** – certain sub-sectors were excluded based on the product manufactured. For example, the breweries, wineries and distilleries sectors were not considered as they are likely to use more glass and less plastic than the soft drink sector.
- **Position within the supply chain** – certain sub-sectors were excluded based on their upstream position in the supply chain. This is the case of the fibre, yarn and thread mills sector which is upstream of the apparel manufacturing sector.
- **No distinction was made at this stage between products and packaging.**

Table 8 lists the chosen sectors, their description, and the corresponding NAICS sub-sectors.[165]

TABLE 8: SELECTED SECTORS FOR ANALYSIS

SECTORS INCLUDED	EXPLANATION	SUB-SECTORS
Athletic goods	Sports goods and equipment manufacturers.	Sporting and athletic goods manufacturing.
Automobiles	Car manufacturers. Does not include car parts manufacturers located further upstream.	Automobile manufacturing.
Clothing and accessories	Clothes and accessories manufacturers. Does include retailers.	Men's and boys' cut and sew apparel manufacturing; women's and girls' cut and sew apparel manufacturing; other cut and sew manufacturing; apparel accessories and other apparel manufacturing; other leather and allied product manufacturing; clothing and clothing accessories stores.
Consumer electronics	Includes computers, TV sets and telephone manufacturing.	Photographic and photocopying equipment manufacturing; electronic computer manufacturing; computer storage device manufacturing; computer terminals and other computer peripheral equipment manufacturing; telephone apparatus manufacturing; broadcast and wireless communications equipment; other communications equipment manufacturing; audio and video equipment manufacturing.

SECTORS INCLUDED	EXPLANATION	SUB-SECTORS
Durable household goods	Includes utensil, small electrical appliances and large household appliances manufacturing.	Cutlery, utensil, pot and pan manufacturing; hand tool manufacturing; power-driven hand tool manufacturing; small electrical appliance manufacturing; household cooking appliance manufacturing; household refrigerator and home freezer manufacturing; household laundry equipment manufacturing; other major household appliance manufacturing.
Food	Processed food producers and manufacturers. Does not include agricultural sectors.	Dog and cat food manufacturing; other animal food manufacturing; flour milling and malt manufacturing; wet corn milling; soybean and other oilseed processing; breakfast cereal manufacturing; sugar cane mills and refining; beat sugar manufacturing; chocolate and confectionery manufacturing from cacao beans; confectionery manufacturing from purchased chocolate; non-chocolate confectionery manufacturing; frozen food manufacturing; fruit and vegetable canning, pickling, and drying; fluid milk and butter manufacturing; cheese manufacturing; dry, condensed and evaporated dairy product manufacturing; ice cream and frozen desert manufacturing; animal (except poultry) slaughtering, rendering and processing; poultry processing; seafood product preparation and packaging; bread and bakery product manufacturing; cookie, cracker and pasta manufacturing; tortilla manufacturing; snack food manufacturing; coffee and tea manufacturing; flavouring syrup and concentrate manufacturing; seasoning and dressing manufacturing; all other food manufacturing.
Footwear	Clothes and accessories manufacturers. Does include retailers.	Footwear manufacturing.
Furniture	Furniture manufacturers. Examples include mattresses, carpet and blind manufacturing.	Carpet and rug mills; curtain and linen mills; wood kitchen cabinet and countertop manufacturing; upholstered household furniture manufacturing; metal and other household furniture manufacturing; mattress manufacturing; blind and shades manufacturing.
Medical and pharmaceutical products	Medicine manufacturers. Does not include medical appliances.	Pharmaceutical preparation manufacturing.
Non-durable household goods	Includes stationary product, soap and cleaning compounds and equipment manufacturing.	Stationary product manufacturing; sanitary paper manufacturing; all other converted paper product manufacturing; soap and cleaning compounds manufacturing; all other miscellaneous manufacturing; broom, brush, and mop manufacturing.
Personal products	Personal hygiene product manufacturing, such as shampoos and make-up.	Toilet preparation manufacturing.
Restaurants and bars	Includes food and drinking places.	Food services and drinking places.
Retail	Includes general, food and clothing retailers. Does not include online retailers.	Food, beverage, health and personal care stores; general merchandise stores; miscellaneous store retailers.
Soft drinks	Soft drinks bottlers and manufacturers. Does not include wineries, distilleries and breweries.	Soft drinks and ice manufacturing.

SECTORS INCLUDED	EXPLANATION	SUB-SECTORS
Tobacco	Tobacco producers. Does not include agricultural sectors.	Tobacco product manufacturing.
Toys	Includes toys, dolls and games manufacturers.	Doll, toy and game manufacturing.

STEP 2: PLASTIC USE QUANTIFICATION

Plastic use per sector was then modelled using input-output modelling. The input-output model calculates inter-industry spend patterns through each tier of the supply chain for each sector using government census data. Thirteen sectors relate to plastic and plastic product manufacturing. The amount spent by the selected consumer goods sectors in these 13 plastic manufacturing sectors was modelled and converted from a financial figure (US$ million spent) to a quantity (tonnage) using a weighted average plastic price based on global production in order to derive an average plastic intensity (tonnes per US$ million revenue) per sector and industry.[166]

Total plastic consumption was disaggregated into 'plastic-in-product', 'plastic-in-packaging', and 'plastic-in-supply-chain'.

1. **'Plastic-in-product'** includes the quantity of plastic directly used in the product, as well as any losses that were incurred during the manufacturing process. An example is the plastic used in the bumper of a car or a polyester t-shirt.
2. **'Plastic-in-packaging'** includes the quantity of plastic directly used in the packaging of the product, as well as any losses that were incurred during the manufacturing and packaging stage. This covers items such as plastic bags and films, as well as water and shampoo bottles.
3. **'Plastic-in-supply-chain'** includes the quantity of plastic used indirectly by consumer goods businesses via their supply chain but is destined to be neither in the final product nor in packaging. It includes all relevant activities, even where not in the consumer goods industry. For example, this includes the plastic containers of fertilisers applied in the agriculture sector, further down the supply chain of the food sector. Trucost calculated the volume of 'plastic-in-supply-chain' to put the first two categories into perspective but did not calculate the related natural capital cost.

Trucost triangulated the results with product-level data on plastic use. For example, the model yields 135kg of plastic for a car costing US$30,000, which falls within the 100-150kg range disclosed in industry reports.[99]

Several limitations should be noted. First, the input-output model is based on average transactions in the economy and may not be representative of particular activities or sectors. Second, the amount of plastic that Trucost has assigned to the categories of plastic-in-product, plastic-in-packaging and plastic-in-supply chain is based on modelled data and should be considered as estimates.

STEP 3: SCOPE AND BOUNDARY SELECTION

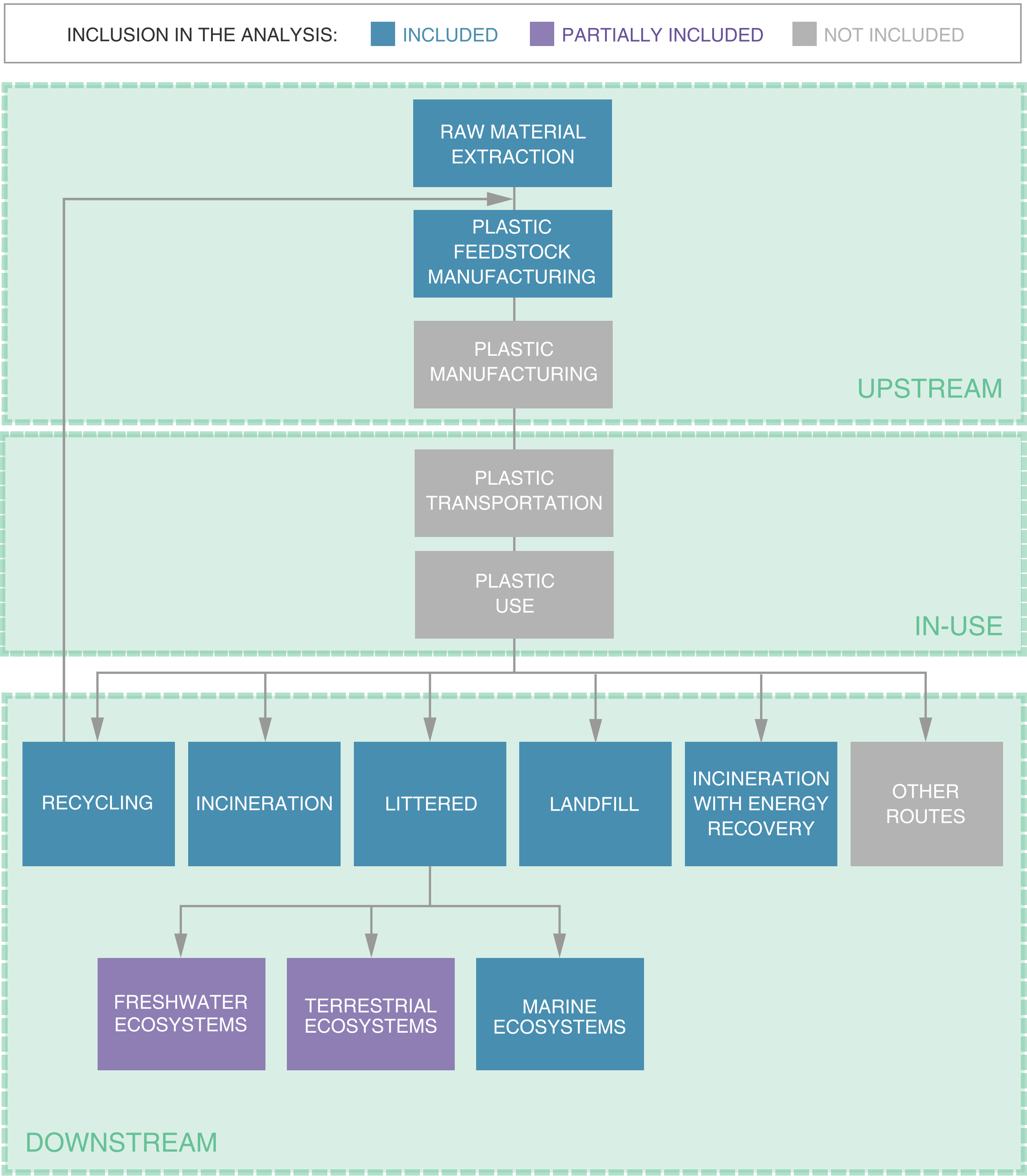
Once plastic use in tonnes is calculated for each sector, the next step is to set up the boundaries that will be used to calculate the impact of plastic. Lifecycle boundaries must first be set, i.e., what lifecycle stages are included in the analysis. Then, impacts to be quantified at each lifecycle stage must be determined.

Figure 22 highlights the lifecycle stages that are included in the analysis. Upstream lifecycle stages quantified in the analysis include raw material extraction and processing into plastic feedstock. Plastic product manufacturing has been excluded due to a lack of detailed data. Different processes exist such as blow moulding and film extrusion. Data is available on these processes, from lifecycle analysis databases like Ecoinvent. However, the multiplicity of products and processes used in each sector does not allow a sector-specific profile for this stage to be built. Exclusion of this stage underestimates upstream impacts, as transforming plastic feedstock into finished products can be energy intensive.

The transportation and use phases have been excluded due to the lack of data and for the sake of simplicity. The transportation stage can generate significant amount of greenhouse gases, and leachate of additives during the use phase has recently come under scrutiny. These stages may also be significant in terms of benefits. For example, switching from heavier materials to plastics may decrease transportation emissions.

Downstream stages include the disposal of plastic after its use. Five end-of-life routes are included in this study, namely littering, landfilling, incineration with and without energy recovery and recycling. Other routes such as conversion to fuel and composting have not been included for lack of country-specific statistics on the quantity of plastic diverted to these routes. The benefits of recycling and incineration with energy recovery have been excluded as part of the baseline calculations and are explained in the quantification section of this methodology. When plastic is littered, it may reach different environments. Freshwater and terrestrial environments have only partly been included due to a lack of data.

FIGURE 22: SCOPE AND BOUNDARY



The second step is to determine which impact can be quantified at each lifecycle stage selected within the scope of the analysis. Table 9 highlights included and excluded impacts.

TABLE 9: IMPACT INCLUSION AND EXCLUSION

LIFECYCLE STAGE	STATUS	COMMENT
Upstream		
Non-renewable resource consumption	Excluded	Natural gas and crude petroleum are non-renewable resources which if over-exploited may not be available for future generations. The opportunity cost of using non-renewable resources has not been included as part of this analysis. The impact of extracting and processing these resources, on the other hand, is included via the three following elements.
Greenhouse gases	Included	Impact of extracting and processing raw materials into plastic feedstock.
Air/land/water pollutants	Included	
Water consumption	Included	
Occupational hazards of chemicals use	Excluded	Lack of consistent and global data
Greenhouse gases, air/land/water pollutants, water consumption of plastic product manufacturing (blow moulding, film extrusion, etc…)	Excluded	This lifecycle stage (and associated impacts) has been excluded. Different processes exist such as blow moulding and film extrusion. Data is available on these processes, from lifecycle analysis databases like Ecoinvent. However, the multiplicity of products and processes used in each sector does not allow to build a sector-specific profile for this stage, hence the exclusion.
In-use		
Transportation	Excluded	The in-use stage has been excluded for lack of data.
Additives leachate	Excluded	
Downstream - Landfilling		
Waste of recyclable resources	Excluded	
Greenhouse gases	Included	
Air/land/water pollutants	Included	
Water consumption	Included	
Downstream – Incineration without energy recovery		
Waste of recyclable resources	Excluded	
Greenhouse gases	Included	
Air/land/water pollutants	Included	

Water consumption	Included	
Ash disposal	Included	
Downstream – Incineration with energy recovery		
Waste of recyclable resources	Excluded	
Greenhouse gases	Included	
Air/land/water pollutants	Included	
Water consumption	Included	
Ash disposal	Included	
Energy production	Excluded	The benefits of energy production have been excluded from the main analysis. An alternative scenario is explained p86.
Downstream - Recycling		
Greenhouse gases	Included	A conservative value of 0 has been used. An alternative scenario is explained p86.
Air/land/water pollutants	Included	
Water consumption	Included	
Primary material displacement	Included	
Downstream – Littered		
Waste of recyclable resources	Excluded	
Nuisance (disamenity) related to littering	Included	
Terrestrial and freshwater pollution of littered plastic	Partially included	Please refer to Appendix 4 for inclusions and exclusions in this category.
Marine pollution of littered plastic	Partially included	Please refer to Appendix 4 for inclusions and exclusions in this category.

STEP 4: QUANTIFICATION OF PLASTIC USE IMPACTS

The quantification stage comprises two separate stages, upstream and downstream impact modelling and quantification.

UPSTREAM MODELLING AND IMPACT QUANTIFICATION

The term 'upstream' refers to impacts generated from 'cradle-to-gate', i.e., the extraction of raw materials such as crude oil and natural gas to the manufacturing of plastic feedstock. Processing into the final product, such as fibres, shapes or packaging film is not included, as explained in the scope and boundary section.

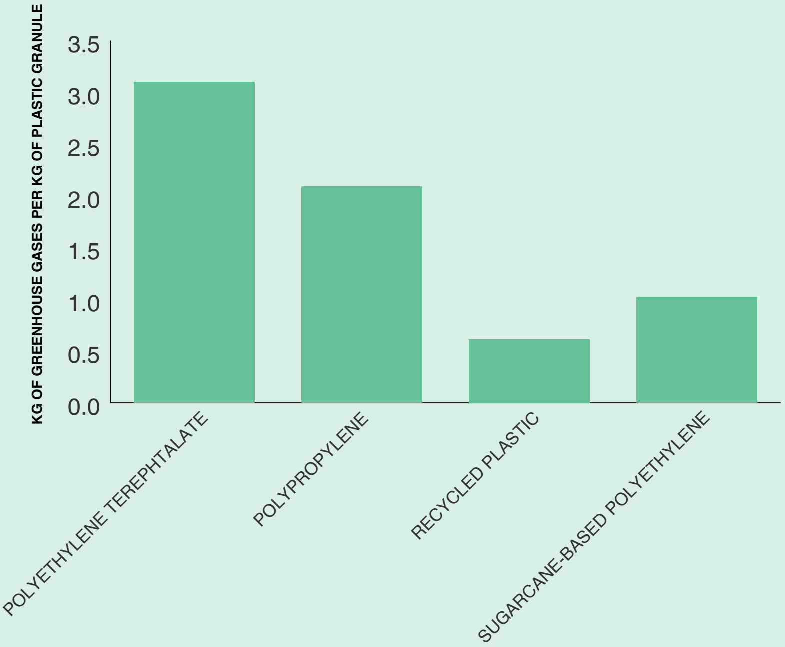
Upstream impacts considered include greenhouse gases, water abstraction, air pollutants, land and water pollutants, and cover the cradle-to-gate manufacturing of amorphous plastic feedstock. Trucost used its environmentally-extended input-output model to calculate the global environmental impact of producing the plastic used in each sector. The environmentally-extended input-output model goes one step further than the input-output model by overlaying environmental impacts data with financial flow data. Each sector has a global environmental profile per unit of output which is derived from numerous sources, including the US Toxic Release Inventory, UK Environmental Accounts, Japanese Pollution Release and Transfer Register and Australia's National Pollution Inventory. The economic magnitude of a sector's input from another sector defines its environmental impact, and so on through the supply chain, until all economic flows to produce a unit of output at the top of the supply chain have beenaccounted for. The model is adjusted on an annual basis to take into account changes in the environmental impact of a unit of output for each sector.

