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The Evaluation of Solid Waste Management Via Urbanization for Kirklareli Province (Turkey)

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Abstract

Due to industrialization and urbanization, resources are consumed disproportionately and as a result, a significant amount of waste is left to receiving environments. The increasing volume of waste affects nations, communities, agricultural lands, families, and individuals. Kırklareli province is the city of Turkey in Western Thrace, which is part of the Marmara Region, which houses a significant part of the national industry and agricultural industry and population. This study aimed to determine the solid waste types and the volume of each type of waste generated in Kırklareli province and to analyze the recycling possibilities of these wastes. Thus, the study aimed to determine the current state of solid waste production in Kırklareli during the urbanization process. The findings of the study showed that the waste collection and disposal procedures implemented in Turkey were also adopted in Kırklareli.

Keywords: Waste management, Recycling, Solid waste, Urbanization, Kirklareli

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INTRODUCTION

Our border province, located on the Yıldız (Istranca) Mountains and Ergene Plain sections of the Marmara Region, is surrounded by Bulgaria in the north, the Black Sea in the northeast, Tekirdağ in the south and southeast, and Edirne in the west. Our province, which has a surface area of 6,550 square kilometers, has 180 kilometers of land border with Bulgaria and 60 kilometers of seacoast to the Black Sea. The north and east of our province, which is 203 meters above sea level, is mountainous and forested, while the other parts are generally flat. The region has a continental climate, with harsh and rainy winters and hot and dry summers. Its main streams are Ergene River and Mutlu Creek. It shows forest and steppe characteristics as vegetation. "Ergene River were directly affected by problems originating from pollutants in the river bed. It has been thought that the yearly observation of the differences in the land use and in the changes occurring in the range of products in the agricultural fields adjacent to the Ergene River in the region and the pooling together of these differences has formed a base in other studies" (Albut et al., 2018).

With the development of society, the amount of solid waste produced every year is increasing. Solid wastes cause various environmental problems if they are not handled and used properly due to their complex structure (Cai et al., 2016). The amount of solid waste produced globally is approximately 1.7 billion tons per year, and this amount is estimated to be 2.7 billion tons in 2024 (Laurent et al., 2014).

However, solid wastes containing precious metals (mining tailings, ore processing wastes, fuel slag, slag from smelting and chemical processes, organs from hospital waste, agricultural waste, etc.) still have reuse value (Mazumder and Rano, 2015). Most of the solid wastes are misused even though they can be recycled after separation and purification.

Solid waste management is important for controlling environmental pollution, reducing greenhouse gas emissions, persistent organic compounds, and conserving resources. With the increase in global waste generation, solid waste management has placed an increasing burden on the planet and needs to be well organised (Hoornweg et al., 2013). The accumulation of carbon dioxide and other greenhouse gas levels in the atmosphere have reached has increased rapidly since the industrial revolution (Bagdatli and Belliturk, 2016a).

Most of the municipal solid wastes are from domestic, commercial, and institutional activities. Food, paper, plastic, glass, textile scrap, wood and other materials are examples of these types of waste. Since materials from such wastes do not decompose naturally and their degradation may take longer, an alternative method must be found to reduce such a problem (Ashani et al., 2020). With the extensive use of pesticides, many waste pesticide packages were produced, which refer to the waste packaging that is directly contacted with pesticides or contains pesticide residues after use, including bottles, tanks, barrels, bags, and other types of containers (Li and Huang, 2018). With the widespread use of pesticides, the supply of pesticides from the market has intensified with plastic bottles, tanks, barrels, plastic bags, and other containers. Waste packages that come into direct contact with pesticides or contain pesticide residues after pesticide use cannot be abandoned to nature (Li and Huang, 2018). Adequate management of such wastes is important to minimize environmental impacts, reduce economic costs and eliminate any social impact on citizens (Stone et al., 2019). One of the main sources of agricultural and non-point pollution is the combined pollution of pesticides and heavy metals (Akter et al., 2022). When dry agricultural lands and irrigated agricultural lands are compared, it has been observed that pesticides and heavy metals are easily released into the receiving environments by the paddy soil and the flowing overload enters these environments and creates serious agricultural non-point source pollution (Schaffner et al., 2010).

