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Impact of Plastic waste on the environment and humans health in Pakistan: Effective Waste Management Strategies and sustainable solutions

Pakistan'da Plastik atıkların çevre ve insan sağlığı üzerindeki etkisi: Etkili Atık Yönetimi Stratejileri ve sürdürülebilir çözümler

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ANAHTAR KELİMELER

Plastik kirliliği
Sağlık tehdidi ve Çevresel problem
Sürdürülebilir çözümler
Geri dönüşüm
Enerji geri kazanımı

KEYWORDS

Plastic pollution
Health threat and Environmental problem
Sustainable solution
Recycling
Energy recovery

ÖZ

Son zamanlarda atıklar ciddi çevre sorunlarından biridir. Plastik okyanusa atılıyor ve insan, hayvan ve su yaşamı için tehlikeli. Plastiğin açık bir şekilde yakılması veya atılması hava kirliliği yaratır. Ayrıca suyu ve toprağı da etkiler. Bu uygulama genel çevreyi ve ekolojik döngüyü bozmaktadır. Mikro-plastik canlıların vücuduna besin zinciri yoluyla geldiği için sağlık tehditleri fark ediliyor. Birçok ülke plastiğin kullanımına kısıtlamalar getirdi ancak bu, plastik kirliliğini ortadan kaldırmak için yeterli değil. Plastik yeniden kullanılabilir ve geri dönüştürülebilir. Bu sorunu çözmek ve başta enerji geri kazanımı olmak üzere plastik atık yönetimi için sürdürülebilir bir çözüm bulmak için çeşitli çalışmalar yapılmıştır. Bu çalışma, çevre veya insan sağlığı sorunları da dahil olmak üzere Pakistan'daki plastik atık sorunlarına odaklanmaktadır. Bu çalışma aynı zamanda Pakistan'da başlatılması gereken sürdürülebilir çözümleri de göstermiştir. Bu çalışma, atıkların yeni teknolojilerle enerjiye dönüştürülmesi konusunda en önemli çözümleri önermektedir.

ABSTRACT

Recently waste is one of the serious environmental issues. Plastic is being thrown into ocean and it is dangerous to human, animal and aquatic life. Burning or dumping plastic openly creates air pollution. It also affects water and soil. This practice disturbs overall environment and ecological cycle. Health threats are recognized due to micro-plastic because it comes to living things' body through food chain. Several countries have put limitations to use plastic but it is not enough to eliminate plastic pollution. Plastic can be reused and recycled. Several studies have been conducted to tackle this issue and find sustainable solution for plastic waste management, especially energy recovery. This study is focused to plastic waste issues in Pakistan including environmental or human health issues. This study also demonstrated sustainable solutions which need to be initiated in Pakistan. This study recommends the most important solutions that waste should be converted into energy with new technologies.

1. Introduction

Waste and its management are universal issues around the globe. Several types of waste have been recognized which are the big threat to environment and health of living things.

Plastic waste is one of the serious global challenges that are increasing day by day. Recently, it is one of the most highlighted issues because plastic waste has been found around the beaches due to lack of social awareness (Hina et al. 2020, Cook and Halden 2020). Every year,

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approximately 800000000 kilograms of plastic waste is discarded into the oceans and this action is destroying aquatic life (Chawla et al. 2022). If it continues, it is predicted that there will be more plastic in the oceans than fish by 2050 (Cook and Halden 2020). Scholars have been striving to tackle this issue that why plastic and rubber wastes is thrown away in the environmental bodies (Alyousef et al. 2021). Plastic waste is social and environmental issue. In addition, it is not only ocean problem; it pollutes the whole environment because plastic waste is burned in several countries (Yusuf et al. 2022, Kanellopoulos et al. 2021). People do not care about it. The social awareness about the environment is important to be given with different medium especially regarding plastic and rubber wastes disposal that cause serious issues around the globe.

Pakistan is one the country where people do not care about environment because of social awareness. Pakistan alone generated about 390000000 kilograms of plastic waste in 2020 (Batool and Ch 2009). Exactly 70% of this plastic waste is sent to landfills, improper dumps into environmental bodies which results in soil and water pollution across the country (Khan 2021, WWF 2022, Jabeen et al. 2022). The Pakistani government has put restriction in different plastic products and allows the manufacture to usage of Oxo-biodegradable shopping bags because these types of bags cannot fly here there with air pressure and most important things is that they are also reusable. Though, there was no proper implementation on these agreements. There is another program, where it was set that only particular substance will be used for this purpose in Pakistan, including Karachi (Desk 2019, Longsheng et al. 2022), but it was also not followed accordingly. Karachi city is one of the largest cities where a large number of locally manufactured plastic products are being used. It is very difficult to manage such huge amount of plastic in a short time (Desk 2019).