ILLUSTRATION OF PLASTIC TYPES

Many different types of plastic are used by industry depending on the characteristics of the material and its application. For example, plastic bottles are commonly made of polyethylene terephthalate (PET) whereas low-density polyethylene is typically used for multi-use grocery bags and polyurethane for car seats.[1,99] Different types of plastic have different environmental impacts. Trucost's calculations are based on an average of the most commonly used plastics across all sectors.

Figure 23 compares the environmental impacts of four plastic types as an example of impact variability during the upstream stage. When considering the impacts of plastic, companies should assess these differences and identify opportunities to switch between plastic types.

FIGURE 23: FOCUS ON THE ENVIRONMENTAL IMPACT OF DIFFERENT PLASTIC TYPES



The results displayed in figure 23 are based on secondary lifecycle analysis studies.[9,167] One should note that there is no consensus on the upstream impact of plastics, especially on bio-based plastics, and companies are encouraged to conduct their own assessments. The use of input-output modelling in this study results in higher estimates – for example 3.48 kg of greenhouse gases for the production of 1 kg of average plastic. Input-output modelling implies larger boundaries, hence the higher estimate.

DOWNSTREAM MODELLING AND QUANTIFICATION

The term 'downstream' refers to impacts occurring when the product is discarded by the consumer. The outbound transportation and in-use phase have been excluded, as explained in the scope and boundary section. The first step is to estimate end-of-life treatment route percentages. The second step is to understand the impact of each treatment route.

In this report, the impact of plastic is weighted differently depending on how it is handled at its end-of-life. Region-specific end-of-life statistics for plastic-in-packaging and plastic-in-product across five different routes were derived: littering, landfilling, incineration with and without energy recovery and recycling/re-use. Other end-of-life routes exist for plastic, such as conversion-to-fuel and composting, but represent a small proportion overall and were not included in the analysis. Due to the lack of national and international standards for waste treatment data collection, compilation and disclosure, Trucost combined several sources, such as the US Environmental Protection Agency, Eurostat, the United Nations, the World Bank and academic articles. The following table details specific assumptions.

TABLE 10: TREATMENT ROUTES SOURCES AND ASSUMPTIONS

ITEM	END-OF-LIFE ROUTE	REFERENCE
Packaging	**Littering:** Percentage of the population served by collection system used as a proxy. **All other routes:** • **Europe:** Eurostat data on plastic packaging waste. • **United States:** US EPA data on plastic packaging waste. • **Australia and New Zealand:** Australian Bureau of Statistics data on plastic packaging waste. • **Other:** Domestic municipal waste used as a proxy, scaled up using US EPA ratio between recycled domestic waste and recycled plastic packaging waste.	8, 10, 168, 169, 170
Automobiles	**Littering:** a minimum of 6% of cars are littered, scaled up by country's specific littering rates for overall waste. **All other routes:** Managed is either recycled or incinerated with energy recovery. The remaining is landfilled. • **Europe, US, Singapore, Japan:** Eurostat data on the proportion of plastics recycled (8%) and incinerated with energy recovery (12%). • **Australia, New Zealand:** Europe recycling rate as a proxy (8%), no energy recovery. • **Other:** 3% recycled/reused, remaining is landfilled or littered.	8, 10, 168, 169, 170, 80, 172, 171
Electronics and household durables	**Littering:** percentage of the population served by collection system used as a proxy. **All other routes:** Managed is either recycled or incinerated with energy recovery. The remaining is landfilled. • **Europe, US, Singapore, Japan:** Eurostat data on the proportion of plastics recycled (8%) and incinerated with energy recovery (36%). • **Australia, New Zealand:** Europe recycling rate as a proxy (8%), no energy recovery. • **Other:** 3% recycled, no energy recovery	8, 10, 168, 169, 170, 80, 171
Tobacco	**Littering:** Percentage of the population served by collection system used as a proxy for littering. **All other routes:** Domestic waste treatment routes used as a proxy, excluding recycling.	8, 10, 168, 169
All other products	**Littering:** Percentage of the population served by collection system used as a proxy for littering. **All routes:** Domestic waste treatment routes used as a proxy. **Recycling:** Recycling figure scaled down using the US EPA ratio between recycled domestic waste and recycled non-durable consumer plastic goods.	8, 10, 168, 169

The international data on the waste treatment routes used for plastic packaging and plastic products is often lacking and/or inconsistent. Trucost used several datasets to compile end-of-life statistics, as listed in table 10. As a consequence, all assumptions used in constructing these datasets apply to this report. In particular, recycling data from many countries does not include industry closed-loop systems, waste recycled outside the country, and waste-picking activities, which may all increase the proportion of waste recycled. In addition, there may be some differences within each category – for example, recycling rates of film packaging, bags and trays (all under 'packaging') may differ.[169]

As a second step, quantified environmental impacts for each end-of-life route have been calculated, and include greenhouse gases, air pollutants, water abstraction and land and water pollutants. Additional impacts have been included for plastics that are littered. Table 11 provides information on how these impacts have been calculated.

- Trucost used lifecycle analysis databases such as Ecoinvent for most end-of-life routes. For littered plastic waste, further impacts have been calculated based on an extensive academic literature review.

- As part of the baseline analysis, no benefits have been attributed to recycling and incineration with energy recovery. For recycling, a conservative value of 0 has been used. The next section discusses this further and explains how the "benefits" of recycling and incineration with energy recovery have been calculated.

TABLE 11: IMPACTS FOR EACH END-OF-LIFE ROUTE

ITEM	BURDENS	COMMENTS
Incineration without energy recovery	Lifecycle analysis data on average plastic mixes for the incineration route.[171]	Burdens include all raw material inputs needed to incinerate as well as the disposal of ash slag.
Landfilling	Lifecycle analysis data on average plastic mixes for the landfilling route.[171]	Burdens include all raw material inputs needed to landfill as well as landfill leachate.
Incineration with energy recovery	Lifecycle analysis data on average plastic mixes for the incineration routes.[171]	Burdens include all raw material inputs needed to incinerate as well as the disposal of ash slag. Refer to the next section for a discussion of incineration with energy recovery benefits.
Recycling	Conservative value of 0	Recycling has both impacts and benefits. However, their relative proportion varies according to several factors such as recycling techniques, what is the recycled material used for, transboundary waste exchanges. Due to a lack of global data on recycling burdens and benefits, Trucost used a conservative value of 0. Refer to the next section for a further discussion.
Littering	Lifecycle analysis data on average plastic mixes for the landfilling route.[171] In addition, Trucost included region and end-of-life specific disamenity impacts relating to the noise, dust, litter, odour, presence of vermin, visual intrusion and enhanced perception of risk, additive leachate in the terrestrial and marine environment, and plastic impacts in the ocean.	Each product and packaging has been assigned a probability of reaching marine ecosystems, based on their weight. All packaging items have a probability of 1, light-weighted products 0.5, and other heavy products 0. While these probabilities can be refined, no global or country-specific data exist on the dispersion of plastics. The analysis excludes terrestrial and freshwater impacts of plastic litter, such as freshwater economic impacts to fishing, tourism, and agriculture, and ecological impact to freshwater and terrestrial species. Refer to Appendix 4 for a detailed discussion of this end-of-life route.

As for upstream impacts, downstream impact calculations refer to an average plastic mix for simplicity purposes, but in reality may vary depending on the type of plastic.

PLASTIC RECYCLING AND INCINERATION WITH ENERGY RECOVERY

As part of the baseline analysis, Trucost only included the impacts of incineration with energy recovery, and used a conservative value of 0 for recycling. End-of-life impact quantification is one of the most contentious areas in lifecycle analysis and several techniques are available. As part of the alternative analysis, Trucost calculated what the total natural capital cost of the consumer goods industry would be if the benefits of recycling and incineration with energy recovery were taken into account. The methodology is the same apart from the two following points:

- For plastic that is recycled or incinerated with energy recovery, both positive and negative effects have been allocated. Positive effects, or credits, include displacing primary plastic production through recycling and energy grid production through incineration with energy recovery. Negative effects, or burdens, include the impacts generated by the recycling process and incineration with energy processes, such as the emission of greenhouse gases and other air pollutants.
- Credit for positive effects and burdens for negative effects were allocated using the 50/50 method – meaning that 50% has been allocated to the "new" user (or upstream impact of a company using recycled plastic in their products and packaging for example) and 50% to the emitter (or downstream impact of a company where the product or packaging is sent for recycling for example).

TABLE 12: CREDITS AND BURDEN ALLOCATION FOR EACH END-OF-LIFE ROUTE

END-OF-LIFE ROUTES	BURDENS	CREDITS	COMMENTS
Incineration with energy recovery	Lifecycle analysis data on average plastic mixes for the incinera-tion routes.[171]	Lifecycle analysis data on impacts that would have been generated by the displaced grid electricity.[171]	Burdens include all raw material inputs needed to incinerate as well as the disposal of ash slag; benefits assume the displacement of grid electricity, taking into account conversion efficiency. Whether the burdens outweigh the benefits will depend on the efficiency of the incineration process, as well as the type of grid electricity displaced and local waste infrastructure. In the absence of global datasets on incineration with energy recovery burdens and benefits, Trucost has used global averages, where burdens outweigh benefits.
Recycling	Lifecycle analysis data on the negative impact of recycling processes and average plastic mixes.[173]	Lifecycle analysis data on impacts that would have been generated by the cradle-to-gate production and disposal of primary feedstock, including conversion losses.[171]	Burdens include air, land and water emissions as well as water consumption of the recycling process and the extraction and manufacturing of secondary raw materials used. Mechanical recycling (in opposition to other recycling techniques such as chemical recycling) is taken as a proxy across all sectors, and may underestimate or overestimate the environmental profile depending on the sector/recycling technique considered. Transportation impacts of transboundary waste exchanges are not included and may thus overestimate the benefit attributed to recycling.

STEP 5: NATURAL CAPITAL VALUATIONS

The final step of the calculation involved transforming physical quantities of plastic into monetary values using environmental or natural capital valuation techniques. These techniques estimate the value of environmental goods or services in the absence of a market price and aggregate them into a single figure.

Trucost applied region-specific valuations for water abstraction and air pollutants, and global averages for land and water pollutants and plastic ending up in the ocean. Toxicity information on land and water pollutants contains many methodological uncertainties, hence the use of a global average. The impacts of greenhouse gases are global, regardless of the location of emission. Finally, little information exists on the dispersion of plastic, hence the use of a global valuation for plastic ending up in the ocean. Other environmental impacts are region-specific. In order to evaluate the global natural capital intensity and cost, Trucost weighted regional averages by market share.[174]

Appendix 4 details the valuation methodology used for each impact. The following table provides an overview of Trucost's natural capital valuation methodology.

TABLE 13: VALUATION METHODOLOGY SUMMARY

	VALUATION SCOPE	METHODOLOGY SUMMARY	GEOGRAPHICAL SCOPE
GHGs	Uses the social cost of carbon (in preference to the market price or abatement cost of carbon) as it best reflects the total damage engendered by the emission of one tonne of CO_2e. The valuation is based on the present value of each metric tonne of CO_2e emitted now, taking account of the full global cost of the damage that it imposes during its time in the atmosphere.	A social cost of 113 US$ 2012 per metric tonne of CO_2e was used to value GHG emissions, which is the value identified in the UK Government's Stern report as the central, business-as-usual scenario, adjusted for inflation to 2012 prices using a global weighted average consumer price index (CPI).	Global average
Air pollution	Valuation methodology for 5 air pollutants: ammonia (NH3), sulphur dioxide (SO_2), Nitrogen oxide (NO_x), volatile organic compounds (VOCs), and particulate matter (PM_{10}). Each pollutant is associated with different but overlapping damage costs. Studies into the damage costs of air pollution use Impact Pathway Analysis (IPA) to follow the analysis from identification of burdens (e.g. emissions) through to impact assessment and then valuation in monetary terms.	Literature reviews were carried out for each air pollutant. The impact pathway approach was used to assess air pollution impacts. Data on the number of effect end points per tonne were compiled to derive an average number of each type of effect per tonne. The general approach taken when performing function transfer for air pollution is to scale the number of effect end points from the literature based on the receptor density. Therefore the number of effect end points per tonne is adjusted based on relevant factors.	Region-specific
Disamenity	The localized impacts of landfill and littering activity that generate negative reactions from those located in the immediate vicinity of a site.	The most common valuation method used in literature for disamenity is to use the hedonic pricing method. This method is based on the idea that the utility that individuals obtain from a particular good, and therefore the 'value' that they place on that good, is a function of the characteristics such as house size, house age, number of rooms, proximity to amenities such as schools, etc.	Region-specific
Water consumption	The environmental services of water, which can be assimilated to the instream services of water (services provided by water in its natural environment).	Trucost has developed a methodology linking the environmental services of water to its scarcity in the region where it is abstracted. As defined by the Food and Agriculture Organization, water scarcity is the freshwater withdrawal as a percentage of total renewable resources.	Region specific
Land and Water pollution/ Additives	Health and ecosystem damages of pollutants released in different media. The valuation is region-specific but due to high uncertainty in toxicity calculations, Trucost chose to use a global average.	Trucost used life cycle analysis models that quantify the health and ecosystem damage of different pollutants released to land and water. Health impacts are calculated in Disability Adjusted Life Years (DALYs) and ecosystem damages in Ecosystem Damage Potential (EDP). Based on secondary literature and benefit transfer, Trucost derived a value for DALYs and EDP based on societal willingness-to-pay.	Global average
Plastic in marine environments	Economic impact on fisheries and aquaculture, tourism, and the opportunity cost of volunteer time; and the entanglement and ingestion impacts on marine species.	Trucost used secondary literature on the economic impact of plastic and on the quantity of marine species impacted by plastic entanglement and ingestion. Willingness-to-pay studies were used to assess the value that society puts on marine species.	Global average

STEP 6: SECTOR-LEVEL AND COMPANY-LEVEL APPLICATION

The output of steps 1 to 5 is a sector and region-specific natural capital intensity figure. Natural capital intensity expresses the natural capital cost of all environmental impacts per US$ million revenue. This can be understood as a measure of risk. If all the environmental and social impacts generated by plastic were to be paid by business, this percentage of their total revenue would be forfeit.

The natural capital intensity figure can then be multiplied by total revenue to derive a total natural capital cost for plastic use, either at a sector or company-level.

Total natural capital cost can also be normalized by service life.[175] Service life is the period of time over which product and packaging are used. The period varies depending on the item. Natural capital cost normalized by service life is useful to partially understand how efficiently plastic is used by dividing the total natural capital cost by the average service life of a typical product/packaging item manufactured by each sector. Total natural capital cost should thus be considered along with normalized total natural capital cost to have an overall understanding of the impact of plastic use.

OUTPUT 1: SECTOR LEVEL ANALYSIS

At the sector level, Trucost calculated the total natural capital cost of plastic use by each consumer goods sector. The total natural capital cost is the total natural capital intensity for that sector, multiplied by its aggregate revenue.[174]

OUTPUT 2: COMPANY ANALYSIS

Trucost collects financial and environmental data on more than 4,500 stock exchange listed companies from publicly available sources such as annual and corporate social responsibility reports. Each company is mapped to one or more of 464 sectors based on its business activities and revenue. At the end of the data collection process, Trucost engages with each company for quality control purposes.

For this particular study, the average plastic consumption was first modelled for each consumer-facing company in Trucost's database based on its respective sector mapping and revenue. One hundred companies were then selected on the basis of their modelled materiality in their respective sectors. When one company operates across different sectors, such as soft drinks and food, it was mapped to its primary sector for reporting purposes.

When the input-output modelling methodology is applied at a company level, plastic consumption and impact may be over or under-estimated depending on a company's business model, product mix, or whether it discloses data on plastic use. This is because the level of impact is modelled on its expenditure in certain sectors – in this case plastic manufacturing sectors. For example, luxury goods companies are likely to have their plastic consumption overestimated, as they have a higher revenue-to-quantity-sold ratio than most other companies.

