ПРОБЛЕМНАЯ СТАТЬЯ

ENVIRONMENTAL IMPACTS OF HUMANITY'S CARELESSNESS
PART III: LANDFILL WASTES AND PESTICIDES

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ABSTRACT. We, humans, have invented many technologies in the past few decades to enhance our lifestyles. Some of them induce the invention of electronics like cell phones, better cooking apparatuses, plastics, and insecticides for better farming. These inventions are utilitarian at first look, but the other side of them greatly goes missing. We are still manufacturing tons of cell phones, whereas the old disposed phones are not properly recycled, hence they stay in the landfills polluting the environment. The toxic elements required to manufacture such electronics also have similar effects. Moreover, the convenient cooking apparatuses are coated with chemicals that are harmful to humans. Similarly, the insecticides, used for better farming are actually deleterious in the long run.

KEYWORDS: electronics, pesticides, plastics, cookware, gallium, bismuth, indium, lithium, cadmium.

INTRODUCTION

Modern inventions have made our life convenient, especially cell phones. But, unfortunately, its manufacture comes with a price that incurs a huge cost on the environment. The several elements required to make electronic products can greatly degrade our nature. Similarly, the outdated electronics, which has already been replaced by the modern one, are still lying on the landfills, slowly ejecting their toxic components into the surroundings.

Other products which have enhanced our life but may jeopardise our environments are plastics. They are not bio-degradable and stay in their original form for eternity. Similar is the case with some chemicals which are used in cookware. They can even cause some forms of cancer.

On the other hand, products that seem to be beneficial could have confounding effects, like with pesticides. They, of course, reduce the insects, leading to a higher yield of crops. But in the long run, it might have opposing effects.

ELECTRONICS

If you take an evening stroll in public in any Russian city, you will witness how deeply smartphones have entrenched into human society. Instead of socially connecting with nearby people, they are glued to the electronic version of communication like WhatsApp and VK of their smartphones. These days, it seems as if everyone owns a cell phone, from children at kindergarten to a woodcutter in a forest. Knowing these facts, it is no longer a surprising fact that almost 7 billion smartphones have been manufactured since this century has begun. Today, 1/3 of the population aged from 18 to 35 possesses at least one smartphone. But in developed countries like Germany, almost 92% of the people of the same age group possess a smartphone (Poushter, 2016).

The technological boom has revolutionised every aspect of human beings, ranging from health and education to agriculture. Now any information can be accessed on the smartphone through the tip of our finger. Moreover, we can now communicate from any corner of the world. But the blooming technology is a double edge sword. Besides its contribution to the welfare of humanity, it has got some dark sides too. Just two decades have passed since smartphones have existed, at the beginning of this century. But their detrimental environmental effects of the manufacturing process are already concerning. Moreover, the disposal of used smartphones also adds an extra burden to the surroundings. It has been estimated by the Greenpeace report that almost 968

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TWh of power has been used till now to manufacture these phones (Jardim, 2017). This amount of power is enough to meet the energy demand of India for an entire year. The fact is even shocking when it is considered that India has 20% of the world's population. Besides it, each device is responsible for increasing the e-waste, which reached 50 million metron tons in 2017 (Mitchell, 2017). On the other hand, miners in developing countries are expected to work in harsh conditions and meet the abysmal demand for metals used in the cell phone manufacturing process. Similarly, the working force in the production plants is treated as slaves and compelled to work beyond their physical comforts.

While some studies claim that smartphones can provide service for 5–10 years, in practice, it has been seen to serve consumers for an average of 2 years (Paiano et al., 2013). Such discrepancy might be initially a shocking fact, but a look at a typical advertisement makes everything clear. New smartphones are pooping every year and their sales are boosted by commercials, touting newer innovation and elegant convenience as compared with their previous models (Poushter, 2016). It is clear that such marketing campaigns see user experience more than a product**.** The trend is especially more popular in Europe, as European customers demand newer, faster and better products. It has been estimated that about 27% of Europeans change their smartphone each year and about 60% of them change their smartphone in two years (Speake and Yangke, 2015).

The environmental implications of this economics are deep and immoral. A huge pile of e-waste is produced when manufacturers sell electronics to the same customer each year, considering the fact that only a fraction of these electronics gets recycled (Paiano et al., 2013). Most of those electronics, which probably still works, finally end up in the landfills without proper management. And toxic chemicals are slowly released for the unmanaged electronics, which finally affect living organisms of the ecosystem. If this goes uncurbed, it has been estimated that Europe will generate more than 12 million tons of e-waste every year (Rees, 2016). Although there is a rising awareness against e-waste and the necessity to recycle or reuse electronics, most of the damage has already been done even before the customers get a hand on their smartphones. The use of fossil fuel is the main culprit as it has been estimated that a single cell phone produces a waste of 200 times its weight while manufacturing it (Paiano et al., 2013).