Globally, wide-ranging studies have been conducted to improve MSW management system that includes proper treatment before discarding (Das et al. 2021, Zhu et al. 2021, Yukalang, Clarke, and Ross 2018). There are several technologies are being adopted by developing countries to manage plastic waste such as reduce; reuse, recycle. It is also documented that waste can be resources for energy recovery. Several methods are being used for energy recovery from solid waste (Malamis et al. 2016). At the moment, urban areas are considered as 56% of the total global-population. It is accountable for producing momentous amount of municipal solid waste (MSW) (Hemidat et al. 2022). Landfills get approximately 70%, whereas, very low percentage of waste is documented for energy production (Vergara and Tchobanoglous 2012). Plastic waste is generated in huge percentage in Pakistan because several companies are using plastic for their production. If this waste is utilized for energy recovery then Pakistan can tackle several deficiencies such as electricity. This study is focused to plastic waste issues in Pakistan

including environmental or human health issues. This study also demonstrated sustainable solutions which need to be applied in Pakistan. One of the most important solutions is that waste has potential to recover energy with certain technologies.

2. Sources of plastic waste in Pakistan

Pakistan is one of the regions with high percentage of plastic waste mismanagement in South Asia (Ferronato and Torretta 2019). Plastic is widely used because it is cheap and convenient. Recently, plastic used in electrical and electronic equipment (EEE) is more in highly developed countries than other countries (Goosey and Goosey 2019). Such waste can be reused and also can be recycled. Such electrical appliances are computers, screens, mobile phones, TVs, etc. (Herrerias-Martínez and Leroy 2019, Goosey and Goosey 2019, Ijomah and Danis 2019, Townsend 2011). In addition, more waste is found in big cities due to urbanization because they use plastic for interior design. Except plastic, some of them are not liable to decompose; they are known as inert waste such as construction waste (dirt, debris, rocks, etc.) and demolition (Ehrig and Stegmann 2018, El-Haggar 2007, Osmani and Villoria-Sález 2019). Industrial sector has different types of waste. Composite wastes are under tetra packs, clothing, waste plastic, etc. Other types of waste such as chemicals, paints, spray cans, shoe polish, bulbs, fluorescent tubes, fertilizers and pesticides belong to domestic hazardous waste and toxic waste. They all also connected with plastic waste (Kundariya et al. 2021, Vignesh, Rajadesingu, and Arunachalam 2021, Woodard and Curran 2006, Artiola 2019, Sam and Barik 2019).

In Pakistan, biggest plastic sources and polluters are Coca-Cola, PepsiCo, Unilever, and Nestle (Maryam Arshad 2020). It needs strict legislation to tackle their plastic pollution. Plastic bottles, plastic bottle caps, plastic straws, stirrers, plastic grocery bags, and food wrappers are the next most common item. In addition, other sources such as Cigarette butts, whose filters have tiny plastic fibers (Belzagui et al. 2021). They are the most common kinds of plastic waste in the environment. Pakistani people are not realizing the facts that, it is difficult to manage the waste because it adversely affects overall environment and living things especially humans (Khan 2021, Ahmed et al. 2020). It affects more wildlife, wildlife habitat (Akram 2010). In addition, it does not decompose on its own easily. Even though Pakistan has become one of 128 countries with a single-use plastic (polythene) bag ban in place in 2019 (Khan 2021) but no one follows the rules and regulations. In Pakistan, sources of plastic waste vary city to city but mostly it comes from industries and home usage products, see fig 1.