MATERIAL and METHOD

Kırklareli province of Turkey is choosen for study area. This city is an important city with its fertile agricultural lands covering a significant part of the fertile plains of Thrace, on the one hand, and a large part of the Yıldız Mountains, which have a rich forest existence, on the other hand. It is an exceptional settlement with tourism potential. With these features, Kırklareli, which is both Thracian and Black Sea, is ranked 11th among 81 provinces in terms of socio-economic development with its fertile lands, industry, historical and natural beauties, artistic and cultural texture, 7th in the education sector development ranking and 15th in the health sector development ranking. is one of the important border provinces of our country, neighboring Istanbul, and Europe.

In the city center, there are small industrial estates and carpenters' estates in different regions. Some of the heavy industry establishments are located at the exits of the city, on the side of the intercity highway. Pollutant elements originating from this region affect the air quality of the city center due to the proximity of this region to the city center.

Despite this, it is necessary to prevent the construction that may create local environmental pollution in different regions and pose problems within the scope of the solution of infrastructure problems. Zoning arrangements should be made to leave a certain distance between industrial facilities and residential areas, and infrastructure works should be carried out to move industrial facilities and workshops outside the city settlement.

The methodology of the study followed to achieve a case study analysis of selected waste types in Kirklareli province as munipical, package, hazardous, excavation, construction and demolition, mineral oil, batery of wehicles, tires, electrical and electronic wastes, medical, vegetable oil, mining, sludges, composts, and hazardous wastes. Additionally, the R^2 values of the logaritmic correlation from datas given in graphics were added with each formula. These values were calculated with microsoft word excel program. The quantity and properties of domestic solid waste are associated with urban characteristics, the social and economic conditions of the population, the climate, the type of fuel consumption, and similar factors.

RESULTS AND DISCUSSION

Based on the Kirklareli Provincial Directorate of Environment and Urbanization 2020 data, the composition of Kirklareli Province solid waste is presented in Figure 1.

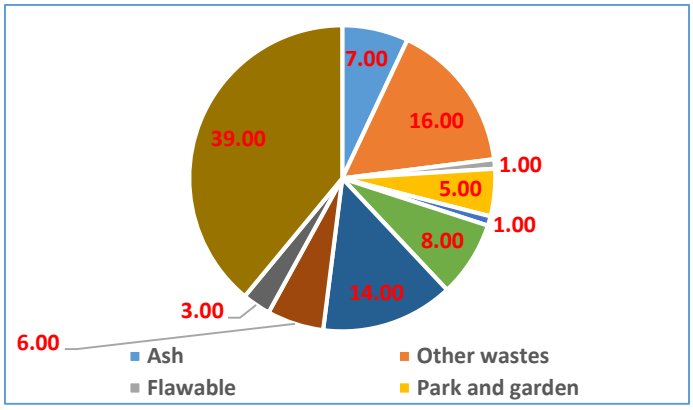

Figure 1. Kirklareli Province Solid Waste Composition

As seen in Figure 1, the ratio of the recycled material to the production is % 14 for plastic, % 1 for metal, % 39 for kitchen waste materials, % 9 for paper and cardboard, and % 7 for ash in Kirklareli province, where % 8 for the recovery of glass packaging.

Municipal Waste

The Sanitary Waste Landfill Area has been transferred to the Kırklareli Local Governments Solid Waste Facilities Construction and Operation Association (KIRK-KAB) by the Municipality of Kırklareli. Due to the electricity transmission line passing over the second lot, which is about to be filled, this lot is planned to be canceled as a second lot by combining lots three and four. Within the scope of the Provisional Article 1 of the "Regulation on Landfilling of Wastes", which was published in the Official Gazette dated 26.03.2010 and numbered 27533, it is planned to build a pre-treatment facility for the reduction of biodegradable wastes.

