

AMERICAN UNIVERSITY OF BEIRUT

PLASTIC WASTE MANAGEMENT AND OPPORTUNITIES
FOR A CIRCULAR ECONOMY IN RURAL LEBANON

by
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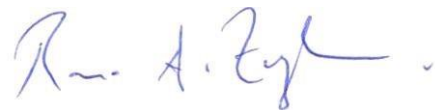
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ABSTRACT OF THE PROJECT OF

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Lebanon is facing a significant waste management problem. The improper disposal of plastic waste in rural areas poses risks to the environment and public health. Rural Lebanon having strong agricultural activities, which generates a lot of waste, makes it a target to the effects of plastic pollution to its soil, water, and food contamination.

Circular economy models, such as closed-loop recycling and waste-to-energy methods, offer potential solutions to reduce waste and pollution while preserving natural resources. However, implementing these strategies in rural areas is challenging due to limited resources, lack of public awareness, and cultural biases. By involving the local community in waste management practices and forming partnerships between stakeholders, opportunities can be created to implement circular economy strategies that improve local economies, create jobs, and decrease dependence on landfilling and burning.

The study's methodology involves conducting a literature review of waste management practices in Lebanon and globally, with a focus on plastic waste management in rural areas. The findings of the literature review will deduce recommendations for implementing a circular economical approach to plastic waste management in rural Lebanon. The significance of the study lies in its potential to establish a comprehensive and sustainable waste management system that promotes environmental protection and supports the development of rural areas. By embracing circular economy concepts and integrating the local community in waste management procedures, there is an opportunity to address the challenges of poor waste management and promote sustainable development in rural areas.

Keywords: Rural Lebanon, Plastic Waste, Waste Management, Rural Areas, Circular Economy, Environment.

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ABBREVIATIONS

CE	Circular Economy
MoE	Ministry of Environment
MSW	Municipal Solid Waste
NGO	Non-governmental Organization
PLA	Poly lactide
UNDP	United Nations Development Program

CHAPTER I

INTRODUCTION

A. Introduction

Lebanon, known for its breathtaking landscapes and rich cultural heritage, faces a pressing problem of waste management, with both urban and rural areas struggling to effectively manage their waste. The problem is particularly acute in urban areas, where poor infrastructure and improper waste management resulted in health and environmental hazards, including Lebanon's infamous crisis of 2015 where mountains of uncollected garbage filled its streets for months (The National, 2021). However, the problem also extends to rural areas, where waste management infrastructure is limited, and waste is often disposed or burned in open-areas, leading to air and soil pollution. Rural Lebanon having high agricultural as well as industrial activities is the area towards which the research will be on since many studies have been done on urban Lebanon and its waste management issues whereas limited studies have been done on rural Lebanon. Plastic waste is a particular concern, since plastic is not biodegradable and can linger in the environment for hundreds of years, it is specifically concerning for the public health and ecosystem. (Human Rights Watch, 2019). This improper disposal of plastic creates a dangerous risk on the environment and the community's health, therefore, there is a need for an innovative solution that addresses the issues sustainably.

In order to improve waste collection, recycling, and disposal, the Lebanese government adopted a National Waste Management Strategy in 2018 (UNDP Lebanon, 2018). However, the implementation of the strategy has been poor and often ineffective.

The circular economy is an economic model that prioritizes the reuse, repair, refurbishment, and recycling of products and materials rather than dumping them, to minimize waste generation and maximize resource efficiency. This model presents a perfect opportunity for sustainable development, such as reducing carbon emissions, conserving natural resources, and creating economic growth (Bocken et al., 2016; Geissdoerfer et al., 2017).

This research aims to review the current waste management practices in rural Lebanon and their impact on the environment, focusing on plastic waste in particular, since it can be harnessed to build a circular economy in rural areas. The research will also review the global view towards a circular economy and their limitations, in order to deduce opportunities to shift rural Lebanon's linear waste management model towards a more sustainable alternative.

