Committee: Ecology & Environment

Topic: Single Use Plastics

Definitions:

Single-use - “Used to refer to a product that can be used once and then thrown away.”
Plastics - “A material produced from oil by a chemical process and which is used to make many objects. It is light in weight and does not break easily.”
Microplastics - “Any type of plastic fragment that is less than 5 mm in length.”
Macroplastics - “Any type of plastic fragment that is greater than 5 mm in length.”

Introduction:

Though organic polymers have been in use since at least 1600 BCE in the form of rubber bands and balls[1], the first fully synthetic, non-organic plastics were synthesised by the Belgian Leo Baekeland[2] in the early 1900s. Development of plastics was slow until the commencement of WWII, when the military-industrial complexes of Britain, Nazi Germany and the USA began to search in earnest for rubber and metal substitutes. By 1941, plastic production in the USA was soaring thanks to heavy subsidies[3], allowing the mass consumption of consumer- rather than military- oriented plastic to commence in earnest. This was stimulated by the post-war “boom” seen in America as demobilised soldiers entered a newly expanding workforce, creating intense demand that allowed the wartime plastics industries to simply switch production rather than collapse. The establishment of plastics as the material of choice for clothes, appliances, disposables and protective items was aided by the expansion of American firms, with a series of technological breakthroughs in the latter half of the 20th century. Examples include DuPont’s monopolisation of the British invention of PETE from 1954 onwards, allowing its integration into clothing manufacture[4], as well as the invention of (disposable) polystyrene also by DuPont in 1954[5] and the introduction (disposable) polyethylene bottles causing the widespread demise of the more expensive glass bottles during the 1960s[6]. Though this may imply the field of plastics has remained static, the case in anything but; it is perhaps a mark of its pervasiveness in our society that the myriad of technological advances in the field since the 1960s are too numerous to detail here.

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[1] Andrady AL, Neal MA (July 2009). "Applications and societal benefits of plastics". *Philos. Trans. R. Soc. Lond. B Biol. Sci*. **364** (1526): 1977–84.
[2] US patent 942699, Leo H. Baekeland, "Method of making insoluble products of phenol and formaldehyde", issued December 7, 1909
[3] Mainland.cctt.org. (2009). *ISTF2010: Lord of the Trash Rings - Properties of Plastic*. [online] Available at: ISTF2010: Lord of the Trash Rings - Properties of Plastic [Accessed 24 Jan. 2020].
[4] "History of Polyester | What is Polyester". *www.whatispolyester.com*. Retrieved 4 December 2018.
[5] Andrady AL, Neal MA (July 2009). "Applications and societal benefits of plastics". *Philos. Trans. R. Soc. Lond. B Biol. Sci*. **364** (1526): 1977–84.
[6] "The History of soft drink Timeline". Retrieved 2008-04-23.

There are six main types of plastics[7] that are used for single use plastics, outlined below:

1. Polyethylene terephthalate (**PET**) is plastic that is used for bottling soft drinks,water, and the like. It's major uses are in the textile business. It is nicknamed polyester.
2. High density polyethylene (**HDPE**) is another plastic of considerable renown. It is used for packaging as well, but it's major use is for injection molding applications.
3. Low density polyethylene (**LDPE**) is generally used for things such as shrink wrap/stretch wrap and is even used for the plastic coating on paper milk cartons or juice boxes.
4. Polypropylene (**PP**) is used mostly in fibers, appliances, and general consumer products.
5. Polystyrene (**PS**) is one of the most versatile and common plastics. It can be either rigid or foamed, though we all know it most commonly in its foamed state as packing peanuts.
6. The "**other**" category consists of packages or other things that are made with a plastic resin other than the previously stated plastics, or has multiple types of plastic resins in it.

Single-use plastics

Ecological Risks:

The ecological effects of single-use plastics can be divided into two categories; firstly, the effect of macroplastics on organisms. This is well documented in the form of infamous imagery of, for example, a seahorse clutching an earbud, or of a tortoise imprisoned by beer can rings. These images highlight a moderately significant side-effect of single-use plastic pollution, though draw attention away from the main culprit. Abandoned fishing gear (known as “ghost gear”) is plastic fishing gear that has been discarded after a single use by fishermen. The fact that it is specifically designed to weather rough saline conditions means it is perhaps the most durable of all single-use plastics. As much as 640,000 tonnes[8] of it threatens marine life by simply becoming attached to them and impeding their ability to mate or find food. Though cases are of course dire, their impact is overshadowed by that of microplastics.

The effect of microplastics on organisms is more subversive. Pieces smaller than 5mm enter the organism, either through simple consumption, through the semipermeable membrane of the skin, or through orifices such as eyes. Plastics such as styrofoam can cause cancer and high blood pressure, and, in high enough concentrations, can reach toxic levels in the bloodstream[9]. Microplastics also act as absorbers for toxic substances such as lead, concentrating them, exasperating the effects of external pollutants. This obviously has the potential to seriously damage ecosystems - even the deep

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[7] Mainland.cctt.org. (2009). *ISTF2010: Lord of the Trash Rings - Properties of Plastic*. [online] Available at: ISTF2010: Lord of the Trash Rings - Properties of Plastic [Accessed 24 Jan. 2020].