Packaging Waste

According to the European Union Packaging and Packaging Waste Directive, packaging includes all recyclable and non-recyclable products manufactured with any material and used for transportation, protection, storage, and sale of a product, including raw materials and processed products, during the delivery of a product from the manufacturer to the user or consumer (Packaging Information System, 2019). Packaging waste was defined as sales, secondary, shipping, and packaging waste that are disposed to the environment, including those used for the presentation of the product during delivery or produced after the consumption of the product, including packaging the economic life of which is over or reusable material excluding the manufacturing waste (Sayar, 2012). For the area owned by Kırklareli Municipality with a surface area of 150.000 m^2 on 589 blocks, 78 parcels in Kırklareli Merkez Karaca İbrahim Mahallesi Kirmizi Yar Locality, on Kirklareli-Pınarhisar road route, with the decision of "Environmental Impacts are Negligible" taken by the Local Environmental Board on 06.07.2000, the site selection of the regular waste storage area The project contract was signed on 01.08.2005, and the design of an area of 80,000 m^2 over 4 lots was carried out. The packaging waste recovery facilities that operate in Kirklareli province in 2020 for zero waste activities are presented in Table 1 and the total number of facilities in province was 886 while the number of facilities in the system was 558**.**

Hazardous waste

In recent years, with the increase in industrial activities, a large amount of toxic and hazardous waste is produced and discharged. If we make the definition of hazardous waste, the expression of waste with chemical composition that harms people, plants, animals, and ecosystems such as disease and death when pollutants are released into the environment is appropriate (EPA, 2021). There are 3 licensed hazardous waste recovery facilities in Kirklareli province, and the recovered waste was 20.059.122 tons in these facilities in 2019 (Kirklareli Province Environmental Status Report, 2020). Since the waste statistics for 2020 in the Waste Management Application contain raw data, the evaluation and examination process of which is still ongoing, the charts and graphs include 2019 as the final data. The equations and R^2 values correlated with recycling, disposure, and export datas between 2016-2019 were given in Table 2. Hazardous waste management in our province according to waste management application data were given in Figure 2.

Table 1. Number of institutions/organizations implementing the zero-waste system as of 2020 (zerowasteinformationsystem.csb.gov.tr, 2021)

Institution Type	Total Number of Institutions	Number of Institutions in the System
Sites with 300 or more residences	3	-
Fuel stations and resting facility	89	84
The mall	6	one
Council	21	23
Industrial facility in Annex-1 of the EIA regulation	66	40
Industrial facility in Annex-2 of the EIA regulation	178	29
Provincial directorate of environment and urbanism	1	5

Educational institution and dormitories	263	105
airport	-	-
City administrations	1	1
Business center and commercial plaza	10	-
Public institution and organization	-	136
Accommodation establishments	6	2
Port	3	-
Organized industrial zone	4	5
Healthcare organizations	76	14
Train and bus terminals	7	-
Chain markets	152	113

Table 2. The equations related with recycling, disposure, and export activities

Data	**Equations**	**R^2**
Recyling	y=YE+0,6ln(x)+8E+0,6	0,6009
Disposure	y=208698ln(x)+3E+0,6	0,0061
Stock	y=1952ln(x)+30935	0,0027
Export	y=-23094ln(x)+40972	0,5611

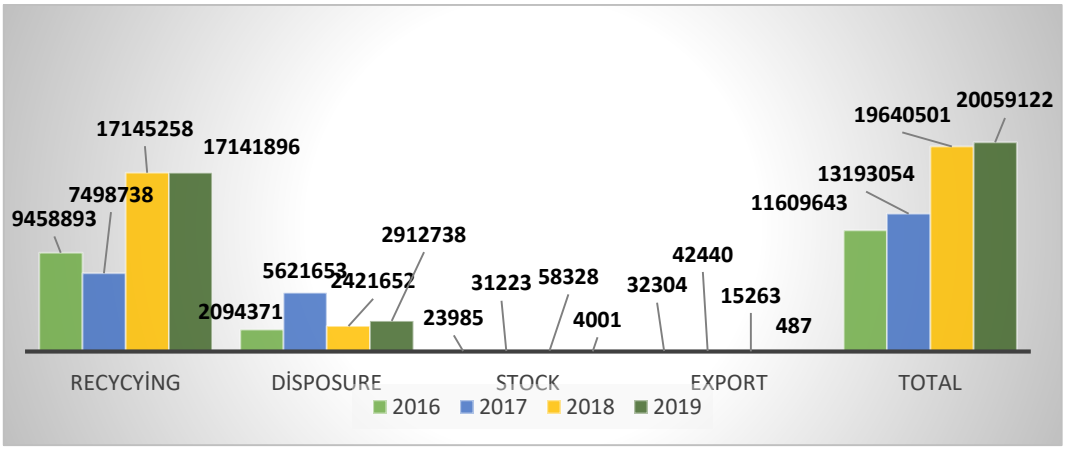

Figure 2. Hazardous waste management in our province according to waste management application data*(Waste Management Application, 2021)

