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Solution to plastic waste in Algeria

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Abstract ;

Since the 1950s, the world has produced an alarming 8.3 billion tons (Mt) of plastic. This has led to plastic pollution becoming a major environmental concern, as the ever-increasing production of disposable plastic products is surpassing the world's ability to manage them. This paper reviews the global situation of plastic production, consumption and pollution. Moreover, this study focus on the proliferation of plastic waste in Algeria. We identify that the existing processes in Algeria are unable to cope with the large amounts of plastic waste produced. As a result, this research suggest an alternative approach to tackling the problem of plastic waste, based on the concept of zero waste.

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1. *Introduction*

The past 70 years have seen an exponential growth in the production and use of plastics. It is a pervasive part of our diet, our water, and our bodies. Since 1950, globally more than 8.3 billion tons of plastic have been produced. Plastic production has surpassed that of almost any other material (Gayer et al., 2017). Unfortunately, the plastic waste created is accumulating at an alarming rate, resulting in harm to both the environment and human health (Browing et al., 2021).

Fossil fuels such as oil and gas are used to produce plastics, which are often blended with hazardous additives. Hence, plastics can take a very long time to decompose, sometimes remaining in the earth or oceans for hundreds of thousands of years. The ocean is not immune to the dangers posed by plastic, which can harm fish, birds, and other marine life. On land, research is still being conducted to determine the long-term effects of plastic's decomposition and how it may impact soil and food.

This research seeks to gain insight into the problem of plastic waste by analysing the numbers and data found in scholarly literature and expert reports. Additionally, the study will focus on Algeria, a developing country struggling with mishandled waste, in order to understand how the country is addressing the issue of plastic waste.

The purpose of this research is to provide an accurate and systematic description of the issue of plastic pollution globally, with a focus on Algeria. Descriptive research is a cornerstone of this project, as it seeks to accurately portray the phenomenon being studied (Dulock, 1993). By taking a global perspective and then narrowing it to a specific case study, a comprehensive overview of plastic pollution can be achieved.

2. plastics: a global overview

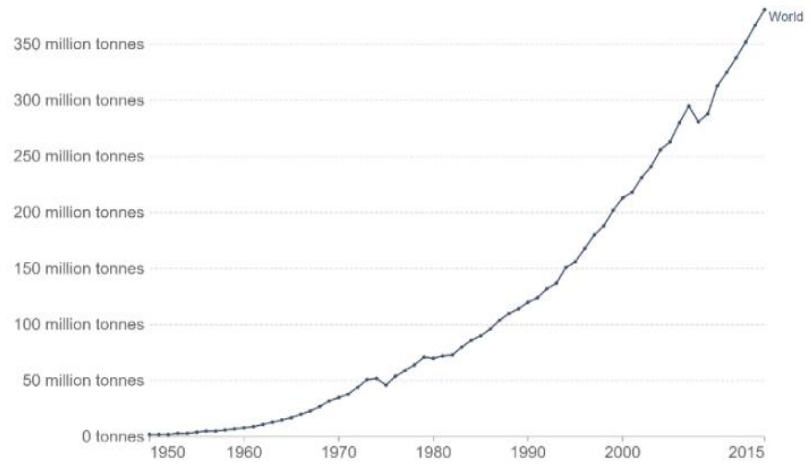
Plastics are a daily part of billions of people and are also widely used in industry. This material is favored by industry due to its advantageous traits like its lightness, strength, durability, and anti-corrosion. Additionally, it has the added benefit of being inexpensive and simple to manufacture (Millet et al., 2018). These qualities have led to a shift in plastic production over the last century. Plastic has been manufactured in large quantities since the 1950s, surpassing the production of most other materials. (Geyer et al., 2017).

In the late 1950s, the economy has become synonymous with the ever-increasing consumption of resources. Manufacturers then took advantage of this to reduce their costs by simplifying their supply chains, laying the foundations for a culture of disposability.

Disposable packaging gradually multiplied to become the norm worldwide. In the late 1970s, and in 1978, Coca-Cola replaced its famous glass bottle with a disposable PET plastic bottle. This change will mark the beginning of a new era for the drinks industry (annual production of single-use plastic bottles of coca cola is 88 billion (ATLAS of plastic, 2022).

Since 1950s, more than 8.3 billion tons metric ton (Mt) of plastic have been produced worldwide. The amount of plastic used has indeed grown constantly over the past 60 years (fig. 1), the global plastic production increased sharply from 0,35 million tons in 1950 reaching over 348 million metric tons in 2018.Enter here the text of first subtitle, Enter here the text of first subtitle, Enter here the text of first subtitle, Enter here the text of first subtitle, Enter here the text of first subtitle, Enter here the text of first subtitle, Enter here the text of first subtitle.

