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Single-Use Plastic Pollution in Qatar's Marine Ecosystems

Abstract

This report talks about how Qatar's heavy use of single-use plastic hurts the environment. Plastic is famous because it is cheap and lasts a long time, but because it breaks down slowly, it pollutes the environment over time. A lot of single-use plastics are used in Qatar, which makes these environmental problems worse. A lot of plastic trash in the ocean is very bad for the ecosystems there. This is especially true along Qatar's coast, where plastic trash makes up most of the trash. The study that was done for this report mostly used secondary research methods. Several ideas have been put forward to try to solve this problem, such as making it easier to recycle, using biodegradable plastics instead, putting in filtration systems to catch plastic waste in waterways, and researching plastics that can be used to make fuel. The most realistic way to solve Qatar's plastic use problems is to use biodegradable plastics, after all four options were thought through.

1. Introduction

In the past few years, both worldwide and locally, a huge amount more plastic waste has been made, which is bad for the environment and people's health in many ways. People in the Arabian Gulf haven't paid much attention to this problem, even though it has so many effects. With a focus on Qatar, this study looks into what can be done to clean up the plastic waste there. There are practical ways to deal with plastic pollution, such as building advanced plastic recycling facilities, putting filtration systems in waterways, and looking into technologies that turn plastic into fuel. However, the main goal of this report is to find out if biodegradable plastics can be used instead and how well they work. By looking at how they are used and what effects they have, this paper tries to figure out what role biodegradable plastics might play in reducing the problem of single-use plastic waste in Qatar's marine environment. A lot of work has been done over many years to cut down on plastic trash and pollution in the water and on land. One thing the European Union did to get things going was make the garbage Framework Directives and the garbage management system in 1975. Keeping things from going to waste, reusing them, recycling them, recovering them, and throwing them away are listed from least to most desired. There are rules like this in many countries, but they

don't always work. Only 8% of plastic trash in the US is recovered. The other 76% is thrown away. Europe throws away 31% of its plastic trash, but 30% of it is recycled (European Union, 2018).

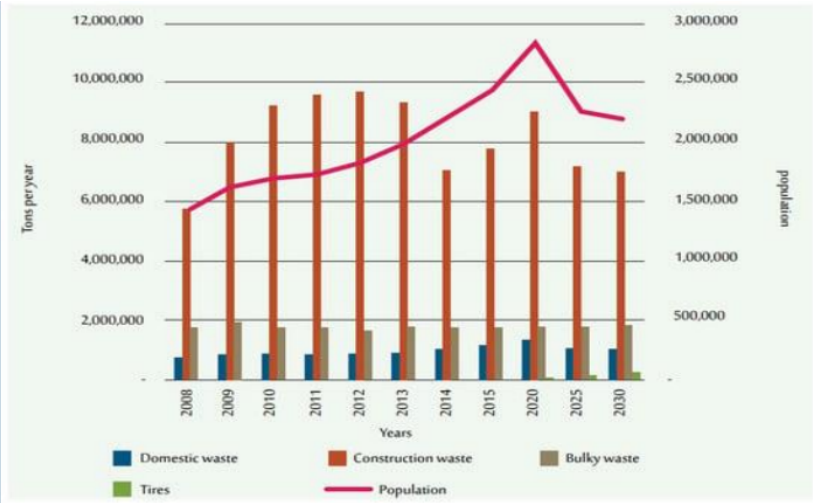

Figure 1: Historic and projected waste production from 2008 to 2030, from the Planning and Statistics Authority in Qatar

Single-use plastics are favored for their affordability and strength. However, they take a very long time to break down, leading to serious pollution. On Qatar's west coast, nearly 71.4% of the litter found in marine areas is plastic.This excessive plastic waste is damaging our oceans and harming marine life.Let us look at Qatar's waste production from 2008 with projections up to 2030. This graph shows an increase in waste production over the years, signaling a need for better waste management. (Veerasingam et al., 2020)

2. Methodology

In Qatar, the problem of single-use plastic waste needs to be fixed in the best way possible. That was our goal. To help us find the best answer for Qatar, we made a list of criteria that we used to rank the solutions we found.

Instead of coming up with new ideas, we looked into ones that already existed. A lot of scholarly papers, news stories, and official websites were read to help us do this. We mostly focused on secondary research because it was easier to find information in the TAMU library than to do our own study. For instance, we used Google Scholar, Science Direct, and other resources to find information about plastic pollution in Qatar and other related issues. Besides that, we counted on academic journals from the TAMU library database because they are trustworthy and full of information. These pieces are reliable sources because they were written by experts who have to keep records of their work.