B. Project Objective

The project has two main objectives. First, it aims to conduct a review of the current management practices in rural Lebanon and assess the impact of poor waste handling on the environment. This review is expected to identify areas where improvements can be made to establish a more sustainable waste management system in rural communities, and in doing so, answer the research questions related to the current management practices and their environmental impact. Second, the project seeks to analyze opportunities for implementing a circular economy plastic waste management approach in rural villages of Lebanon, and in doing so, answer the research questions related to the worldwide experience with harnessing plastic waste for building a circular economy and the peculiarities of these efforts as applied in rural areas. The focus is on

identifying innovative and sustainable solutions to manage plastic waste, which can be tailored to meet the unique needs and challenges of rural communities. Ultimately, the project aims to establish a comprehensive and sustainable waste management system that promotes environmental protection and supports the development of rural areas, while addressing the research questions of the study.

C. Research Questions

- i. How is plastic waste managed in rural Lebanon, and its effect on the environment?
- ii. What is the worldwide experience with harnessing plastic waste management for building a circular economy worldwide?
- iii. What are the peculiarities of these efforts as applied in rural areas?

CHAPTER II LITERATURE REVIEW

A. Overview

Waste management techniques, such as recycling, are continuously evolving and improving. With these techniques under expansion, it is important to highlight the effect of plastic waste pollution and the management techniques being applied particularly in developing countries, where plastic is often burned or dumped in landfills (Kibria et al. 2023). Lebanon constitutes several major landfills around the country including Saida, Tripoli, Costa Brava, and Zahle Landfill. Although modern landfills around the world are designed to keep toxic trash contained, leaks do happen. That's why poorly managed landfills such as those found in Lebanon are dangerous to the environment and human health. The methane that is released due to the decomposing waste is a potent greenhouse gas that contributes to global climate change (*National Geographic, 2022*). This form of poor waste handling can have significant effects on Lebanon's population and land, beginning with the country's rural areas which are hardly tackled.

Due to Lebanon's significant plastic waste generation, research on future plastic pollution and effective waste management techniques must include rural areas in order to assist decision-makers in reducing environmental and public health risks, and to encourage the development of circular initiatives.

In rural Lebanon, a circular economy (CE) approach to waste management is crucial because it may foster local business and employment growth, advance sustainable development, and lessen environmental degradation (Payne et al., 2019). This literature review will further discuss the research done to evaluate how plastic

waste is being managed in rural Lebanon and how poor waste handling can affect the rural areas. The review will also discuss circular economic chances to address poor plastic waste management in rural areas and the opportunities to target CE in rural Lebanon.

B. Plastic Waste Management in Rural Lebanon

1. Waste Generation in Lebanon

Wastewater and sewage, involving hazardous, medicinal, infectious, and solid waste, including municipal and non-hazardous industrial solid waste, are the primary components of the waste sector in Lebanon. The breakdown of solid waste in Lebanon is as follows: 50% organics, 17% paper and cardboard, 13% plastics, 6% metals, 4% glass, and 10% other materials. Nowadays, Beirut and Mount Lebanon account for over 58% of all municipal solid waste (MSW) production, with North Lebanon coming in second with 16%, South Lebanon with 15%, Nabatiyeh with 15%, and the Beqaa with 11%.(Abbas et al., 2019)

2. Plastic Waste Generation in Rural Areas

A total of 2,040,000 tons of MSW are generated annually in Lebanon, which had a population of 5.6 million in 2013. Although the majority of the wastes are organic (exceeding 50%; this percentage varies between urban and rural locations, as well as between summer and winter), paper/cardboards and plastics make up a sizeable share, with glass and metal also making a substantial contribution. Based on waste management data obtained from the Ministry of Environment (MoE) as well as various studies undertaken in Lebanon the MSW generation per capita is thought to range from

0.7 Kg/p/d in rural areas to 0.85 to 1.1 Kg/p/d in urban areas, with a weighted average for the country estimated at around 0.95 Kg/p/d.