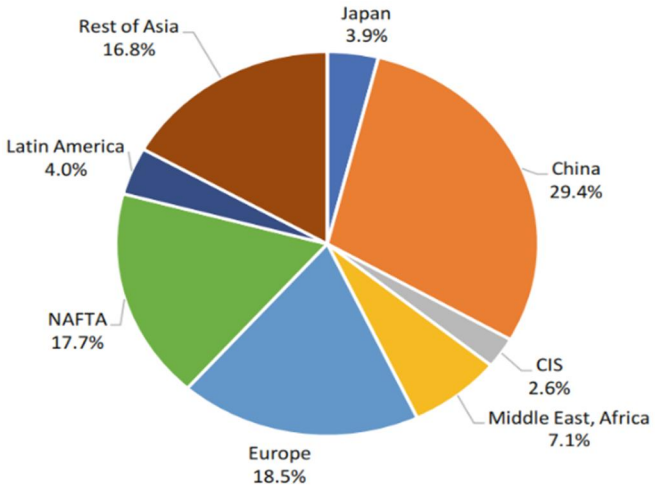
Fig.(01): Global plastics production



Source: Our world in data, (2022)

In term of distribution of global plastics production (fig. 2), China is the world's largest producer of plastics, accounting for 29.4% of global production in 2017, followed by Europe (18.5%) and North America (17.7%).

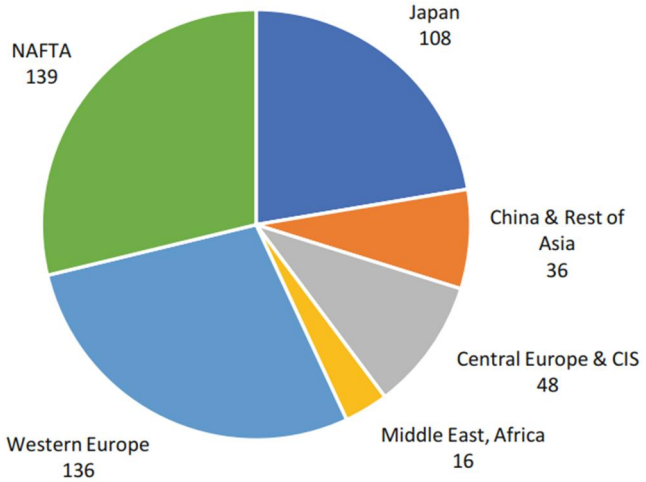
Fig. (2): Distribution of global plastics production in 2017 (kg/person)



Source: Adapted form, Plastics the fact (2018)

On a global scale, North America, Western Europe and Japan have the highest consumption rates (Figure 2). The regions that produce the most plastic are not necessarily the largest consumers. For example, Japan has one of the lowest rates of plastic production; however, it is one of the biggest consumers. On the other hand, China is the largest producer, but the rate of consumption is lower than in other regions (nearly four times lower than North America or Europe).

Fig. 3: Plastic rate consumption per region 1980-2015 (Kt)



Source: Adapted from, Statista.com

The global production of plastic increased to over 458 million Mt in 2018 and, based on present growth rates, is projected to more than triple by 2050 (Kaza et al., 2018).

3. Plastic pollution:

3.1 plastic waste in world

To date, 75% of all plastic ever produced has become waste, and volumes are rising quickly (Silpa Kaza et al., 2018). The World Bank reports that by 2050, the world is expected to generate 3.40 billion tons of waste annually, increasing drastically from today's 2.01 billion tons (World Bank, 2018) .

The largest use market for plastics is packaging; in 2018, approximately 36% of all primary production of plastic was used for packaging (Sheldon and Norton, 2020). In addition, plastic packaging typically has a very short "in-use" lifetime (often around six months or less). Some items are even used and disposed of within a few hours (e.g., single-use plastic cups, plates, carrier bags…) (Geyer, 2020). Packaging is therefore the dominant generator of plastic waste, responsible for 46% of the global total in 2018 (Ibid). As much as 32% of this waste is "mismanaged"- meaning that it is either uncollected, dumped, littered or disposed of in uncontrolled landfills- and thus likely to become pollution (Jambeck et al. (2015). In a business-as-usual scenario, global mismanaged plastic waste is forecast to triple by 2060. (Lebreton and Andrady, 2019).

High production rates and a lack of consumer awareness have led to uncontrolled plastic waste generation. Globally, around 150 million tons are released every year (Singh et al., 2017). In the USA, 34.56 million tons of post-consumer plastic waste (including residential, commercial, and institutional sources) was generated in 2015. Recycling rates remain low (slightly higher than 9%), while almost 76% of PSW is disposed in landfills the remaining fraction is used as an energy source (EPA, 2018). In 2016, the European Union countries plus Norway and Switzerland generated 27.1 million tons of post-consumer plastic waste. Of this, 31.1% was recycled, 41.6% was recovered as energy, and 27.3% ended up in landfills. It was the first time that recycling overtook landfilling (Plastic the facts, 2018). In developing countries, the percentage of plastics in MSW streams is on the increase, mainly due to changes in people's lifestyle. The summary of annual PSW generation in some Asian cities (from Indonesia, India, Thailand, Malaysia, Iran, and Bangladesh) can be estimated around 1 million tons (Dhokhikah and Trihadiningrum, 2012) .

