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LOCAL CLIMATE ACTION IN TURKEY'S WASTE, WASTEWATER AND AIR QUALITY MANAGEMENT

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In case of discrepancies with the English translation, the Turkish version is valid.

LOCAL CLIMATE ACTION IN TURKEY'S WASTE, WASTEWATER AND AIR QUALITY MANAGEMENT

CONTENT

ABBREVIATIONS

C40	Large Cities Climate Leadership Group
CO	Carbon monoxide
CO_2	Carbon dioxide
COP	Conference of Parties
EMEP/EEA	European Monitoring and Evaluation Programme/European Environment Agency
EU	European Union
H_2SO_4	Sulphuric Acid
HCl	Hydrogen Chloride
HNO_3	Nitric Acid
ICLEI	Local Governments for Sustainability
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
N_2O	Nitrous oxide
NO_2	Nitrogen dioxide
NO_3	Nitrate
NO_x	Nitrogen Oxides
O_3	Ozone
OECD	Organisation for Economic Cooperation and Development
PM	Particulate Matter
SLCPs	Short Lived Climate Pollutants
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides
UCLG	United Cities and Local Governments
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

The cities are under the threat of various climate change risks such as increasing temperatures, extreme weather events, rising sea level and decreasing water and food safety. The climate change affects urban infrastructure and superstructure and the problems in these systems further increase the risks of climate change. For instance, improper and incomplete practices in waste and wastewater management not only lead to methane and nitrous oxide emissions and increase greenhouse gas emissions but also damage the environment. The improvements to be made will mitigate greenhouse gas emissions and contribute climate change adaptation actions.

Similarly, the fact that the pollutants that cause air pollution lead to ozone which is a greenhouse gas with short life and it is required to prevent air pollutant emissions in order to prevent ozone formation clearly demonstrates the impact of air pollution control in combating climate change. Black carbon, which is a component of particulate matters, is released during the combustion of fossil fuels. It causes not only air pollution and affects human health but also increases the heating by absorbing the incoming radiation. In the case of accumulation on snow and ice surfaces, it decreases the surface albedo, leading to the surface heating and acceleration of the melting.

One of the most essential actions that need to be done in the cities for combatting climate change is the preparation and implementation of climate change action plans which clearly demonstrate the mitigation and adaptation strategies. For mitigation, the most suitable strategies for each sector that causes greenhouse gas emissions should be identified and net mitigation target should be set. For adaptation, critical infrastructure is determined and the changing conditions are evaluated and prioritized according to probability of risk occurrence and regional impacts. The adaptation strategies should be temporally prioritized according to regional conditions and planning should be made in order to mitigate the impacts of climate change on critical infrastructures. Numerous actions to be performed within the framework of these plans will both mitigate the greenhouse gases and prepare the cities to the risks caused by climate change.

This study has been prepared in order to demonstrate the contribution of efforts to be performed in cities in the fields of waste, wastewater and air quality management, to the greenhouse mitigation and adaptation actions for combatting climate change.

In the first section of the study designed for this purpose, the current situation in Turkey, international and national obligations are presented; the second section presents the relationship between waste management and climate change, environmental impacts of waste management, waste management in Turkey, recommendations for greenhouse gas emissions from wastes mitigation strategies and implementation of strategies; the third section presents the relationship between wastewater management and climate change, impacts of climate change on water management, wastewater management in Turkey, mitigation of greenhouse gas emissions from wastewater and wastewater adaptation strategies; and the fourth section presents the relationship between air quality management and climate change, air pollutants, regulations in Turkey and strategies for air quality control and mitigation of air pollution.

1. CITIES AND CLIMATE CHANGE

More than half of world's population live in cities. Rate of those living in cities will significantly increase compared to those living in rural areas and it is expected that this rate will increase up to 68% in 2050. (UN – Department of Economic and Social Affairs, 2018). 75% of energy consumption takes place in cities and a total of 50- 60% of the greenhouse gas emissions are released from cities. (UN HABITAT, 2019).

Cities, one of the main responsible for climate change, are at the same time affected from the risks of climate change. Cities have a significant potential for the mitigation of greenhouse gas emissions and for adaptation efforts. However, the required capacity does not exist in many cities (ibid). For that reason, the role of local administration is highly important in developing adaptation strategies and combating climate change.

Total greenhouse gas emissions of Turkey are 526.3 million tons of CO_2 equivalent in 2017. A significant portion of greenhouse gas emissions arises from the energy sector having 72.2% of the total (Figure 1, Figure 2) (TurkStat, 2016). This is followed by industrial processes and product use with 12.6%, agricultural activities with 11.9% and waste management with 3.3%, respectively. Although waste management ranks last in this list, since the measures to be taken in this sector are less costly and more easily applicable compared to other sectors and also contribute to the adaptation efforts, it is highly important to carry out mitigation activities in the waste sector. Besides, since the waste management is related with all sectors, proper waste management has more potential than thought in greenhouse gas mitigation.

The CO_2 equivalent emission per capita in Turkey is 6.6 tons in 2017. According to Greenhouse Gas Emission Inventory of Istanbul Climate Action Plan, the total carbon footprint of the city for 2015 is 47.3 million tons of CO_2 equivalent. Of this amount, 37% has arisen due to electricity consumption, 28% from transportation, 25% from natural gas consumption, 6% from waste management and the remaining 4% from the consumption of other fuels. Footprint per capita is 3.23 tons CO_2/person (İBB, İklim.İstanbul and İSTAÇ, 2019). According to the studies in which carbon footprint is monitored at global scale, the carbon footprint is calculated as 5.2 tons CO_2/person in Istanbul and 6.9 tons CO_2/person in Ankara. When the total emissions are analysed, Istanbul ranks first while Ankara is the second at local scale. At global scale, Istanbul is 26th and Ankara is 80th (Moran et al., 2018).

Figure 1: *Turkey's Total Greenhouse Gas Emissions by Sectors (Mt CO_2/year) (UNFCCC, 2019a)*