According to the Ministry of Environment's estimates of waste generation per governorate (Mohafaza), Beqaa, which is mostly rural, produces 750 tons of waste/day, accounting for an estimated 13% of the country's total waste generation. (*SWEEPNET, 2012*)

3. *Waste Management in Lebanon*

Nearly all of Lebanon's MSW is collected by public or private carriers (99% in rural regions, 100% in urban areas); nevertheless, different regions manage MSW differently: 8% are recycled, 15% are composted, 51% are landfilled, and 26% are dumped in open pits. (*SWEEPNET, 201*)

4. *Plastic Waste Management in Rural Lebanon*

Plastic waste in rural areas of Lebanon is typically managed through a combination of formal and informal practices. Some of the informal practices that are being used include burning, burying, or dumping in open spaces. Formal practices, such as recycling and waste collection, are limited in rural areas due to lack of resources, technology, and policy support. However, some initiatives have been taken to promote proper plastic waste management in rural areas of Lebanon. (Kabbara et al. 2019) For example, the Lebanese government in collaboration with the United Nations Development program (UNDP); have launched multiple projects to enhance the integrated solid waste management in Lebanon and its rural areas by promoting recycling and composting practices of the municipal solid waste (*UNDP, 2019*).

Moreover, some non-governmental organizations (NGOs) such as Live Love Recycle have also emerged to address the poor waste handling in Lebanon and implemented a mobile application that allows users with just one click to request waste collection services around Lebanon and track the recycling process, which has been used in multiple rural areas.

Although multiple initiatives are emerging, most of the projects face various challenges, such as lack of funding, appropriate infrastructure, and community participations, which affects the sustainability of the projects and their effectiveness (UNDP, 2019). A more comprehensive and integrated approach is needed in rural Lebanon, which should involve stakeholders from local government, local communities, and businesses.

C. Plastic Waste Effect on Rural Lebanon

1. Plastic Pollution Destination Sites

The primary sources of plastic pollution include domestic trash, tourism, agricultural use, fishing, and waste imports. In the context of inadequate rural waste management infrastructure, these channels are linked to unregulated disposal alternatives such as open burning, burying, and open dumps, which contaminate the soil-air-water nexus. Open dumping and burning of rubbish are examples of poor waste management practices that pollute the soil, water, and air and are common in many low- and middle-income countries (Ferronato and Toretta, 2019).

2. Effects of poor plastic waste management

a. On water resources

Plastic pollution in the oceans endangers plant, animal, and human life. Sources of plastic pollution include marine transport activities, shore-to-shore movement by

waves and currents, and debris transferred from land to sea by rivers. In the case of Lebanon; being connected to the Mediterranean Sea; have companies that produce trash in numerous Mediterranean nations and dumping them in rivers or municipal networks (Chalhoub, 2022). Plastics like bags, balloons, beverage bottles, caps/lids, food wrappers and containers, straws, and tobacco packaging are still present on Mediterranean beaches and in the water, posing a serious threat to the Mediterranean marine environment due to their highly persistent nature. (*Lebanese Environment Forum, 2021*).

b. Effects of poor plastic waste management on soil

Agricultural soil in rural areas is especially vulnerable to microplastic pollution. Agroecosystems are essential for food security and biodiversity but have been under increasing stress as a result of climate change and population growth. Understanding the additional stress that microplastics in soils may generate is necessary to determine how they might affect rural populations, global food supply, and the environment. Rural communities and agricultural areas, in particular, are reliant on the land, and contaminants like microplastics could have a harmful influence on those living and working in rural areas (Mihai et al., 2022). Microplastic and chemical pollutants may be released as a result of the decomposition of plastic in the environment, and these substances may subsequently find their way into terrestrial and aquatic food systems. Lethally persistent organic pollutants like dioxins, which are emitted from plastic polymers, cause cancer and brain damage in people (*Lebanese Environment Forum, 2021*).