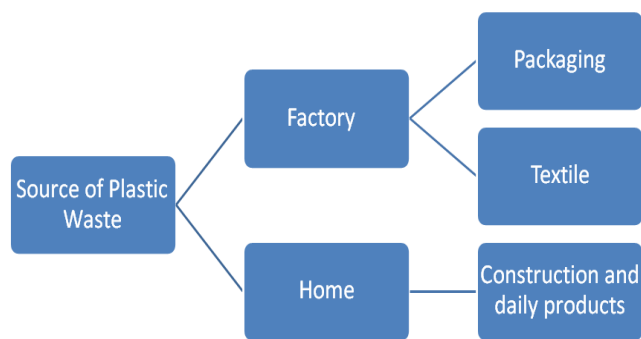


Figure 1. Main sources of plastic waste in Pakistan

Pakistan Plastic Manufacturers Association (PPMA) reported that the use of plastic per capita is 5.5 kilograms in Pakistan and the country imports 1070 kilograms of polymers annually (Desk 2019). Regrettably, plastics waste is considered as 65% of the total waste in Pakistan; with an estimated annual increase of 15% of plastic bag usage (WWF 2022). Pakistan banned some plastic production and it affects 600,000 kg annually. The achievement of the ban is determined by social awareness. State should take steps (especially Ministry of Climate Change) such as educational campaigns for citizens and manufacturers. In addition, there should be the free distribution of alternative bags for a limited time so that people should be habitual. This program should be taken by the Pakistan Environmental Protection Agency (EPA) and special attention should be given by media coverage agencies. Approach to reusable bags and social awareness should be given to the citizens (Khan 2021, Ahmed et al. 2020). These practices can tackle this plastic pollution.

3. Impact of plastic waste on environment and human health

Indeed there is no any engineered way of disposal in Pakistan (Siddiqi et al. 2019). Several technologies have been introduced to deal with waste. Those technologies propose best solution to tackle public health and environmental problems in Pakistan. Implementation of those technologies may reduce amount of waste and it will improve uncontrolled manner of management regarding waste (Longsheng et al. 2022). Main problem is to implement properly. Plastic recyclers are working in several cities of Pakistan but their methods are not eco-friendly and that's the reason it is threat to the environment or on public health. They just melt the plastic and make new plastic for further usage (Desk 2019). Problems due to plastic waste are increasing day by day. All problems should be highlighted so that authorities and nation should take some steps to deal with them.

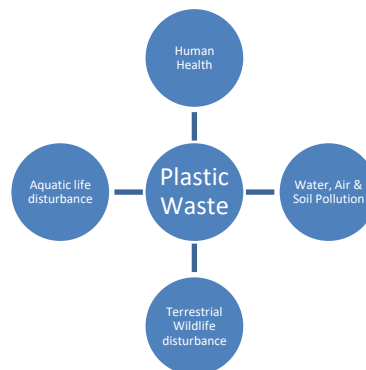


Figure 2. Impact of Plastic Waste

In Pakistan, condition of solid waste management is a problem of crucial concern because waste-related diseases is responsible for death around 5 million people each year (Akmal and Jamil 2021). Several health hazards caused by solid waste have been documented such as diseases like diarrhea, dysentery, typhoid, hepatitis, cholera, skin, eye infections etc. (Jerie 2016, Ankit et al. 2021). Inhalation problems in children and adults are caused due to dust in the air at dumpsites (Njoku, Edokpayi, and Odiyo 2019). Due to improper disposal, several species such as mosquitoes, flies, bacteria, dogs, cats and rats spread several types of diseases such as malaria, flea born fever, yellow fever, plague, intestinal, parasitic and skin diseases etc. (Mataloni et al. 2016). Pakistan is working for solid waste management including all types of wastes but immediate steps should be taken to avoid such health issues. Due to proper waste management, several problems including health and pollution will be solved.

4. Transportation of solid waste in Pakistan

Transportation plays a prominent role in waste management. It is used to transfer the waste from collection point to recycling or disposal destination (Hina et al. 2020). Inefficient waste management and inadequate waste collection system negatively impacts the environment, leading to socio-environmental and serious health issues (Batool and Ch 2009). Developed countries have organized system of transportation for waste collection but developing countries or poor countries have improper way which adversely impact. Similar to other developing countries, Pakistan is also having poor waste management infrastructure so it is leading to serious environmental challenges (Marshall and Farahbakhsh 2013). Donkey carts or tractor trolleys are used for waste collection and transportation from the societies and streets. Huge amount of waste is dropped out from those transportation means on the roads. Smell spreads in the air and citizens feel disturbance (Shah et al. 2019). Waste is dumped on the common roads and streets in several areas and proper waste collection system is not available. In urban areas, there is no appropriate system for waste collection separately for different types of waste as other countries had initiated this system long ago (Khan 2021, Ahmed et al. 2020). Key issues

concerning solid waste management in Pakistan are needed to be solved.

In addition, landfill sites in Pakistan are not sanitary controlled so this thing brings environmental issues such as soil, water and air pollution. Moreover, Citizens are not aware of risks and they do not know the ways of disposing of wastes. Improper disposals, lack of appropriate discarding techniques and resources for solid waste management have created environmental and public health issues (Siddiqi et al. 2019, Ahmed et al. 2021, EPA 2022, Maria et al. 2020). Pakistan government needs to take steps for proper waste management and Pakistani nationals are required social awareness about it, including reduce, reuse, recycle and energy recovery from waste.