Researchers estimated that in 2015, the Asian continent was the largest contributor to global plastic waste, generating 82 million tons. Recent statistics on plastics waste generation shows that many countries have made efforts to reduce their waste, but others are continuing along the same path. For example, China's overall plastic waste production had fallen to 21.60

million tons in 2016 compared to 59.08 million tons produced in 2010, a reduction of nearly 28 million tons (for comparison, U.S. production fell less than 4 tons during the same time period). At 34.02 million tons, the United States was the largest producer of plastic waste in the world in 2016. Germany produced 14.48 million tons of plastic waste in 2010, in 2016 the production has fallen to 6.68 million tons. Pakistan generated about 6.41 million tons of plastic waste in 2010, making it the sixth-largest producer of plastic waste, but fell to 16th in 2016 with a total of 2.73 million tons. Russia's production rose from about 5.84 million tons of plastic waste in 2010 to nearly 8.47 million tons in 2016, making it one of the few countries whose production of plastic waste is increasing rather than decreasing. (Plastics waste by countries, 2022).

3.2 The burden of plastic pollution:

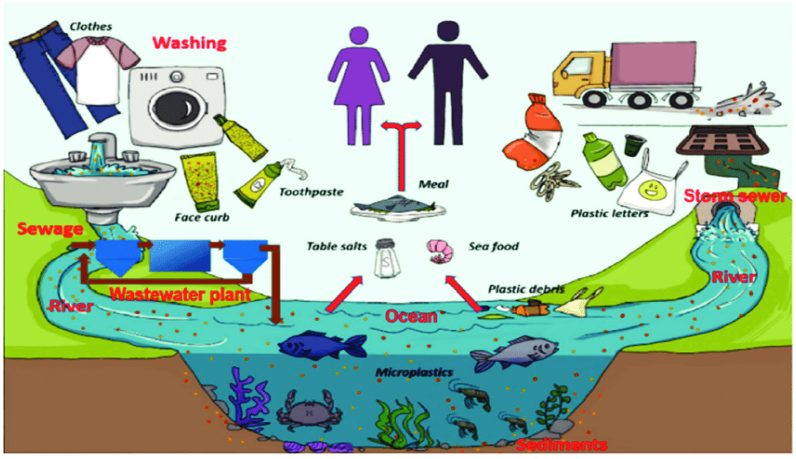
The vast majority of the monomers used to make plastics, such as ethylene and propylene, are derived from fossil hydrocarbons (Bahl et al., 2021). Due to their chemical composition, none of the commonly used plastics are biodegradable. Therefore, they accumulate in landfills or in the natural environment and do not decompose naturally (Geyer et al., 2017). Only 9 billion tons of plastic that the world has ever produced has been recycled (Atlas of plastics, 2022). Most end up in landfills or in the environment. If current consumption patterns and waste management practices continue, there will be about 12 billion tons of plastic waste in landfills and the environment by 2050 (Geyer et al., 2017). Thus, the almost permanent contamination of the natural environment by plastic waste is a growing concern. Plastic debris has been discovered in all major ocean basins (Barnes et al., 2009) (fig.4). With an estimated 4-12 million Mt of plastic waste produced on land and entering the marine environment in 2010 (Boucher and Billard, 2019).

Fig.4: Plastic waste in ocean

Plastic is the largest polluter in the oceans. According to the 2019 annual UN Environmental Survey, 8 million tons of waste are dumped into the oceans each year, 80% of which comes from plastic. There are also increasing reports of contamination of freshwater systems and terrestrial habitats (Wagner et al., 2014) and as the contamination of the environment by synthetic fibers (Zubris and Richard, 2005).

Studies suggest that it takes thousands of years for plastic bags and Styrofoam containers to decompose, contaminating soil and water (Bashir, 2013). In the light of these alarming findings, environmental NGOs speak of a major environmental disaster comparable to the threat of global warming. But beyond the environmental catastrophe, plastic waste is now entering our plates, because the material has finally intruded. For example, scientists recently discovered microplastics (fig. 5) everywhere from the bottom of the Mariana Trench to human placentas (Browning 2021). Micropalstics originate from breack down of larger plastic litter and debris in rivers and the ocean as result of exposure to UV radiation and abrasive wave action. Microplastics become now a major plastic pollution (Wu et al., 2017).