c. Food Contamination and Public Health threats

Unintended materials like contaminants, oligomers, or degradation products may be present in plastic packaging, in addition to solvent residues from the manufacturing process. (Mihai et al. 2022) According to the findings of the nation's first study on microplastic particles, the average Lebanese person may consume more than 30,000 tiny pieces of plastic annually just from seafood. The European anchovy, which is frequently served fried as "bizri," and the spiny oyster, which is frequently served simply as mussels, were the two marine species examined in the study, and both were found to have high amounts of plastic contamination. (*Lebanese Environment Forum, 2019*)

Cancer, birth defects, lowered immunity, endocrine disruption, developmental and reproductive effects, etc. are just a few examples of the severe negative health consequences associated with exposure to harmful chemicals during manufacturing, leaching in stored food items while using plastic packages, or children chewing on plastic teething rings and toys. (Rustagi et al., 2011)

D. CE Opportunities

1. Definition

The Ellen MacArthur Foundation provided the most well-known definition of the CE, defining it as "an industrial system that is restorative or regenerative by intention and design"(*McArthur Foundation, 2019*).

The CE is a regenerative system in which resource input and waste, emissions, and energy leakage are minimized by slowing down, closing, and cutting down on material and energy loops. This can be accomplished by employing durable design,

upkeep, repair, reuse, remanufacturing, refurbishment, and recycling methods.(Geissdoerfer et al. 2017)

The over consumption of waste has terrible consequences for people, animals, and the environment. A CE, where waste and pollution are designed out, products and resource are maintained in use for longer, and natural systems can regenerate, is more necessary than ever for society. Nevertheless, evidence suggests that a CE can create significant opportunities and have a positive impact on a variety of companies, sectors, and people's lives in addition to addressing environmental issues. (*The Circular Economy In Detail, 2019*)

2. CE approach to plastic waste

Both developed and developing nations are becoming more concerned about how to manage their plastic waste, especially rural areas that face multiple difficulties in the collection and disposal of waste. That's why a CE strategy presents an encouraging option, an economic concept that places a strong emphasis on using resources in closed-loop cycles to reduce waste and increase resource efficiency, an approach that aims to reduce waste, maximize the use of resources, and minimize the environmental impact of production and consumption (Geissdoerfer et al., 2017). The potential for CE approach to plastic waste is addressed by Saifullah et al. (2019) who conducted a study done on potentials for a CE in developing countries. The authors addressed how CE models, like closed-loop recycling, resource recovery, and waste-to-energy, can be used in developing countries (Saifullah et al. 2019)

Much study has been done on renewable alternatives as a result of growing environmental concerns. Because to its green credentials, polylactide (PLA), a

bioplastic, has thus been one of the top contenders during the previous 20 years.(Payne et al., 2019) The goal of controlling plastic pollution has steadily changed from early restrictions on the use of plastic bags and general waste management to easing the transition to a CE. As a result of this change in emphasis, legislation has been created, such as the European Single-Use Plastic Directive, which tries to regulate plastic at all phases of its life cycle rather than just the garbage phase. The necessary policy measures must be put in place for a transformation to succeed. (Alhazmi et al., 2021)

3. CE benefits for rural areas

Due to their reliance on natural resources and social-economic inequalities, rural communities have particular challenges as well as possibilities for sustainable development. The CE might take advantage of these opportunities and address these issues by encouraging resource efficiency, innovation, and local value creation. (Farrant et al., 2020). According to multiple articles conducted on rural areas in developing countries some of the benefits of a CE are as follows:

- i. CE could help in reducing waste and pollution while preserving natural resources. For instance, circular agriculture techniques could encourage regenerative farming, agroforestry, and organic waste management, which could improve soil health, biodiversity, and water quality (Böhm et al., 2018; Ge et al., 2020).
- ii. E could create economic opportunities and value for rural communities by promoting local production, consumption, and reuse. Circular tourism, for instance, might promote environmentally friendly tourism strategies like eco-

lodges, farm-to-table dining, and circular souvenirs, which could be advantageous to both visitors and locals (Duch-Brown et al., 2020).