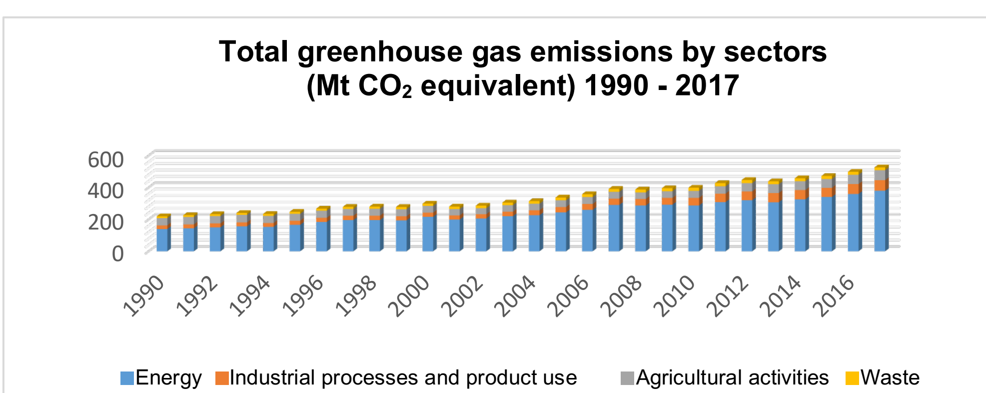
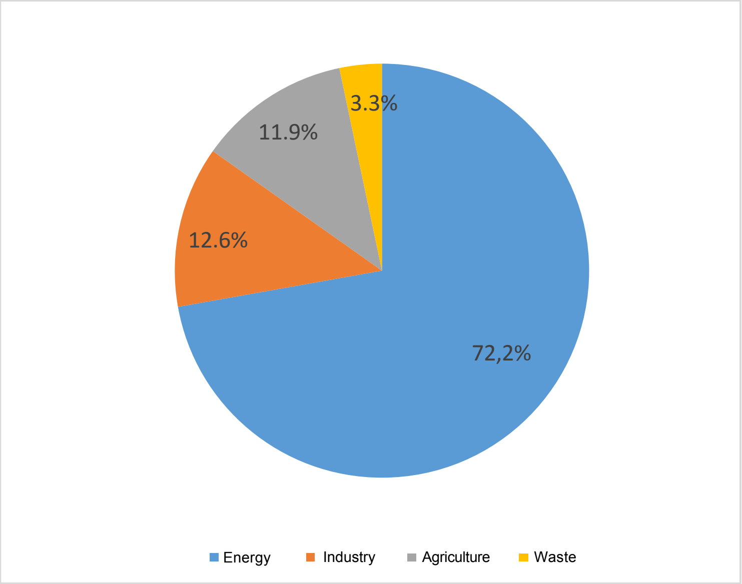


Figure 2: *Shares of Turkey's Greenhouse Gas Emissions in 2017 (UNFCCC, 2019a)*



It is highly important that the cities determine mitigation targets and set their strategies based on these targets in order that countries can fulfil their commitments to intended nationally determined contribution. Besides, global networks, in which the cities give voluntary commitments for mitigation and adaptation, also provide support to the cities for greenhouse gas mitigation and adaptation. In particular, in cities which are the main reasons for greenhouse gas emissions, actions should be taken in order to mitigate emissions resulted from energy, buildings, transportation, waste management and agriculture.

Local administrations are also obliged to carry out adaptation studies in combating climate change. The most important risks that affect the cities could be listed as increasing temperatures, extreme weather events, rising sea level, and water and food safety in danger (van Staden, 2014). It is highly important to develop urban heat management strategies, to increase green areas and green roof practices, to create wind corridors and to strengthen the infrastructure against the increasing health problems, air pollution and urban heat island impact, which are among the problems arising with increasing temperatures. In particular, due to the construction of the sewage infrastructure without taking the climate change into account and the cities being covered with concrete and asphalt materials, problems such as floods and overflows from canals could occur as a result of heavy rains. Against these problems, it is necessary to increase green areas, to strengthen the infrastructure, to determine proper methods for separate collection of wastewater and flood waters and to create disaster action plans.

Emergency plans should be prepared for developing early alert systems against rising sea levels and storm surge, strengthening the coastal infrastructure, moving the service buildings at the coastal zone to inner regions, and evacuation in case of any crisis (ibid).

The decrease in water assets could particularly lead to drinking water scarcity, outbreak of waterborne diseases, decrease in food safety and high food prices. For sustainable water utilization, methods like reducing water losses and leakages, separate collection, rain gardens, green roofs, rainwater store reservoirs and strategies like separate collection of the storm water and improvement of the wastewater treatment could be used.

In this study, the current situation of waste, wastewater and air pollution for combating climate change and adaptation will be evaluated, best practices from Turkey and the world will be delivered and recommendations for solution will be proposed for Turkey

1.1. International Obligations

Republic of Turkey is responsible from fulfilling various obligations as a country that is a party to United Nations Framework Convention on Climate Change (UNFCCC). Preparation of National Greenhouse Gas Emission Inventory, National Communications, Biannual Reports and Intended Nationally Determined Contribution are the main obligations. These official documents cover the issues related to waste, wastewater and air quality management in Turkey, as well as combating climate change at local level and adaptation to climate change.

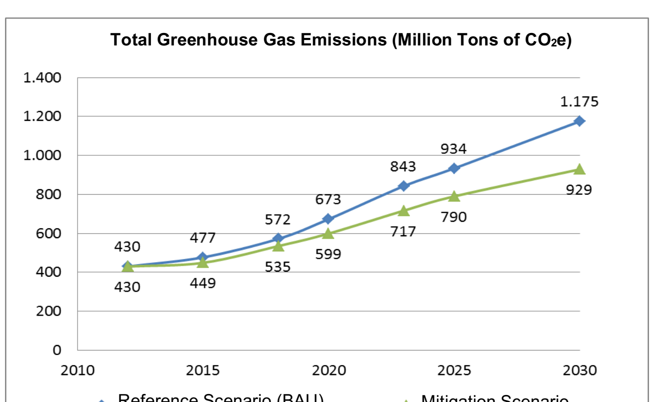
1.1.1. National Greenhouse Gas Emission Inventory

Turkey, which is an UNFCCC Annex 1 country, is obliged to present its National Greenhouse Gas Emission Inventory to UNFCCC Secretariat annually. Since 2006, using 1996 Intergovernmental Panel on Climate Change (IPPC) Guidelines, National Greenhouse Gas Emission Inventory is annually prepared under the coordination of Turkish Statistical Institute, and presented to UNFCCC. The inventory includes greenhouse gas emission statistics from energy, industrial processes and product use, agriculture and waste sectors.

1.1.2. Contribution Targets of Turkey

"Intended Nationally Determined Contributions" (INDCs) were presented to the United Nations in 2015 before COP21. "European Union and Member States" committed in the INDC document to decrease their greenhouse gas emissions by 40% in 2030 compared to year 1990 (UNFCCC, 2015). Republic of Turkey, as a developing country, does not take the reference year as 1990 in its INDC Document (UNFCCC, 2019b). The reference year was selected as 2012. Turkey expects that its emissions would increase by 116% in 2030 compared to its 2012 level. It is foreseen that 2030 reference scenario, which is 1,175 $MtCO_2$ equivalent emissions, will be reduced to 929 $MtCO_2$ equivalent emissions with a rate of 21%. Figure 3 demonstrates the emission mitigation scenario that Turkey presented in its INDC document.

Figure 3: *Turkey's INDC Targets (UNFCCC, 2019b)*



Currently, studies have been performed regarding mitigation calculations. INDC should be updated by reviewing the growth scenarios and re-evaluating the mitigation potential of each sector in these studies. Energy planning and energy efficiency, transition from fossil fuels to renewable energy, application of emission mitigation techniques in industrial facilities and prompt implementation of the mitigation actions in sectors such as agriculture and waste where emission mitigation costs are low could be considered as priority mitigation strategies.