[8] https://www.worldanimalprotection.org.uk *World Animal Protection,* [Accessed 24 Jan. 2020]

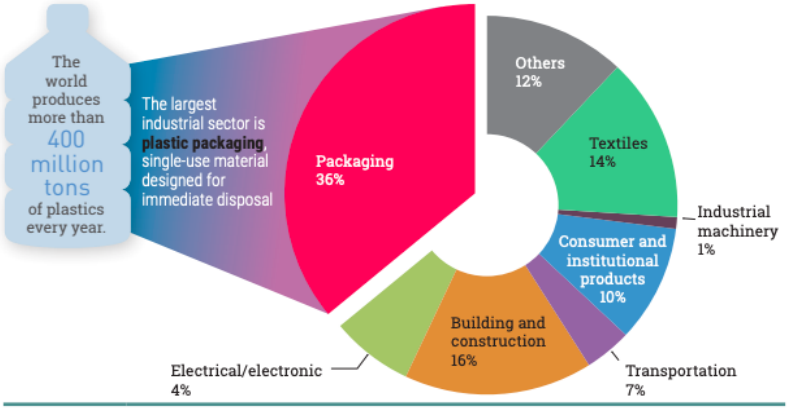
[9] “Single-use plastics; a roadmap for sustainability” SINGLE-USE PLASTICS, *United Nations Environmental Programme,* United Nations, [Accessed 24 Jan. 2020]

sea is littered with as many as four billion microplastic fibres[10], with potentially over 200,000 tonnes of microplastic permeating the ocean[11] - but may also harm humans. Considering that microplastics agglomerate as one ascends the food chain, it is likely that in as little as ten years, as much as 8% of the weight of the average fish will be plastic. Their effects are not limited to the ocean; as many as 80% of microplastics originate from land pollution, and scientists document an increase in microplastic concentration in birds (including chickens) and cattle. Aside from any concerns about animal welfare, microplastics have the potential to seriously impact global food supplies by either killing the animals that contain them or rendering their meat inedible.

Key Statistics:

- As evinced by the diagram, disposable plastics such as plastic packaging account for at least 36% of global production.
- In 2014, North East Asia produced 26% of single-use plastic. North America produced 21%, the Middle East produced 17%, Europe produced 16% and South Asia and Australasia produced 12%.
- Single-use items such as plastic foam cups are expected to take as long as 50 years to degrade, while those such as fishing line will take as many as 600[12].

Figure 1.2. Global plastic production by industrial sector, 2015



Source: Adapted from Geyer, Jambeck, and Law, 2017

- At least 80% of global ocean plastic pollution - including single-use - occurs by way of ten rivers in Asia[13].
- Environmental microplastic concentration has been steadily increasing since 1978. They are present at all levels of the food chain, with unknown long-term effects, though they can be cancerous in humans[14].

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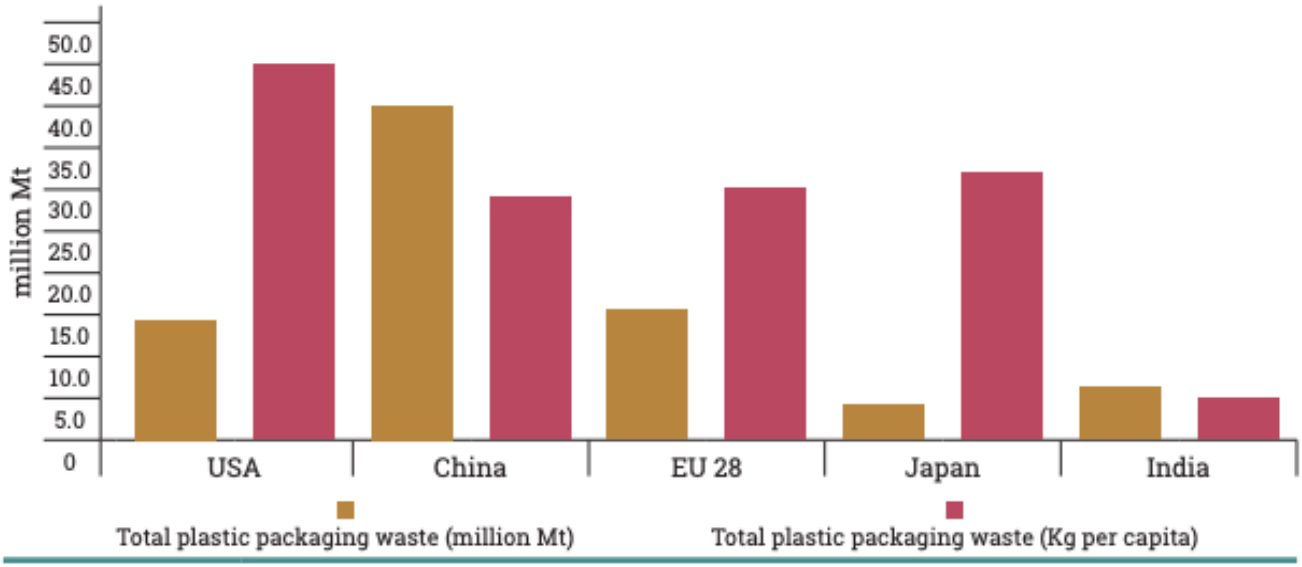
[10] Deep sea littered with plastic debris, *Natural History Museum*, [Accessed 24 Jan. 2020]
[11] https://www.worldanimalprotection.org.uk *World Animal Protection,* [Accessed 24 Jan. 2020]
[12] Le Guern, Claire (March 2018). "When The Mermaids Cry: The Great Plastic Tide". *Coastal Care*. Archived from the original on 5 April 2018. Retrieved 10 November 2018.
[13] Christian Schmidt; Tobias Krauth; Stephan Wagner (11 October 2017). "Export of Plastic Debris by Rivers into the Sea". *Environmental Science & Technology*. **51** (21): 12246–12253. Bibcode:2017EnST...5112246S. doi:10.1021/acs.est.7b02368. PMID 29019247
[14] Barnes DK, Galgani F, Thompson RC, Barlaz M (July 2009). "Accumulation and fragmentation of plastic debris in global environments". *Philos. Trans. R. Soc. Lond. B Biol. Sci*. **364** (1526): 1985–98. doi:10.1098/rstb.2008.0205. PMC 2873009. PMID 19528051.

