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Analysis of the Quantity and Composition of Waste in the Peja District, Kosovo

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ABSTRACT

The conducted study aimed to investigate the quantity and composition of municipal waste deposited in landfills in the Peja District of Kosovo over the period of 2005–2021. The study covered four municipalities within the district: Peja, Klina, Istog, and Deçan. A total of 705,246.7 tons of waste were deposited during the analyzed period, with the municipality of Peja depositing the largest amount (428,347.9 tons) and Deçan the smallest (67,143.6 tons). Regarding the composition of waste, the majority of municipal waste consists of biodegradable components (about 38%), followed by plastic (20 %), paper and cardboard (17%), glass (7%), textile (5%), diapers (3%), tetrapak (1.5%), metals (1%), construction materials (1%) and small waste (6.5%). This investigation contributes to municipal waste management to know the exact amount of waste produced and its composition.

Keywords: sustainable waste management, environmental pollution, landfill, recycling, waste generation, waste disposal, waste reduction.

INTRODUCTION

Waste management is a crucial issue that has significant impacts on both public health and the environment. However, in Kosovo, although there is progress, waste management practices are inadequate, with a high percentage of waste being disposed of in uncontrolled dumpsites or burned in open pits, which has negative effects on public health and the environment. These practices do not meet the required standards for waste management and pose significant challenges for effective waste management. According to the reports by Eurostat (2021, 2022), and KEPA (2021), Kosovo generates around 452 000 tonnes of waste annually, with municipal solid waste (MSW) accounting for the largest share of waste generated. The amount of waste generated per capita in Kosovo has been increasing in recent years, with 178 kg per capita in 2015 and 253 kg per capita in 2019. However, this is still significantly lower than the EU average of 502 kg per capita in 2019 (EEA, 2021). With all the achievements and progress in strengthening the legal basis related to waste management, Kosovo is well on its way to harmonizing its environmental legislation with EU legislation (EU, 2018). The Law on Waste (No. 2012/04-L-060) has several main goals, such as: a) prevention and reduction of the generation of waste as much as possible, b) reuse of used components from waste, c) sustainable development through protection and preservation of human resources, d) prevention of negative effects of waste in the environment and in human health, and f) final storage of waste in an environmentally acceptable method. Analyzing the composition of municipal waste is a crucial aspect of waste management, as it provides a database of the types of waste that are collected over the course of a year, including their quantity and quality.

By understanding the composition of municipal waste, waste management authorities can identify the main sources of waste, the potential for waste reduction, and the appropriate disposal methods for different types of waste. This information can also be used to develop the strategies for promoting recycling and composting, which can reduce the amount of waste that ends up in landfills. Therefore, a comprehensive analysis of the composition of municipal waste, based on the total annual amount collected, is essential for effective waste management planning and implementation (EPA, 2022; Kuçi et al., 2021; Adeniran et al., 2017; Gallardo et al., 2016; Zotesso et al., 2016).

The sustainable management of waste remains one of the main challenges in improving the state of the environment in Kosovo; to achieve this goal, financial and human resources are needed, in addition to knowledge and accurate analysis of the waste produced in order to be able to plan a sustainable waste management system which would include their disposal, processing, and further use, generating financial income (Cheng, 2010). Despite improvements in waste management infrastructure, significant amounts of industrial waste, construction waste, clothing, mobile devices, food waste, and other types of waste are still being illegally dumped in various locations, including near rivers, in public spaces, and in the environment. These actions have detrimental effects on the ecosystem and raise concerns about public health. As reported by Abdel-Shafy & Mansour (2018), these issues suggest that there is still much work to be done to improve waste management practices in the region. It is crucial to address these challenges by implementing effective waste management policies, promoting public awareness, and enforcing regulations to prevent illegal dumping of waste. Failure to do so may lead to irreparable damage to the environment as well as jeopardize the health and safety of the population.