Publicly available data on plastic use for the financial year 2011/12 were then incorporated to refine results based on sector averages. Specific data points collected include plastic consumption, recycled content, bio-based content, quantitative information on upstream initiatives such as quantity of plastic saved through lightweighting, quantitative information on downstream initiatives such as takeback programs. Trucost also gathered revenue data at a regional level to estimate the quantity of products and packaging ending their lives in different regions. To be "usable" the data provided needed to be clear as to coverage and granularity of application. Many companies disclosed both quantitative and qualitative data that could not be integrated within the calculations.

Scope and boundaries are not always clear from companies' reports, so data can lack comparability. When assessing reports, Trucost had to make some assumptions to overcome this issue. An example is the percentage of recycled content: some companies report a rate which covers all materials, in which case Trucost made the assumption that this rate would be the same for plastic. Globally, plastic recycling rates are lower than for traditional materials such as metals, pulp, and glass. As a result, recycling rates for these companies have been overestimated.

The following example illustrates how the calculations were performed for a mock company.

COMPANY-LEVEL CALCULATIONS

Company A is a publicly listed company which operates in the 'soft drink and ice manufacturing', 'chocolate and confectionery manufacturing from cacao beans', and 'Air conditioning, refrigeration, and warm air heating equipment manufacturing' sectors. Each sector generated US$8m, $6m, and $2 million revenue respectively in 2012, as reported in its income statement.

Company A's plastic use is modelled as follows:

Plastic use in the 'air conditioning, refrigeration, and warm air heating equipment manufacturing' is excluded as this sector is not in scope for this report.

The 'soft drink and ice manufacturing' sector has an average plastic in packaging intensity of 15 tonnes per US$ million revenue (and zero for plastic-in-product). Thus, Company A's activities in this sector is modelled as 8x15 tonnes of plastic, or 120 tonnes in total.

The ‘chocolate and confectionery manufacturing from cacao beans’ sector has an average plastic-in-packaging intensity of 4 tonnes per US$ million revenue (and zero for plastic-in-product). Thus, Company A’s activities in this sector are modelled as using 4x6 tonnes of plastic, or 24 tonnes in total.

The total modelled plastic use of Company A is 120 + 24 = 144 tonnes, and the total plastic intensity of company A is 10 tonnes per US$ million revenue.

To create a more refined estimate, Company A’s Disclosure is integrated as follows:

Company A does not report on total plastic use, which would have been used to override the modelled data.

Company A reports on an estimated reduction in weight per consumer use of 20% over a two-year time period, the total plastic consumption is 144x(1 – 20%) = 115 tonnes.

Company A also reports on 1 tonne of plastic saved due to lightweighting initiatives, its total plastic consumption is 115 – 1 = 114 tonnes.

Company A also report a 5% recycled content rate, thus total primary plastic consumption is 114x(1-5%) = 107 tonnes and total recycled plastic use is 114x5% or 7 tonnes. This methodology also applies for bio-based content.

The average upstream natural capital cost of one tonne of plastic is US$760 per tonne of virgin plastic, and 0 for recycled plastic. Thus the modelled upstream natural capital cost of Company A plastic use is thus 107 tonnes of virgin plastic x US$760 + 7 tonnes of recycled plastic x US$0= **US$ 81,320.**

Company A generates 60% of its revenue in North America and 40% in Asia. As a result, this report assumes 60% x 114 tonnes, or 68 tonnes, are discarded in North America and 46 tonnes in Asia. The downstream plastic-in-packaging natural capital valuation in the soft drinks sector is US$480 per tonne in Asia and US$60 per tonne in North America. The downstream plastic-in-packaging natural capital valuation in the food sector is US$480 per tonne in Asia and US$70 per tonne in North America.

The downstream natural capital cost of Company A’s plastic use is calculated as follow:

Soft drinks sales in North America: 95.5 tonnes used in the soft drink sector x 60 % of sales in North America x US$60 = US$ 3,438

Soft drinks sales in Asia: 95.5 tonnes used in the soft drink sector x 40 % of sales in Asia x US$480 = US$18,336

Food sales in North America: 18.7 tonnes used in the food sector x 60 % of sales in North America x US$70 = US$785

Food sales in Asia: 18.7 tonnes used in the food sector x 40 % of sales in Asia x US$480 = US$3,590

The total downstream natural capital cost of Company A’s plastic use is thus 3,438 + 18,336 + 785 + 3,590 = **US$26,149.**

Company A does not report quantitative data on take-back schemes and therefore we assume country average recycling rates.

The total upstream and downstream natural capital cost of Company A’s plastic use is 81,320 + 26,149 = US$107,469 and its natural capital intensity is 107,469 / (8 + 6) is US$7,676 per million dollar revenue or 0.7% of its overall revenue.

APPENDIX 4: NATURAL CAPITAL VALUATION

This appendix explains in detail how natural capital valuations were derived for greenhouse gases, air pollutants, water use, land and water pollutants, managed waste and littered waste. For an explanation of how they were integrated in the analysis, refer to Appendix 3.

GREENHOUSE GAS EMISSIONS

A greenhouse gas is a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. The primary greenhouse gases are water vapour, carbon dioxide, methane, nitrous oxide and ozone. Greenhouse gas emissions can be valued using a marginal abatement cost, a market price or the social cost of carbon. This section defines these three methods and justifies why the social cost of carbon is the preferred valuation method. It then describes the valuation study used to derive the natural capital valuation applied in this study.

STEP 1: SELECTING AN APPROACH FOR VALUING GREENHOUSE GAS EMISSIONS

Three approaches for valuing the marginal or incremental cost of an additional tonne of GHG emitted are summarised below.

MARGINAL ABATEMENT COST (MAC)

Definition: Valuing carbon using the known costs to reduce carbon to achieve an emissions reduction target, for example through energy efficiency improvements, renewable energy, materials substitution and/or carbon capture and storage technology.

Advantages: Based on the known actual costs of existing reduction efforts.

Disadvantages: Costs of reduction will fluctuate over time, by sector and by geography. Different reduction targets will translate into different MACs for each country. Estimates of the costs or benefits of increasing energy efficiency or switching to renewable energy are influenced by fossil fuel prices, carbon prices and other policy measures. The policies and technologies used to support carbon abatement will therefore influence pricing.

MARKET PRICE

Definition: The value of traded carbon emissions rights under policies which constrain the supply of emissions permits, credits or allowances. The market price should be equal to the MAC for a given target, if the carbon market covers all emissions sources and is competitive. In the absence of a comprehensive international emissions trading scheme, a cap consistent with the optimal stabilization goal would result in a market price of carbon equal to both the MAC and social cost of carbon.

Advantage: Market prices are easily accessible.

Disadvantages: Market-based mechanisms have been slow and fragmented so companies are unlikely to pay market prices for emissions across global operations. Traded market prices do not reflect non-traded carbon costs, nor the impact of other market-based mechanisms such as carbon/fuel taxes, subsidies for removal of fossil fuels, or support for low carbon technologies (i.e. feed-in-tariffs for renewable energy supplies). Current market prices are too low to induce the level of emissions reductions required and are not representative of future abatement costs of the expected costs of damages from climate change impacts.

SOCIAL COST OF CARBON (SCC)

Definition: The global cost of damages resulting from GHG emission-induced climate change. The value is based on the present value of each metric tonne of carbon dioxide equivalent (CO_2e) emitted now, taking into account the full global cost of the damage that it imposes during its time in the atmosphere.

Advantages: The SCC signals what society should be willing to pay now to avoid the future damage caused by carbon emissions and therefore best reflects the total damage caused by emitting one tonne of CO_2e. In theory, climate policy would set emissions reduction targets that result in a MAC equal to the SCC and, in perfect markets the price of carbon should equal the SCC. SCC is therefore the most complete measure of the damage generated by the emission of GHGs and is the method used by Trucost.

Disadvantages: SCC valuations are highly contingent on assumptions, in particular the discount rate chosen, emission scenarios and equity weighting. Please see the next section for a discussion of each.

Trucost uses the Social Cost of Carbon method as it best reflects the total damage by the emission of one tonne of CO_2e. In theory, optimal climate policies would set emissions reduction targets that result in a MAC equal to the SCC. Further, in perfect markets, the price of carbon should be equal to its damage cost (i.e. to the SCC). Therefore, the SCC is the most complete measure of the damage generated by GHG emissions.

STEP 2: CALCULATING THE SOCIAL COST OF CARBON

Over 300 studies attempt to put a price on carbon, valuing the impacts of climate change on agriculture, forestry, water resources, coastal zones, energy consumption, air quality, tropical and extratropical storms, and human health. Estimates across studies vary from below-zero to four-figure estimates, mainly due to four factors:

Emissions scenarios: In order to derive the social cost of carbon, assumptions need to be made on future emissions, the extent and pattern of warming, and other possible impacts of climate change, so as to translate climate change to economic consequences. Tol identified three methodological approaches undertaken by the literature – expert review, enumerative method, and statistical method – and conducted a meta-analysis of the results.[176] Studies are in broad agreements on the fact that the negative effects of climate change outweigh the short-run benefits of inaction.

Discount rate: The discount rate used to calculate the present value of future economic damages resulting from carbon emitted today can be the most significant source of variation in estimates of the social cost of carbon. Higher discount rates result in lower present day values for the future damage costs of climate change. Variations in discount rates can be due to differences in assumptions about factors such as the rate of pure time preference, the growth rate of per capita consumption and the elasticity of marginal utility of consumption.

Equity weighting: A global SCC can take into account variations in the timings and locations at which the costs of climate change impacts will be internalized, which may differ from the locations where the GHGs are emitted. Some studies including Stern and Tol take account of equity weightings – corrected for differences in the valuations of impacts in poor countries.[176,177]

Uncertainties: Variations in valuations are influenced by uncertainties surrounding estimates of climate change damages and related costs. However climate change studies since 1995 tend to take account of net gains as well as losses due to climate change.The mean estimate of the social cost of carbon, as well as the standard deviation, have declined since 2001, suggesting decreasing uncertainty in the understanding of climate change impacts. Further, GDP loss estimates in relation to climate change have declined over time, as later studies focus on the positive and negative effects of climate change and take adaptation into account.

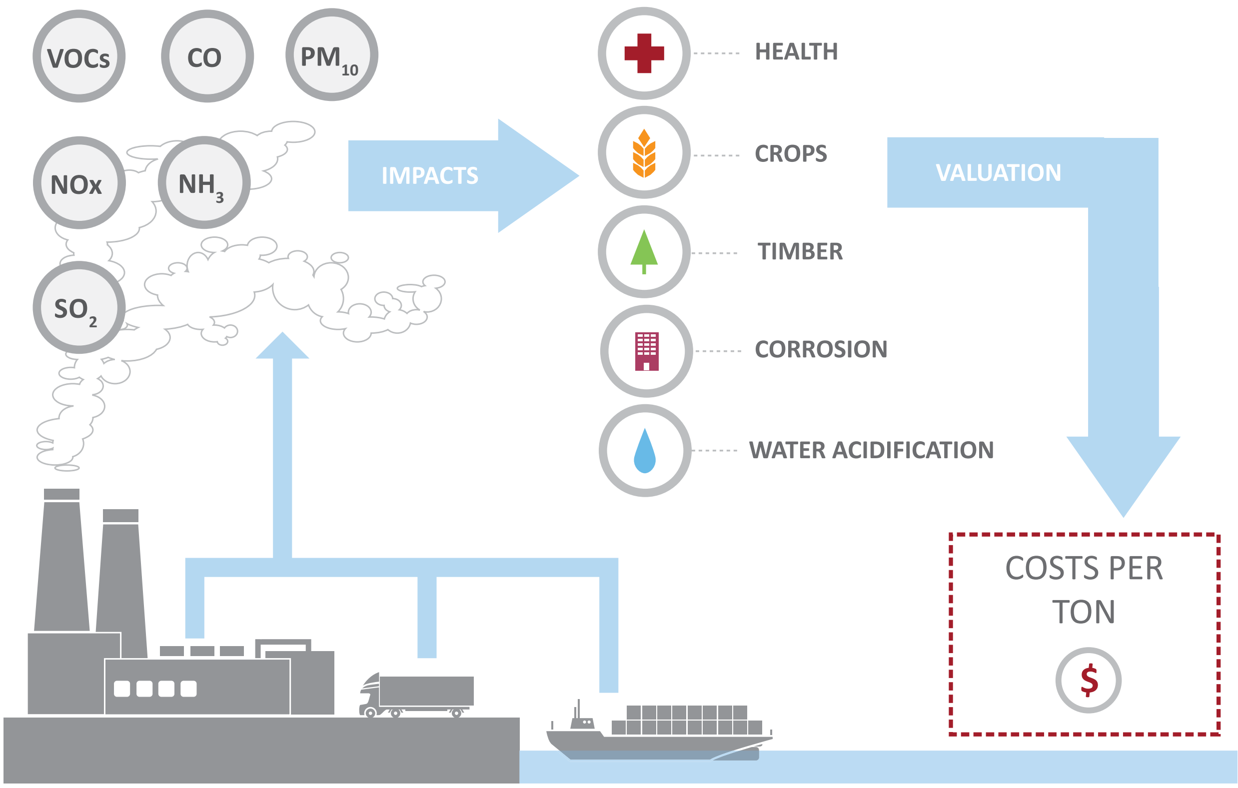
A social cost of 113 US$ 2012 per metric tonne of CO_2e was used to value GHG emissions, which is the value identified in the UK Government's Stern report as the central, business-as-usual scenario value, adjusted for inflation to 2012 prices using a global weighted average consumer price index (CPI).[177]

AIR POLLUTANTS EMISSIONS

The main air pollutants include sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), ammonia (NH_3), carbon monoxide (CO) and volatile organic compounds (VOCs). Each pollutant impacts human health and/or crop and forest yields in a unique way. The economic damage caused per unit of pollutant depends on the specific location, and is driven by population and crop and forest density.

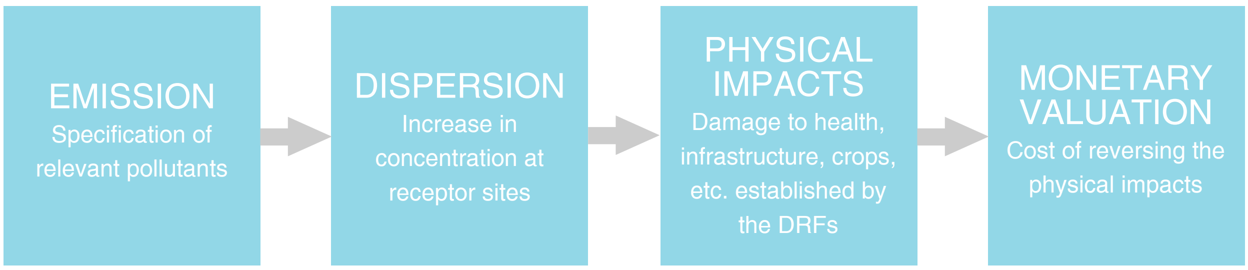
Each pollutant is associated with different but overlapping types of external costs. Some effects are caused directly by the primary pollutant emitted (e.g. health impacts of particulates) and some are caused by secondary pollutants formed in the atmosphere from pollutants that acts as precursors (e.g. sulphur dioxide forming sulphuric acid as well as sulphate compounds which contribute to smog). As each pollutant has a unique set of effects, each pollutant is valued using an individual methodology (although there is overlap between methodologies).

FIGURE 24: AIR POLLUTION VALUATION



Studies of the costs of damages from air pollution use the Impact Pathway Approach (IPA) to identify burdens (e.g. emissions), assess their impacts and value them in monetary terms.[178] In this approach, emissions are translated into physical impacts using dose–response functions (DRFs) which use peer-reviewed scientific data to measure the relationship between a concentration of a pollutant (the dose) and its impact on human health, building materials, crops, etc (the receptor). A financial value is then assigned to each impact.

FIGURE 25: IMPACT PATHWAY APPROACH



STEP 1: IDENTIFYING THE MAIN IMPACTS FOR EACH AIR POLLUTANT

Trucost identified which environmental impacts to consider for each air pollutant using the Impact Pathway Approach. Where impacts are excluded, such as the impact of particulate matter on crops and forestry, it was due to immateriality relative other effects. The table below summarizes which impacts are included for each air pollutant.