Fig. 5: Micro-plastic pollution in aquatic environments and impacts on food chains

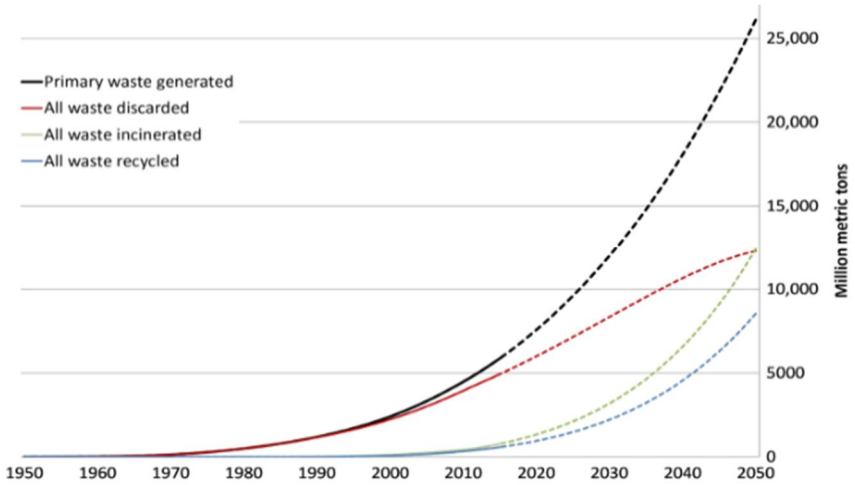


Source : Wu et al., (2017), p2

4. Limits of current plastics waste solutions:

Today, the only seemingly available options for plastic waste disposal are incineration, landfill or recycling (Nkwachukwu et al., 2013). Projecting current trends in global waste management by 2050 (fig. 6), 9,000 Mt of plastic waste will have been recycled, 12,000 Mt incinerated and 12,000 Mt released to landfills or the natural environment.

Fig. 6: Cumulative plastic waste generated and disposal (Mt metric)



Source: Geyer et al., (2017), p3

In fact, the solutions for treating plastics waste are very inadequate. In other words, the current plastic economy is not sustainable (Evode et al., 2021). Recycling plastics can be a way to prevent plastics from entering the environment, but it is compromised if products are not properly designed. Chemicals added to plastic polymers, mixed materials and food packaging contaminated with food waste make recycling difficult and expensive (Geueke et al., 2018).

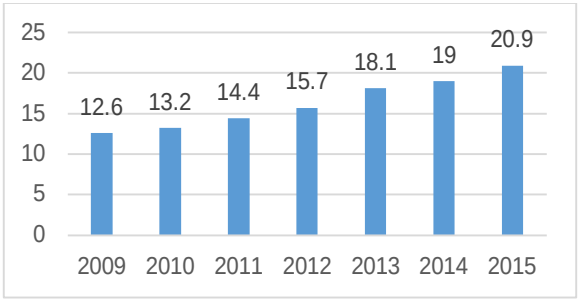
Thus, the plastic problem is a design problem (Foschi et al., 2020). The systems of plastic manufacturing, distribution, consumption and trade - that is, the global economy - must change (Law and Narayan, 2022). The linear model of planned obsolescence, whereby objects are designed to be disposed immediately after use, must be terminated. Governments need to be at the forefront of this shift, forcing manufacturers to be responsible for the lifecycle of their products. Hence, an effective response to the plastic pollution problem requires new approaches across the entire value chain for plastics (Johansen et al., 2022). It seems clear, however, that in many countries and communities around the world poor waste management is a key driver of the problem (Johansen et al., 2022). Many developing countries cannot manage the waste they produce due to a variety of constraints, such as lack of infrastructure and education (Browning 2021; Chow et al., 2017). While developing countries are dealing with the burden of properly disposing of their own waste, many developed countries like the US and the EU decide to ship their waste to these countries with already fragile waste management systems (Browning, 2021).

5. Plastic pollution in Algeria:

Three factors have been attributed to the rising rates of plastic pollution in the world, and these are also applicable in developing countries. These factors are human population growth, urbanization and industrialization (Waters et al. 2016), and with an increase in these factors, plastic pollution rate may further be exacerbated, and its impacts get more severe .

Available literature shows that GDP has a strong impact on plastic consumption (Hossain et al., 2021), which can also be seen for African countries. For example, the yearly per capita plastic consumption for Algeria was growing up from 12.6 kg/year in 2009 to 20.9 kg/year in 2015. It has almost doubled in less than ten years with a significant evolution (fig. 7) .

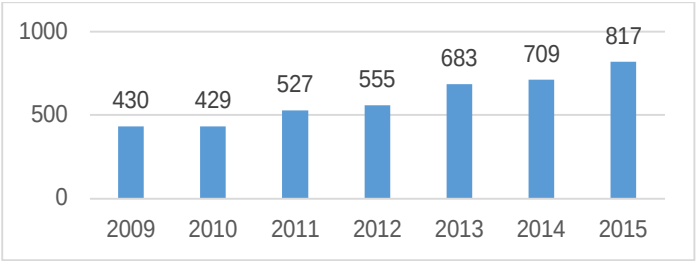
Fig. 7: Plastics consumption per capita (Algeria) Kg/year



Source: Adapted from, EUROMAP (2016)

Otherwise, one general observation is that plastics are imported at higher amounts in primary form than as finished products. This implies that the rates of plastic processing and production activities using imported primary polymers are high in many countries of Africa. For Algeria, the data provided by the National Center for Informatics and Statistics of the Algerian Customs (CNIS) show imports worth 2.174 billion USD of plastics, of which USD 1.904 billion of raw products destined for the plastic industry with a rate of 87.58% and USD 269 million of finished plastic products (AND, 2020).