Figure 1.5. Plastic packaging waste generation, 2014 (million Mt)[17]



Source: Adapted from Geyer, Jambeck, and Law, 2017

Possible solutions:

- Encourage governments to restrict consumption of single use plastics, including:
  - Public information campaigns such as those employed by institutions as varied as the NUS[15] and the United Nations[16]
  - Ban distribution of single-use plastics by suppliers to consumers, as employed by the New Zealander government[17]
- Encourage government to reduce the supply of single use plastics, including
  - Taxation of imports of single use plastic, as employed by the British government[18]
  - Taxation of production of plastics

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[15] "Plastic Free Campaign @ Sustainability." *NUS Plastic-Free Campaign*, sustainability.nus.org.uk/our-works/plastic-free-campaign/plastic-free-campaign [Accessed 24 Jan. 2020]

[16] "UN Declares War on Ocean Plastic." *Cleanseas*, www.cleanseas.org/impact/un-declares-war-ocean-plastic [Accessed 24 Jan. 2020]

[17] Millward, David. "New Zealand Stores Face Massive Fines as Draconian Ban on Plastic Bags Comes into Force." *The Telegraph*, Telegraph Media Group, 30 June 2019, [Accessed 24 Jan. 2020]

[18] "Plastic Waste Tax Set for 2022 Launch." *Plastic Waste Tax Set for 2022 Launch | Accountancy Daily*, 24 July 2019, www.accountancydaily.co/plastic-waste-tax-set-2022-launch [Accessed 24 Jan. 2020]

    - Publish voluntary guidelines for companies to choose follow
    - Introduce Extended Producer Responsibility (EPR) schemes where the producer is made legally liable for single-use plastic, as employed by the South African and German governments[19]
    - Ban single-use plastic items, as employed by the EU parliament[20]
- Encourage the development and adoption of alternative materials
    - Bioplastics, while superficially similar to plastics, will naturally degrade over much shorter periods of time, and in some cases will degrade in extremely short periods of time if heat and sugar are applied. They can be composed of either feedstock (edible plants), cellulosic feedstock (non-edible parts of plants) or algae; respectively, 1st, 2nd and 3rd generation bioplastics[21]. This raises the concern of whether global goof production would be able to both produce enough food and plastic substitute. Depending on the substance, bioplastics are much more expensive and can harm soil quality when degrading - if used on the scale of current single-use plastic, they have the potential to cause even greater damage[22].
    - Use of PDCs - integration of oxidation-inducing substances such as cobalt stearate that artificially promote erosion of the plastic into bacteria-friendly fragments[23]. This doesn't simply turn it into microplastics; unlike microplastics, these fragments are neutral and are neither toxic nor do they act as agglomeraters of toxic substances in the same way as microplastics. They are bio-erodable in the same way as sand or small pieces of grit.

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[19] "Single-use plastics; a roadmap for sustainability" SINGLE-USE PLASTICS, *United Nations Environmental Programme,* United Nations, [Accessed 24 Jan. 2020]
[20] "Single-Use Plastics Ban Approved by European Parliament." *BBC News*, BBC, 24 Oct. 2018, www.bbc.co.uk/news/world-europe-45965605 [Accessed 24 Jan. 2020]
[21] Barrett, Axel. "Bioplastic Feedstock 1st, 2nd and 3rd Generations." *Bioplastics News*, 23 Aug. 2019, bioplasticsnews.com/2018/09/12/bioplastic-feedstock-1st-2nd-and-3rd-generations/.
[22] Barrett, Axel (5 September 2018). "The History and Most Important Innovations of Bioplastics". *Bioplastics News*.
[23] Trimarchi, Maria, et al. "Top 10 Eco-Friendly Substitutes for Plastic." HowStuffWorks Science, HowStuffWorks, 20 Apr. 2019