TABLE 14: ENVIRONMENTAL IMPACTS CONSIDERED

AIR POLLUTANT	ENVIRONMENTAL IMPACTS
Particulate Matter (PM_{10})	Health
Ammonia (NH_3)	Health and forestry
Nitrous Oxides (NOx)	Health, crops and forestry
Volatile Organic Compounds (VOCs)	Health, crops and forestry
Sulphur dioxide (SO_2)	Health, freshwater, forestry and materials

STEP 2: BUILDING COUNTRY SPECIFIC VALUATIONS

AIR POLLUTANT IMPACTS ON HEALTH

The health costs developed by Trucost include the cost mortality; chronic bronchitis; hospital admission; asthma attacks; restricted activity days; respiratory symptom days; congestive heart failure; chronic cough; cough and wheeze; and bronchodilator use. These costs were calculated as follow:

Calculation of number of end points

Trucost compiled data on the number of end points (number of health impacts) generated by the emission of one tonne of each air pollutant. In the context of health impacts, the number of end points is driven by population density, which is country specific.

Development of global average health costs

Trucost conducted a literature review to identify country specific studies calculating the willingness to pay to avoid the different health impacts listed above. Using these studies, Trucost built a country specific model and calculated a global average cost weighted by population for each health impact. A global average was chosen to avoid the ethical considerations of applying different values to health and life across countries.

Application of global average costs

Natural capital valuation coefficients for each air pollutant are obtained by multiplying the number of end points by the global health costs.

ENVIRONMENTAL IMPACTS OF OTHER AIR POLLUTANTS IMPACTS

Natural capital valuations of air pollutant impacts on crops, timber, water and building materials are country specific and were calculated as follow:

Literature compilation

Trucost compiled data from IPA studies on the cost of air pollutants' damages on crops, timber, water and building materials.

Adjustment of the cost based on receptor densities factors

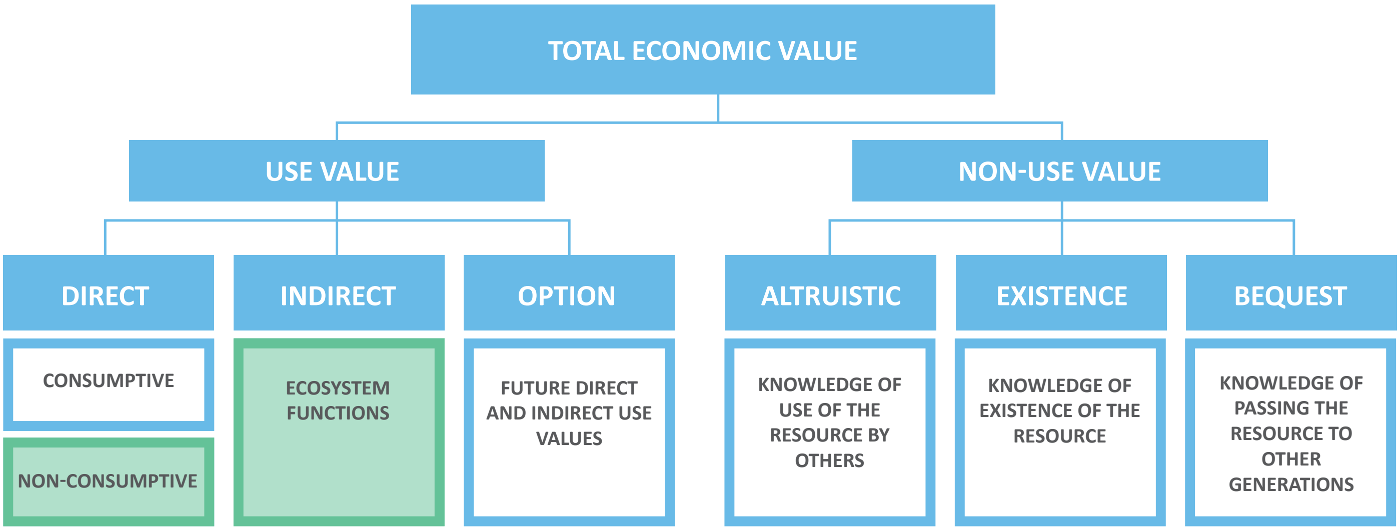
Trucost adjusted the country-specific data obtained from the literature based on receptor densities such as percentage of crop or forest cover in a country. Impacts on building materials use maintenance costs which have been adjusted using purchasing power parity. Impacts on water acidification, included in the valuation of SO_2 is a global average.

WATER CONSUMPTION

Pressures are growing on water resources, with risks from climate change impacts increasing the unpredictability and security of supplies. Information on the benefits of water and the costs of damages from depleting resources are usually not recognised in market prices or in risk analysis.

According to the Total Economic Value (TEV) framework, the value of water can be broken down into "use" values and "non-use" values (Figure 26). Use values can be further broken down into direct use, indirect use, and option values. Within direct use, the values can apply to "consumptive" or "non-consumptive" uses.[179]

FIGURE 26: COMPONENTS OF THE TOTAL ECONOMIC VALUE OF WATER



However, in this report, only values shaded in green have been included in Trucost's water valuation model. The valuation of water is based on the opportunity cost of water or the value generated by water when it is not abstracted. Consumptive uses (for agriculture or industry) of water have therefore been excluded. Option and non-use values have also been excluded given the difficulty inherent in their valuation. Values for direct non-consumptive uses (including hydro-electric power, recreation, navigation and cultural activities) and indirect uses (including ecosystem services such as flood control, regulation of water flows and supplies, carbon sequestration, nutrient retention and climate regulation) were identified in academic literature in different geographical locations.[180,181]

A function of water value (in \$ per m^3) relative to water scarcity (% of internal renewable water resources abstracted) was developed based on the values estimated in the academic literature.[179,180,181] This function was then used to estimate the opportunity cost of water in any geographic location where water scarcity is known, by adjusting the function for purchasing power parity at that location.

LAND AND WATER POLLUTANTS

STEP 1: QUANTIFICATION OF IMPACTS

Life cycle analysis characterization models, such as Recipe, calculate the human, terrestrial, freshwater and marine toxicity of thousands of substances when released in different media. Trucost used a global adaption of Recipe by EUSES-LCA to model land and water pollutants. Human toxicity impacts are expressed in Disability Adjusted Life Years (DALYs) and terrestrial, freshwater and marine toxicity are expressed in Ecosystem Damage Potential (EDP).[182,183,184,185,186] While it is hard to state an order of magnitude, toxicity data are among the most uncertain in lifecycle analysis characterization models. Trucost based its analysis on the best available data, but recognizes this weakness in the underlying data.

STEP 2: VALUATION OF ENVIRONMENTAL TOXICITY

The NEEDS Project approach developed a formula to estimate the monetary cost per kilogram of toxic substances deposited in natural ecosystems.[187] Within the NEEDS project, a regression analysis between willingness-to-pay and several variables were performed. The EDP valuation is known to have a positive correlation with population – as more people live close to an area with high biodiversity there will be more people that value biodiversity. The EPD value is known to have a negative correlation with the ecosystem size – if an ecosystem covers a larger area, the value per unit area will be less. Similarly, as biodiversity change increases, the value per unit of biodiversity diminishes. Using these variables, the formula below calculates the value of EDP in different regions.

$$\text{Ln (VEDP)} = 8.740+0.441*\ln(PD)+1.070*FOR-0.023*RIV+0.485*COA-2.010*dEDP-0.312\ \ln(AREA)$$

VEDP= Value of ecological damage potential (willingness-to-pay)
PD= population density ('000 inhabitants/km^2)
FOR= dummy variable for forest ecosystems
RIV= dummy variable for river ecosystems
COA= dummy variable for coastal ecosystems
dEDP= change in EDP
AREA= size of ecosystem in hectares

The value of ecosystem damage is a function of the change in biodiversity due to the emission of the toxic substance and the willingness to pay for biodiversity (adjusted for purchasing power parity).

STEP 3: VALUATION OF HUMAN TOXICITY

In order to put a value on the years of life lost, Trucost used the NEEDS project approach. The results of this approach are based on a contingent valuation questionnaire applied in nine European countries: France, Spain, UK, Denmark, Germany, Switzerland, Czech Republic, Hungary and Poland. The value was adapted to other countries based on country-specific income levels. To avoid ethical criticisms on the value of life and disease incidence in different countries, Trucost applied the global median value to value DALYs in different countries.

MANAGED PLASTIC

As explained in appendix 3, plastic can be collected and treated through different routes. Treatment routes considered here are landfill, incineration with and without energy recovery and recycling. One should note that even if impacts are generated by the treatment of waste, treatment is a necessity and its impact is small compared to those of littered plastic.

In order to apply natural capital valuations on these treatment routes, Trucost calculated the quantity of greenhouse gas and other air, land and water pollutants emitted, and water used in these processes as per Appendix 3 and Tables 9 and 10, and applied the relevant valuations as described above.

LITTERED PLASTIC

When littered in an unregulated manner, Trucost assumed two possible pathways depending on the sector under consideration, namely reaching or not reaching marine environments. The following table summarises the pathway of each product.

It is understood that a significant amount will be transported over time by the winds, streams, waterways, and eventually partially end up in the ocean. While there are estimates of the total volume of plastic from land reaching the ocean per year, there is insufficient data to model this accurately. For the purpose of this report, conservative assumptions have been taken so as to not overstate the problem. For example, the report assumes, that in the fullness of time, all tobacco filters and packaging materials that were littered eventually reach the ocean due to their lightweight, while heavier plastic such as car parts are assumed to remain on terrestrial environments (see table 15).

TABLE 15: PERCENTAGE OF LITTERED PRODUCT AND PACKAGING REACHING THE OCEAN

SECTORS INCLUDED	% OF LITTERED PACKAGING REACHING THE OCEAN	% OF LITTERED PRODUCT REACHING THE OCEAN
Automobiles		0%
Soft drinks and ice		NR
Clothing and accessories		50%
Consumer electronics		0%
Durable household goods		0%
Food		NR
Personal products		NA
Athletic goods		50%
Toys	100%	50%
Tobacco		100%
Furniture		0%
Non-durable household goods		50%
Footwear		50%
Medical and pharmaceutical products		NR
Retail		NR
Restaurants and bars		NR

No consensus and very little data exist on the percentage of plastic reaching the marine environment, let alone on different types of plastic/products made of plastic in different countries. Trucost thus had to make assumptions and use best-guess estimates.

The valuation for waste ending up in the ocean includes the disamenity caused to society, and the ocean valuation (explained in greater detail in the following part). The valuation for waste not reaching the ocean include the air, land, and water emissions generated in the open-dump and the leachate of additives, as well as the disamenity caused to society. Other ecological, economic and society impacts of litter on freshwater and terrestrial ecosystems are not included for lack of data.

DISAMENITY

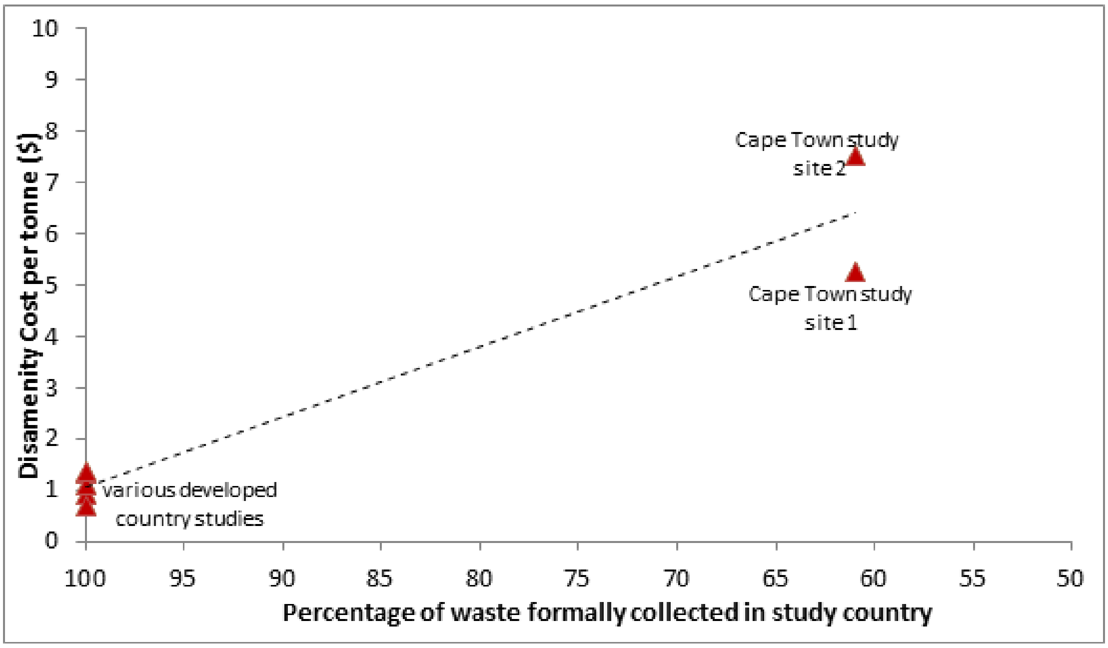
Disamenity does not have one agreed upon definition in the literature, however, it generally refers to the localised impacts of landfill activity that generate negative reactions from those located in the immediate vicinity.[188] The European Commission specifies disamenity impact as referring to the 'nuisance' caused locally as a result of the presence of landfill – noise, dust, litter, odour, the presence of vermin, visual intrusion and enhanced perceptions of risk. The magnitude of the effects will depend on distance from the site, type of waste (non-hazardous or hazardous), status of the site (existing, new, or proposed), management practices, topography and prevailing wind directions.

Only a limited number of valuation studies of disamenity have been undertaken for the waste sector.[189,190] A number of studies were conducted in the US in the 1980s and early 1990s (especially for landfills). Only two European studies have been identified. Disamenity impacts were excluded completely from the Exiopol study in 2009 because it said that disamenity impacts were site specific. The study only indicates an order of magnitude based on a study from 2006 by Walton (1 Euro per tonne).[191]

Hedonic pricing studies require information on house prices near to a landfill site and specific information on sales of houses in this radius. Conducting a primary hedonic pricing study is not appropriate for this study as the location of the landfill sites is unknown and the number of sites is very large, making this technique beyond the scope of this valuation.

It is likely that disamenity effects would be higher in countries where waste is managed poorly (as the disamenity effects such as noise, nuisance, vermin, etc are likely to be higher). Most studies have been carried out in countries with high quality waste management. A recent study is the only study found from a country with a lower collection rate (South Africa, where approximately 60% of waste is formally collected).[192] When disamenity (adjusted for PPP to adjust for differences in house prices) was plotted against formal waste collection rates, it indicated a negative relationship between percentage of waste formally collected and disamenity cost (see Figure 27 below).

FIGURE 27: DISAMENITY COSTS (PPP ADJUSTED) VERSUS PERCENTAGE OF WASTE COLLECTED

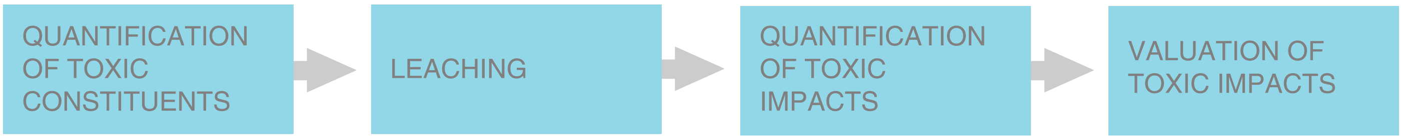


Due to the large number of regions included in this analysis, and the fact that the specific locations are unknown, a disamenity scale was derived from the figures provided in the literature, plotted against formal waste collection rates in each region. The disamenity cost for a tonne of waste in a particular region is then estimated based on the collection rate in the region in question. The resulting figure for each region is then adjusted for PPP to take account of differences in house prices. Adjusting for PPP is a widely used technique, especially for transfers between countries or regions[189]

ADDITIVES

Additives are chemicals added to plastic during the manufacturing process to enhance its properties, such as heat resistance and flexibility. Recently, there has been growing concerns on the leaching of these substances and their impacts on human health and the environment. The impacts additives leachate follows the following framework.

FIGURE 28: QUANTIFICATION OF THE PLASTIC CHEMICAL IMPACTS FRAMEWORK



Trucost calculated the quantity of additives per type of plastic based on an Organisation for Economic Co-operation and Development report focusing on plastic additives.[175]

LEACHING

Data regarding the leaching of additives from plastic into its environment is nascent and the results are highly uncertain. Furthermore, few data points exist on the leaching rate of plastics' constituents into a marine environment. Hence, Trucost used the leaching rate calculated by Organisation for Economic Co-operation and Development for plastics "outdoor, leaching to environment".[175] The annual leaching rate is 0.16% per year. At this rate, it would take 625 years for 100% of the additives to be released from the plastics. Trucost discounted the total natural capital cost using this timeframe, thereby producing what is believed to be a conservative estimate of the impact. Future studies may reveal more accurate leaching rates, including in the marine environment, which would likely revise upwards the impacts calculated in this report.