1.1.3. National Communication and Biennial Reports

Annex 1 countries of United Nations Framework Convention are obliged to submit National Communication in every four years. Since Turkey is one of the member countries of Organization of Economic Cooperation and Development (OECD), it is included in Annex 1 countries. Thus, Turkey has presented its First National Communication in 2007 and the Sixth National Communication in 2016 to the United Nations. National Communications include the titles of country conditions, greenhouse gas emissions inventory, policies and measures, greenhouse gas projections, impacts, vulnerability and adaptation, financing resources and technology transfer, research and systematic observation, education, training and public awareness.

Again, due to being an Annex 1 country, Turkey presents biannual reports to the Secretariat. Turkey submitted its first and second biannual reports in January 2016. The third biannual report was delivered to the Secretariat in January 2018. In the reports, information is given on greenhouse gas emission mitigation, finance, technology transfer and capacity building. In the third biannual report, the updated version of national greenhouse gas inventory is provided.

1.2. Global City Networks

Global city networks aim at supporting the fight against climate change with specific emphasis on cities. Some of these solidary networks are C40 (Large Cities Climate Leadership Group), ICLEI (Local Governments for Sustainability), UCLG (United Cities and Local Governments) and UN Habitat (United Nations Habitat).

C40 is a global coalition and solidarity network created by mega cities supporting climate action for healthy cities and sustainable future. It represents 94 cities and more than 700 million people. Mayors joined in C40 try to realize the goals of Paris Agreement at local level and to contribute in keeping the city air clean.

ICLEI has members from 1750 cities with different scales in 124 countries. ICLEI offers low emission development, nature based development, circular development, resilient development and fair and human-centred development as local climate policy to the cities. The main objective of UCLG is to "be a united voice and world-scale defender of democratic local governance and protect their values, purposes and interests in collaboration with local administrations and international community" (UCLG-MEWA, 2015). UN Habitat has been carrying out studies at of city and region scale in order to both mitigate the greenhouse gases and build climate resilient cities.

City networks have come together to establish European Union Covenant of Mayors and Compact of Mayors, which started to operate in 2008 and 2014, respectively. These two covenants were combined thereafter to create "Global Covenant of Mayors for Climate & Energy (GCoM)". GCoM is the largest local climate and energy initiative among all. It aims at mitigating local greenhouse gas emissions, increasing resistance against global warming and monitoring the progress. Cities and regions that signed the GCoM have long term targets such as creating carbon neutral and resilient regions that provide sustainable and low cost energy for all. These cities and regions contribute to this vision voluntarily by fulfilling the targets determined at regional or national level in relation to irrigation, adaptation and access to energy. They prepare *Climate and Energy Action Plans* which are subject to monitoring process. Cities and regions which signed GCoM encourage the cities to work together with regions, states and central governments (UCLG-MEWA, 2018).

Ankara Çankaya Municipality, Antalya Metropolitan Municipality, Bursa Metropolitan Municipality, Bursa Nilüfer Municipality, Eskişehir Metropolitan Municipality, Eskişehir Tepebaşı Municipality, Istanbul Bağcılar Municipality, Istanbul Kadıköy Municipality, Istanbul Maltepe Municipality, İstanbul Pendik Municipality, İstanbul Şişli Municipality, Gaziantep Metropolitan Municipality, Sakarya Metropolitan Municipality, İzmir Bornova Municipality, İzmir Metropolitan Municipality, İzmir Karşıyaka Municipality, İzmir Seferihisar Municipality, İzmir Bayındır Municipality, Balıkesir Karşıyaka Municipality are the signatories of GCoM from Turkey (Covenant of Mayors for Climate and Energy, n.d.).

1.3. National Obligations

Although combating climate change is not clearly addressed in the national legislation, many articles in the by-laws are important in relation to combating climate change. In particular, there are important targets for waste, wastewater and air management in the climate change adaptation strategy and action plans, as well as national strategy, policy, program and action plans. The 10th Development Plan and National Energy Efficiency Action Plan have been analysed below from the point of *combating climate change*.

In the Tenth Development Plan (2014-2018) very important points have been underlined in relation to environment and climate. The connections between two concepts could be highlighted more in the further stages. For example, in Article 981, it is stated that "Sewage system and wastewater treatment infrastructure will be developed in the cities; it will be ensured that these infrastructure operates so as to meet the discharge standards determined according to basins; and the reuse of treated wastewaters will be encouraged" and in Article 982, it is stated that "Solid waste management will be performed more efficiently and waste minimization, source separation, collection, transportation, recycling and disposal sites will be developed as a whole in technical and financial terms; institutional capacity building and awareness raising will be prioritized. It is also stressed that "Utilization of recycled materials in manufacturing will be encouraged". These two articles include very important policies in terms of combating climate change in cities. In the further sections, studies for linking with climate change would be quite valuable.

In the National Energy Efficiency Action Plan (2017-2023) it is aimed to increase energy efficiency in particular for building and services, industry and technology, energy, transportation and agriculture sectors (EYODER, 2017). With the action numbered B4 under the Building and Services Sector, namely "Increasing energy efficiency in municipality services", it is aimed that the municipalities determine opportunities and implement measures primarily in the fields of water supply, wastewater treatment, waste collection, waste recovery, waste disposal and public transportation as well as energy efficiency. Only in this action the energy efficiency action is targeted for waste and wastewater while all actions in the plan serve improving air quality and combating climate change by means of energy efficiency.

2. WASTE MANAGEMENT AND CLIMATE CHANGE

2.1. Waste

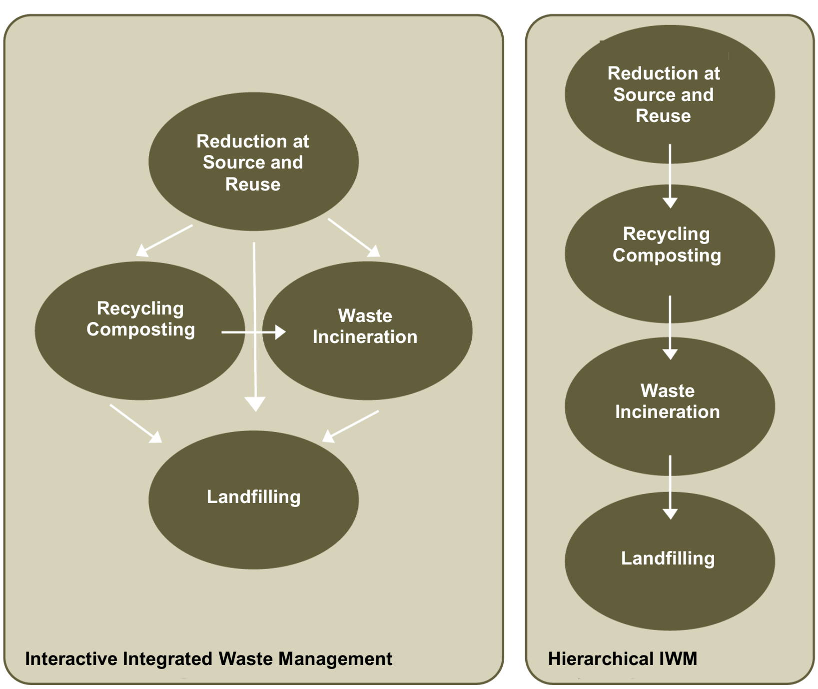
Any material which the owner wants to get rid of is defined as waste. IPCC considers the waste types in three categories; household waste, industrial waste and other wastes (IPCC, 2006). Separate collection of those which could be sent to recycling among these wastes is very important for the mitigation of greenhouse gas emissions.