2.1 Decision Matrix and Criteria

To find the best way to deal with Qatar's problem with single-use plastic pollution, we created a framework with four criteria and ranked the suggested solutions by how well they met those criteria. First, we took a close look at all the possible ways to improve Qatar's current position. It took more than four different ideas to find a way to lessen the damage that single-use plastic does to the earth. The product was judged on how well it worked, how long it lasted, how cheap it was, and how easy it was to use (Phanisankar et al., 2020). Which choices would save the most money were chosen by giving the most weight to the ones that would have the least effect on the budget. When figuring out how easy something was to do, the focus was on how doable the idea was when time and resources were limited. The main way to rate how well a solution worked was by how well it fixed the environmental issues in Qatar. The last criterion looked at how long the suggested ways would last and work. We ranked each answer from 1 (worst) to 4 (best) so that we could see how it measured up. We made a decision matrix to help people make the best choice after putting these numbers and factors together. Figure 1 shows a decision grid that was used to choose the best resolution from the ones that were looked at.

Criteria	Upgrade Plastic Recycling Facilities	Biodegradable Plastic Use	Install Waterway Filters	Develop Plastic-to-Fuel Conversion Methods
Cost	High initial investment, but potentially lower long-term operational costs	Moderate upfront costs for new materials, may be offset by reduced waste disposal fees	Moderate to high installation and maintenance costs	High initial investment in research and development, potentially high operational costs
Ease of Implementation	Complex and time-consuming to implement, requires infrastructure upgrades and training	Requires changes in material sourcing and potentially consumer behavior	Moderately complex, requires identifying suitable locations and managing filter systems	Highly complex, requires significant technological advancements

Effectiveness in Reducing Plastic Pollution	Potentially high effectiveness if recycling rates increase significantly	Effectiveness depends on biodegradation rates and proper composting infrastructure	Can prevent plastic from entering the ocean but doesn't address existing plastic pollution	May reduce plastic waste but creates air pollution concerns
Long-Term Sustainability	Encourages a circular economy by keeping plastic in use	Requires ongoing production of biodegradable materials, potential for microplastic pollution if biodegradation is incomplete	Requires ongoing filter maintenance and disposal of trapped plastic waste	May create dependence on a new technology with unknown long-term environmental impacts

Table 1: Decision Matrix that was used to find the best solution

3. Research Findings

Qatar, like many other wealthy countries, has to deal with the rising problem of pollution caused by single-use plastics. This problem hurts the area's beautiful shoreline and puts the area's many marine ecosystems in great danger (Kunwar et al., 2016). In line with Qatar's National Vision 2030 for an environmentally friendly future and in recognition of this problem, let us look into different ways to deal with single-use plastic trash and the damage it does to marine environments.

3.1 Biodegradable Plastic:

This type of plastics is a good alternative because they break down faster than regular plastics. That way, trash made of plastic will not end up in landfills, rivers, or the ocean. Before its use is implemented in Qatar, there are some important things to think about. Plastics that break down on their own come in different types. Where they come from, some may take years to break down, but in some composting conditions, they may break down fast. It is important to pick materials that break down at the right speed for the weather and the way trash is handled in Qatar (Kumar et al., 2020). For biodegradable plastics to break down fully in compost, the right conditions must be present. If Qatar does not have the right building blocks for these things, putting them in dumps might not be good for the environment. Building recycling areas and teaching people the right way to throw away trash are both very important. If you recycle plastic,

very small bits of plastic called microplastics may come out. These tiny pieces of plastic may still be harmful to ecosystems and sea life.

A thorough grasp of the characteristics of biodegradable plastics and suitable waste management techniques are necessary for their implementation. Biobased and biodegradable plastics must be separated from one another because they are not always the same. While biodegradable plastics decompose into natural components but may not always be biobased, biobased plastics use biomass as a raw source and may not always biodegrade. It is crucial to choose materials taking into account Qatar's waste infrastructure and climate. Processing biodegradable polymers requires taking into account factors including flow anomalies, heat degradation, and moisture management once they have been chosen. For these plastics to keep their qualities, pre-drying and specialist processing tools would be needed. Biodegradable plastics have a wide range of applications, such as compostable trash bags, mulch films, catering supplies, and medical technology (European Bioplastic, 2008). Their disposal, though, needs to be handled with caution. The following options have an impact on the environment: landfill, composting, incineration with energy recovery, and recycling. The most environmentally beneficial option is composting; nevertheless, in order to achieve effective degradation, facilities need to be maintained and equipped appropriately. Furthermore, certification is essential for confirming compostability and directing customers (European Bioplastics, 2016; Rujnic-Sokele, 2017).