This study will help to identify the composition of the waste, in addition to the potential for recycling and the treatment of organic waste, in order to provide a clear overview of the data that determine the municipal plans and policies for the collection, recycling and treatment of waste in municipal level and country level.

MATERIAL AND METHODS

This research was conducted in the four western municipalities of Kosovo: Pejë, Istog, Klinë, and Deçan in the period from 2005 to 2021. This research includes the amount of collected waste and the analysis of its composition. The data for the amount of collected waste were obtained from the regional landfill in the village of Sferkë. In turn, the analysis of the composition of the waste was done in the four western municipalities of Kosovo. The samples for waste composition analysis were taken in urban and rural areas. In urban areas, 10 containers (standard size 1.1 m^3) were taken, in different places in the city, while in rural areas, 30 baskets of 120 L were taken, after collection on the ground, the material was transported to the place to analyze the composition of the waste. In advance, of the preparation of the location, a 400 m^2 concrete surface, where the waste analysis will be done, the samples were carried by a special truck to the location where the analyses were made.

The samples for waste analysis were taken in three areas of the city, including the areas where waste is thrown into collective containers, as well as the areas where waste is thrown into individual containers and mixed. The region of Peja (Figure 1) where the research was conducted covers an

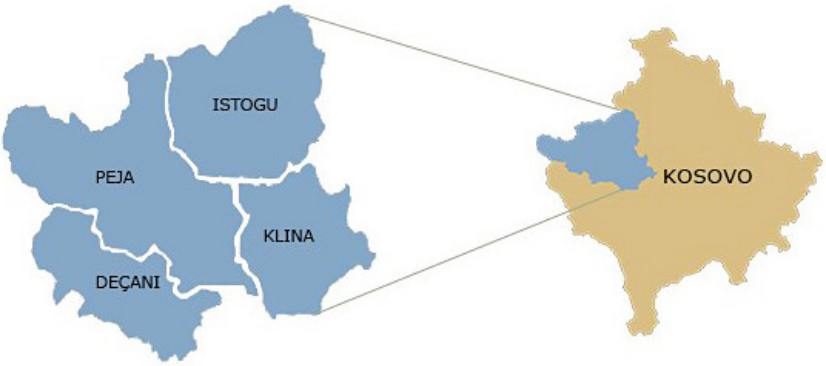

Figure 1. The region where the research was conducted

area of 1545.8 km^2, which includes four large urban areas (cities) and 243 villages (SAK, 2011). The following tools were used for the waste analysis process: a work suit, gloves, scales, plastic bags, and a calculator. Graphs are done using plotly package in R (Sievert, 2020).

RESULTS AND DISCUSSION

This research has analyzed the amount of municipal waste deposited in landfills and its composition in the region of Peja (municipalities: Peja, Istog, Klinë, and Deçan) during the years 2005–2021. During this period, a total of 705,246.7 tons of waste were deposited. Of this amount, the municipality of Peja has deposited 428,347.9 tons, Klina 124993.6 tons, Istogu 84761.6 tons, and Deçani 67143.6 tons (Figures 1 and 2). As for the composition of waste, the majority of municipal waste consists of biodegradable components (about 38%), followed by plastic (20%), paper and cardboard (17%), glass (7%), textile (5 %), diapers. (3%), tetra-pak (1.5%), metals (1%), construction materials (1%) and small waste (6.5%).

The provided information describes the waste situation in the Peja region, including the amount of waste deposited by each municipality, the composition of the waste, and the potential for using waste as an energy source. According to the data, the municipality of Peja has deposited the most waste over the years, with a total of 428,347.9 tons. The least amount of waste was deposited in 2005 (14,591.4 tons) while the most was deposited in 2021 (36,063.3 tons). The average disposal for Peja from 2005–2021 is 25,196 tons, which is reasonable given that the municipality has a larger population (97,360 residents) compared to the other three municipalities.