Most part of the wastes in the cities comprises the household wastes. Household wastes consist of food waste, garden and park waste, cardboard, wood, textiles, diapers, rubber and leather, plastic, metal, glass and other waste (ash, dust, batteries, electronic waste, etc.) and most of these are recyclable and reusable materials.

2.2. Waste Management

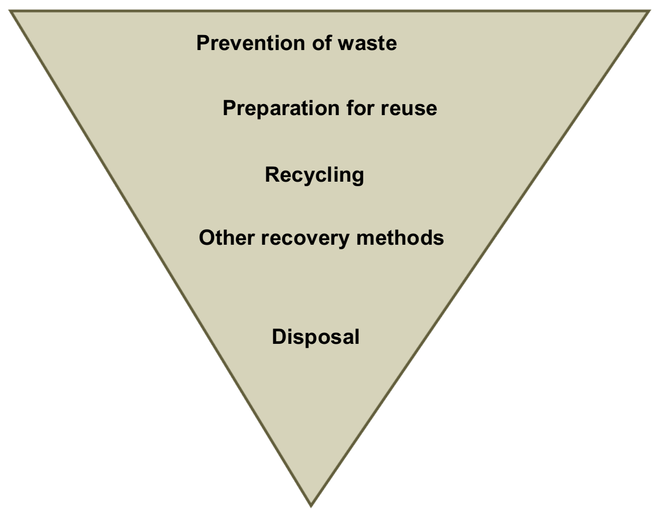
Whereas waste management demonstrates diversity among countries and regions, it could generally be divided into two as hierarchical and interactive integrated waste management. Whereas interactive integrated waste management primarily include reduction at source and reuse stage, it is possible that the remaining fragments could be directly sent to landfill. However, in hierarchical management, reduction at source and reuse, recycling and composting, waste incineration and landfilling are applied respectively (Figure 4). In this method, reduction at source and reuse should be applied primarily, then followed by recycling and composting, incineration of the remaining mixed wastes and finally landfilling of the slag.

Figure 4: *Integrated Waste Management Models (Tchobanoglous & Kreith, 2002)*



In Europe, this model is further developed and only the prevention of waste is at the top stage. If the waste generation could not be prevented, integrated waste management steps are implemented (Figure 5). Sustainable waste management could be implemented in addition to interactive and hierarchical integrated waste management. In sustainable waste management, waste management starting with waste reduction continues with reuse and recycling, anaerobic methods, aerobic composting, energy recovery, methane recovery from landfill sites, methane combustion in landfill sites, disposal to landfill sites without methane recovery and disposal to wild dumping sites, which is an order from the best to the least desired method (Rosenzweig et al., 2015).

Figure 5: *Integrated Waste Management Model in Europe (UCCRN, 2015)*



2.3. Environmental Impacts of Waste Management

Landfill Sites: Each of the methods involved in waste management causes environmental impacts and certain greenhouse gas emissions, especially methane. Most greenhouse gas emissions emerge from landfills. While biodegradable wastes lead to methane emissions in landfill sites, these emissions cause both climate change and risk of fire and explosion. Therefore, it is important to prevent methane emissions from landfill sites, especially for greenhouse gas reduction. In order to prevent these emissions, it is essential to reduce waste at source and to implement waste separation countrywide. Leachates resulting from the degradation of wastes also mix with groundwater and surface waters and pollute the soil. Since existing landfills reach their capacity in time, lands are required for new landfill sites. Therefore, the opportunity to use these lands for more beneficial purposes is prevented. Landfill sites also lead to significant noise and odour problems for the inhabitants.

Mechanical and biological pre-treatments reduce methane and leachate resulted from organic matter. After treatment, the materials can be used for recycling and energy recovery. By preventing all wastes sent to the landfills, more efficient use of the landfills could be achieved.

Recycling: Recycling is of great importance in terms of energy saving. The production from raw materials obtained from recycling consumes less energy than pure raw materials. For example, the most energy-intensive part of glass production obtained by melting sand and other minerals at high temperatures is the energy required to melt the mixture (EIA, 2013). Since the recycled glass still needs energy to be melted, the energy recovery rate remains in the range of 10-15% (AGI, 2019). For aluminium obtained from aluminium ore, a very high amount of heat and electricity is required during the separation of aluminium. This process is not necessary for recycled aluminium. While only cleaning and melting stages are sufficient, 94% energy saving is obtained compared to aluminium obtained from aluminium ore (U.S. Department of Energy, 2007). The greatest energy savings by recycling are generally from metals. It is easy to recycle and avoids energy-intensive mining and production processes. For example, energy saving by recycling is 80% from beryllium, 75% from lead, 72% from iron and steel, and 50% from cadmium (AGI, 2019). Greenhouse gas emissions are reduced in parallel with energy savings. In addition, recycling ensures sustainable use of limited raw material reserves. Recycling prevents the environmental impact that could arise from the extraction of pure raw material.

Compost: Compost is a humus-like product formed by microorganisms via decomposition of organic wastes in aerobic environment. The resulting product differs in terms of organic matter and minerals depending on the type of waste used. By composting organic household wastes, vegetable wastes, animal faeces and the treatment sludge, the environmental problems caused by these wastes could be prevented. However, the quality of the product obtained after the process should be tested. There shall be no pathogens in the product and the nutrient content and organic matter values should be at sufficient level. It could be applied on agricultural lands, parks, gardens depending on the quality. With the utilization of compost, the financial and environmental problems created by the chemical fertilizer most of which is imported will be avoided and with the dissemination of composting, it would be possible for the farmers to produce their own fertilizers. However, this method which has many advantages is not being widely applied in Turkey.

Compost method ensures that less organic wastes are sent to the landfill site and thus the amount of methane released as a result of decomposition of organic waste is decreased. The compost product obtained after composting process could be used as soil conditioner by reducing the use of mineral fertilizer. By increasing soil organic matter, it increases the carbon storage capacity of the soil. It improves soil fertility and reduces the need for inorganic fertilizers. Since it increases the water retention capacity of the soil, it reduces the need for irrigation and reduces erosion levels. However, attention should be paid in terms of carbon dioxide, methane and nitrous oxide emissions that may occur during composting. Studies have shown that aerobic composting systems cause lower emissions than anaerobic composting systems (Ministry of Agriculture and Forestry in Canada, 2019).