- iii. CE could enhance social inclusion and well-being in rural areas by fostering community engagement, creativity, and resilience. Examples of social innovation that could be supported by circular efforts include repair cafés, community gardens, and local exchange networks. These innovations could increase social capital and lessen social exclusion (Preston et al., 2020; Caprotti et al., 2021).

These advantages are especially important for rural regions since they present special opportunities and difficulties for sustainable development. The CE could improve rural communities' resilience, wellbeing, and prosperity by encouraging resource efficiency, innovation, and local value creation.

- a. Harnessing waste to build a CE worldwide

As a means of fostering a more sustainable and CE, several nations have put regulations and programs in place to encourage waste reduction, reuse, and recycling. For instance, the CE Action Plan of the European Union aims to accelerate the transition to a CE, while the Zero Waste Policy of Japan establishes goals for lowering waste production and fostering resource efficiency (*European Commission, 2020; Ministry of the Environment, Japan, 2021*).

Research has emphasized the potential advantages of using waste to form a CE, including lowering environmental pollution, protecting natural resources, and opening up new markets and sectors to generate revenue. For instance, research has demonstrated that supporting a CE approach to waste management can result in the development of new businesses and occupations, as well as a decrease in energy use

and greenhouse gas emissions (Ellen MacArthur Foundation, 2015; Kaza et al., 2018). A CE approach to waste management can also help the world achieve other sustainable development objectives, like reducing poverty and tackling climate change (*United Nations Environment Program, 2018*).

The success of these initiatives depends on many factors which include the development of sustainable infrastructure and technology, effective policy execution, stakeholder participation, and other variables that have a role in whether these programs are successful. The implementation of a CE approach to waste management has difficulties related to limited resources, a lack of public knowledge, and the requirement for substantial changes in cultural attitudes and behavior.

b. Limitations to achieve a CE in rural areas

There are a number of challenges to implementing a CE in rural areas, including poor infrastructure, a lack of market access, a lack of funding and financing options, and a lack of knowledge of CE principles (Ellen MacArthur Foundation, 2018). The adoption of CE techniques in rural areas might be limited by social and cultural issues as well, such as a preference for traditional methods and resistance to change (Kaza et al., 2018). In certain papers (Farrant et al., 2020; Maestre-Andrés et al., 2020), it is also stressed how important it is to have legal and regulatory frameworks that are specifically designed to meet the demands and circumstances of rural areas.

4. The Rural Economy in Lebanon

The agricultural sector in Lebanon is the primary economic sector in many rural areas (ILO and FAO, 2020). However, Lebanon's rural economy faces numerous challenges such as a lack of infrastructure, restricted access to financing, and lack of

markets for rural products. The World Bank points out that there are considerable economic and social differences between rural and urban parts of Lebanon, where rural parts experience greater rates of poverty and less access to essential services like healthcare and education (*World Bank*, 2021). Despite these challenges, the rural economy in Lebanon has significant potential for growth, especially the agro-industry sector, which provides a significant amount of jobs and income in many rural areas (ILO and FAO, 2020).

5. Opportunities for a CE in Lebanon

In the case of Lebanon, harnessing plastic waste for building a CE in rural areas may present a number of opportunities for sustainable growth. In terms of managing solid waste, Lebanon has experienced several difficulties, with rural areas being most impacted. Due to poor waste management practices, Lebanon has recently experienced a trash crisis that has had a negative impact on both the environment and public health. However, there are chances for Lebanon to implement CE methods for disposing of waste in rural areas. For instance, supporting CE ideas in rural areas could boost local economies, create new job possibilities, and lessen the dependency on landfilling and incineration. (Kibria et al. 2023)

a. The Importance of the CE in rural Lebanon

The CE has the potential to provide significant benefits to the rural economy in Lebanon by creating new job opportunities, reducing waste and pollution, improving access to finance, and enhancing local value creation.