VALUATION OF TOXIC IMPACTS

Depending on whether plastic is likely to reach marine environments or not (see table 5), Trucost either quantified marine, land or freshwater toxicity impacts. Lifecycle analysis characterization models calculate the human, terrestrial, freshwater and marine toxicity of thousands of substances when released in different media. Trucost used a global adaption of Recipe by EUSES-LCA to model the marine and human impacts additives.[182,183,184,185,186] Human toxicity impacts are expressed in Disability Adjusted Life Years (DALYs) and terrestrial, freshwater and marine toxicity are expressed in Ecosystem Damage Potential (EDP). These toxicity impacts were then valued using same methodology as for land and water pollutants (described earlier).

MARINE LITTER

Important quantities of plastic reach the ocean every year. Media's attention has been particularly focused on entanglements from fishing nets or ingestion of plastic bags. More and more reports and scientific literature assess these impacts which are diverse, economic as well as ecological, and come from plastics as well as microplastics. The objective of this methodology is to obtain a value in monetary terms per kilo of plastics reaching the ocean.

STEP 1: IDENTIFYING THE IMPACTS OF PLASTICS IN THE OCEAN

The impacts of plastics into the ocean are complex for various reasons:

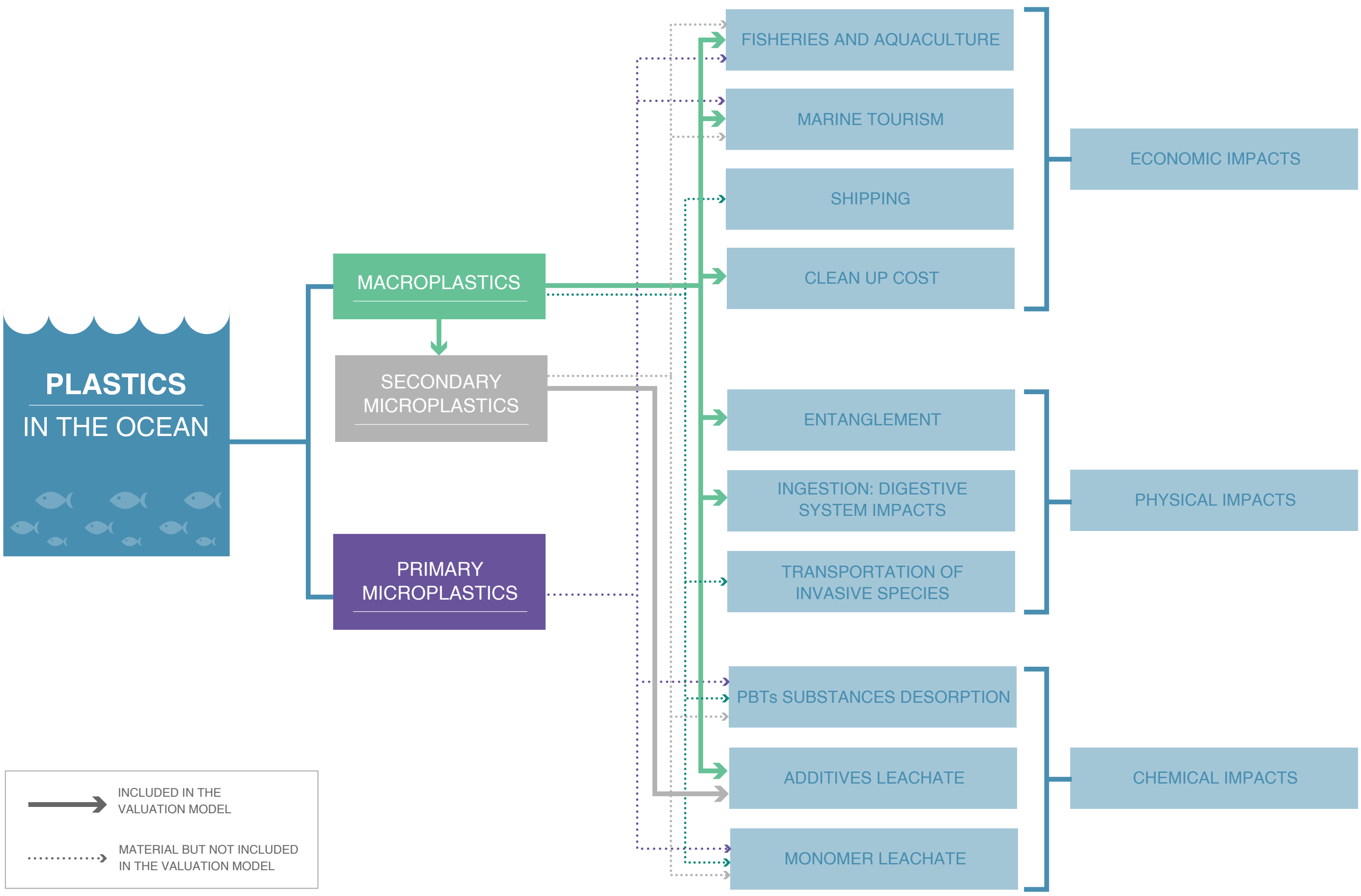
- Plastics degrade very slowly over time, and this degradation depends on the type, shape and location of the plastics. As a consequence, plastics accumulate and it is difficult to quantify the amount of plastic which is today in the ocean.
- Macroplastics and microplastics have some overlapping and some distinct impacts.
- Water flows makes it challenging to track plastic geographically. For this reason, Trucost built a global average valuation of plastic rather than a location specific one.

Due to the complexity of plastics impacts, Trucost built a valuation model based on a simplified interpretation of these impacts. The figure below presents these impacts. Light arrows represent potential impacts which have been excluded from the valuation. For example, the valuation excludes primary microplastics impact for lack of adequate data, even though this area of research has been receiving more attention recently.

WHERE DO MICROPLASTICS COME FROM?

There are primary and secondary forms of microplastics. Primary forms of microplastics are found in personal care products such as toothpaste and skin care products, synthetic textiles such as blankets, fleeces or shirts, and industrial sources such as plastic resin pellets used in industrial feedstocks. These primary microplastics are problematic as they are not filtered during sewage treatment and can be released directly into the ocean or other water bodies (e.g. personal care products and textiles) or lost through poor management operations and during transport (e.g. pre-production plastic resin pellets). Secondary microplastics are formed when plastic items fragment and disintegrate; the rate at which fragmentation occurs is highly dependent on the environmental setting.[193] In the marine environment larger plastic items can break into secondary microplastics through combined effects of wave action and photo-degradation from sunlight. The key to stemming flows of plastic debris to the ocean is to prevent this debris entering the environment. Larger items are much easier to identify and potentially to control than small ones.

FIGURE 29: IMPACTS OF MACRO AND MICRO PLASTIC



ECOLOGICAL IMPACTS

Plastics in the ocean generate economic impacts which are often paid by those affected rather than plastic producers or consumers. Economic impacts relate to the loss of revenue caused by marine plastics. Industries concerned by this issue are fisheries and aquaculture, marine tourism and shipping. Additionally, plastics litter on beaches will imply clean-up costs.[5]

ECOLOGICAL IMPACTS

Ecological impacts refer to the morbid or lethal effects endured by marine biodiversity. These impacts can be broken down into physical impacts, referring to the impacts coming from the shape of plastics objects, and into chemical impacts, referring to the impacts coming from the toxic substances present in the plastic.

PHYSICAL IMPACTS

Entanglement: marine biodiversity such as marine mammals can be entangled, which can lead to suffocation, starvation, drowning or increased vulnerability to predators.

Ingestion: marine species can ingest plastic by mistaking it for food. This can lead to starvation, malnutrition or internal injury.[6]

Transportation of invasive species: floating plastic can act as vector of invasive species which would alter community structure.[6] This impact has not been included in the valuation model due its complexity and for lack of quantitative data.

CHEMICAL IMPACTS

Persistent Bioaccumulative Toxic substances (PBTs) desorption: plastics can act as a carrier for the ingestion of PBTs.[25] PBTs are chemicals that degrade slowly in the environment and accumulate in organism tissues. Due to industrial activity, the oceans now have varying concentrations of PBTs to which marine life is already exposed. However, due to its chemical characteristics, plastic in the ocean absorb these PBTs increasingly over time. If the plastic is then ingested by marine wildlife, PBTs can be transferred to the animal and potentially bio-accumulate further through the food chain. While PBTs absorption and desorption impacts are likely to be more material that additives leachate, the data available was specific to certain situations, and did not lend itself to broad-based application through the valuation model. Research in this field is constantly evolving.

Additives leachate: additives are chemicals added to plastic feedstock in order to enhance their properties including but not limited to heat and corrosion resistance, hardness and colours. The quantity of additives varies based on the type of plastic and its usage – for example plasticisers are often used in PVC products to improve flexibility and flame retardants in electronics and automobiles for safety reasons.

Monomers leachate: the molecules bonded together to form plastics are called monomers. When plastic degrades, these monomers can leach and be ingested by biodiversity. Some of the monomers are hazardous, such as styrene which is the monomer of polystyrene. This impact has not been included in the valuation model due to its complexity and for lack of quantitative data.

STEP 2: BUILDING THE VALUATION MODEL

ECONOMIC IMPACTS

The main approach to value economic impacts generated by marine plastics is based on calculating the yearly revenue loss attributable to plastic litter.

Fisheries and aquaculture

According to Mouat et al., marine fisheries and aquaculture lose every year respectively 2% and 0.03% of their revenue.[28] Trucost assumed that the same percentage of revenue loss was applicable at a global level. It was estimated that marine fisheries and aquaculture generated in 2009 revenue of approximately 52 and 1 billion 2012 US$.[194] Considering that plastics comprise between 50% and 80% of marine waste, Trucost calculated that plastics were responsible for a yearly revenue loss of 794 and 7 million 2012 US$ for fisheries and aquaculture activities.

Marine tourism

Marine tourism includes seawater and freshwater angling, sailing and boating, water sports, and inland cruises. Studies estimated that beach litter in Sweden was responsible for a tourism decrease between 1 and 5%. Based on these numbers, Trucost assumed that 3% of global marine tourism revenue was lost because of marine litter. As result, Trucost calculated that plastic litter was responsible for a yearly revenue loss of 4 million US$.

Clean-up cost

To calculate the clean-up cost imposed by plastics litter on beaches, Trucost based its model on the number of volunteers estimated globally by the Ocean Conservancy.[120] In 2012, more than 5 million volunteers helped clean beaches around the world. To put a value on the time spent by these volunteers on cleaning beaches, Trucost calculated the opportunity cost of their time, based on the global average income per capita per year and on the assumption that each volunteers dedicates half a day per year. As a result, the global opportunity cost of volunteers is 74 billion 2012 US$. While there could be a benefit to collection – volunteers becoming more aware of the environment for example – this has not been included in the analysis.

To obtain the economic values per kilo, the annual values calculated must be divided by the quantity of plastics reaching the ocean every year. UNEP estimates that 6.4 million tonnes of litter enter the ocean every year – this figure is likely to be an underestimate, as it is based on research published in 1975.[5] In 2013, a European Commission Green Paper suggested 10 million tonnes per year.[16] No consensus exists today on this quantity which is highly complex to estimate. Trucost decided to use the figure which would give the more conservative result and based its calculation on a study done by Raveender Vannela in 2012, according to which 20 million tonnes of plastics reach the ocean every year.[17]

ECOLOGICAL IMPACTS

Physical impacts: entanglement and ingestion

According to the Secretariat of the Convention on Biological Diversity and the Scientifc and Technical Advisory Panel—GEF, the number of species with entanglement and ingestion records is 45% and 26% for marine mammals, 0.39% and 0.24% for fish and 21% and 28% for seabirds.[6] To value these impacts, Trucost based its analysis on a contingent valuation, a survey-based economic technique where people are asked directly their willingness to pay for the preservation of an ecosystem good or service. This technique is often applied to capture non-use values such as the existence of species. Trucost applied a benefit transfer technique to a study done by Ressurreição A. et al., which assessed how much people would be willing to pay to avoid a loss of 10% and 25% of different categories of marine species.[195] This study ignores the actual ecosystem services provided by each individual species. Yet, contingent valuations indirectly include the perceived services that these animals render to society.

Chemical impacts

As the only chemical impact considered, additive leachate is handled as per the valuation methodology described earlier in this appendix.

APPENDIX 5: COMPANY ANALYSIS

This appendix provides more information on the companies for which plastic natural capital cost and intensity were calculated. The first column highlights which sectors of activity of the company were included in the analysis. The second column identifies the regions where sales occur, which is used for downstream modelling. The third column displays quantitative data points that Trucost was able to include in the analysis. Most companies disclose some data around plastic use and disposal; however, data could be integrated in the model only in half of cases due to insufficient coverage and details. Finally, the last column provides the source for this information. Refer to Appendix 3 for a more detailed explanation of how total natural capital cost and intensity were modelled at a company level.

TABLE 16: COMPANIES' SECTOR, COUNTRIES OF SALES, DISCLOSURE AND SOURCE

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Imperial Tobacco	Tobacco (100%)	Europe, Asia	NA	Imperial Tobacco. 2013. Focused on Sustainable Growth. Annual Report and Accounts 2013. [report].
Japan Tobacco	Tobacco (80%), Soft drinks (18%), Medical and pharmaceutical products (2%)	Asia, Europe	Quantity used, Recycled content	Japan Tobacco. 2012. CSR Report 2012. [report].
Philip Morris International	Tobacco (100%)	Europe, Asia	NA	Philip Morris International. 2014. Environmental Performance. [online] Available at: http://www.pmi.com/eng/sustainability/pages/environmen-tal_performance.aspx [Accessed: 31 Jan 2014].
Altria Group	Tobacco (100%)	North America	NA	Altria. 2012. Corporate Responsibility Progress Report. [report].
Reynolds American	Tobacco (100%)	North America	NA	Reynolds American. 2014. Reynolds American Inc.. [online] Available at: http://www.reynoldsamerican.com/ [Accessed: 31 Jan 2014].
British American Tobacco	Tobacco (100%)	Europe, Asia	NA	British American Tobacco. 2012. Annual Report 2012. [report].
Daimler	Automobile (100%)	Europe, Asia	NA	Daimler. 2012. Sustainability Report 2012. [report].
Fiat	Automobile (100%)	North America, Europe	NA	Fiat. 2012. Sustainability Report 2012. [report].
Ford Motor	Automobile (100%)	North America, Europe	Quantitative measures	Ford Motor. 2013. Sustainability 2012/13. [report].
General Motors	Automobile (100%)	North America, Europe	NA	General Motors. 2012. 2012 Sustainability Report. [report].
Nissan Motors	Automobile (100%)	Asia, North America	Quantitative measures	Nissan Motors. 2012. Sustainability Report 2012. [report].
Toyota Motors	Automobile (100%)	Asia, North America	NA	Toyota Motor Corporation. 2012. Sustainability Report 2012. [report].

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Volkswagen	Automobile (100%)	Europe, Asia	NA	Volkswagen. 2012. Sustainability 2012. [report].
Britvic	Soft drinks (100%)	Europe	Quantitative measures	Britvic. 2012. Sustainable Business Report 2012. [report].
China Huiyuan	Soft drinks (100%)	Asia	NA	China Huiyuan. 2014. China Huiyuan Juice Group Ltd.. [online] Available at: http://www.huiyuan.com.cn [Accessed: 31 Jan 2014].
Coca-Cola	Soft drinks (100%)	Asia, Latin America, North America	Recycled content, Bio-plastic content	Coca-Cola. 2012. 2011/2012 GRI Report. [report].
Dr Pepper Snapple	Soft drinks (100%)	North America	Quantitative measures	Dr Pepper Snapple Group. 2012. Sustainability Report 2012. [report].
Lotte Chilsung	Soft drinks (100%)	Asia	Quantitative measures	Lotte Chilsung Bev. 2012. Sustainability Report 2012. [report].
Tingyi	Soft drinks (100%)	Asia	NA	Tingyi (Cayman Islands) Hold Group. 2012. 2012 Annual Report. [report].
Uni-President	Soft drinks (54%), Food (46%)	Asia	NA	Uni-President. 2014. [online] Available at: http://www.uni-president.com [Accessed: 31 Jan 2014].
Want Want China Holdings	Soft drinks (66%), Food (34%)	Asia	NA	Want Want China Ho. 2012. Annual Report 2012. [report].
Apple	Consumer electronics (100%)	North America, Asia	Quantity used	Apple. 2014. Apple and the Environment. [online] Available at: http://www.apple.com/uk/environment/ [Accessed: 31 Jan 2014].
Canon	Consumer electronics (100%)	Asia, Europe	NA	Canon. 2012. Canon Sustainability Report 2012. [report].
Hewlett Packard	Consumer electronics (100%)	North America, Asia	Quantity used	HP. 2012. HP 2012 Global Citizenship Report. [report].
LG Electronics	Consumer electronics (75%), Durable household goods (25%)	Asia, North America	Recycled content	LG Electronics. 2012. 2012 - 2013 LG Electronics Sustainability Report. [report].
Ricoh	Consumer electronics (100%)	Asia, North America	NA	Ricoh. 2013. Ricoh Group Sustainability Report 2013. [report].
Samsung Electronics	Consumer electronics (69%), Durable household goods (31%)	Asia, Europe	Quantity used, recycled content	Samsung Electronics. 2012. Global Harmony with People , Society and Environment. [report].
Sony	Consumer electronics (100%)	Asia, North America	Recycled content, Quantitative measures	Sony. 2012. CSR Reporting 2012. [report].
Arcelik	Durable household goods (100%)	Africa, Europe	Quantity used	Arcelik A.S. 2012. Sustainability Report 2012. [report].
Electrolux	Durable household goods (100%)	North America, Europe	Quantity used, recycled content	Electrolux. 2014. [online] Available at: http://www.electrolux.com/ [Accessed: 31 Jan 2014].