Klina, Istog, and Deçan are the other three municipalities in the Peja region. Klina has deposited a total of 124,993.6 tons of waste from

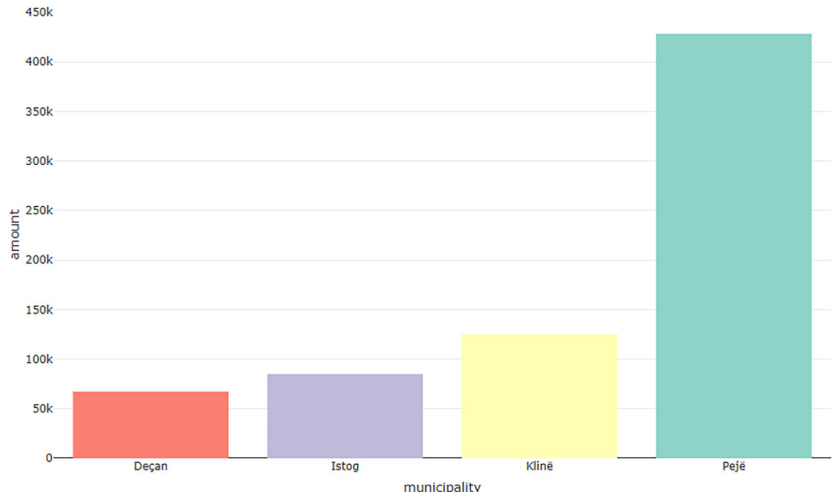

Figure 2. The amount of waste in the Peja District

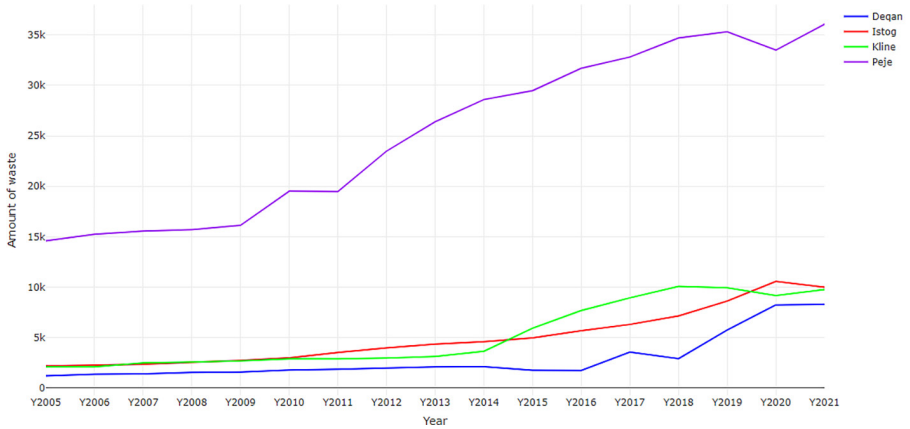

Figure 3. The amount of waste according to the years 2005–2021 in the four municipalities of the Peja District

2005–2021, with the least amount in 2006 (2,100 tons) and the most in 2018 (10,069.6 tons). The average disposal for Klina from 2005–2021 is 7,352 tons. Istog has deposited a total of 84,761.6 tons of waste from 2005–2021, with the least amount in 2005 (2,165.6 tons) and the most in 2020 (10,565.5 tons). The average disposal for Istog from 2005–2021 is 4,985 tons. Deçan deposited the least amount of waste from 2005-2021, with a total of 67,143.6 tons. The least amount was deposited in 2005 (1,200 tons) and the most in 2021 (8,298.4 tons). The average disposal for Deçan from 2005–2021 is 3,949 tons.