- i.* Increase resource efficiency: Through encouraging material reuse, repair, and recycling, the CE can aid rural areas in Lebanon in becoming more resource-

efficient. This can lower the manufacturing costs and the need for new raw materials, improving the strength and profitability of rural businesses (*European Environment Agency, 2016*).

- ii. New job opportunities: In Lebanon's rural areas, the CE has the potential to generate new employment possibilities. For instance, according to a research by the Ellen MacArthur Foundation, the CE might generate up to 100,000 new jobs in the European Union by 2030. (Ellen McArthur, 2015) In Lebanon's case, similar potential for employment development might be expected.
- iii. Reducing waste and pollution: The CE can help rural areas of Lebanon to reduce waste and pollution, which can have environmental and health benefits. For example, by implementing recycling and composting programs, rural areas can reduce the amount of waste sent to landfills and incinerators, which can lead to lower greenhouse gas emissions and improved air quality (*World Economic Forum, 2016*).
- iv. Improved access to finance: The CE can improve access to finance for rural businesses by making them more attractive to investors. CE will transform the business world as it will be seen as less risky, more resilient, and more profitable in the long term, which can make them more attractive to lenders and investors. (Jensen, 2023).
- v. Enhanced local value creation: The CE can help rural areas of Lebanon to enhance local value creation by promoting local production and consumption. Since the CE promotes the local circulation of materials and resources (*European Environment Agency, 2016*).

b. Implementing CE in Rural Areas in Lebanon

Despite the potential advantages, implementing CE in Lebanon's rural areas has its difficulties. In order to optimally utilize the CE's potential in rural Lebanon, a number of issues must be resolved. The main obstacles are:

- i. lack of waste infrastructure
- ii. restricted access to technology
- iii. lack of knowledge about the advantages of CE strategies

In order to overcome these obstacles in Lebanon, it is essential to involve the local community in waste management practices, create distributed waste management systems, and create partnerships between local stakeholders, such as governmental and non-governmental groups, and businesses. This waste management system is not something that can be accomplished overnight; rather, it is accomplished at a number of levels and phases. (El Charani and Raimi 2022) By doing this, Lebanon may take use of the opportunity of utilizing plastic waste to create a CE and encourage sustainable development in rural regions.

E. Conclusion

Plastic waste management in Lebanon is a complex issue that requires a multi-pronged approach. The literature review highlights the challenges associated with waste management in Lebanon generally, it also states the main causes of plastic pollution in rural Lebanon, including household waste, tourism, agricultural use, fishing, and garbage imports, as well as the negative effects that improper waste management methods, including open burning, burying, and open dumps, can have on the environment's soil, water, and air. The literature review also highlights the importance of a more thorough and integrated approach to the waste management sector.

In the aim of addressing poor waste handling and its effect on the environment and the public health sector, CE is a valuable fragment of the solution.

The CE offers a potential solution to address poor waste handling and its effect on the environment and public health sector. CE could help reduce waste and pollution while preserving natural resources. Also, circular agriculture techniques can improve soil health, biodiversity, and water quality, while circular tourism can create economic opportunities and value for rural communities. The review revealed that CE models, such as closed-loop recycling, resource recovery, and waste-to-energy methods can be applied to developing and rural countries like Lebanon. However, due to limited resources, lack of public awareness, and cultural biases, implementing a CE approach to waste management in rural areas is challenging. The needs and conditions of rural communities must be taken into consideration while creating legal and regulatory frameworks. Nonetheless, by involving the local community in waste management practices, developing distributed waste management systems, and forming partnerships between local stakeholders, can create opportunities to implement CE strategies that improve local economies, create new job opportunities, and decrease the dependence on landfilling and burning.

In conclusion, this literature review has shed light on the need for a more thorough and integrated strategy to waste management and highlighted the opportunities and challenges in managing plastic waste in rural Lebanon. By embracing CE concepts and integrating the local community in waste management procedures, there is an opportunity to address the challenges of poor waste management and promote sustainable development in rural areas

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