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Husqvarna	Durable household goods (100%)	North America, Europe	Quantity used	Husqvarna Group. 2012. Sustainability Report 2012. [report].
Indesit	Durable household goods (100%)	Europe	Quantity used, recycled content, quantitative measures	Indesit. 2014. Indesit – efficient, reliable and functional household appliances for modern living. [online] Available at: http://www.indesit.com [Accessed: 31 Jan 2014].
Makita	Durable household goods (100%)	Europe, Asia	NA	Makita. 2012. Company Profile/Sustainability Report. [report].
Panasonic	Durable household goods (55%), consumer electronics (45%)	Asia, North America	Recycled content	Panasonic Corporation. 2012. Sustainability Report 2012. [report].
Seb	Durable household goods (100%)	Europe, Asia	Quantity used	Groupe SEB. 2012. Business and Sustainable Development Report 2012. [report].
Whirlpool	Durable household goods (100%)	North America, Latin America	Quantitative measures	Whirlpool Corporation. 2012. 2012 Sustainability Report. [report].
Clorox	Non-durable household goods (100%)	North America	Quantitative measures	The Clorox Company. 2013. 2013 Integrated Annual Report. [report].
Colgate Palmolive	Non-durable household goods (87%), Food (13%)	Latin America, Europe	Quantitative measures	Colgate-Palmolive. 2012. Sustainability Report 2012. [report].
Kao Corp	Non-durable household goods (72%), Personal products (28%)	Asia	Quantity used	Kao. 2012. Sustainability Report 2012. [report].
Kimberly Clark	Non-durable household goods (100%)	North America, Asia	Quantity used, Recycled content	Kimberly-Clark. 2012. 2012 Sustainability Report. [report].
Procter and Gamble	Non-durable household goods (52%), Personal products (24%), Medical and pharmaceutical products (15%), Durable household goods (10%)	North America, Europe	Recycled content, Quantitative measures	P&G. 2012. 2012 Sustainability Report. [report].
Reckitt Beckinser	Non-durable household goods (66%), Personal products (22%), Medical and pharmaceutical products (9%), Food (3%)	Europe, North America	NA	Reckitt Benckiser. 2012. Sustainability Report 2012. [report].
Svenska Cellulosa	Non-durable household goods (100%)	Europe, North America	NA	Svenska Cellulosa Aktiebolaget. 2012. Sustainability Report 2012. [report].

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Fast Retailing	Clothing and accessories (100%)	Asia, Europe	Quantity used, Quantitative measures	Fast Retailing. 2012. CSR Report 2012. [report].
Gap	Clothing and accessories (100%)	North America	NA	Gap Inc. 2012. 2011-2012 Social & Environmental Responsibility Report. [report].
Hanesbrands	Clothing and accessories (100%)	North America	Recycled content, Quantitative measures	Hanes. 2014. [online] Available at: http://www.hanes.com/corporate [Accessed: 31 Jan 2014].
Hennes and Mauritz	Clothing and accessories (100%)	Europe	Recycled content	H&M. 2012. Sustainability Report 2012. [report].
Inditex	Clothing and accessories (100%)	Europe	NA	Inditex. 2012. Annual Report 2012. [report].
Kering	Clothing and accessories (100%)	Asia, Europe	Quantity used, bio-based content, quantitative measures	Kering. 2012. Reference Document 2012 - Annual Report. [report].
VF Corp	Clothing and accessories (100%)	North America, Europe	NA	VF Corporation. 2012. 2012 Annual Review & Performance Update. [report].
Danone	Food (83%), Soft drinks (17%)	Europe, North America	Recycled content, Quantitative measures	Danone. 2012. Sustainability Report 2012. [report].
Kellogg	Food (100%)	North America, Europe	NA	Kellogg Company. 2012. Corporate Responsibility Report. [report].
Meiji Holdings	Food (89%), Medical and pharmaceutical products (11%)	Europe, Asia	Quantity used	Meiji. 2014. Meiji Holdings Co., Ltd.. [online] Available at: http://www.meiji.com/english/ [Accessed: 31 Jan 2014].
Mondelez	Food (100%)	North America, Europe	NA	Mondelez International. 2014. Mondelez International, Inc. [online] Available at: http://www.mondelezinternational.com/ [Accessed: 31 Jan 2014].
Nestlé	Food (100%)	North America, Europe	Quantity used, recycled content	Nestlé. 2012. Nestlé in society. Creating Shared Value and meeting our commitments 2012. [report].
PepsiCo	Food (67%), Drinks (33%)	North America, Europe	Recycled content, Quantitative measures	PepsiCo. 2012. Sustainability Report 2011/2012. [report].
Carrefour	Retail (100%)	Europe	Quantitative measures	Carrefour. 2012. Registration Document Annual Financial Report. [report].
Costco	Retail (100%)	North America	NA	Costco Wholesale. 2012. Annual Report 2012. [report].
CVS	Retail (100%)	North America	Quantitative measures	CVS Caremark. 2012. 2012 Corporate Social Responsibility Report. [report].
Kroger	Retail (100%)	North America	Quantitative measures	Kroger. 2013. 2013 Sustainability Report. [report].

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Tesco	Retail (100%)	Europe, Asia	NA	Tesco. 2012. Corporate Responsibility Review 2012. [report].
Walmart	Retail (100%)	North America, Latin America	Quantitative measures	Walmart. 2012. 2012 Global Responsibility Report. [report].
Bidvest	Restaurants and bars (92%), Durable household goods (8%)	Europe, Asia	NA	Bidvest Group. 2012. Annual Integrated Report. [report].
Compass	Restaurants and bars (100%)	North America, Asia	NA	Compass Group. 2013. Our formula for growth. Annual Report 2013. [report].
McDonald's	Restaurants and bars (100%)	North America, Europe, Asia	Recycled content	McDonald's. 2012. 2012 Global Sustainability Highlights. [report].
Sodexo	Restaurants and bars (100%)	Europe, North America	NA	Sodexo. 2013. Better Tomorrow Plan Progress Review. [report].
Starbucks	Restaurants and bars (100%)	North America, Asia	Reusable content	Starbucks. 2012. 2012 Global Responsibility Report. [report].
Sysco	Restaurants and bars (100%)	North America	NA	Sysco Corporation. 2012. 2012 Sustainability Summary Report. [report].
Abbott	Medical and pharmaceutical products (80%), Food (20%)	North America, Europe	Quantitative measures	Abbott. 2012. 2011 Abbott Global Citizenship Report. [report].
Johnson and Johnson	Medical and pharmaceutical products (80%), Personal products (15%), Non-durable household goods (5%)	North America, Europe	NA	Johnson & Johnson. 2012. 2012 Citizenship & Sustainability Report. [report].
Merck	Medical and pharmaceutical products (100%)	North America, Europe	NA	Merck. 2012. Corporate Responsibility Report 2012. [report].
Novartis	Medical and pharmaceutical products (100%)	Europe, North America	Quantitative measures	Novartis. 2012. Annual Report 2012. [report].
Pfizer	Medical and pharmaceutical products (100%)	North America, Europe	NA	Pfizer. 2012. Annual Review 2012. [report].
Sanofi	Medical and pharmaceutical products (100%)	North America, Europe	Quantitative measures	Sanofi. 2012. Corporate Social Responsibility 2012. [report].
Asics	Footwear (100%)	Asia, Europe	NA	Asics. 2012. CSR Report 2012. [report].
Belle International	Footwear (64%), Clothing and Accessories (26%)	Asia	NA	Belle International. 2014. [online] Available at: http://www.belleintl.com/ [Accessed: 31 Jan 2014].
Daphne Holdings	Footwear (100%)	Europe, North America	NA	Daphne Holdings. 2014. [online] Available at: http://www.daphneholdings.com/ [Accessed: 31 Jan 2014].

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Salvattore Ferragamo	Footwear (65%), Clothing and Accessories (35%)	Asia, Europe	NA	Salvatore Ferragamo. 2014. Salvatore Ferragamo. [online] Available at: http://www.ferragamo.com [Accessed: 31 Jan 2014].
Stella International	Footwear (100%)	North America, Europe	NA	Stella.com.hk, (2014). Stella International. [online] Available at: http://www.stella.com.hk/index.html [Accessed 4 Apr. 2014].
Tod's	Footwear (100%)	Europe, Asia	NA	Tod's. 2012. Annual Report 2012. [report].
Hasbro	Toys (100%)	North America, Europe	Quantitative measures	Hasbro. 2014. Products and the Environment. [online] Available at: http://csr.hasbro.com/sus12-product-life-cycle.php [Accessed: 31 Jan 2014].
Hornby	Toys (100%)	Europe	NA	Hornby. 2014. [online] Available at: http://www.hornby.com/ [Accessed: 31 Jan 2014].
Mattel	Toys (100%)	North America, Europe	NA	Mattel. 2012. Global Citizenship Report. [report].
Avon	Personal products (100%)	Latin America, Europe	Quantitative measures	Avon. 2014. Corporate Responsibility Report. [online] Available at: http://www.avoncompany.com/pdfreportbuilder/default.aspx [Accessed: 31 Jan 2014].
Beierdorf	Personal products (100%)	Europe, Asia	NA	Beiersdorf, (2014). Sustainability. [online] Available at: http://www.beiersdorf.com/sustainability/overview [Accessed 31 Jan. 2014].
Estée Lauder	Personal products (100%)	Europe, North America	NA	Estée Lauder. 2012. Corporate Responsibility Report 2012. [report].
L'Oréal	Personal products (100%)	Europe, North America	Quantitative measures	L'Oréal. 2012. RAPPORT DÉVELOPPEMENT DURABLE. [report].
Natura Cosmeticos	Personal products (100%)	Latin America	Recycled content, Quantitative measures	Natura. 2012. Report 2012 Full GRI Version. [report].
Shiseido	Personal products (99%), Medical and pharmaceutical products (1%)	Asia, North America	Packaging used, Quantitative measures	Shiseido. 2014. Environmental Activity Results Data l Social Responsibility l Shiseido group website. [online] Available at: http://group.shiseido.com/csr/performance/env/index.html [Accessed: 31 Jan 2014].
Unilever	Personal products (35%), Food (47%), Non-durable household goods (18%)	Europe, North America	Recycled content, Quantitative measures	Unilever. 2012. Sustainable Living Plan. [report].
Ekornes	Furniture (100%)	Europe, North America	NA	Ekornes Asa. 2012. Annual Report 2012. [report].
Fortune Brands	Furniture (100%)	North America	NA	FBHS. 2014. Fortune Brands Home & Security. [online] Available at: http://www.fbhs.com/ [Accessed: 31 Jan 2014].

	SECTORS INCLUDED	MAIN REGIONS OF SALES	DISCLOSURE USED	SOURCE
Interface	Furniture (100%)	North America, Europe	Recycled content, Biobased content	Interface Global. 2014. Interface - Sustainability. [online] Available at: http://www.interfaceglobal.com/sustainability.aspx [Accessed: 31 Jan 2014].
Leggett and Platt	Furniture (100%)	North America, Asia	NA	Leggett & Platt. 2012. Annual Report 2012. [report].
Mohawk	Furniture (100%)	North America, Europe	Quantitative measures	Mohawk. 2012. Corporate Responsibility and Sustainability Report. [online] Available at: http://www.mohawksustainability.com/ [Accessed: 31 Jan 2014].
Samson Holdings	Furniture (100%)	North America	NA	Samson Holding. 2014. Samson Holding LTD. [online] Available at: http://www.samsonholding.com/ [Accessed: 31 Jan 2014].
Amer Sports	Athletic Goods (100%)	Europe, North America	NA	Amer Sports. 2014. Amer Sports - Product. [online] Available at: http://www.amersports.com/responsibility/environmental/product [Accessed: 31 Jan 2014].
Anta Sports	Athletic Goods (100%)	Asia	NA	Anta. 2014. [online] Available at: http://www.anta.com.cn [Accessed: 31 Jan 2014].
Jarden Corp	Athletic Goods (42%), Non-durable household goods (58%)	North America, Asia	NA	Jarden. 2014. [online] Available at: http://www.jarden.com/ [Accessed: 31 Jan 2014].
Peak Sport	Athletic Goods (100%)	Asia	NA	Peak Sport. 2012. 2012 Annual Report. [report].

REFERENCES

1. PlasticsEurope. 2013. Plastics - the Facts 2013. [report] Brussels: PlasticsEurope.
2. Thompson, R. C., Moore, C. J., Vom Saal, F. S. and Swan, S. H. 2009. Plastics, the environment and human health: current consensus and future trends. Philosophical Transactions of the Royal Society B: Biological Sciences, 364 (1526), pp. 2153—2166
3. Gyres Institute. 2013. Microplastics in consumer products and in the marine environment. Position Paper. [report]
4. Gyres Institute, Plastic Soup Foundation, Surfrider Foundation, Plastic Free Seas, Clean Seas Coalition.
5. UNEP. 2005. Marine Litter, An Analytical Overview. [report] Nairobi: United Nations Environment Program.
6. Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel - GEF. 2012. Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions. Technical Series.[report] Montreal.
7. NOAA, UNEP. 2011. The Honolulu Strategy: A Global Framework for Prevention and Management of Marine Debris. [report]
8. Hoornweg, D. and Bhada-Tata, P. 2012. What a Waste, A Global Review of Solid Waste Management. Urban Development Series Knowledge Papers. [report] Washington: World Bank
9. Plasticseurope. 2014. PlasticsEurope - Eco-profiles - PlasticsEurope. [online] Available at: http://www.plasticseurope.org/plasticssustainability/eco-profiles.aspx [Accessed: 31 Jan 2014].
10. Eurostat. 2014. Introduction. [online] Available at:http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/introduction/ [Accessed: 31 Jan 2014].
11. EPA.gov. 2014. Wastes Homepage | US EPA. [online] Available at: http://www.epa.gov/osw/ [Accessed: 3 Mar 2014].
12. Pilz, H., Brandt, B. and Fehringer, R. 2010. The Impact of Plastics on Life Cycle Energy Consumption and Greenhouse Gas Emissions in Europe. [report] Vienna: PlasticsEurope.
13. Franklin Associates. 2014. Impact of Plastics Packaging on Life Cycle Energy Consumption & Greenhouse GasEmissions in the United States and Canada. [report] The American Chemistry Council and the Canadian Plastics Industry Association.
14. Opcleansweep.org. 2014. Operation Clean Sweep. [online] Available at: http://www.opcleansweep.org/ [Accessed: 3 Mar 2014].
15. Tang, X., Li, N., Kang, L., Dubois, A. M., Gong, Z., Wu, B., Lai, G., Yang, A., Ruan, X., Gao, H. and Others. 2013. Chronic low level trimethyltin exposure and the risk of developing nephrolithiasis. Occupational and environmental medicine.
16. European Commission. 2013. On a European Strategy on Plastic Waste in the Environment. Green Paper. [report] Brussels: European Commission.
17. Raveender Vannela, Are We “Digging Our Own Grave” Under the Oceans? Biosphere Level Effects and Global Policy Challenge from Plastic(s) in Oceans, 46(15) ENVTL. SCI. & TECH. 7932, 7932 (2012), available at https://sustainability.water.ca.gov/documents/18/3334111/Ocean+Pollution.pdf.
18. The Declaration of the Global Plastics Associations for Solutions on Marine Litter. 2012. Progress Report. [report]
19. Plasticsoupfoundation.org. 2014. Plastic Soup Foundation. [online] Available at: http://plasticsoupfoundation.org/ [Accessed: 3 Mar 2014].
20. Truthout. 2014. Pacific Ocean Floor Is a Huge Underwater Garbage Dump. [online] Available at: http://www.truth-out.org/news/item/17386-pacific-ocean-floor-is-a-huge-underwater-garbage-dump [Accessed: 3 Mar 2014].
21. Schlining, K., Von Thun, S., Kuhnz, L., Schlining, B., Lundsten, L., Jacobsen Stout, N., Chaney, L. and Conor, J. 2013. Debris in the deep: Using a 22-year video annotation database to survey marine litter in Monterey Canyon, central California, USA. [report] Deep Sea Research Part I: Oceanographic Research Papers.
22. Mbari.org. 2014. MBARI News Release: MBARI research shows where trash accumulates in the deep sea. [online] Available at: http://www.mbari.org/news/news_releases/2013/deep-debris/deep-debris-release.html [Accessed: 3 Mar 2014].
23. Kinver, M. 2013. Microplastics ‘pose toxic threat to marine biodiversity’. BBC News, 2 December 2013.
24. Rios, L. M., Moore, C. and Jones, P. R. 2007. Persistent organic pollutants carried by synthetic polymers in the ocean environment. Marine Pollution Bulletin, 54 (8), pp. 1230--1237.
25. Rochman C.M., et al, 2013, Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress, Scientific reports.
26. Mcilgorm, A., Campbell, H. and Rule, M. 2008. Understanding the Economic Benefits and Costs of Controlling Marine Debris in the APEC Region. [report] Coffs Harbour: APEC Marine Resources Conservation Working Group.
27. Scotland.gov.uk. 2014. Marine Litter Issues, Impacts and Actions. [online] Available at: http://www.scotland.gov.uk/Publications/2012/09/6461/4 [Accessed: 31 Jan 2014].
28. Mouat, J., Lopez Lozano, R. and Bateson, H. 2010. Economic Impacts of Marine Litter. [report] KIMO.
29. B.H., S., A, J. and W, K. 2012. The Cost to West Coast Communities of Dealing with Trash, Reducing Marine Debris. [report] US Environmental Protection Agency.
30. Nrdc.org. 2014. Testing The Waters: Health and Economic Impacts | NRDC. [online] Available at: http://www.nrdc.org/water/oceans/ttw/health-economic.asp [Accessed: 3 Mar 2014].
31. StyleResearch. 2013. Conscientious ESG Investing. [report].
32. Eccles, R., Ioannou, I. and Serafeim, G. 2013. The Impact of Corporate Sustainability on Organization Processes and Performance. Working Paper. [report] Harvard Business School.
33. Goldman Sachs. 2010. Crossing the Rubicon: Our Investment Framework for the Next Decade. GS Sustain. [report] Goldman Sachs.
34. Interface Global. 2014. Interface - Sustainability. [online] Available at: http://www.interfaceglobal.com/sustainability.aspx [Accessed: 31 Jan 2014].