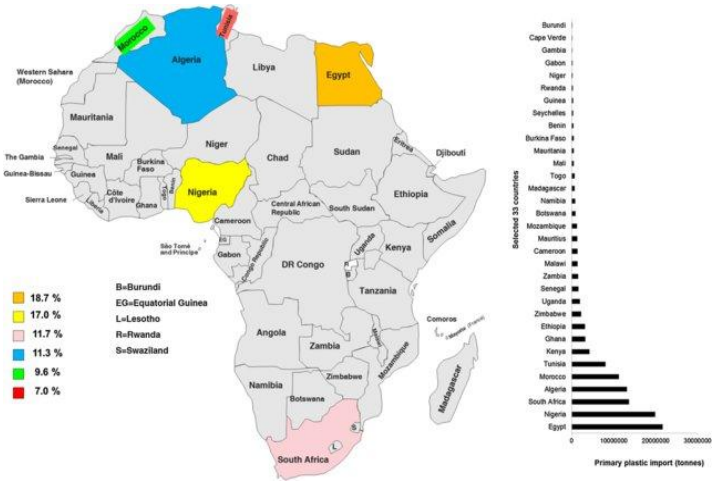
Fig. 8: Algerian's Plastic import per Kt



Source : Adapted from, EUROMAP

The time trend for plastics imports in Algeria (Fig.8) shows a consistent yearly increase - from an import of 430 Kt in 2009 to 817 Kt in 2016. From 2009 to 2016, approximately 4150 Kt were imported and this makes up about 11.3% of the whole primary plastics importation in Africa (fig.9). Babayemi et al., (2019), using available data between 1990 and 2017, examined plastic imports in the form of polymers and products from 33 African countries. Over the course of the 27-year period, these countries used 118 million tonnes of imported plastic. In all, six nations—Egypt, Nigeria, South Africa, Algeria, Morocco, and Tunisia—consumed 75% of the 33 African nations' total imports of plastic – 51% of the extrapolated total plastic consumption in Africa.

Fig. 9: The six African countries with the highest import and use of plastic (1990/2017)



Source: Babayemi et al., (2019), p7

Another cause of the high rate of plastic pollution is rapid and uncontrolled urbanization in developing countries. Indeed, one of the most worrisome consequences in the developing world, is the management of solid, liquid, and toxic waste. For example, Africa generated a total of 19 million tonnes of plastic waste in 2015, of which 17 million tonnes were mismanaged (Babayemi et al., 2019). This is compared to the global amount of 60-99 million tonnes of mismanaged plastic waste in 2015, projected to triple by 2060 in the business-as-usual scenario (Lebreton and Andrady, 2019). The developing countries are poor waste management practice and ignorance of its consequences on human and environmental health (Browing et al., 2021). There are no adequate infrastructures for solid waste management or land use practice that forestalls indiscriminate waste disposal (Ibid). Actually, Algeria is no exception and is facing problems of waste proliferation as a result of strong population growth, lifestyle change and rapid urbanization. Algeria generated each year 34 Mt of waste with 13.1 Mt of municipal solid waste MSW, this waste can be of a variety of nature and materials (organic waste, plastics, paperboard, glass, etc.). Plastics constitute 15% of MSW in Algeria ; while an estimated 0.52 Mt of waste plastic are mismanaged yearly in the country,

with 70,000-190,000 tonnes constituting marine debris (AND, 2020). In addition to contamination by landfill sites, the light weight of some plastic bags, plastic packaging, straws and polystyrene make it easier for winds to blow them around - eventually moving them into water bodies. Together with other waste plastic like PET bottles, they constitute a larger fraction of marine litter. Algeria has a coastline stretching over more than 1,600 km, this area represents a fragile ecosystem and is constantly threatened by various pollution, in particular plastic waste, 81% of marine waste is plastic waste (AND, 2020) and is of terrestrial origin, it is waste deliberately or accidentally escaped from collection circuits

5.1. Waste management in Algeria:

Waste management in Algeria is currently carried out through four methods: direct management by municipalities, public industrial and commercial establishments, public procurement contracts with companies, and public service delegation:

- In the case of direct management, the municipality assumes complete control of waste removal and disposal services. This method is the most widely used among Algerian municipalitie.