Waste mineral oils

Oil waste is partially or completely composed of mineral, synthetic, or biogenic oil waste. Mineral oils are employed in lubrication of mechanical tools and equipment, and after a certain period, the chemical and physical properties of the mineral oil deteriorate due to friction and development of solid residue and should be replaced. Oil waste could be recyled by reclaiming the oil waste as raw material or by adding to energy fuels.

Efforts have been spent to ensure the disposal of oil waste in accordance with the "Oil Waste Control Regulation" in Kirklareli, and to raise awareness in public and private organizations that produce oil waste. The storage of oil waste is not allowed in the facilities in the province. However, the facilities that desire to store oil waste in the facility are provided with a temporary waste storage permit if they meet the required physical conditions. In 2019, 203870 tons of oil waste was produced in the province (Kirklareli Province Environmental Status Report, 2020). It was informed that the facilities should collect and send the waste mineral oils in accordance with the "Regulation on the Control of Waste Oils". Waste Mineral Oil Collection Amounts in Kırklareli Province by Years is given in Figure 3.

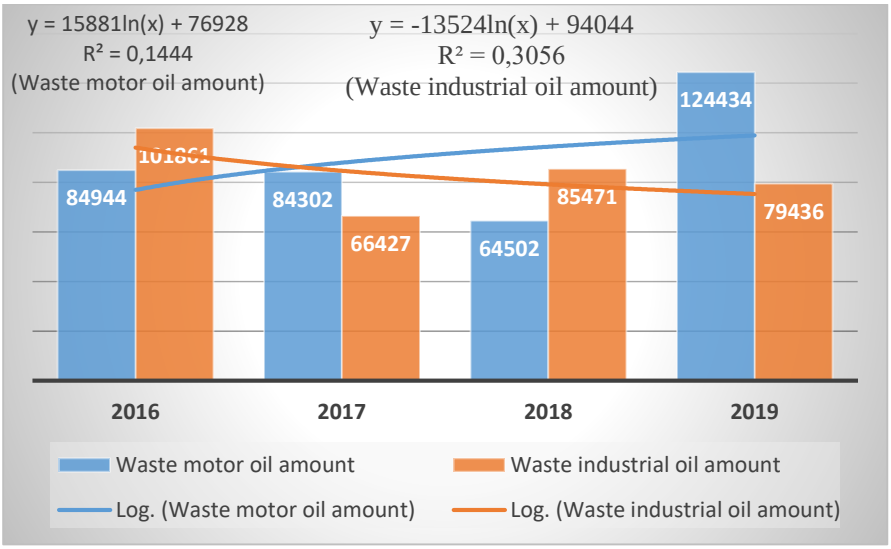

Figure 3. Waste Mineral Oil Collection Amounts in Kırklareli Province by Years (Waste management application, 2021)

Most excavation, demolition and construction waste are employed for municipal landfill cover material and rehabilitation in Kirklareli. Furthermore, excavation and vegetative soil are employed in landscaping and reclamation of private land. Thus, inhabitable private real estate is reclaimed for agriculture.

Waste batteries and accumulators

With the new technologies they use, battery manufacturers not only create more benefits, but also produce more environmentally friendly products. However, we should not throw exhausted batteries into the environment or in the trash. Because various chemicals in waste batteries can cause pollution by mixing with groundwater and soil in landfills. "Increasing world population, changing climate conditions and economic activities are growing with each passing day makes it more important than water" (Bağdatli and Bellitürk, 2016b). For this reason, as well as to increase the efficient use of natural resources through the recycling of waste batteries, waste batteries should be collected in plastic bags, cardboard boxes or jars, thrown into waste battery boxes in supermarkets, schools, headman offices, collection centers determined by municipalities, or returned to the point of sale where they were purchased. Heavy metal content in batteries and vehicle batteries could lead to damages in the central nervous system, cancer, kidney, liver, brain tissue damages, and birth defects. In addition to heavy metals, electrolytes (KOH, H_2SO_4, etc.) found in batteries have adverse effects on all living organisms in the ecosystem and lead to pollution in the receiving environment and soil. For example, an exhausted mercury oxide battery could pollute 800,000 liters of drinking water (Skeete et al., 2020).