3.2 Investing in Advanced Recycling Facilities:

Chemical recycling, often known as advanced recycling, is an addition to conventional mechanical recycling techniques. Advanced recycling uses chemical changes to turn plastic trash into easily usable commodities, whereas mechanical recycling comprises washing, shredding, and pelletizing plastic waste. Advanced recycling can treat mixed, multi-layered, and contaminated plastics, in contrast to mechanical recycling, which works best with clean, high-quality waste. Utilizing pyrolysis facilities is a crucial component of advanced recycling, as demonstrated by a study on the pyrolysis of plastic waste. Four distinct pyrolysis facilities were investigated, each of which produced different oil characteristics that had an impact on the total recycling efficiency (Namkun et al., 2022. It was discovered that the kind of feedstock and particular pyrolysis circumstances affected the pyrolysis oil's efficiency and chemical properties. Operating circumstances had a substantial impact on the amount of pyrolysis gases produced, but not on their composition.

Different types of plastic can be separated with modern sorting technology. This makes recycling more effective and cuts down on the amount of plastic trash that ends up in Qatari landfills. These changes could make Qatar's general recycling rate much higher. Making new plastic, which takes a lot of energy and materials, is less necessary when people recycle more. This means that Qatar's use of plastic has less of an impact on the environment (Constantinescu et al., 2019). Putting this idea into action, on the other hand, needs careful planning. Long-term cost analysis is important because making changes to a building costs money up front. It is very important to look at the long-term cost benefits compared to the present system as well as any possible financial gains from more recycling. It also becomes clear how important it is to educate consumers. Campaigns to make people more aware are necessary to get people to separate their trash properly. As a way to get the most out of modern recycling centres, it is very important that people know how to sort things correctly.

3.3 Installing Waterway filtration systems:

Another proactive strategy is to keep plastic waste from ever entering the ocean, as opposed to just treating the pollution that is already there. Installing stream filters in appropriate locations to catch plastic waste before it enters water bodies is one useful tactic. By stopping plastic pollution immediately, this strategy provides benefits right away. However, thorough planning, consistent upkeep, and suitable infrastructure are necessary for successful implementation. To improve outcomes, it is essential to determine where filtering devices should be installed based on plastic concentration and water flow patterns. Plastic waste can be prevented from entering marine habitats by carefully putting filters in streams and rivers. By acting as barriers, these filters stop plastic from washing downstream.

Dilkes-Hoffman et al. (2019) highlight the efficacy of this strategy, which stops plastic waste at its source and offers an instant remedy. By addressing the underlying cause of plastic pollution, stream filters differ from reactive cleanup initiatives. Despite their potential, stream filters need to be installed carefully and maintained continuously. Filters must be cleaned and inspected frequently to guarantee their continued functionality. Isahaku (2024) emphasizes how crucial regular upkeep is to maintaining filters at peak performance. In addition, infrastructure and specialist resources are needed for the proper disposal of the gathered plastic. The optimal location of filtration systems should take into account areas with a high concentration of plastic and the dynamics of water flow.

3.4 Developing plastic-to-fuel conversion technologies:

Researchers have looked into creative ways to deal with the problems that plastic trash poses to the ecosystem. Conversion techniques, which turn waste plastic into clean chemicals and fuels, are one such alternative. By keeping plastic out of waterways, these techniques provide a proactive approach to reducing plastic pollution. It involves heating discarded plastic without oxygen. By breaking down polymer chains, this method produces useful byproducts like synthesis gas (syngas), bio-oil, and bio-crude oil. While bio-crude oil acts as a predecessor to conventional crude oil, bio-oil can be further refined for use in transportation. Applications for syngas, a hydrogen and carbon monoxide combination, are numerous. The other method, liquefaction, uses supercritical water or solvents to turn plastic trash into a liquid product.

Plastics are broken down into tiny hydrocarbons that can be used to produce fuel by supercritical water. Finally, gasification is the process of processing waste plastic at high temperatures with steam or air to produce syngas. The effective application of these techniques necessitates frequent maintenance, thoughtful evaluation of process parameters, and the location of filtration systems in relation to plastic concentration and water flow dynamics (Nanda et al., 2021).

4. Analysis

Criteria	Upgrade Recycling	Biodegradable Plastic	Waterway Filters	Plastic-to-Fuel
Cost Effective	3	4	3	3
Ease of Implementation	2	4	2	1
Effectiveness in Reducing Plastic Pollution	4	3	2	2
Long-Term Sustainability	4	4	2	4
Total	13	15	9	10

4.1 Upgrade plastic recycling facilities with advanced sorting tech

Adding state-of-the-art sorting tools to plastic recycling sites costs a lot of money up front because the tools need to be bought and set up (Schmaltz et al., 2020). Still, in the long run, fewer steps of sorting by hand and better recycling might lead to lower working costs. It's hard to use this answer because it's so complicated, but it might be useful. Lots of changes need to be made to the

building and the staff needs to be taught how to use the new technology properly. It could cut plastic waste by a lot if recycling rates are raised and a circular economy is supported, which means that plastics are used over and over again.