The composition of the waste is shown in Figure 4. Biodegradable components make up the largest portion of the waste (38%), followed by plastic (20%), paper and cardboard (17%), glass (7%), textile (5%), diapers (3%), tetra-pak (1.5%), metals (1%), construction materials (1%), and small waste (6.5%). The data for the composition of each category of waste is shown in Figures 5–10. For biodegradable waste, food waste dominates (80%) with green waste accounting for the remaining (20%). For plastic waste, PET bottles make up (25%), plastic bags (31%), and the largest portion is plastic remaining (44%). For metal waste, ferrous metal accounts for (55%) and non-ferrous metal accounts for (45%). For paper and cardboard waste, cardboard accounts for (56%) and paper accounts for (44%).

Regarding recyclable waste, plastic accounts for (24%), cardboard and paper accounts for (23%), tetra pak accounts for (2%), textile and shoes account for (7%), wood accounts for (3%), organic waste accounts for (37%), and other waste accounts for (4%). The analysis also shows the potential for using waste as an energy source.

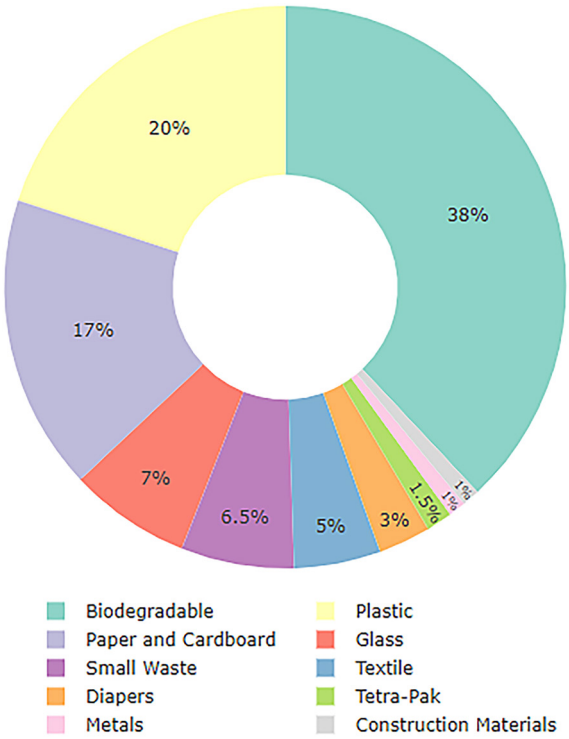

Figure 4. The composition of waste in the Peja District