35. Packagingdigest.com. 2014. Packaging Materials, Equipment, and News | Packaging Digest. [online] Available at: http://www.packagingdigest.com/smart-packaging/replenish-concentrates-conserving [Accessed: 3 Mar 2014].

36. BBC News. 2010. EU bans chemical in baby bottles. [online] Available at: http://www.bbc.co.uk/news/world-europe-11843820 [Accessed: 28 Feb 2014].

37. Gold, M., Mika, K., Horowitz, C., Herzog, M. and Leitner, L. 2013. Stemming the Tide of Plastic Marine Litter: A Global Action Agenda. Pritzker Environmental Law and Policy Briefs. [report] Emmett Center on Climate Change and the Environment.

38. UNEP. 2014. Regional Seas. [online] Available at: http://www.unep.org/regionalseas/ [Accessed: 28 Feb 2014].

39. 34. NOAA, UNEP. 2011. The Honolulu Strategy: A Global Framework for Prevention and Management of Marine Debris. [report] NOAA, UNEP.

40. Europarl.europa.eu. 2014. Plastic waste: Parliament sounds the alarm. [online] Available at: http://www.europarl.europa.eu/news/en/news-room/content/20140110IPR32385/html/Plastic-waste-Parliament-sounds-the-alarm [Accessed: 28 Feb 2014].

41. Surfrider.org. 2014. Plastic Bag Bans and Fees. [online] Available at: http://www.surfrider.org/pages/plastic-bag-bans-fees [Accessed: 28 Feb 2014].

42. Nytimes.com. 2014. Log In - The New York Times. [online] Available at: http://www.nytimes.com/2014/02/11/nyregion/ban-sought-on-microbeads-in-beauty-items.html?_r=0 [Accessed: 16 Apr 2014].

43. Los Angeles Times Articles. 2014. State bill targets tiny plastic beads. [online] Available at: http://articles.latimes.com/2014/feb/13/business/la-fi-california-microbead-ban-20140213 [Accessed: 16 Apr 2014].

44. Products, C., Cosmetics, N. and App, F. (2014). California Assembly Passes Historic Law to Remove Plastic Microbeads from Personal Care Products. [online] Ecowatch.com. Available at: http://ecowatch.com/2014/05/24/california-ban-plastic-microbeads/ [Accessed 24 May. 2014].

45. Interbrand.com. 2014. Interbrand - Creating and managing brand value | Global Branding Consultancy. [online] Available at: http://www.interbrand.com/en/ [Accessed: 16 Apr 2014].

46. Stop Coca-Cola trashing Australia. 2013. [video] http://www.youtube.com/watch?v=Q7Uxaw6YoRw: Greenpeace.

47. the Guardian. 2010. Lessons from the palm oil showdown. [online] Available at: http://www.theguardian.com/sustainable-business/palm-oil-greenpeace-social-media#_ [Accessed: 3 Mar 2014].

48. Financial Times. 2014. How Nestlé dealt with a social media campaign against it - FT.com. [online] Available at: http://www.ft.com/cms/s/0/90dbff8a-3aea-11e2-b3f0-00144feabdc0.html#axzz2tsj4Fadv [Accessed: 3 Mar 2014].

49. WXYZ. 2014. Social media campaign Litterati helps clean the planet. [online] Available at: http://www.wxyz.com/news/social-media-campaign-litterati-helps-clean-the-planet [Accessed: 3 Mar 2014].

50. Beat the Micro Bead. 2014. [online] Available at: http://beatthemicrobead.org/en/ [Accessed: 31 Jan 2014].

51. Marin Independent Journal. 2014. San Rafael's Sun Valley students get Crayola to recycle. [online] Available at: http://www.marinij.com/ci_23463498/san-rafaels-sun-valley-students-get-crayola-recycle [Accessed: 3 Mar 2014].

52. Non-toxic Kids. 2013. Elementary School Kids Get Crayola to "ColorCycle" Used Markers - Non-toxic Kids. [online] Available at: http://non-toxickids.net/2013/06/elementary-school-kids-get-crayola-to.html [Accessed: 3 Mar 2014].

53. Kingston, H. 2014. Principles for Responsible Investment - An investor initiative in partnership with UNEP Finance Initiative and UN Global Compact. [online] Available at: http://www.unpri.org/ [Accessed: 31 Jan 2014].

54. CDP. 2014. CDP - Driving sustainable economies. [online] Available at: https://www.cdp.net/en-US/Pages/HomePage.aspx [Accessed: 31 Jan 2014].

55. Zhang, B. and Tam, W. 2010. Plastics Disclosure Project Survey Report. [report] PDP.

56. TEEB in Business and Enterprise, (2011), Available at URL: http://www.teebweb.org/publications/teeb-study-reports/business-and-enterprise/, Accessed March 2013

57. UN PRI/ UNEP FI, (2011), Universal Ownership: Why environmental externalities matter to institutional investors

58. The World Bank, (2013), Available at URL: http://www.worldbank.org/en/news/press-release/2012/06/20/massive-show-support-action-natural-capital-accounting-rio-summit, Accessed March 2013

59. EPA.gov. 2014. Toxics Release Inventory (TRI) Program | US EPA. [online] Available at: http://www2.epa.gov/toxics-release-inventory-tri-program [Accessed: 3 Mar 2014].

60. KIMO International. 1990-2013. Fishing for Litter. [online] Available at: http://www.kimointernational.org/FishingforLitter.aspx [Accessed: 30 May 2014].

61. European Commission. 2014. Fisheries – News and events - Reducing plastic marine litter in Mediterranean: a "Fishing for Litter" campaign in France. [online] Available at: http://ec.europa.eu/fisheries/news_and_events/press_releases/2011/20110520/index_en.htm [Accessed: 30 May 2014].

62. Saltwater people working together. 2013. GhostNets Australia saltwater people working together – Home. [online] Available at: http://www.ghostnets.com.au/ [Accessed: 30 May 2014].

63. Interface Magazine. 2013. Net Effect – 2013. [online] Available at: http://interfacegobeyond.com.au/documents/Net_Effect_Interface_Magazine.pdf [Accessed: 29 May 2014].

64. Method products, pbc. 2014. Ocean Plastic. [online] Available at: http://methodhome.com/ocean-plastic/ [Accessed: 30 May 2014].

65. Resource Media Limited. 2014. Ecover to launch recycled ocean plastic packaging. [online] Available at: http://www.resource.co/sustainability/article/ecover-launch-recycled-ocean-plastic-packaging [Accessed 30 May 2014].

66. Ecouterre.com. 2014. Nike Outfits World Cup Teams in Jerseys Made from Recycled Bottles. [online] Available at: http://www.ecouterre.com/nike-outfits-world-cup-teams-in-jerseys-made-from-recycled-bottles/ [Accessed: 30 May 2014].

67. Parlay for the Oceans. 2014. The Vortex Project. [online] Available at: http://www.parley.tv/thevortexproject#vortex1 [Accessed: 30 May 2014].

68. Globalreporting.org. 2014. Global Reporting Initiative. [online] Available at: https://www.globalreporting.org/Pages/default.aspx [Accessed: 31 Jan 2014].

69. Sustainability Accounting Standards Board. 2014. Sustainability Accounting Standards Board. [online] Available at: http://www.sasb.org/ [Accessed: 7 Mar 2014].

70. IIRC. 2014. The IIRC | INTEGRATED REPORTING. [online] Available at: http://www.theiirc.org/ [Accessed: 7 Mar 2014].

71. Greenpeace. 2014. A Little Story About the Monsters in Your Closet. [report] Greenpeace.

72. Clean Production Action. [online] Available at: http://www.cleanproduction.org/ [Accessed: 16 Apr 2014].

73. Apple. 2014. Environmental Progress. [online] Available at: http://www.apple.com/uk/environment/progress/ [Accessed: 31 Jan 2014].

74. Gesamp.org. 2014. GESAMP - Joint group of Experts on the Scientific Aspects of Marine Environmental Protection. [online] Available at: http://www.gesamp.org/ [Accessed: 31 Jan 2014].

75. UNEP. 2011. UNEP YEAR BOOK 2011. [online] Available at: http://www.unep.org/yearbook/2011/ [Accessed: 7 Mar 2014].

76. Dr Pepper Snapple Group. 2012. Sustainability Report 2012. [report].

77. LG Electronics. 2012. 2012 - 2013 LG Electronics Sustainability Report. [report].

78. Mackerron, C. 2012. Unfinished Business: The Case for Extended Producer Responsibility for Post-Consumer Packaging. [report] Oakland: As You Sow.

79. European Commission. 2012. Ensuring bio-based plastics are truly sustainable. [online] Available at: http://ec.europa.eu/environment/integration/research/newsalert/pdf/280na5.pdf [Accessed: 7 Mar 2014].

80. Bio Intelligence Service. 2011. Plastic Waste in the Environment. [report] Paris: European Commission.

81. Natureworksllc.com. 2014. NatureWorks LLC Home Page. [online] Available at: http://www.natureworksllc.com/ [Accessed: 31 Jan 2014].

82. The Cambridge - MIT Institute. 2013. The ImpEE Project: Recycling of Plastics. [online] Available at: http://www-g.eng.cam.ac.uk/impee/topics/RecyclePlastics/files/Recycling%20Plastic%20v3%20PDF.pdf [Accessed: 7 Mar 2014].

83. Coca-Cola. 2012. 2011/2012 GRI Report. [report].

84. European Commission. 2014. REACH legislation, nanomaterials, guidance, archives - Chemicals - Enterprise and Industry. [online] Available at: http://ec.europa.eu/enterprise/sectors/chemicals/documents/reach/index_en.htm [Accessed: 31 Jan 2014]

85. Epa.gov. 2014. Basic Information| Polychlorinated Biphenyls (PCBs)| Wastes | US EPA. [online] Available at: http://www.epa.gov/osw/hazard/tsd/pcbs/about.htm [Accessed: 31 Jan 2014].

86. Natura. 2012. Report 2012 Full GRI Version. [report].

87. Hasbro. 2014. Products and the Environment. [online] Available at: http://csr.hasbro.com/sus12-product-life-cycle.php [Accessed: 31 Jan 2014].

88. Ricoh. 2013. Ricoh Group Sustainability Report 2013. [report].

89. Sony. 2012. CSR Reporting 2012. [report].

90. Panasonic Corporation. 2012. Sustainability Report 2012. [report].

91. Avon. 2014. Corporate Responsibility Report. [online] Available at: http://www.avoncompany.com/pdfreportbuilder/default.aspx [Accessed: 31 Jan 2014].

92. Mbapolymers.com. 2014. Welcome to MBA Polymers—Smarter Recycled Plastics. [online] Available at: http://www.mbapolymers.com/home/ [Accessed: 16 Apr 2014].

93. 4R Sustainability. 2011. Conversion technology: A complement to plastic recycling. [online] Available at: http://plastics.americanchemistry.com/Plastics-to-Oil [Accessed: 7 Mar 2014].

94. The Environmental Blog. 2012. Diesel from Plastic Waste Will Fuel Plane Flight. [online] Available at: http://www.theenvironmentalblog.org/2012/10/diesel-plastic-waste-fuel-sydney-london-plane-flight/ [Accessed: 7 Mar 2014].

95. Unilever. 2012. Sustainable Living Plan. [report].

96. ChemEurope. 2014. Polyester. [online] Available at: http://www.chemeurope.com/en/encyclopedia/Polyester.html [Accessed: 31 Jan 2014].

97. Technorati. 2010. Athletic Clothing Made from Recycled Plastic Bottles. [online] Available at: http://technorati.com/lifestyle/green/article/athletic-clothing-made-from-recycled-plastic/ [Accessed: 31 Jan 2014].

98. Plastics Europe. 2012. Sport, Leisure, Design - PlasticsEurope. [online] Available at: http://www.plasticseurope.org/use-of-plastics/sport-leisure-design.aspx [Accessed: 31 Jan 2014].

99. Szeteiova, K. n.d. Automotive Materials - Plastics in Automotive Markets Today. [report] Bratislava: Slovak University of Technology Bratislave.

100. PlasticsEurope. 2013. Automotive: The World Moves with Plastics. [report] Brussels: PlasticsEurope.

101. Food and Agriculture Organization of the United Nations and International Cotton Advisory Committee. 2013. World Apparel Fiber Consumption Survey. [report] Washington: Food and Agriculture Organization of the United Nations and International Cotton Advisory Committee.

102. Mcintyre, J. E. 2005. Synthetic fibres. Cambridge: CRC/Woodhead Pub.

103. Browne, M., Crump, P., Niven, S., Teuten, E., Tonkin, A., Galloway, T. and Thompson, R. 2011. Accumulation of Microplastic on Shorelines Worldwide: Sources and Sinks. Environmental Science Technology, 45 (21), pp. 9175-9179.

104. Balan, S., Bours, J., Daniels, S., Kausch, M., Pabo, N. and Plamthottam, S. 2012. Identifying substances of concern during informal recycling of electronics. [report] Berkeley Center for Green Chemistry.

105. Bidwell, A. 2013. U.N. Seeks to Solve Growing Global E-Waste Problem - US News. [online] Available at: http://www.usnews.com/news/articles/2013/12/16/un-seeks-to-solve-growing-global-e-waste-problem [Accessed: 7 Mar 2014].

106. Wang, F., Kuehr, R., Ahlquist, D. and Li, J. 2013. E-Waste in China: A Country Report. The StEP Green Paper Series. [report] United Nations University/StEP Initiative.

107. Yale Environment 360. 2014. In Developing World, A Push to Bring E-Waste Out of Shadows by Mike Ives: Yale Environment 360. [online] Available at: http://e360.yale.edu/feature/in_developing_world_a_push_to_bring_e-waste_out_of_shadows/2736/ [Accessed: 7 Mar 2014].

108. Five Winds International, LP. 2001. An Environmental Scan of Toxic and Hazardous Materials in IT and Telecom Products and Waste. [report].

109. Keller Heckman. 2014. Waste Electrical and Electronic Equipment (WEEE) Legislation. [online] Available at: http://www.khlaw.com/showpublication.aspx?Show=1500 [Accessed: 31 Jan 2014].