Environmental impacts should also be examined, with appropriate controls in place to manage the air pollutants produced during the pyrolysis process. In addition, the studies offer suggestions for how policies should be interpreted and how to manage pyrolysis oil facilities and products better. These suggestions include identifying areas for ongoing improvement in the management of pyrolysis facilities and maximizing the quality of the products, monitoring and controlling air pollutants to minimize environmental impact, and informing advanced waste recycling policies (Thiounn et al., 2020)

4.2 Biodegradable plastic use

Finding and moving to other materials can cost a little money up front when you switch to biodegradable plastics. Setting up the right infrastructure for trash disposal and composting is important for this plan to work, even though lower trash disposal fees might be able to cover these costs. To encourage proper disposal methods, its application calls for changes in where materials come from and maybe even how people behave. Two important factors that show how well biodegradable polymers work at reducing plastic pollution are the rates at which they break down and the number of composting sites that are available (Alagha et al., 2022). But problems with partial biodegradation and the possible creation of microplastics still exist. This means that more research is needed to make materials that don't harm the environment.

The degradation process of biodegradable plastics is complicated by variables such as composition, temperature, and humidity. For implementation to be successful, materials must be chosen with suitable rates of biodegradation that are compatible with Qatar's climate and waste management system. In addition, adequate composting facilities are necessary to guarantee that biodegradable polymers completely decompose. The environmental benefits of these materials could be compromised if there is insufficient infrastructure and they end up in landfills. Thus, it is essential to invest in composting facilities and educate the public on appropriate disposal techniques. Nevertheless, even if biodegradable polymers are biodegradable, there is still a chance that microplastics will form when the plastic breaks down. Marine life and ecosystems are still at risk because of this. Therefore, to effectively reduce this risk, research efforts need to concentrate on decreasing the formation of microplastics.

4.3 Install Waterway Filters to Trap Plastic Waste

Setting up and maintaining canal filters that are meant to catch plastic trash costs a moderate to high amount of money. These filters are good at keeping plastic out of the water, but they don't clean up the pollution that's already there. This means that more steps need to be taken to treat and get rid of waste (Flury & Narayan, 2021). Two difficult parts of the execution process are finding the right places to put filters and keeping track of filter systems. However, consistent work is needed to make sure that this solution will work in the long run. This includes regular maintenance and getting rid of the collected plastic trash in the right way to keep the environment from getting worse.

By collecting plastic debris before it enters rivers, lakes, and the ocean, pathway filtration systems play a crucial role in the fight against plastic pollution and protect aquatic ecosystems. This study explores how these systems are installed and operate, concentrating on Pan et al.'s (2022) new integrated magic filter. The magic filter is made of waste plastic shavings, loofah, and waste iron shavings that are produced during the processing of plastic, crops, and steel. It is intended to operate at peak efficiency. Phosphorus removal was enhanced by micro-electrolysis of waste iron shavings, while simultaneous removal of nitrogen and phosphorus was made possible by microorganisms adhered to the filler surfaces. Moreover, the filled fillers reduced effluent SS by acting as efficient physical filters.

4.4 Develop Plastic-to-Fuel Conversion Methods

Plastic pollution could be fixed by turning trashed plastic into fuel that can be used. This would cut down on the amount of plastic that ends up in dumps or the environment. But there are some important things that need to be looked into more thoroughly. To begin, a lot of money needs to be spent on research projects and infrastructure upgrades because putting this technology to use requires a lot of research and development (Moshood et al., 2022). It is important to do a full analysis of whether or not the idea will work and how much it will cost compared to other choices. Second, concerns have been raised about the waste that might be caused by the conversion process itself. This shows how important it is to strictly follow environmental laws (Sheavly & Register, 2007). Lastly, to find out if turning plastic into fuel is sustainable, a full life-cycle assessment is needed to look at how the process affects the earth over its whole lifetime. This includes factors like energy use and greenhouse gas emissions.