- An alternative method of managing waste removal and disposal is through the establishment of Public Administrative Institutions (EPAs) and Public Industrial and Commercial Institutions (EPICs). However, this method is not widely used in Algeria. A decree was issued in the late 2000s outlining the procedures for establishing EPICs, and by 2020, 62 EPICs had been established in the country (AND, 2020) .

- Public procurement refers to a contract for the supply of works, supplies, or services between a municipality and a company, which may cover all or part of the public service, including both administrative and industrial and commercial sectors.

- Public service delegation is typically used in cities where there are shortages of municipal waste collection equipment and staff. According to Section 155 and 156 of the 2001 Act, communal public services, such as household waste services, may be delegated to other organizations.

Over the past decade, Algeria has experienced significant environmental pressures, particularly in regards to municipal waste management. These pressures have resulted in a decline in hygiene and public health, despite efforts by the government to address the issue (Djemassi, 2012).

In fact, waste management is a significant challenge in Algeria and other developing countries due to high levels of waste production. In Algeria, the amount of waste collected is only a small fraction of the total waste produced, and there are no reliable statistics on the quantities of waste collected or produced. It is estimated that the overall amount of waste generated in Algeria will almost double over the next 17 years, increasing from 34 million tons (0.8 kg/inhabitant) currently to 73 million tons (1.23 kg/inhabitant) by 2035 (SNGID, 2035), (MEER, 2018). In most developing countries, the simplest way to dispose of household waste is through controlled or uncontrolled landfills (fig. 10). A significant portion of household waste, including plastics, is still disposed of in this manner. This method is the most convenient option for disposing of these residues.

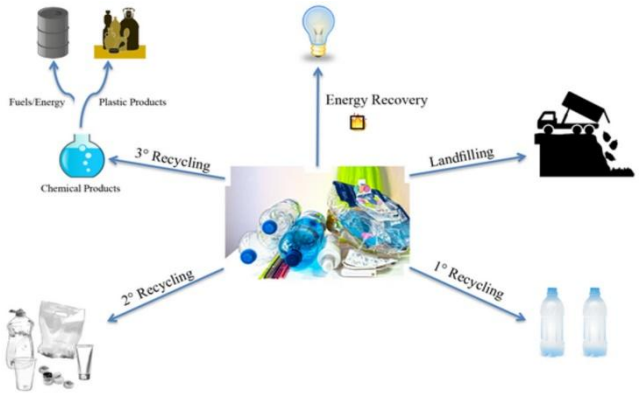
Fig. 10: Landfill site

However, this method has the disadvantage of being unattractive and not providing any benefits, it has the drawback of being neither aesthetic nor rewarding. Landfills also pose environmental risks, including soil imbalances, water contamination from leachates, and air pollution from smoke releases. The inadequate functioning of household waste management services in major Algerian cities is a public health concern. There is a lack of equipment for municipal waste management. Despite Algeria investing 83 billion DA between 2002 and 2017 to improve waste management services (AND, 2020), the chosen approach has shown its limitations. In landfills and wild dumps, waste continues to accumulate and grow without any limits.

5.2. Recovering plastic waste:

Once produced, there are two main ways to make plastic waste valuable: incineration, and recycling (Huang, 2015; Schneider and Ragossnig, 2015) (fig. 11):

Fig. 11: Approaches for treating plastic waste



Source: Thiounn and Smith, 2020, p1349

- Waste incineration is a widely used method for recovering energy from municipal solid waste (Schneider and Ragossnig, 2015). This method allows for the utilization of the energy potential of plastics, which can generate electricity as plastics have a very high calorific value, often exceeding 40 MJ/kg (KMN, 2017). However, this method has the disadvantage of emitting greenhouse gases such as carbon dioxide (CO2) and potentially toxic products, such as acid gases (HCl, SO2, HF), dioxins, furans, heavy metals, and polychlorinated compounds (Agnes and Rajmund, 2016).
- Recycling is the best solution for processing plastic waste as it limits environmental impact and generates significant socioeconomic benefits (d'Ambrières, 2019). Over the years, several recycling methods have been developed, such as primary recycling, where used plastics are recovered by extrusion and made into materials similar to the original materials. However, this process requires separate and selective collection of plastic waste for each type of plastic, which poses a problem of high operating costs.
- Mechanical or secondary recycling involves collecting, sorting and washing waste, then melting and molding it into a new shape or processing it into granules. This method is only possible for simple polymers, as the more complex and contaminated the waste, the harder it is to sort and recycle using this technique (Vollmer et al., 2020; Ragaert et al., 2017).An alternative to mechanical recycling is chemical recycling of plastic waste. Efficient chemical recycling can produce feedstocks for various uses, including fuels and chemical feedstocks to replace petrochemicals (Thiounn and Smith, 2020; Ragaert et al., 2017; Jiang et al., 2022). This type of recycling converts plastic materials into smaller molecules, usually liquids or gases, such as pyrolysis oil or synthesis gas, which are commonly used as raw materials for new fuels (kerosene, dimethyl ether, gas oil) and chemicals (e.g. methanol, olefins, alcohols, fertilizers, insecticides, fungicides) (Fahim et al., 2021).