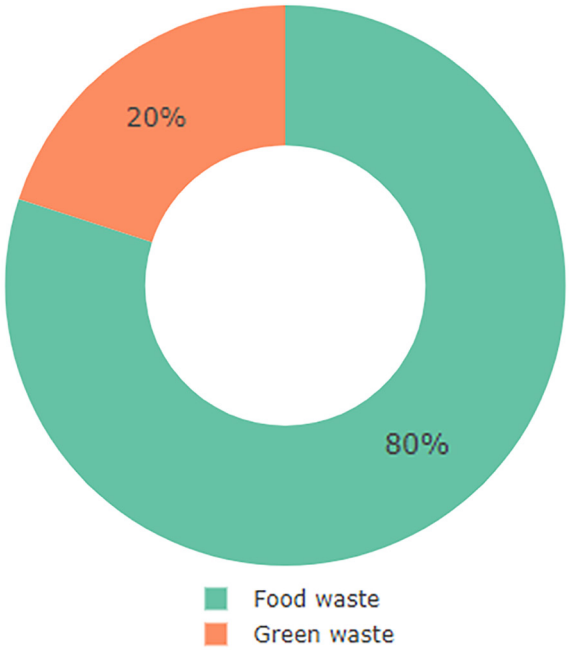

Figure 5. Organic waste composition in percentages

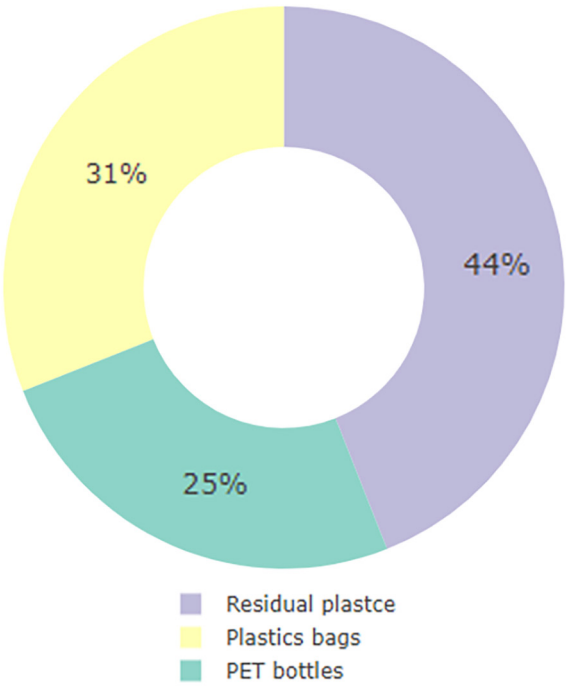

Figure 6. Plastic waste composition in percentages

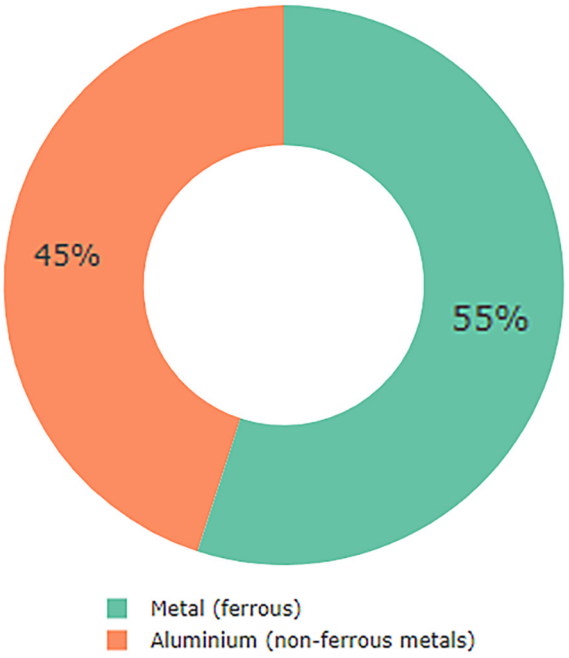

Figure 7. Metal waste composition in percentages

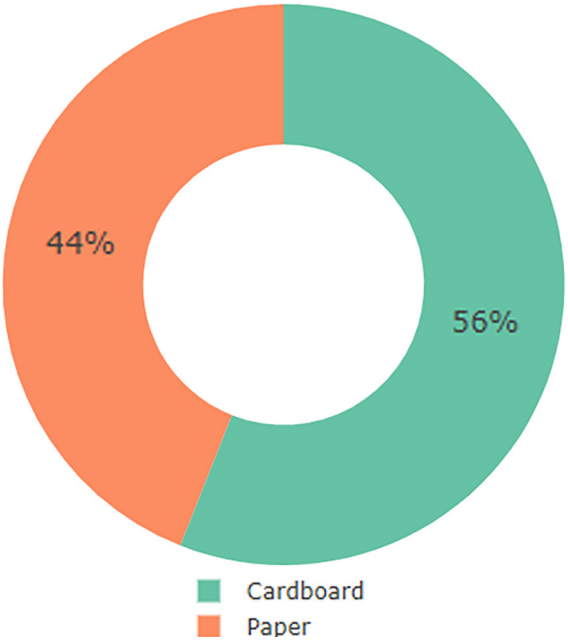

Figure 8. Cardboard and paper waste composition in percentages

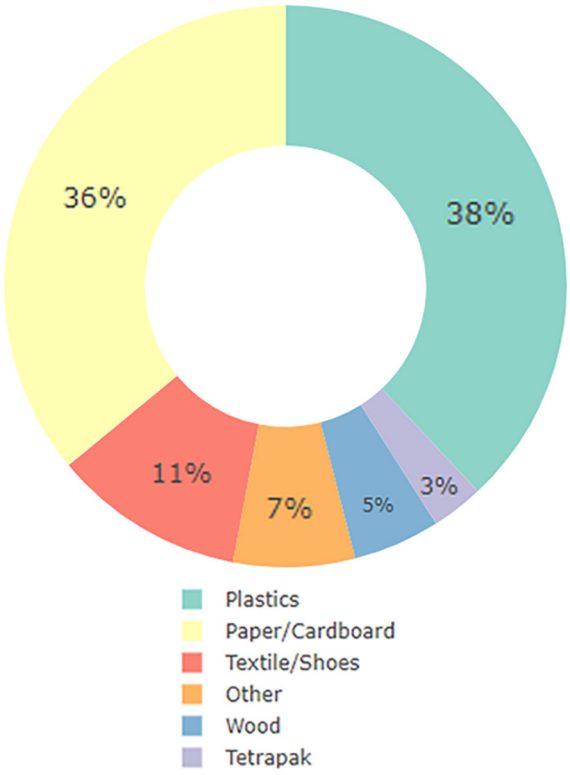

Figure 9. Potential energy by each category of waste

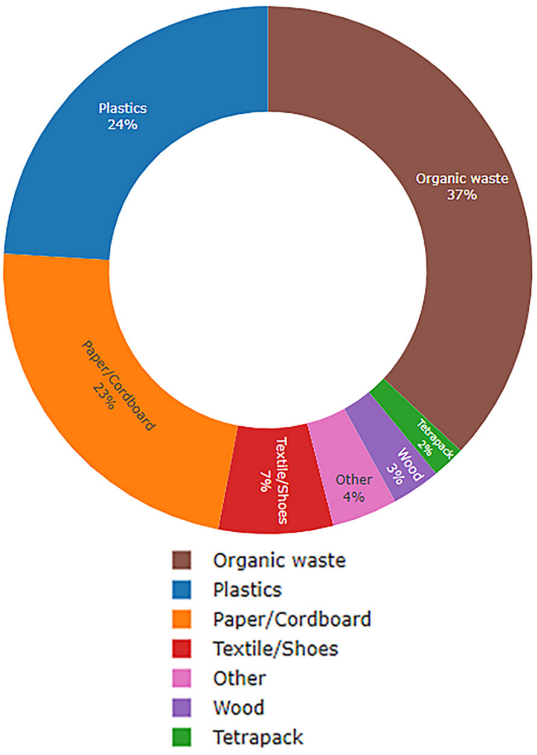

Figure 10. Percentage of waste type used for recycling

The data presented in Figure 9 shows that plastic (38%), cardboard and paper (36%), textile and shoes (11%), wood (5%), as well as other waste (7%) have the potential to be used for energy generation. Waste management: The data presented indicates that the four municipalities of Peja, Klina, Istog, and Deçan in Kosovo have generated a substantial amount of waste over the years. Proper waste management is crucial to ensure that this waste does not end up polluting the environment and harming public health. It is important for municipalities to implement effective waste

management systems that include recycling, composting, and proper disposal of hazardous waste. This requires efficient collection and transportation systems that are designed to minimize the impact of waste on the environment and human health (WHO, 2018).

Recycling – the data also shows the composition of the waste generated in these municipalities, including the percentage of waste that can be recycled. This highlights the importance of recycling in reducing the amount of waste that ends up in landfills or polluting the environment. During this phase various technologies and processes are used to treat waste materials, with the aim of reducing the amount of waste that needs to be disposed of in landfills. This includes practices such as composting, incineration and recycling (EPA, 2022). It is crucial for municipalities to promote recycling and create the necessary infrastructure for effective waste separation and recycling, considering that the least amount of waste should be directed to landfills and increasing quantities should be reused (Mazzarano et al., 2016). Another option is waste recycling in a circularity framework of fluxes and materials as well as waste-to-energy practices (Chifari et al., 2017; EPA, 2016; Rogge et al., 2017).