Battery and vehicle battery waste are collected by licensed institutions in Kirklareli province based on the Regulation on Control of Battery and Accumulator Waste. The amount of waste batteries and batteries (kg) collected in Kırklareli province by years is presented in Figure 4.

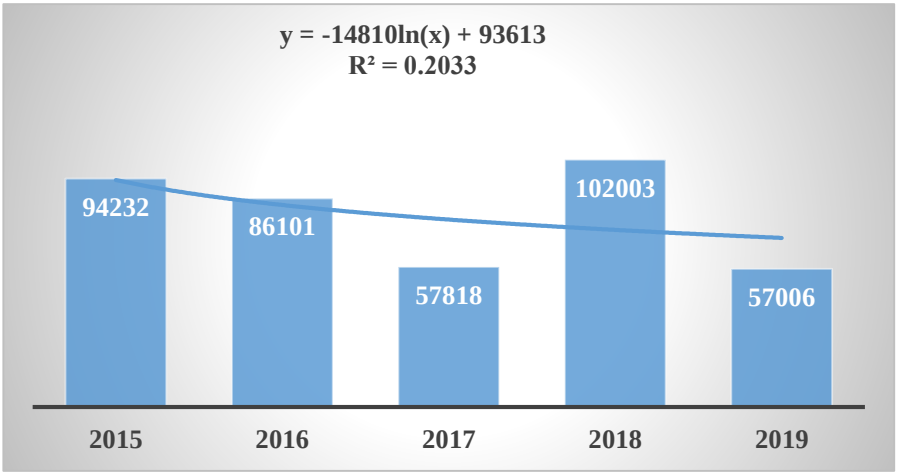

Figure 4. Amount of waste batteries (kg) collected by years in Kırklareli province (Waste management application, 2021)

As seen in Figure 4, the annual battery and vehicle battery waste collection has increased due to public awareness and realization of the fact that recycling plays a key role in environmental health.

End of life tires

End-of-life tire stock in Kirklareli are processed based on "Regulation on the Control of End-Of-Life Tires" provisions. Tires include hazardous and non-biodegradable substances in their chemical composition. The increase of these pollutants due to the increasing population and number of vehicles, their accumulation in the ecosystem for extended periods and transmission to the food chain pose a danger for the living organisms. The end-of-life tires collected annually in Kirklareli are presented in Figure 5 Collected tires are processed with two methods in the province in recycling and waste incineration facilities.

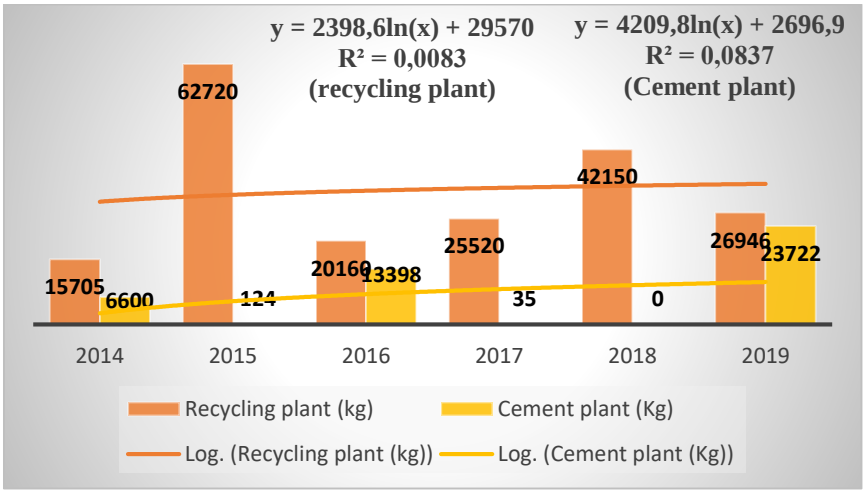

Figure 5. The total amount of tires sent to recycling facilities and waste incineration facilities in Kırklareli province by years (kg/year)

Electrical and electronic waste

Although the increase in electrical and electronic equipment waste are 3 times higher than urban waste, the collection, processing and recycling of electrical and electronic equipment waste are still quite low. However, valuable material content in electronic devices and equipment that completed their economic life are a significant source of secondary raw material due to their reuse and recycling capacity. However, when e-wastes are not properly separated and disposed of, they could turn into toxic substances and cause major problems for human and environmental health due to their hazardous content (Senturk, 2019).