5.3. Limitations of recovering plastic waste tools and methods:

There are several limitations to the current tools and methods used for recovering plastic waste. One limitation is that not all types of plastic can be easily recovered or recycled using current technology. Some types of plastic are difficult to sort and recycle, making them less economical to recover. Additionally, the cost of collecting, sorting and recycling plastic waste can be high, making it difficult for municipalities and waste management companies to implement these methods on a large scale. Another limitation is that not all recovered plastic can be used to produce new products of the same quality as virgin plastic. This means that recycled plastic may not be suitable for certain applications and therefore may have a lower value. Furthermore, the lack of proper infrastructure and collection systems in some areas can make it difficult to recover plastic waste.

While recycling is generally considered more preferable than incineration, it does present significant economic and technical challenges. These challenges are one reason why only 14% of all plastic waste has been recycled worldwide. However, the energy savings to society from recycling one ton of mixed plastic waste is approximately seven barrels of oil. This demonstrates the potential for significant oil and energy conservation through the implementation of an effective recycling strategy (Thiounn and Smith, 2020).

In Algeria, incineration with energy recovery does not exist, the major obstacle is the very high cost of this type of installation. Regarding recycling, the rate is also very low because the waste recovery networks are not developed. Only 5-7% of household and similar waste is recycled, the recycling rate of plastic packaging waste is between 2-3% (although obtaining up-to-date figures and valid information on this rate remains difficult due to the informal nature of the stakeholders that prevails in this sector). A study of the National Agency for Waste (NAW) found that the plastic recovery rate is less than 3%, with respect to the number of recyclers and recyclers registered in the NAW database: 358 for PET, 343 for HDPE and 336 for plastic films (AND, 2020). This study mentions that about 8 Billion DA/year is the loss of profit for the Algerian economy due to unrecovered waste. In addition, it projects that if plastic recycling sector is developed, we can create more than 7,200 jobs, including 220 direct and more than 5,000 indirect jobs, and 90 units in the field of plastic waste recycling. According to the study, the recycling of plastic waste will increase the area of 100,000 m3 at the level of the Technical Landfill Center (TLC), where the availability of land is very high in several wilayas (AND, 2020).

In fact, the recycling industry in Algeria is poorly organized and requires a new approach. Adopting new incentives to bring together the various stakeholders in this field, including those working informally, is necessary. By implementing measures to encourage recycling,

manufacturers of plastic products, regulators, waste management companies, and consumers can all play a significant role in the growth of the recycling industry (d'Ambrières, 2019).

In a global scale, currently 14% of plastic packaging is recycled, which is insufficient compared to the huge amounts of plastic waste produced. Recycling alone will not solve the plastic crisis. We need new ideas that get to the root of the problem. Existing processes that offer alternative uses for plastic waste cannot handle the volumes produced, which are considerable. And as consumption rises, even high-quality recycling fails to bring down the quantities of oil and gas extracted.

The most effective solution to the damage caused by this material at the end of its useful life would therefore be to reduce its production at source, and the first step to be taken is to eliminate single-use items (d'Ambrière, 2019). However, consumption patterns must also change.

Indeed, on March 15, 2019, the UN brought together over 170 member states of the Environment Assembly in Nairobi to make several commitments, including a significant reduction in single-use plastics. In response to this awareness, 60 countries have implemented bans on certain single-use plastic items, sending a strong message to the rest of the world that change is necessary (Hege et al., 2020) .

6. Zero waste approach as an alternative solution:

Waste management is a pressing issue facing communities around the world. Landfills and incinerators, which are the most common methods of waste disposal, have negative environmental and health impacts. Moreover, these methods do not address the root causes of waste generation and do not promote resource conservation.

Zero waste management is a holistic approach that aims to eliminate waste and pollution at the source by redesigning systems and products to be regenerative and to close the loop on resource use (Lau et al., 2020). It is an alternative to the traditional waste management system that focuses on end-of-life disposal (Zaman, 2015; Lehmann, 2011). In the Zero Waste stream, waste is framed as a resource, an environmental good that moves in a circular path, recovered through Reuse, Recycle, or Repair at source. Zero waste means "designing and managing products and processes systematically to avoid and eliminate waste, and to recover all resources from the waste stream" (Zero Waste International Alliance, 2009). The zero waste management model is based on the following principles:

a) Waste prevention: This involves reducing the amount of waste generated at the source by designing products and systems that eliminate the need for waste.

b) Reuse: This involves using a product more than once before it is recycled or disposed of.

c) Recycle: This involves breaking down a product into its raw materials and using those materials to create new products.

d) Recovery: This involves using waste as a resource by turning it into energy or using it as a feedstock for other products.

e) Redesign: This involves redesigning products and systems to eliminate waste and promote resource conservation.