Biodegradable waste – the data shows that a significant percentage of the waste generated in these municipalities is biodegradable. This includes food waste and green waste, which can be composted and used for soil improvement. Composting can help reduce the amount of waste sent to landfills and provide a source of organic fertilizer for agricultural production. Proper management of biodegradable waste can help decrease greenhouse gas emissions and contribute to soil health through the production of compost. Composting biodegradable waste can also help to reduce the amount of waste going to landfill, which in turn can help decrease the generation of landfill gas (EPA, 2022; EEA, 2020). While biodegradable waste can be beneficial if managed properly, there are some challenges associated with its management. For example, improperly managed compost can emit methane and other greenhouse gases, which can contribute to climate change. In addition, managing biodegradable waste requires proper infrastructure and resources, which may be a challenge in some regions (National Geographic, 2022). Landfills consume many land resources. Therefore, many countries, such as Germany, Austria, Belgium, Denmark, Finland, and Sweden, prohibit the direct disposal of biodegradable waste in landfills (Fei et al., 2022). Energy recovery – the data also shows that a significant amount of waste in these municipalities has the potential to be used for energy recovery. This includes plastics, paper/cardboard, textiles/shoes, wood, and other waste. Energy recovery technologies such as waste-to-energy and anaerobic digestion can be used to recover energy from waste, reducing the reliance on fossil fuels and providing a renewable energy source. Energy recovery from waste is the process of converting non-recyclable waste materials into usable forms of energy. This approach offers a sustainable way to manage waste, reduce greenhouse gas emissions, and generate electricity, heat, or fuel. The recent studies found that waste-to-energy incineration facilities, gasification, pyrolysis, anaerobic digestion etc. can reduce greenhouse gas emissions by up to 80–99%, compared to landfilling (Eriksson, 2017; Dadhich, 2016).

Overall, the data presented highlight the need for effective waste management systems and the importance of recycling, composting, and energy recovery to reduce the environmental impact of waste. It is important for municipalities to prioritize these issues and work towards creating sustainable waste management practices. It is important to monitor waste management practices and enforce regulations to ensure that waste is being managed in an environmentally responsible manner. This involves implementing monitoring programs to track waste generation and disposal, as well as enforcing regulations that promote sustainable waste management practices (Kaza, 2018).

CONCLUSIONS

In conclusion, the analysis of the quantity and composition of waste in the Peja District of Kosovo highlights the need for improved waste management practices in the region. The data indicates that a significant amount of waste is generated in the district, and a large proportion of this waste is not disposed of appropriately. This poses significant challenges for public health and the environment, and urgent action is required to address this issue. Effective waste management practices should involve a combination of waste reduction, reuse, and recycling, along with appropriate treatment and disposal of residual waste. This requires collaboration between all stakeholders, including waste management authorities, local communities,

and the private sector, to promote socially inclusive, environmentally sustainable, and economically feasible waste management practices.

On the basis of the general results from 2005 to 2021, the amount of collected waste has been continuously increasing, this is owing to the commitment of central and local institutions which have improved the quality of services and have extended the services even to the most remote areas in their municipalities based on the Strategy for Waste Management 2013–2022. Municipal institutions and companies that deal with waste management must achieve the following objectives in accordance with the strategy for integrated waste management 2021–2030: development of a new generation of integrated waste management services and infrastructure; professionalization of the waste management and recycling sector; strengthening regulation and control in the waste management sector by filling the gaps and clarifying the implementation mechanisms; promotion of the values and practices of a circular economy. By implementing these objectives, it is possible to minimize the negative impacts of waste management on public health and the environment, while promoting economic growth and social equity in the region.

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