5. Sustainable solutions to decrease the plastic waste in Pakistan

In many regions of Pakistan, solid waste is generally discarded in open places (Masood, Barlow, and Wilson 2014). Management of Solid waste and its methods are varied province to province and city to city. Sometimes Pakistan's waste is reused and recovered for recycling, mostly by scavengers (Majeed, Batool, and Chaudhry 2017). There should advance-technology to manage MSW from the time it is generated to its safe-disposal. The local and public municipal authorities need to work together for managing overall cities waste every day. There are landfill sites in major cities of Pakistan but poor waste management has been noticed. Usually, waste management costs more than US\$20 per tonne of waste, and this cost is generally for waste collection from the spot only (Masood, Barlow, and Wilson 2014). Pakistan's biggest city Karachi uses three big sanitary landfill sites, whereas, Lahore is second-largest city uses two landfill sites. Pakistan's Other big cities are still planning to build proper sanitary landfill sites (Ahmed et al. 2021). Bahawalpur is a region with pre-dominant rural-urban infusion; its current waste management system is classified by straining resources, prominent source separation, little production rates (0.424 kg/capita/day), and open discarding system. The waste composition analysis revealed that organic wastes as the bigger constituent (64%), recyclables (27%) and inert (9%) (Majeed, Batool, and Chaudhry 2018).

Pakistan needs strict environmental laws regarding solid waste management issues and there should be immediate implementation. Though, Pakistan has reported that environmental laws and government agencies have been developed to overcome environmental problem (Siddiqi et al. 2019). Pakistan is receiving technical support from donors, including the World-Bank. Notwithstanding the environmental institutes, laws, and other initiatives, Pakistan could not resolve the all issues. Environmental-legislation is not yet mature in Pakistan, comparing to those developed countries (Jabeen et al. 2022). There should be strict rules in public and street for waste disposal and implementation is important especially in big cities.

Ministry of environment around the globe are recognizing the need to change national action plans and coordinate action to accelerate circular plastic solutions (Khan 2021). Pakistani Government should do so. Awareness should be given to people to practice different to avoid waste generation.

5.1. Shop Friendly

Plastic bags were considered as a modern convenience several years ago but recently they are burden. Due to plastic pollution, people should change their behavior to avoid this problem around the world. Pakistani government should take actions. They can be efficiently replaced by other reusable bags. In some countries, consumers are supposed to bring own shopping bags instead of using plastic bags (Nguyen 2021). Consumers may understand the importance of sustainability and are willing to accept a greener option. Everyone should think about how many bags you mostly carry out of a grocery store, you will know your contribution to plastic pollution and multiply that by the number of times you visit the grocery shop. It is really huge plastic pollution you are contributing and it's destruction of environment and economy (Chang and Chou 2018). It is recommended that everyone should carry a bag and always reuse plastic bags as much as possible if you have them. There are some other ways to adopt reduce and reuse policies.

5.2. Reduce, Reuse and Recycling Policy

Several countries have taken measure to reduce the use of plastic bags. In some countries, these measure entailed partial bans on the use of plastic bags. In some countries, they have resorted to different fees and taxes on plastic bags to tackle this issue (Senturk and Dumladag 2021). Reusing method is also good option. In some countries, consumers are supposed to bring own shopping bags instead of using plastic bags (Nguyen 2021). However, currently, recycling rates are very low. The majority of plastic waste is transported to landfills or the sea. In every country there are some technical limitations to overcome but there should be strategy for increasing recycling and up-cycling rates for addressing the problems caused by plastic pollution. (Jung et al. 2023). Plastic waste and utilizing it in a sustainable aggregate in concrete has been recognized as better strategy (Alyousef et al. 2021). Recycling is generally at the forefront, but now it is at the last minute (Kumar, Pali, and Kumar 2023). Recent advancements have been noticed in recycling industries. It should be adopted by every country especially low-income countries. (Jung et al. 2023). It is better option; it should be adopted by countries around the world.