6.1. Transition to zero waste model:

According to Zaman and Lehmann (2011), the key drivers of a Zero Waste city are based on shortterm and long-term implementation strategies. Awareness and education, behavior change and systems thinking are long-term strategies (Chow et al., 2017), whereas innovative industrial design, legislation and 100% recycling are the short-term strategies to implement in a city. All these drivers facilitate the conversion of solid waste into resource, where waste is recirculated in the market. By recirculating, waste is avoided from the disposal facility and moves in circular pattern.

Transitioning to a zero waste model requires a systems-level approach that involves the participation of multiple stakeholders, including governments, businesses, and communities. Some steps that can be taken to transition to a zero waste model include:

- Develop a zero waste plan: This involves identifying the current sources of waste, setting goals and targets for waste reduction, and developing strategies to achieve those targets.
- Implement waste prevention programs: This involves designing products and systems that eliminate the need for waste, such as refillable packaging, repairable products, and compostable materials.
- Promote reuse and repair: This involves encouraging the use of second-hand goods and the repair of broken or damaged products.
- Enhance recycling and recovery: This involves improving recycling infrastructure, increasing the recycling rates of materials, and finding innovative ways to recover resources from waste.
- Engage stakeholders: This involves involving multiple stakeholders, such as governments, businesses, and communities, in the transition to a zero waste model.

6.2. Benefits from ZWMS:

Implementing a zero waste management system can have numerous benefits for the environment, economy, and society. Some of these benefits include:

- Environmental benefits: Zero waste management reduces the negative impacts of waste on the environment, such as air pollution, water pollution, and greenhouse gas emissions. It also conserves natural resources, such as water and minerals, by reducing the need to extract new resources and by recycling and reusing existing ones.
- Economic benefits: Zero waste management can create jobs and stimulate economic growth by establishing a circular economy that promotes the reuse and recycling of materials. It can

also reduce costs for businesses and governments by decreasing the need for waste disposal and increasing the value of resources.

- Social benefits: Zero waste management can improve public health by reducing the negative impacts of waste on air and water quality. It can also enhance community well-being by promoting social cohesion and sustainability.

Many developed countries have already adopted this approach. However, the proliferation of similar approaches is essential in developing countries like Algeria to ensure a just transition to a plastic-free economy. For example, in 2018, the city of San Fernando in the Philippines managed to ensure that 80% of its waste does not end up in landfills, but is recycled by a cooperative (Ancheta et al., 2020).

The city has implemented several measures to decrease its impact on the environment caused by plastic. One of the most significant actions was the prohibition of plastic shopping bags, which impacted 9,000 businesses. Additionally, a tax on disposable packaging was introduced while providing alternative solutions, which were well received by 85% of residents due to the city's efforts to educate and communicate the changes through home visits, radio announcements, professional dialogues, and meetings with shopping centers, which are significant producers of waste. This initiative not only helped the environment but also had a positive impact on the city's finances. The expenses for transporting solid waste to the 40 km landfill decreased by 82%, which allowed the city to hire new staff and improve current infrastructure.

The example of San Fernando illustrates that a successful zero waste strategy must incorporate both "substantive" and "formal" measures. "Substantive" measures relate to the management system itself and include the handling of organic waste, the separation of different types of waste, the adoption of decentralized and low-tech models, economic incentives, the ban on certain materials, and the implementation of policies and measures to decrease waste. "Formal" measures involve engaging individuals and professionals throughout the policy development process, resulting in the emergence of new business models and savings for municipalities that can be reinvested into the community (Ancheta et al., 2020).

7. Conclusion:

This study presented a general overview of plastic pollution worldwide. Plastic waste remains a thorny environmental problem. We have presented the available means to deal with plastic waste. While incineration and recycling offer many benefits, these solutions will not solve the plastic crisis. Moreover, this research showed Algeria’s difficulties in dealing with plastic waste that negatively affects the environment. Algeria should develop a new policy to overcome the shortcomings of the current waste management system. Hence, we presented a

zero waste approach that can be an effective alternative to solve the plastic waste problem in Algeria. A zero waste strategy must combine ‘substantive’ and ‘formal’ measures based on circular economy principles. The first concerns the management system itself and concerns the treatment of organic waste, the separate collection of different types of waste, the implementation of decentralized and low-tech models and economic incentives, the prohibition of certain materials and the adoption of policies and measures to reduce waste. "Formal" measures involve individuals and professionals at all stages of policy development. Without significant and immediate attention, we run the risk of a social and environmental catastrophe.The conclusion of a research paper needs to summarize the content and purpose of the article. The conclusion of a research paper needs to summarize the content and purpose of the article. The conclusion of a research paper needs to summarize the content and purpose of the article. The conclusion of a research paper needs to summarize the content and purpose of the article. The conclusion of a research paper needs to summarize the content and purpose of the article.

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