Although electrical and electronic waste is not collected regularly in Kirklareli province, a collection system that was established by the municipalities and licensed contractors is available. Electronic waste collected by the municipal authorities based on the citizens' application are delivered to these licensed facilities. There is one Electrical and Electronic Equipment Waste Processing facility in the province. Efforts are underway to collect the Electrical and Electronic Equipment Waste based on a waste management plan (Waste Management application, 2020).

Within the scope of the harmonization of the European Union's Waste Electrical and Electronic Equipment Directive No. 2002/96/EC and the Directives No. 2002/95/EC on the restriction of the use of certain harmful substances in electrical and electronic equipment, which prohibits the use of dangerous substances used in the production of electrical and electronic equipment, "Waste Electrical and Electronic Equipment Control (AEEE) Regulation" was prepared and entered into force by being published in the Official Gazette dated 22.05.2012 and numbered 28300.

The regulation includes large household goods, small household appliances, information and telecommunications equipment, consumer equipment, lighting equipment, electrical and electronic equipment (excluding large and fixed industrial appliances), toys, recreational and sports equipment, medical devices (implantation products and disease-communicable devices). It includes electrical and electronic goods included in the categories of monitoring and control instruments and vending machines, electric light bulbs and household lighting equipment. In the province of Kırklareli, there is no collection facility for Waste Electrical and Electronic (WEEE) Goods in 2020.

Medical waste

One of the most important waste materials in the hazardous waste category is wastes generated during medical activities. The health institutions, which are the source of this type of waste, are subject to strict rules that determine the classification, separation at source, temporary storage, transportation, processing, and final disposal of this waste to minimize the possible damages to human health and environment both onsite and outside based on the regulation on control of waste (Awodele et al., 2016) In addition to infectious content, medical waste may also contain substances such as drugs, radioactive materials, cutting-piercing materials, toxins, and hazardous chemicals (Omeleke et al., 2021).

The collection, transportation and sterilization processes of medical wastes generated in Kırklareli province are carried out by 1 licensed company. Medical wastes collected in Kırklareli are sterilized in the Sterilization Facility of the company contracted with Lüleburgaz Municipality.

All health institution waste in the province is collected by the above-mentioned facility. Regular inspections are conducted to prevent improper disposal and collection of medical waste. Health institutions and other medical waste producers temporarily store the waste in temporary storage areas or containers in the facility. The annual medical waste production in Kirklareli province is presented in In Figure 6 (Kirklareli Province Environmental Status Report, 2020).