In Pakistan, well managed recycling on a large scale or small scale, even in big cities does not exist (Akmal and Jamil 2021, Ahmed et al. 2020, Siddiqi et al. 2019). Municipal solid waste is increasing every year with some percentage over the last four decades, due to over population and their rising standard of living, industrialization and urbanization

(Korai, Mahar, and Uqaili 2017, Safar et al. 2021, Ahmed et al. 2021). In Lahore, the recycling activities exert a important impact on resource conservation, provision of economic opportunity, creation of jobs, and reduction in the problems related to waste disposal. Lot of money can be saved if we own recycling industries (Batool, Chaudhry, and Majeed 2008). Municipal solid waste is managed by the municipal authorities or contractors who are responsible for waste collection, transport and disposal but there is no proper waste recycling system over all Pakistan. There is no system of waste collection from rural areas (Batool, Chaudhry, and Majeed 2008, Batool and Ch 2009, Shah et al. 2019, Ali 2018). Pakistan needs proper waste knowledge, its related problems and social awareness.

6. Plastic biodegradation in Pakistan

A fungus has been discovered in a rubbish dump in Pakistan that could support to save the planet and it could potentially give benefit to us to get rid of the issues of plastics which are non-biodegradable (Nannan 2017). The fungi are proficient to break down plastic waste few weeks that would otherwise stick for years in the environment (Kumari et al. 2022). *Aspergillus tubingensis* is generally found in soil (Barratt et al. 2003), but the study revealed that it can also grow on the surface of plastics (Kumari et al. 2022). New studies actually demonstrated that it was found on a rubbish dump in Islamabad, Pakistan (Nannan 2017). It secretes enzymes which break down the molecules and then use its mycelia to break them apart. It is documented that all kinds of fungi have good properties that are not yet discovered. If deforestation and other human activities which continue to abolish habitats, then such species maybe destroyed and cannot be used for solving environmental issues (Nannan 2017). The performances of fungus are affected by many environmental parameters such as pH, temperature and the type of culture medium used. It could cover the method for large-scale usage of the fungus in several treatment plants, such as, waste treatment plants, solid waste treatment plants. It is also utilized for application in soils already polluted by plastic waste (Nannan 2017). There are several other microorganisms which can be useful to solve environmental issues. There should be deep study by environment and biotechnology specialists.

7. Energy Recovery:

Electricity demand is increased because population growth, economic development and industrialization. The rapid buildup of municipal, industrial and agricultural wastes is caused by these same factors. In developing countries, these all types of wastes generally end up in open landfills. This system creates severe environmental problems. Waste management is still one of the critical issues. Apart from other reuse or recycling technologies, waste-to-energy technology is an effective method to decrease the waste and help to minimize fossil fuels usage and mitigate environmental related issues. Biomass waste is one of the best energy sources in terms of economy and emissions

which is abundantly available in Pakistan in the forms of plastic waste, agriculture waste, poultry waste, animal manure and kitchen waste (Yaqoob et al. 2021, Korai, Mahar, and Uqaili 2017). If it is properly managed then the solid waste produced in Pakistan has huge potential to generate energy by thermo-chemical and bio-chemical process up-to 50.35 million m³/year and 265 million m³/year respectively (Korai, Mahar, and Uqaili 2016). Waste-to-energy (WtE) methods present sustainable solutions for transforming waste into clean energy (Longsheng et al. 2022). Determining the key components of solid waste is critical to produce any sort of energy from it. The input of energy resources from solid-waste is predictable like 0.07% by bio-chemical and 0.34% by thermo-chemical in the total main energy supply of the country (Korai, Mahar, and Uqaili 2017). Pakistani government should work on it, especially agricultural waste because Pakistan has huge agricultural waste due to agricultural country.

8. Conclusion and Recommendations:

Plastic disposal on the land and micro-plastic in ocean has been declared a serious problem around the globe. This issue has been found more in developing countries than developed countries. This study concluded that plastic pollution is dangerous to human, animal and aquatic life. Several diseases are recognized due to improper disposal. In addition, micro-plastic in ocean has wide-range impact on living things because its food chain. It also pollutes the ocean water and may cause disturbance in aquatic life. Burning or dumping plastic openly cause air pollution. It also affects water and soil. Several countries have banned plastic but it is not enough to eliminate plastic pollution. It is recommended that creative and sustainable solutions should be implemented to prevent and mitigate plastic waste and pollution. In Pakistan, waste management system is not organized. Transportation of waste and dumping system are not proper. Open dumping and burning are common. It causes serious environmental issues. In addition, People need awareness. Pakistani government should run campaigns to create awareness regarding not throwing plastic here there and using these eco-unfriendly products. It is also recommended that small entrepreneurs should work on city waste management. Surveys and research studies have documented that Pakistan has huge potential of waste. Plastic waste can be recycled and energy can be recovered. Pakistan should look to bring in laws that can help the industry grow safely and at the same time mitigate the environmental problem. Companies may convert plastic into other products, especially energy recovery. It can be beneficial for national economy and overall country environment.

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