People updating their electronics each year should confess their unsustainable behaviour and realise how their unhealthy practice impacts the environment. However, customers alone can't flip the current situation. The weak standards for industries allow the manufacturers to find loopholes in the regulations and produce goods with planned obsolescence. In spite of lasting for 8–10 years, these electronics serve only for a few years as new software updates don't support old hardware sold just a few years back. This approach has been embraced by Microsoft as well, as the latest operating system of Microsoft Windows 11 doesn't run on some processors released even in 2017, making them redundant just after 4 years of their debut (Microsoft, 2022). Similarly, the new enticing designs of cell phones have made them even more vulnerable to cracks and damages. For example, the back glass panels are attractive but they're easily breakable whose official repair costs the price of the smartphone itself. This makes people more likely to get a new replacement than to reuse the old one.

Contemporary electrical machines, including smartphones, require a multitude of elements for their manufacture. Let's see some of those elements and the consequences they impose on the environment.

Bismuth is considered a rare metal. It is used by humans in electronics (semiconductor production), in the production of plastics, pigments, metal alloys, as an alternative to lead, and in the pharmaceutical and cosmetic industries (Kjølholt et al., 2003; Filella, 2010). Bismuth can enter the environment during the combustion of coal and oil products for the production of energy and household waste, as a by-product in the purification of other metals and disposition of electronics (Kjølholt et al., 2003).

In Ghana, especially in an e-waste disposal area, the degree of environmental pollution with bismuth was assessed as high in soil and rivers (the level in soils was 9 times higher and in water, it was 1–15 times higher). These results also confirm the fact that increased concentrations of bismuth were detected in the hair of residents of the analysed area compared to the control (Tokumaru et al., 2017). India has also faced a similar challenge, with bismuth levels topping up to 6–10 times higher in soil, and reaching up to 242 times higher in soil (Ha et al., 2009). China is also not in good shape in this aspect, as it was found that the relative concentration of bismuth in soil exceeded the normal level by 6 times (with the upper limit reaching up to 11 times). Xiong et al. concluded that this pollution was predominantly associated with transport, metallurgy, and coal industries (Xiong et al., 2015).

***Image 1**: A heap of old electronics in Accra, Ghana (Yeung P., 2019)*

Today, bismuth is considered a more environmentally friendly substitute for many heavy metals and a relatively non-toxic metal for humans (Filella, 2010). However, it has the ability to accumulate in living organisms, which can harm them and the environment with increased use (Kjølholt et al., 2003).

Gallium is widely used in the manufacture of electronic equipment, semiconductors, LEDs, solar cells; medicine; in metal alloys (Jensen et al., 2018; White and Shine, 2016; Kjølholt et al., 2003). Environmental pollution with gallium occurs during the production or disposal of electronic equipment, in the extraction of minerals, and combustion of coal and oil products (Jensen et al., 2018; White and Shine, 2016; Kjølholt et al., 2003).

In a study from Taiwan, it was noted that the level of gallium in groundwater, in the vicinity of the Hsinchu Science-based Industrial Park (HSIP) was significantly higher than in the areas that were analysed as a control. So, in the first case, 100% of the wells had a gallium level above 1.0 μg/L (83.3% more than 10.0 μg/L with an average value of 19.34 μg/L), and in the second – only 6.7% had increased gallium level. Gallium concentrations in HSIP groundwater were approximately 1000 times higher than in the Hsiangshan District (control area in the city of Hsinchu) (Chen et al., 2006). Downwind air from a science and industrial park in Central Taiwan had a gallium content 2.5 times higher than when measured upwind (Chen et al., 2016). Elevated gallium concentrations in the environment were also found near mines and metallurgical plants (Shiller and Frilot, 1996).

Indium is an element, that is not widely spread in the crust of the Earth. It is generally used in semiconductor products, liquid crystal displays, touch screens, LEDs, and solar panels. Due to the growing use of these products, the release of indium into the environment is inevitable (Chang et al., 2019; White and Hemond, 2012). In addition, when there is combustion of coal in power plants and when metal ores are processed, this element gets released into the environment in a form of the by-product of the production of other metals (White et al., 2015; Jensen et al., 2018).

In a study from Taiwan, it was noted that the level of indium in groundwater around the scientific and industrial park was significantly higher than in the areas analysed as controls. So, in the first case, 86.7% of the wells had an indium level higher than 1.0 μg/L (36.7% more than 10.0 μg/L), and in the second case, 100% had a pollution level lower than 1.0 μg/L. This allows us to regard industrial conglomerates as serious sources of anthropogenic pollution of the environment with indium (Chen et al., 2006).