Incineration Plants: Different problems arise with the use of fossil fuels in energy recovery facilities. Greenhouse gases such as CO_2 and N_2O causing climate change may emerge from a plant where household wastes are incinerated. An incineration plant which does not filter air pollutants could cause pollutants such as NO_x, SO_2, HCl, particulates, dioxins.

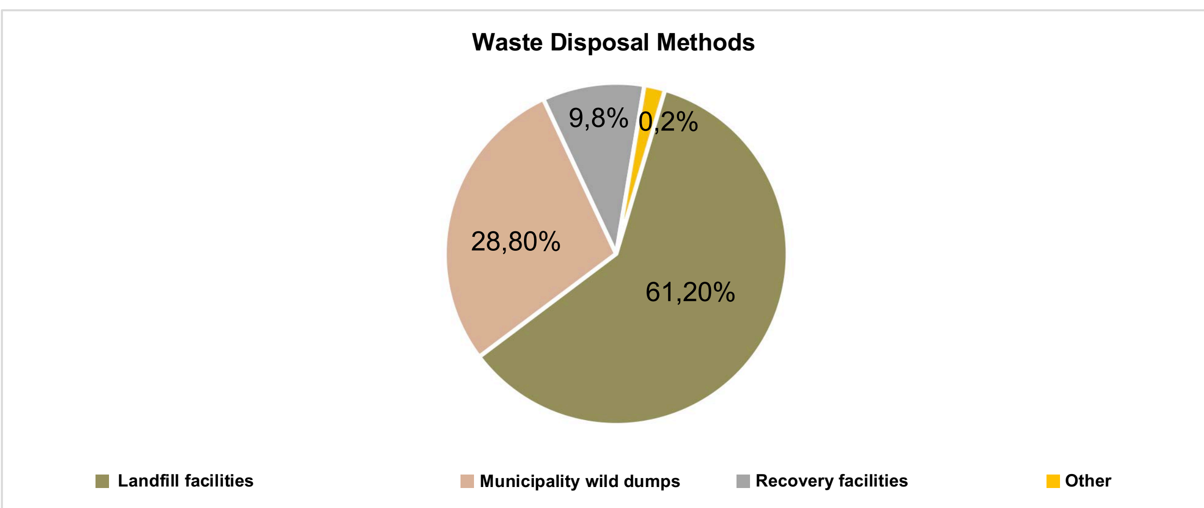
When waste management is evaluated from a climate change perspective, the first thing to be considered is the control of methane emissions from landfill sites. For this, control of organics prior to be sent to the landfill site is of great importance.

Utilization of other recyclable materials in the industry as raw materials and thus reduced energy consumption result in a reduction in the use of fossil fuel. In this way, greenhouse gas mitigation would be ensured. Paper recycling could lead to less tree cutting and thus it could be possible to protect the trees and increase carbon capture. Rather than transporting the waste to landfill sites for long distances, performing the waste management at distances closer to the generation of waste will ensure saving energy resources consumed at these distances (Ackerman, 2000). The most important step for the successful implementation of all these methods is waste reduction and separation of waste at source.

2.4. Waste Management in Turkey

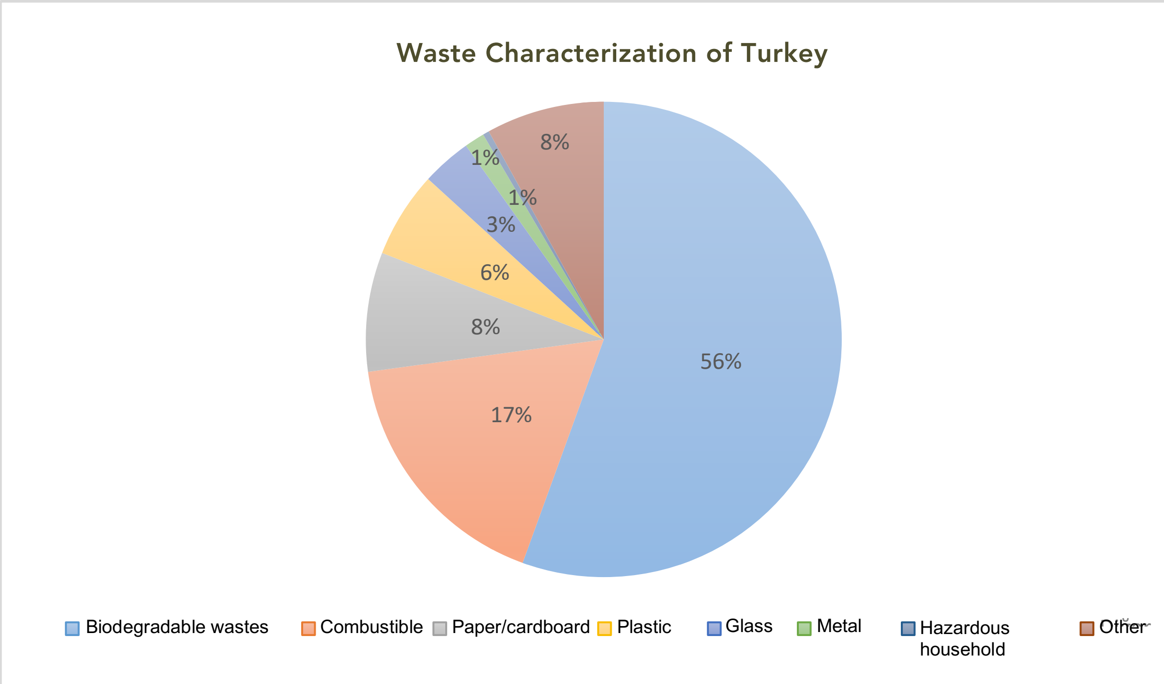
Turkey has disposed of its waste in the wild dumping sites for many years, and in recent years has made the transition to landfills. As of 2016, 61.2% of wastes were landfilled, 28.8% went to wild dumping sites, 9.8% were recycled and 0.2% was disposed by other methods (Figure 6) (Turkish Ministry of Environment and Urbanisation, 2017). However, sending the waste to the landfills is not a preferred method not only with regard to climate change, but also protection of nature. A research conducted by a research company in the UK in 2017 showed that Turkey is among the countries that throw away its waste at most among the European countries (Hürriyet Daily News, 2017).

Figure 6: *Waste Disposal Methods in Turkey, 2016 (Turkish Ministry of Environment and Urbanisation, 2017)*



There are many valuable raw materials suitable for recycling in the solid waste. When waste characterization of Turkey is examined, it could be seen that biodegradable wastes are at the highest rate (56%) among the whole wastes (Turkish Ministry of Environment and Urbanisation, 2017). It is followed by recyclable materials such as paper/cardboard (8%), plastic (6%), glass (3%) and metal (1%) (Figure 7). Reducing and reuse of waste, recycling and composting are the methods that are required to be implemented immediately in our country. The priority condition for this is the separate collection of the waste.