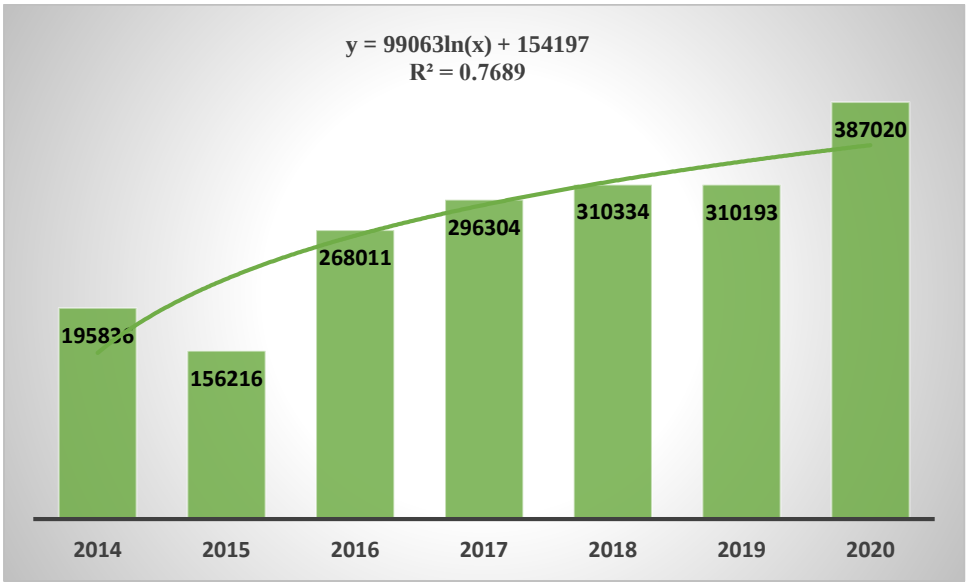

Figure 6. Medical Waste in Kirklareli Province

As seen in Figure 6, the collected medical waste has increased every year in the province. Hazardous medical waste is sterilized in the medical waste sterilization facility that operates in the city, and then transferred to the regular landfill, demonstrating that medical waste is properly managed.

Wastewater treatment facility sludge

In Kirklareli, the treatment facility sludge (16324 tons/year) produced in municipal domestic/urban wastewater treatment plants and industrial enterprises are collected by licensed businesses and recycled by drying to obtain fuel alternative or incinerated (Kırklareli Water and Sewerage Administration, 2021)

Compost

There is no compost facility in Kirklareli province where organic waste is recycled (Kirklareli Province Environmental Status Report, 2020). Considering the population growth and the fact that the domestic waste constitutes 34% of the total waste, recycling organic waste as compost would significantly reduce the waste volume disposed to regular landfills, extend the regular storage life, and allow the utilization of the compost in the agricultural cultivation, which is very important to meet the demands of the population growth.

Zero-waste management

It is a waste management method that includes the prevention of waste, effective employment of available resources, the prevention of waste production by analyzing the reasons for waste production, and the collection and recovery of waste at the source.

Zero-waste management aims

- The improvement of performance and productivity in a clean environment,
- Cost reduction by preventing waste of resources,
- The reduction of environmental risks,
- Savings and economic profits (Awasthi et al., 2021).

To improve and expand the Zero-Waste Project, which was introduced in the Presidential Complex and the Ministry of Environment and Urbanization, information meetings were organized for all the supervisors in all public institutions in Kirklareli and the focus personnel in the institutions responsible with the project, District Governorships, Mayorships, soldiers, and students, and the project was initiated in February 2018. With the enforcement of the "Zero-Waste Regulation" in 2019, Waste collection Centers were established in 178 district municipalities in Kirklareli to establish an effective zero-waste management system based on the Waste Collection Center Directive and these centers were licensed by the Kirklareli Provincial Directorate of Environment (Kirklareli Zero Waste Management Plan, 2020). Information on the types of institutions that have received the Basic Level Zero Waste Certificate as of 2020 is given in Table 3.

Table 3. Information on the types of institutions that have received the Basic Level Zero Waste Certificate as of 2020 (zerowastemanagementsystem.csb.gov.tr, 2021)

Institution type	**Number of facilities reporting activities in zero waste system**	**Number of facilities with zero waste certificate**
Sites with 300 or more residences	-	-
Fuel stations and resting facility	14	22
The mall	-	-
Council	9	2
Industrial facility in Annex-1 of the EIA regulation	25	12
Industrial facility in Annex-2 of the EIA regulation	3	-
Provincial directorate of environment and urbanism	2	-
Educational institution and dormitories	2	-
airport	-	-
City administrations	-	-
Business center and commercial plaza	-	-
Public institution and organization	53	46
Accommodation establishments	-	-
Port	-	-
Organized industrial zone	4	3
Healthcare organizations	4	1
Train and bus terminals	-	-
Chain markets	62	1