110. Speigel, R. 2014. Patchwork of state e-waste laws keeps expanding. [online] Available at: http://edn.com/electronics-news/4363788/Patchwork-of-state-e-waste-laws-keeps-expanding [Accessed: 7 Mar 2014].

111. Foresman, C. 2012. Recyclers disagree on impact of glued-in Retina MacBook Pro batteries. [online] Available at: http://arstechnica.com/apple/2012/07/recyclers-disagree-on-impact-of-glued-in-retina-macbook-pro-batteries/ [Accessed: 7 Mar 2014].

112. Apple. 2014. 15-inch MacBook Pro with Retina Display. Environmental Report. [report].

113. Clancy, H. 2013. Dell Steps Up E-Waste Recycling With African Hub. [online] Available at: http://www.forbes.com/sites/heatherclancy/2013/12/05/dell-steps-up-e-waste-recycling-with-african-hub/ [Accessed: 7 Mar 2014].

114. Environmental Leader. 2013. Dell Helps Develop E-Waste Business Model • Environmental Management & Energy News • Environmental Leader. [online] Available at: http://www.environmentalleader.com/2013/12/05/dell-helps-develop-e-waste-business-model/ [Accessed: 7 Mar 2014].

115. GreenBiz. 2014. Innovating a sea change in reducing plastic waste. [online] Available at: http://www.greenbiz.com/blog/2012/07/09/innovating-sea-change-reducing-plastic-waste [Accessed: 7 Mar 2014].

116. Dailey, J. 2014. Dell Will Be First Tech Company to Use Ecovative Mushroom Packaging for Shipping. [online] Available at: http://inhabitat.com/dell-will-be-first-tech-company-to-use-ecovative-mushroom-packaging-for-shipping/dell-mushroom-packaging/ [Accessed: 7 Mar 2014].

117. HP. 2012. HP 2012 Global Citizenship Report. [report] HP.

118. Green Peace. 2011. Guide to Greener Electronics. [online] Available at: http://www.greenpeace.org/international/Global/international/publications/climate/2012/GuideGreenerElectronics/HP.pdf [Accessed: 7 Mar 2014].

119. World Packaging Organisation/ PIRA International. 2008. Market Statistics and Future Trends in Global Packaging. [report] World Packaging Organisation/ PIRA International.

120. Ocean Conservancy and International Coastal Cleanup. 2013. Working for Clean Beaches and Clean Water. [report] Washington: Ocean Conservancy.

121. Loughborough University. 2014. IMCRC - Working with industry - Taking steps to end footwear waste. [online] Available at: http://www.lboro.ac.uk/eng/research/imcrc/brochure/first-edition/footwear-waste.html [Accessed: 31 Jan 2014].

122. The Daily Green. 2014. Biodegradable Shoes. [online] Available at: http://www.thedailygreen.com/living-green/blogs/recycling-design-technology/biodegradable-shoes-461009 [Accessed: 31 Jan 2014].

123. Trend Hunter. 2014. 12 Biodegradable Footwear Designs. [online] Available at: http://www.trendhunter.com/slideshow/biodegradable-footwear [Accessed: 31 Jan 2014].

124. Perennial. 2014. Product Comparison - Plastic furniture versus wood furniture. [online] Available at: http://epsplasticlumber.com/index.cfm/page/p_product_comparison/product-comparison.cfm [Accessed: 31 Jan 2014

125. ChemEurope. 2014. Polyester. [online] Available at: http://www.chemeurope.com/en/encyclopedia/Polyester.html [Accessed: 31 Jan 2014].

126. Interface Flor. 2012. On World Oceans Day, Interface and ZSL announce partnership to tackle environmental problem blighting developing world shores. [online] Available at: http://www.interfaceflor.co.uk/web/about_us/media_centre_landing_page/press_releases/press-On-World-Oceans-Day-Interface-and-ZSL-announce-partnership-to-tackle-environmental-problem-blighting-developing-world-shores [Accessed: 31 Jan 2014].

127. Plastics Europe. 2014. PlasticsEurope - Medical & Health. [online] Available at: http://www.plasticseurope.org/use-of-plastics/medical-health.aspx [Accessed: 31 Jan 2014].

128. Merck. 2012. Corporate Responsibility Report 2012. [report].

129. Johnson & Johnson. 2012. 2012 Citizenship & Sustainability Report. [report].

130. United States Environmental Protection Agency. 2011. 2011 Facts and Figures. Municipal Solid Waste in the United States. [report] US EPA.

131. P&G. 2012. 2012 Sustainability Report. [report].

132. Colgate-Palmolive. 2012. Sustainability Report 2012. [report].

133. CTPA. 2014. Packaging - The Facts About The Cosmetic, Toiletry and Perfumery Association. [online] Available at: http://www.thefactsabout.co.uk/content.aspx?pageid=41 [Accessed: 31 Jan 2014].

134. England, R. 2014. Wasted beauty: Packaging in the cosmetics industry. Resource, p. http://www.resource.uk.com/article/Packaging/Wasted_beauty_Packaging_cosmetics_industry#.Uuo4ePl_urE.

135. Lush. 2014. Our Environmental Policy. [online] Available at: http://www.lush.com.au/shop/info/22/our-environmental-policy [Accessed: 31 Jan 2014].

136. Lush. 2014. The Mighty Shampoo Bar. [online] Available at: https://www.lush.co.uk/content/view/1090 [Accessed: 31 Jan 2014].

137. PDP. 2011. Corporate Plastic Disclosure [confidential].

138. Lush. 2014. Lets get STATISTICAL!. [online] Available at: https://www.lush.co.uk/content/view/3816 [Accessed: 31 Jan 2014].

139. Lush. 2014. Lush hasn't lost its sparkle. [online] Available at: https://www.lush.co.uk/content/view/7772 [Accessed: 31 Jan 2014].

140. Landau, E. 2014. Plastic micro beads' to be removed from soap. [online] Available at: http://edition.cnn.com/2013/01/07/health/microplastics-soap-unilever/ [Accessed: 7 Mar 2014].

141. Premium Beauty News. 2013. Premium Beauty News - Microplastics: Lush hot on Unilever's heels. [online] Available at: http://www.premiumbeautynews.com/en/microplastics-lush-hot-on-unilever,5091 [Accessed: 7 Mar 2014].

142. Smithers, R. 2012. London restaurants launch 'straw wars' campaign. The Guardian, 1st Feb, Available at: http://www.theguardian.com/environment/2012/feb/01/london-restaurants-straw-wars

143. Carbon Clear. 2014. Disposable Cups vs Reusable Cups. Solving the Carbon Intensity Question. [report] pp. http://www.carbon-clear.com/files/cup_assessment.pdf

144. Walmart. 2012. 2012 Global Responsibility Report. [report].

145. Carrefour. 2012. Registration Document Annual Financial Report. [report].

146. Kroger. 2013. 2013 Sustainability Report. [report].

147. Ethicalconsumer.org. 2014. Packaging of soft drinks. [online] Available at: http://www.ethicalconsumer.org/ethicalreports/softdrinkssectorreport/packaging.aspx [Accessed: 31 Jan 2014].

148. Shayon, S. 2013. Greenpeace Goes After Coca-Cola in Ongoing Recycling Battle in Australia. [online] Available at: http://www.brandchannel.com/home/post/2013/05/10/Greenpeace-Coca-Cola-051013.aspx [Accessed: 7 Mar 2014].

149. The Coca-Cola Company. 2014. Container Deposit Schemes. [online] Available at: http://www.coca-colacompany.com/coca-cola-unbottled/container-deposit-schemes-not-as-simple-as-they-sound [Accessed: 7 Mar 2014].

150. Coca-Cola. 2012. 2011/2012 GRI Report. [report].

151. As You Sow. 2014. As You Sow - Beverage Container Recycling. [online] Available at: http://www.asyousow.org/sustainability/beverage.shtml [Accessed: 7 Mar 2014].

152. Ekocycle. 2014. EKOCYCLE™ inspires the brands you love to create products made in part from recycled materials.. [online] Available at: http://www.ekocycle.com/ [Accessed: 7 Mar 2014].

153. Coca-Cola. 2014. The Coca-Cola Company and Ford Unveil Ford Fusion Energi with PlantBottle Technology™ Interior. [online] Available at: http://www.coca-colacompany.com/plantbottle-technology/the-coca-cola-company-and-ford-unveil-ford-fusion-energi-with-plantbottle-technology-interior [Accessed: 31 Jan 2014].

154. Ellen MacArthur Foundation. 2014. Circular Economy - Ellen MacArthur Foundation. [online] Available at: http://www.ellenmacarthurfoundation.org/circular-economy [Accessed: 7 Mar 2014].

155. ENCAMS. 2006. What is the Situation with Cigarette Related Litter in England. [report] DEFRA.

156. Shevchenko, V. 2012. Characterization of Chemical Compound in Cigarette Filters Leachates. [report] San Diego: San Diego State University.

157. Novotny, T. E., Lum, K., Smith, E., Wang, V. and Barnes, R. 2009. Cigarettes butts and the case for an environmental policy on hazardous cigarette waste. International journal of environmental research and public health, 6 (5), pp. 1691--1705.

158. Slaughter, E. 2010. Toxicity of Cigarette Butts and their Chemical Components to the Marine and Freshwater Fishes, Atherinops Affinis and Pimephales Promelas. [report] San Diego: San Diego State University.

159. Imperial Tobacco. 2013. Focused on Sustainable Growth. Annual Report and Accounts 2013. [report].

160. Japan Tobacco. 2012. CSR Report 2012. [report].

161. Reynolds American. 2014. Reynolds American Inc.. [online] Available at: http://www.reynoldsamerican.com/ [Accessed: 31 Jan 2014].

162. Plastipedia. 2014. The Plastics Encyclopedia - A History of Plastics. [online] Available at: http://www.bpf.co.uk/plastipedia/plastics_history/default.aspx [Accessed: 31 Jan 2014].

163. Eco-Healthy Child Care. 2014. Plastics and Plastics Toys. [online] Available at: http://www.oeconline.org/resources/publications/factsheetarchive/Plastics%20%20Plastic%20Toys.pdf [Accessed: 31 Jan 2014].

164. East Sussex County Council. 2014. Facts and figures about rubbish and recycling. [online] Available at: http://www.eastsussex.gov.uk/environment/rubbishandrecycling/factsandfigures/default.htm [Accessed: 31 Jan 2014].

165. Naics Census.Gov, S. 2014. North American Industry Classification System (NAICS) Main Page U.S. Census Bureau. [online] Available at: https://www.census.gov/eos/www/naics/ [Accessed: 16 Apr 2014].

166. ICIS. 2014. Price Reports. [online] Available at: http://www.icis.com/about/price-reports/ [Accessed: 31 Jan 2014].

167. Liptow, C. and Tillman, A. 2012. A comparative life cycle assessment study of polyethylene based on sugarcane and crude oil. Journal of Industrial Ecology, 16 (3), pp. 420--435.

168. Hyder Consulting. 2011. Waste and Recycling in Australia 2011. [report] Sydney: Department of Sustainability, Environment, Water, Population and Communities.

169. United States Environmental Protection Agency. 2011. 2011 Facts and Figures. Municipal Solid Waste in the United States. [report] US EPA.

170. Staudinger, J. and Keoleian, G. 2001. Management of End-of Life Vehicles in the US. [report] University of Michigan.

171. Ecoinvent. 2014. Home. [online] Available at: http://www.ecoinvent.ch/ [Accessed: 31 Jan 2014].

172. Biddle, M. 2004. Breaking the Plastics Industry Mould. Plastics Recycling. [report] Richmond: Recycling International.

173. Franklin Associates. 2010. Life cycle inventory of 100% post consumer HDPE and PET recycled resin from post consumer containers and packaging. [report] Prairie Village: The Plastics Division of the American Chemistry Council.

174. Marketline.com. 2014. Information for the Competitive Edge. [online] Available at: http://www.marketline.com [Accessed: 31 Jan 2014].

175. Organisation for Economic Co-operation and Development. 2009. Emission Scenario Document on Plastic Additives. OECD Series on Emission Scenario Documents. [report] Paris: OECD.

176. Tol, R. S. 2011. The social cost of carbon. Annu. Rev. Resour. Econ., 3 (1), pp. 419--443.

177. Stern, N. H. 2007. The economics of climate change. Cambridge, UK: Cambridge University Press.

178. ExternE Project (2003) Method for Estimation of Physical Impacts and Monetary Valuation for Priority Impact Pathways. Externalities of Energy. [report]. Oxfordshire, UK.

179. Eftec (2010), Scoping Study on the Economic (or Non-Market) Valuation Issues and the Implementation of the Water Framework Directive – Final Report, Prepared for the European Commission Directorate-General Environment, September 2010.

180. Moran, D. and Dann, S. (2008) The economic value of water use: Implications for implementing the Water Framework Directive in Scotland. Journal of Environmental Management, p.484-496.

181. Loomis, J (1987), The Economic Value of Instream Flow: Methodology and Benefit Estimates for Optimum Flows, Journal of Environmental Management, p.169-179.

182. Van Zelm, R., Huijbregts, M.A.J., van de Meent, D., 2009. USES-LCA 2.0 – global nested multi-media fate, exposure and effects model. Int J Life Cycle Assess-

ment, 14: 282-284

183. Van Zelm, R., Huijbregts, M.A.J., van de Meent, D., 2009. USES-LCA 2.0 – global nested multi-media fate, exposure and effects model. Int J Life Cycle Assessment, 14: 282-284

184. Sleeswijk, A., Heijungs, R., 2010. GLOBOX: A spatially differentiated global fate, intake and effect model for toxicity assessment in LCA. Science of the Total Environment, 408: 2817-2832

185. Lijzen, J.P.A., Rikken, M.G.J. (eds.), 2004. EUSES: European Union System for the Evaluation of Substances, Version 2.0, Background Report. RIVM Report no. 601900005/2004

186. Goedkoop, M., Heijungs, R., Huijbregts, M., De Schryver, A., Struijs, J., van Zelm, R., 2013. ReCiPe 2008. Report I: Characterisation, updated May 2013.

187. New Energy Externalities Developments for Sustainability (NEEDS) (2006) Assessment of Biodiversity Losses. Sixth Framework Programme. [report] Zurich: Econcept AG.

188. DEFRA. 2014. A study to estimate the disamenity costs of landfill in Great Britain. Cambridge Econometrics in association with EFTEC and WRc. [online] Available at: http://archive.defra.gov.uk/environment/waste/strategy/legislation/landfill/documents/landfill_disamenity.pdf [Accessed: 7 Mar 2014].

189. Eshet, T., Baron, M. and Shechter, M. 2007. Exploring Benefit Transfer: Disamenities of Waste Transfer Stations. Environmental and Resource Economics, 37 (3), pp. 521-547. Available from: doi: 10.1007/s10640-006-9047-6.

190. European Commission, DG Environment. 2000. A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste. [online] Available at: http://ec.europa.eu/environment/enveco/waste/pdf/cowi_ext_from_landfill.pdf [Accessed: 7 Mar 2014].

191. Walton, H., Boyd, R. and Markandya, A. 2014. Explaining Variation in Amenity Costs of Landfill: Meta-Analysis and Benefit Transfer. Department of Economics and International Development, University of Bath, UK, Available at: http://www.webmeets.com/files/papers/ERE/WC3/552/Walton_WASTE_META.pdf [Accessed: 7 Mar 2014].

192. Nahman, A. 2014. Pricing landfill externalities: emissions and disamenity costs in Cape Town, South Africa. Waste Management, 31 (9-10), pp. 2046-56. Available from: doi: 10.1016/j.wasman.2011.05.015.

193. UNEP Microplatics Brochure http://www.gpa.unep.org/index.php/global-partnership-on-nutrient-management/publications-and-resources/global-partnership-on-marine-litter-gpml/233-microplastics-brochure-english/file

194. Douglas-Westwood Limited. 2005. Marine Industries Global Market Analysis. Marine Foresight Series. [report] Kent

195. Ressurreição A. et al, 2011, Economic valuation of species loss in the open sea, Ecological Economics 70(2011) 729-73

CONTACT

PLASTIC DISCLOSURE PROJECT

T: +852 8197 7378

E: info@plasticdisclosure.org

www.plasticdisclosure.org

TRUCOST

T: +44 (0) 20 7160 9800

T: +1 800 402 8774

E: info@trucost.com

www.trucost.com

UNEP

Secretariat of the
Global Programme of Action for the
Protection of the Marine Environment
from Land-based Activities (GPA)

E: gpa@unep.org

www.gpa.unep.org

www.unep.org

United Nations Environment Programme
P.O. Box 30552 - 00100 Nairobi, Kenya
Tel.: +254 20 762 1234
Fax: +254 20 762 3927
e-mail: publications@unep.org
www.unep.org

UNEP