Figure 7: *Waste Characterization of Turkey, 2014. (Turkish Ministry of Environment and Urbanisation, 2017)*



2.5. Waste Management Regulation in Turkey

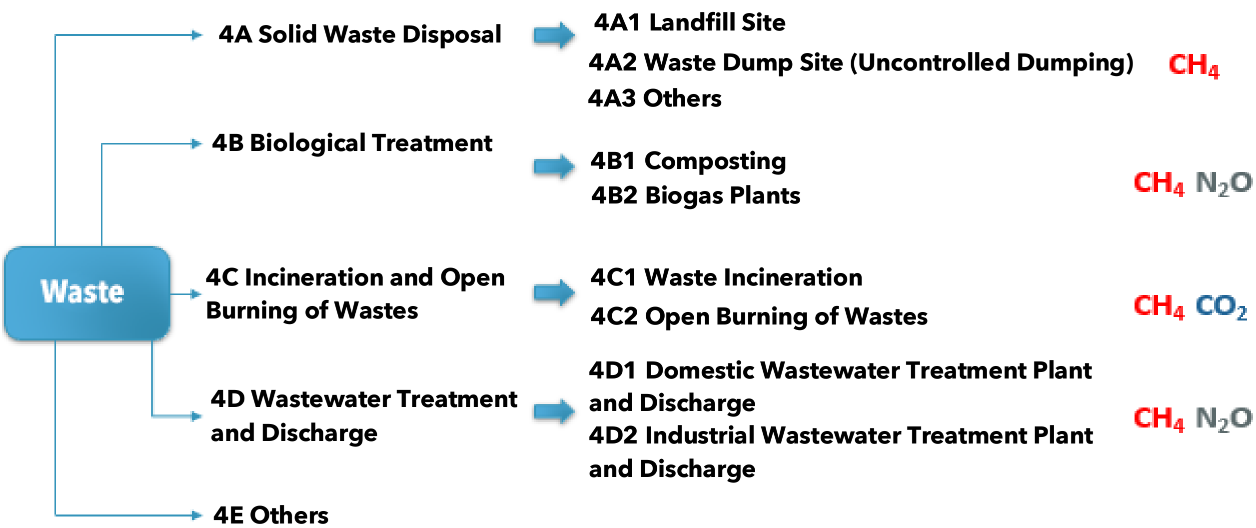
By-laws being enforced by the Ministry of Environment and Urbanisation, General Directorate of Environmental Management, Waste Treatment Department and Zero Waste Management Department as well as their dates of entry into force are indicated below. Among these by-laws, "By-law on Waste Management", "By-law on Control of Packaging Wastes", "By-law on Landfilling of Wastes" and "Notice on Composting" are essential in terms of combating climate change. Local administrations are required to implement these by-laws and ensure the management of waste in the best manner. For example, in the "By-law on Landfilling of Wastes", there is a provisional article for reducing biodegradables. In the Provisional Article 1 - Reducing Biodegradables, it is stated that in 2015, 75% of the 2005 waste will be sent to landfills, then 50% in 2018 and 35% in 2025. Application of this article means reduction of waste and control of organic waste by composting or other methods. All these can be more clearly stated in the by-law and transformed into an encouraging structure in the application field. As the emissions from landfill sites are decreased with the reduction in wastes going to landfill sites and sustainable use of raw material reserves and energy saving are ensured, implementation of these by-laws is crucial in combating climate change (Turkish Ministry of Environment and Urbanisation, 2018b).

In addition to these by-laws, National Waste Management Action Plan is prepared within the scope of national regulation and EU harmonization efforts. In this plan, the waste management strategies are presented according to the prioritization of methods by wastes and regions. Besides, in this action plan, waste controlling methods for the waste to be generated in 2023 is provided in detail with middle and long term targets (Turkish Ministry of Environment and Urbanisation, 2017).

2.6. Greenhouse Gas Emissions from Waste

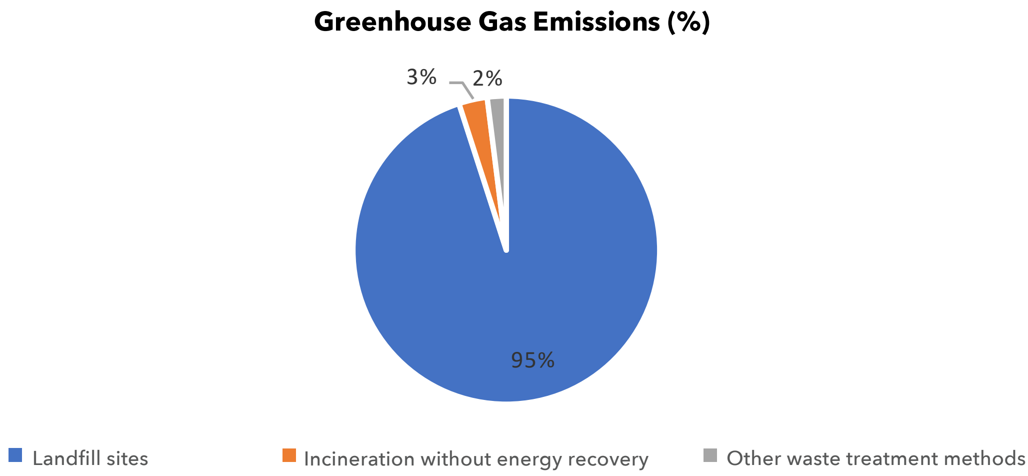
According to the IPCC national greenhouse gas inventory guidelines (IPCC, 2006), waste categories are evaluated under five categories, namely solid waste disposal, biologic treatment, incineration and open burning of wastes, wastewater treatment and discharge and others. Emissions from the waste are particularly the methane and nitrous oxides from bacterial activities. Methane is the most common greenhouse gas from the landfill sites.

Figure 8: *Greenhouse Gas Emissions from Waste According to IPCC Guidelines (ibid)*



According to the study of the European Environment Agency, the most important reason for the emissions from waste is the landfill sites with a rate of 95% (Figure 8) (EEA, 2014). Incineration and other waste management methods follow landfilling. Since incineration method is not much used in Turkey, the greenhouse gas emissions arising from landfill sites and wastewater treatment plants are the two priority categories under the waste sector.