Waste is studied based on the economic and environmental approaches. The transportation, collection, disposal, and management of the waste of various types such as solid waste, packaging waste, hazardous waste, medical waste, special waste generated by the consumption of products in daily life are quite important. Attention should be paid to the management of solid waste. Several types of solid waste significantly affect humans, nature, health, environment, and economy. Costs incurred during storage, collection, and transportation of waste could adversely affect national economies. Thus, the solid waste is recycled to minimize these costs. Although recycling is a broad topic, it should be prioritized by every segment in the society. The recycling of products such as paper, plastic and batteries, the negative effects of waste on the environment could be reduced and recycling could contribute to the economy. In addition, the negative effects of wastes on agricultural lands should not be ignored. Many agricultural residues in our country are either burned or thrown away because they cannot be used under appropriate conditions. One of the best ways to evaluate agricultural residues is to use these residues in the production of vermicompost (Belliturk et al., 2018) The main cause of the eliminate the negative effects are related with unconscious use of pesticides since they are in the class of hazardous wastes

A strict inspection program has been implemented to ensure that industrial establishments create hazardous waste storage areas in accordance with the legislation and to send the hazardous wastes generated in the enterprises to licensed institutions with licensed vehicles, thus preventing the dumping of such wastes into the soil with domestic wastes. It is essential to improve more inclusive aquaculture extension lead and training program (Afreen et al., 2022). It has been ensured that industrial establishments collect packaging waste at its source and give it to licensed establishments.

Necessary correspondences were made with municipalities regarding the collection of recyclable wastes, and presentations were made to provincial and district schools. In our province, studies are continuing the selection of a location for the storage of excavation soil, construction, and demolition wastes.

As a result of the contract signed with a private company, in the 'Solid Waste Landfill Facility' of Kırklareli Municipality, the power of 1,232MWm/1,200MWe (with an increase in capacity of 2,464MWm/2,400 MWe) and the annual electrical energy production amount of 8,294,400 kWh "Electricity Production from Garbage Biogas" Under the name of “KIRKAB-1 Garbage Biogas Power Plant Project”, an electrical power generation facility was established in Kırklareli in order to utilize the methane gas generated in the solid waste landfill site and to contribute to the economy.

In Kırklareli, studies are continuing the selection of a location for the storage of excavation soil, construction, and demolition wastes. The solution of the chronic waste management problems, which have been neglected for several years, requires large-scale and high-cost investments. However, it seems difficult to conduct these activities successfully with the existing structure and resources. Municipalities, which are organized as the main implementation units, do not have the resources for these investments, and they lack instruments such tax revenues that would finance waste management costs or these costs could not be entirely funded by waste producers based on the principle of “polluter pays”. Although the separation of waste at source and the recycling of the separated recyclable waste are the basis of waste management policies, decomposition at source and recycling are quite primitive in Turkey. In fact, the current legislation imposes the responsibility of separation on all manufacturing, distribution, and sales units, including households and end consumers, and misconduct is penalized. It even prohibits the disposal of waste other than organic waste in landfills and mandates recycling.

On the other hand, recycling is mostly conducted by street collectors under insanitary conditions, manufacturing and distribution business that are required to recycle meet their quotas mostly by financing the street collectors rather than undertaking this activity.

CONCLUSION

It could be suggested that the waste collection and disposal processes are conducted like the rest of the country in Kirklareli province. Thus, the development of a modern and effective waste management system would not be possible only through the efforts of public institutions and organizations or industrial and commercial corporations. All social segments have important responsibilities in this issue. Thus, participatory policies should be developed to maximize the support and contribution of institutions and organizations such as non-governmental and professional organizations, educational and academic institutions, media, etc. To solve the waste management problems, institutional capacity should be improved. The institutional capacity of the Ministry should be improved to introduce an effective monitoring, auditing, and reporting infrastructure, to increase cooperation and coordination between relevant institutions and organizations, and to concentrate on research, training and orientation activities. The administrative and technical capacity of the provincial organizations in the Ministry should be strengthened and they should operate effectively as monitoring and deterrence systems. The number of pilot projects implemented to encourage waste recycling and seperation at the source should be increased and the implementation should be disseminated in all cities as soon as possible. For this purpose, the Ministry should assist the establishment of the necessary technical and sociocultural infrastructure. Dissemination of the deposit method instead of quota approach in the recycling of packaging waste would lead to a much higher recycling rate. Despite the significance of the issue, social, cultural, and economic concepts would be a major factor in the planned implementation of ideas and sanctions to favor the society in Turkey. Thus, local governments should be more sensitive to public health and protection of natural balance.

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