Increased concentrations of indium in the environment are found not only in areas where products from it are manufactured (Chen et al., 2015) but also in e-waste disposal sites (Robinson, 2009). It is known that this waste is often illegally sent to countries such as China, the Philippines, Nigeria, India and Ghana. Toxic elements are transported by rain or wind to soils and water bodies and can subsequently spread to other areas (Brigden et al., 2008). For instance, indium has highly polluted soil in Ghana. These results also confirm the fact that increased concentrations of indium were found in the hair of residents of the analyzed area compared to the control (Tokumaru et a., 2017). A similar picture was presented in India (Ha et al., 2009). Robinson suggests that developing countries were more susceptible to indium pollution than developed ones (Robinson, 2009).

In Nigeria, the concentration of cadmium in agricultural soils in some states exceeds acceptable levels. The highest levels of this element were found in soybeans, breadfruit, and tangerines (Orisakwe et al., 2012). Anthropogenic factors play a vital role: smoking (smoking 1 cigarette increases the intake of cadmium in the body by 0.1 μg), polluted environment and industry are the main culprit (Nawrot et al., 2010).

As Li-ion and Li- alkaline batteries are widely used to power modern electrical devices, they possess a threat to environmental pollution, being an unquenchable source of lithium (Dolara, 2014).

COOKWARE

If you are not a fashion icon or don't change your iPhone each year, you could still be harming the environment simply by cooking food. Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are the chemical agents primarily used in making non-sticky frying pans. Besides cookware, they are frequently used for several purposes like for making strain resistant carpets and clothes. Similarly, they have found their applications in producing more efficient firefighting foams. Not to mention, military, electronics, aerospace, automotive industries heavily rely on them. Once the PFAS are used, they enter into the food chain and make their way into the human body. Since the intake of the chemicals is higher than excretion, they slowly accumulate in the body (National Institute of Environmental Health Sciences, 2019). Despite the fact that PFAS are metabolically inert, they are capable of tampering with endogenous metabolic processes. This can result in altered metabolism which in turn can change normal biochemical and physiological processes (Jiang et al., 2015).

PLASTICS

Plastic is any synthetic or semisynthetic organic polymer, however, most of them are synthetic, which are made mostly of synthetic organic polymers: polystyrene, low-density polyethylene, high-density polyethylene, polypropylene, polyvinyl chloride and polyethylene terephthalate (Kik et al., 2020). The production of plastic is growing with an unprecedented amount. In 1950, there were only about 1.7 million tons of plastics, whereas in 2017 there were already 335 million tons of them worldwide (Plastics Europe, 2017).

Even worse, the production of plastics is estimated to be doubled in the coming years (Hesler et al., 2019). The main problem of one of the widely used plastic – polystyrene is that it is non-biodegradable and end up accumulating along the food chain (Kik et al., 2020). It is well-known fact that they are harmful to the living organism, which was once more proved by ingesting polystyrene of a diameter of 50 nm to the species of Tigriopus japonicas in the concentration of 12.5 mg/L to 1.25 mg/L. This resulted in a 10 % mortality of the organism (Lee et al., 2013). As far vertebrates are concerned, several kinds of researches have been conducted, which have confirmed the penetration of chorion of zebrafish by nano plastics (Pitt et al., 2018), accumulate in the tissue and affect its behaviour and physiology (Pitt et al., 2018; Chae et al., 2018; Mattsson et al., 2017).

Furthermore, not only aminals are affected by it, but humans have also been found to be victim of nano plastics, as they were recently found in human placenta as well (Ragusa et al., 2021). An experiment conducted in 1988 showed that doses of 50 and 250 mg/kg of body weight for 4-5 days caused female rats to grow a minor number of malignant and mammary gland tumours (Conti et al., 1988). In regard to humans, they are thought to cause cancer (Loss et al., 2014). Most of the risk is inflicted on marine life as plastics are the main culprit for sea and ocean pollution (Kik et al., 2020), which is increasing rapidly (Lebreton et al., 2018). For example, in the Pacific sea, north of the equator, there is a Great Pacific garbage patch that consist of around 80 million kilograms of floating plastic in an area of thrice the size of continental France. It has been estimated that almost 1.8 trillion pieces of plastics are circulating around the ocean. It is assumed that there are at least 3 more similar garbage patches. (Boucher, 2019).

***Image 2**: Great Pacific Garbage Patch in the Pacific Ocean between Hawaii and California (Allygate, 2021).*

CHEMICAL PESTICIDES

They are the mixture of substances used in agriculture for protecting plants from pests, weeds or diseases. Some examples of them are insecticides, fungicides, herbicides, and rodenticides (World Health Organization, 1990; Alewu et al., 2011). These pesticides may be metabolized, stored, excreted or bioaccumulated in the body in fat (Pirsaheb et al., 2015). The adverse health consequences caused by insecticides include dermatological, neurological, carcinogenic, gastrointestinal, reproductive, respiratory, and endocrine effects (Sanborn et al., 2007). Similarly, misuse of pesticides can cause the population of beneficial soil microorganisms to decline. Overuse of these chemicals have effects on the soil organisms similar to human overuse of antibiotics, which can be useful for a short period of time, but after a while, they aren't beneficial for soil organisms to hold into the nutrients in the long run (Savonen, 1997). There are a number of classes of chemical pesticides, but the major ones are organochlorines, organophosphates, and carbamates.