Figure 9: *Greenhouse Gas Emissions from Waste (%) (EEA, 2014)*

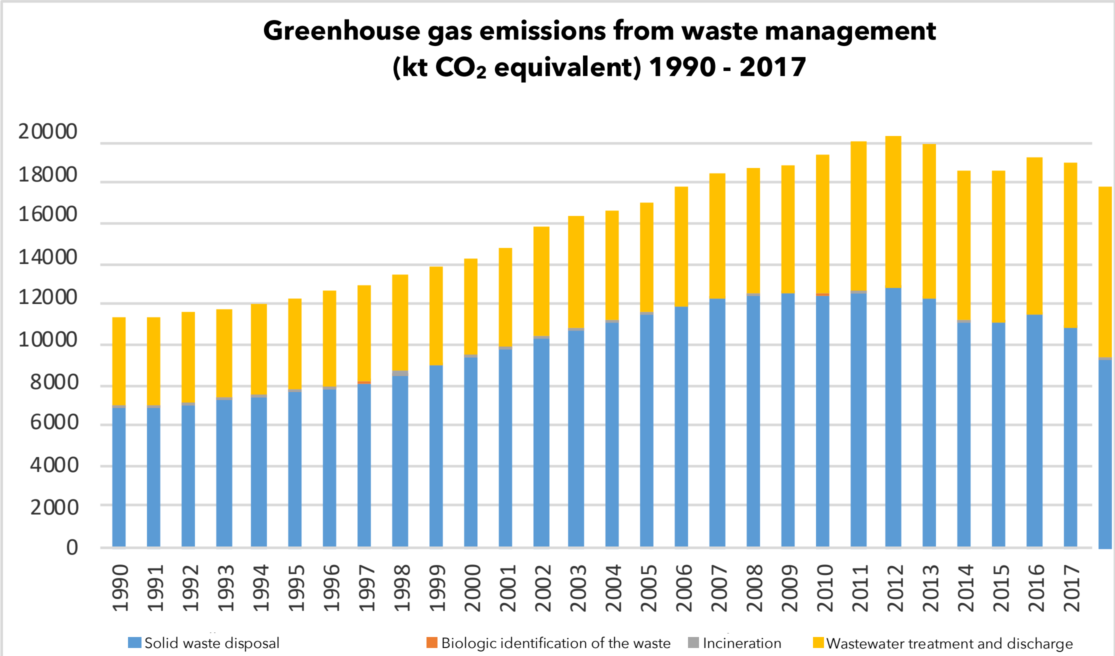


17.3 $MtCO_2$ of greenhouse gas emissions are resulted from waste in Turkey as of 2017 and 52% of it arises from the solid waste disposal, namely landfill sites. The next emission source in the waste sector is the wastewater treatment with a share around 48%. For that reason, solid waste disposal methods and wastewater treatment and discharge should be properly handled and managed within the mitigation efforts. At this point, the control of wastewater treatment sludges in particular is of utmost importance. It is not appropriate to apply the treatment sludges directly to the soil. It could be applied to the soil as soil conditioner or by composting in accordance with the "By-law on Utilization of Domestic and Urban Treatment Sludges in the Soil".

Table 1: *Greenhouse Gas Emissions in Turkey from Waste - 2017 ($ktCO_2$/year) (UNFCCC, 2018)*

	Total CO_2 equivalent
Solid waste disposal	9,079
Biological treatment of waste	14
Incineration	4
Wastewater treatment and discharge	8,258
Total	17,355

Figure 10: *Greenhouse Gas Emissions in Turkey from Waste (UNFCCC, 2019a)*



2.7. Strategies for Mitigating Greenhouse Gas Emissions from Waste

As of 2018, OECD countries sent 36% of the waste to recycling and composting, 20% to the incineration plants with energy recovery, and the remaining 42% to the landfill sites. Current recycling rate in Turkey is around 10% (OECD, 2019).

Prevention of Waste:

The first step in reducing greenhouse gas emissions from waste is prevention, reduction at source and reuse. If this could not be achieved, it could be recommended to reduce waste or reuse the material until end of its life.

Recycling:

Recycling through separate collection of wastes has various advantages such as sustainable use of limited raw materials, less energy consumption during recycling, less fossil fuel use and need for less landfill sites. Recycling of organics by composting is very beneficial for the soils that have low level of organic matter. As a result of applying compost to the soil, the organic matter of the soil and accordingly carbon retention capacity of the soil increases. Thus, use of mineral fertilizers will be decreased and emissions from the production and consumption of mineral fertilizers will be prevented. In this way, tackling climate change is supported in terms of both mitigation and adaptation.

Recovery:

A good example of recovery is transformation of organic wastes into biogas by decomposition and obtaining energy from this gas. Biogas facilities can produce a gas similar to natural gas (98% methane) which enables increase in renewable energy and thus reduces emissions by energy sector via reducing utilization of fossil fuels in the facility and its vicinity. Biogas could be used both as fuel and for electricity generation. The product arising with the transformation of the organic product used during the process could be used as soil conditioner. In Germany, organic wastes are sent to biogas facility. Currently there are 9,500 biogas facilities (Buddle & Newman, 2019). Since the presence of pathogen in the product to be obtained using animal fertilizer in the facilities would create a risk, household organic waste is preferred by the municipalities. With the utilization of the product to be obtained from biogas process, production and use of mineral fertilizer can be decreased and accordingly greenhouse gas emissions can be reduced as well (Ağaçayak & Öztürk, 2017). Moreover, carbon retention capacity of the soil is increased by increasing organic matter of the soil and biogas utilization which is a type of renewable energy is increased and fossil fuel consumption is decreased.

Landfilling:

Whereas landfill sites are not a preferred option in developed countries, the capturing landfill gas in the existing regular landfill sites and recovery of methane are highly important. With decreasing the amount of organic wastes sent to landfills by composting method, it will be possible to decrease the waste amount and accordingly the emissions from landfills.

Strategies presented in the Waste Section of Turkey's INDC Report are as follows (EEA, 2014).

- Directing solid wastes to landfills;
- Reuse, recycling of wastes and their recovery with other processes to obtain secondary raw material, using them as energy source or disposal;
- Energy recovery from waste by subjecting wastes to processes such as material recovery, biodrying, biomethanization, composting, advanced thermal processes or incineration;
- Methane recovery from landfill gas resulted from managed (landfills) and unmanaged (dumps) disposal sites;
- Utilization of wastes arising from the industry as alternative raw material or fuel in another sector, industrial symbiosis approach which enables a waste generated by a sector to be a raw material for another sector;
- Conducting feasible studies for the utilization of wastes resulted from breeding and chicken farms;
- Rehabilitation of dumping sites and disposal of the wastes in landfill sites.

In addition to these, a comprehensive strategy can be developed for wastewater. At local level, municipalities have solid waste management plans and it will be important that they associate their activities in this context with combating climate change. Municipalities that signed the Covenant of Mayors have developed emission mitigation strategies. Yet, the fact that cities, which cause the most part of greenhouse gas emissions, are also exposed significantly to the impacts of climate change, impose significant responsibilities on each local administration.

2.8. Recommendations for Implementation of Strategies

The following strategies could be adopted in order to implement the strategies mentioned in the previous section.

Prevention of Waste:

- Raising awareness among public on waste and separate collection
- Municipalities organizing campaigns related to waste
- Organizing campaigns related to nature protection

Recycling, Recovery:

- Ensuring capacity and infrastructure necessary for implementing waste management by-laws
- Organizing trainings for increasing waste prevention, recycling and recovery practices instead of managed or unmanaged dumping sites;
- Organizing awareness raising activities in order to ensure source separation of waste for the waste minimization, reuse and recycling;
- Determining and implementing methods encouraging separate collection of wastes for recycling;
- Ensuring necessary infrastructure for waste collection and improving recycling infrastructure
- Collecting organic wastes separately for compost and biogas production and to do this raising public awareness and providing necessary infrastructure
- Informing farmers on the hazards of mineral fertilizers and developing encouraging practices on utilization of compost.