To find ways to turn plastic into petrol, a lot of money has to be spent up front on research and development to look into and improve the technology. The costs of doing business could be high, depending on how well the chosen way of

conversion works. Putting this solution into action is very hard, and for it to be widely used, it needs a lot of big technological improvements and infrastructure building. Using this method might help cut down on plastic waste, but how well it works and how it impacts the world will determine how well it works. To make sure that the conversion process is sustainable in the long term, things like energy use and air pollution emissions must be carefully thought out, and the process must be constantly monitored and evaluated in terms of its environmental effect (Shen et al., 2020).

5. **Recommendation**

After carefully looking at several options, we think that biodegradable plastic should be the first thing that is used to reduce the damage that single-use plastic does to the marine environment in Qatar. Biodegradable plastics are one way to help ecosystems and sea life deal with the damage that plastic trash does. Biodegradable plastics break down faster than regular plastics, so they don't build up in dumps and rivers as quickly. This lowers the risk of pollution. It is very important to make sure that these materials' rates of biodegradation work with Qatar's climate and waste handling systems. Also, there must be enough composting tools available to allow for complete breakdown. Also, it's important to try to cut down on the microplastics that are made when things break down.

In conclusion, using biodegradable plastics is a preventative way to protect Qatar's marine ecosystems from the damage that single-use plastics cause through pollution. By switching to eco-friendly products and spending money on garbage management infrastructure, Qatar can reduce its plastic waste and help protect marine life. Biodegradable plastics must be a top priority for people from a wide range of businesses as part of a larger plan to protect Qatar's valuable marine resources for future generations and support environmental sustainability.

References

Alagha, Danah I., et al. "Material flow analysis of plastic waste in the gulf co-operation countries (GCC) and the Arabian gulf: Focusing on Qatar." *Science of The Total Environment* (2022): 154-745. Online Document.

Constantinescu, Marius, et al. "From Plastic to Fuel - New Challenges." *Materiale Plastice* (2019): 721-729. Online Document.

Dilkes-Hoffman, L.S., et al. "The Role of Biodegradable Plastic in Solving Plastic Solid Waste Accumulation." *Plastics of Energy* (2019): 469-505. Online Document.

European Bioplastics (2008) Bioplastics FAQ. European Bioplastics, June 2008.

European Bioplastics (2016) European Bioplastics.

European Union. *Changing the Way We Use Plastics*. Brussels, Belgium: Publications Office of the European Union, 2018.

Flury, Markus and Ramani Narayan. "Biodegradable plastic as an integral part of the solution to plastic waste pollution of the environment." *Current Opinion in Green and Sustainable Chemistry* (2021). Online Document.

Isahaku, Ziddane. "A Novel Application of Filtration for the Collection of Microplastics in Waterways." (2024). Online Document.

Kumar, Awinash, et al. "Study on Conversion Techniques of Alternative Fuels from Waste Plastics." *Energy Recovery Processes from Wastes* (2019): 213–224. Online Document.

Kunwar, Bidhya, et al. "Plastics to fuel: a review." *Renewable and Sustainable Energy Reviews* (2016): 421-428. Online Document.

Moshood, Taofeeq D., et al. "Sustainability of biodegradable plastics: New problem or solution to solve the global plastic pollution?" *Current Research in Green and Sustainable Chemistry* (2022). Online Document.

Namkung, Hueon, et al. "Investigation of Oil and Facility Characteristics of Plastic Waste Pyrolysis for the Advanced Waste Recycling Policy." *Energies* 15.12 (2022): 4317.

Nanda, Sonil, and Franco Berruti. "Thermochemical conversion of plastic waste to fuels: a review." *Environmental Chemistry Letters* 19.1 (2021): 123-148.

Phanisankar, B. S. S., N. Vasudeva Rao and J. E. Manikanta. "Conversion of waste plastic to fuel products." *Materials Today: Proceedings* (2020): 5190-5195. Online Document.

Rujnić-Sokele, Maja, and Ana Pilipović. "Challenges and opportunities of biodegradable plastics: A mini review." *Waste Management & Research* 35.2 (2017): 132-140.

Schmaltz, Emma, et al. "Plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution." *Environment International* (2020). Online Document.

Sheavly, S. B. and K. M. Register. "Marine debris & plastics: environmental concerns, sources, impacts and solutions." *Journal of Polymers and the Environment* (2007): 301-305. Online Document.

Shen, Maocai, et al. "Are biodegradable plastics a promising solution to solve the global plastic pollution?" *Environmental Pollution* (2020): 112-134. Online Document.

Thiounn, Timmy, and Rhett C. Smith. "Advances and approaches for chemical recycling of plastic waste." *Journal of Polymer Science* 58.10 (2020): 1347-1364.

Veerasingam, S., et al. "Sources, spatial distribution and characteristics of marine litter along the west coast of Qatar." Marine Pollution Bulletin 159 (2020): 111478.