The most widely used organochlorine is dichlorodiphenyltrichloroethane (DDT) (Alewu et al., 2011). There is also evidence that DDT and its metabolite p,p-dichlorodiphenyldichloroethylene (DDE) may have endocrine-disrupting potential and carcinogenic action (Turusov et al., 2002). In-utero exposure to both DDT and DDE has been linked with neurodevelopmental effects in children (Eskenazi et al., 2006). Moreover, a recent study has showed that DDE is related to hepatic lipid dysfunction in rats (Rodriguez-Alcala et al., 2015).

Glyphosate is the most commonly used organophosphate, which was promoted as a more ecological alternative to organochlorines (Jaga and Dharmani, 2003). This group of pesticides has been associated with dysfunction of cholinesterase enzymes (Jaga and Dharmani, 2003), interference with normal cellular metabolism of proteins, fats and carbohydrates, and a decrease in insulin secretion (Karami-Mohajeri and Abdollahi, 2011). Moreover, genotoxic effects (Li et el., 2015) and mitochondrial dysfunctions (Karami-Mohajeri and Abdollahi, 2011) are also linked with this kind of pesticides.

Some of the carbamate pesticides are aldicarb, ziram, and carbofuran. They mainly disrupt endocrine activities (Goad et al., 2004), reproductive function (Jamal et al., 2015), and usual cellular metabolism (Karami-Mohajeri and Abdollahi, 2011). Furthermore, in vitro studies have revealed carbamate's ability to result in a cytotoxic and genotoxic effect in hamster ovarian cells (Soloneski et al., 2015), induce apoptosis and necrosis in human immune cells (Li et al., 2011), natural killer cells (Li et al., 2012), and T-lymphocytes (Li et al., 2015). Similarly, new pieces of evidence suggest that carbamate can cause neurobehavioral effects (Wesseling et al., 2002), dementia (Lin et al., 2015) and non-Hodgkin's lymphoma (Zheng et al., 2001). Finally, it has been proved that carbaryl of carbamate pesticides can act as a ligand for hepatic aryl hydrocarbon receptor, which is involved in the mechanism of dioxin toxicity (Denison et al., 1998).

CONCLUSION

Overall, if counteractive measures are not applied on time, the action of cutting down trees results in deforestation, restraining nature to heal up damage caused by human beings. This imposes an extra risk for humans to exist in the long run. Global warming can also have similar devastating effects on living organisms on Earth. Similarly, overusing natural resources in unintended tasks and for industrial benefits also have the potential to eradicate us. Furthermore, the chemicals used to enhance our living standards can be harmful to us if their by-products are not properly managed and not disposed properly. Until we relent the temptation of succumbing to contemporary technology and fashion, Mother Nature will continue dwindling its ability to flourish itself, hence we risk losing our habitat. And, finally, jerry-rigging with the natural compounds can also have devastating effects, as we are still not able to comprehend the intricate relationship among different aspects of nature. This can lead to an unforeseen catastrophe, against which humanity might not yet be ready.

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Conflict of interest

Authors declare no conflicts of interest.

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ЭКОЛОГИЧЕСКИЕ ПОСЛЕДСТВИЯ ЧЕЛОВЕЧЕСКОЙ БЕЗОТВЕТСТВЕННОСТИ
ЧАСТЬ III: СВАЛКИ И ПЕСТИЦИДЫ

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РЕЗЮМЕ. Чтобы улучшить качество нашей жизни, в последние десятилетия изобретено множество технологий, таких как: электроника, персональные мобильные телефоны, особые покрытия посуды, пластик, инсектициды и многое другое. Такие вещества и приборы облегчают наше существование. Однако у этого явления есть и обратная сторона. Мы производим тонны мобильных телефонов, в то время как старые аппараты не перерабатываются и неправильно утилизируются. Они остаются на свалках, отравляя окружающую среду. Токсические элементы, необходимые для производства подобной электроники, оказывают наибольшее патогенное воздействие. Кроме того, современные кухонные приборы покрыты соединениями, вредными для человека и других видов. Использование инсектицидов же для усовершенствования сельского хозяйства в долгосрочной перспективе приведет к плачевным последствиям.

КЛЮЧЕВЫЕ СЛОВА: электроника, пестициды, пластик, посуда, галлий, висмут, индий, литий, кадмий.