Landfilling:

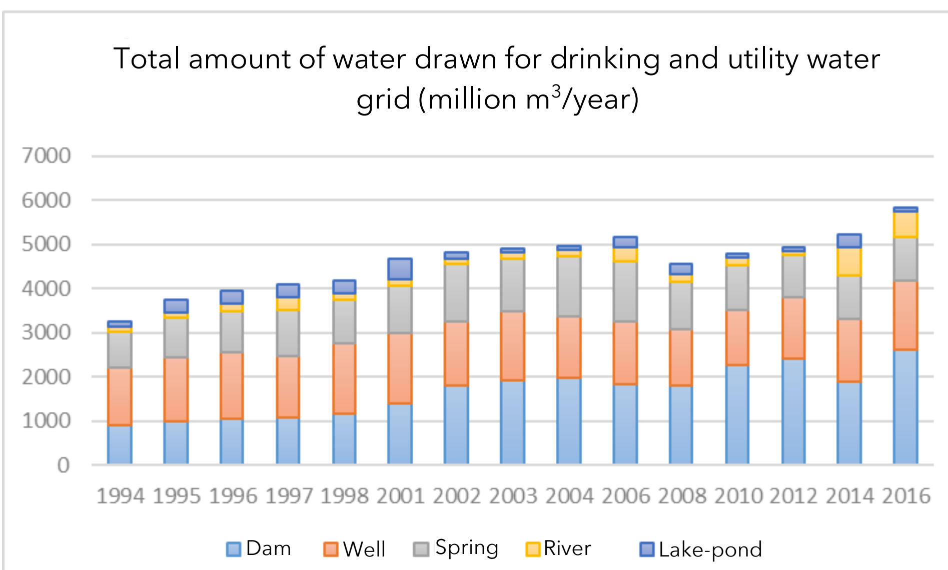
- Transforming all dumping sites into landfill sites
- Ensuring necessary infrastructure for recovering methane from landfill gas from managed and unmanaged dumping sites;

3. WASTEWATER MANAGEMENT AND CLIMATE CHANGE

3.1. Wastewater Management

Water safety, which is defined by the United Nations as "the capacity of a society to access sufficient and good quality water in a sustainable manner in order to maintain its life, ensure its socio-economic development, protect itself against water pollution and water-borne disasters, and protect the ecosystems in the environment of peace and stability", has become highly important due to climate change. According to Falkenmark Index, accessible water between 1000-1700 m^3/person-year means that water stress is being experienced. Turkey is a country which suffers from water stress with an accessible water amount of 1387 m^3/person-year. While increasing temperature and decreasing precipitation will create negative impact on resources, population increase, social and economic developments will negatively affect the resource use. Due to all these factors, Turkey will become a water-poor country by the year 2050 (Ağaçayak & Keyman, 2018). For this reason, water resources should be used in the most efficient manner and the wastewaters should be discharged to the receiving environment after treatment. Currently, 86% of the wastewaters are discharged to the receiving environment after treatment (TurkStat, n.d.). Investments necessary for treating all wastewater should be prioritized.

Figure 11: *Total Amount of Water Drawn by Municipalities in Turkey (TurkStat, 2018)*



Wastewater systems lead to formation of methane and nitrous oxides during wastewater transmission, treatment and disposal, as well as due to formation of wastewater treatment sludge. The most important reason for nitrous oxides is the sewage systems and wastewater treatment (Major et al., 2011). While wastewater treatment process leads **to greenhouse gas emissions, climate change negatively affects wastewater treatment plants and the treatment processes** (Zouboulis & Tolkou, 2014). The increase of pollutants in waters, overflows, floods, flash floods, sedimentation and algal blooms could be set examples for these (EPA, 2017). The crucial impacts of climate change on water supply systems could be listed as drought, water shortage, increase in sea level and salty water intrusion to fresh waters. Taking all of these problems into account, the local administrations should take adaptation actions considering the climate change and connected uncertainties in their water supply and wastewater management plans.

The most important strategy in wastewater management is the collection of storm waters separately from the wastewaters. Canal systems which are constructed without taking into account the climate change could not bear the load of the city during heavy rains. The fact that, in the big cities of Turkey, major part of the precipitation reaches to seas and lakes as surface flow due to asphalt surfaces, prevents the water resources from reaching the subsurface and underground waters. In order to tackle these problems, it is necessary to consider the wastewater management in terms of both mitigation and adaptation. The examples could include water recovery, separate collection of storm water, improved treatment, improving forestation activities, developing methods towards preventing deforestation, increasing park and garden areas, improving water distribution networks and preventing losses and leakages.

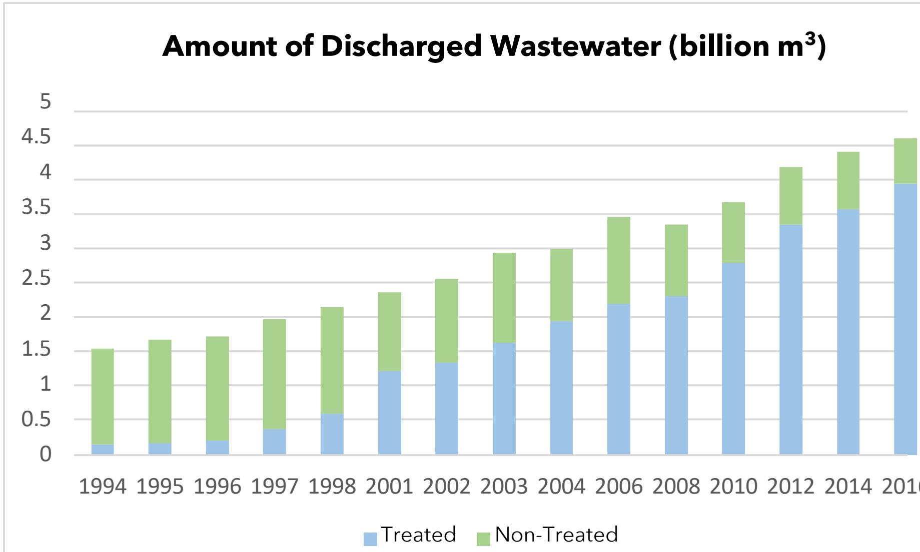
3.2. Impacts of Climate Change on Water Management

Increasing temperatures and heat waves negatively affect the water resources due to increasing vaporization and water demand. Climate change both leads to problems in the treatment systems and the release of greenhouse gases from the facilities contributes negatively in the climate change. Increasing water temperatures lead to decrease of dissolved oxygen in water resources, release of phosphorus and other polluters from anoxic zones and sediments, decreasing mixture, decreasing water quality, increasing algal blooms (including blue-green toxic ones). In water treatment, various problems occur such as impact on water quality, increasing treatment costs due to algae, odour and taste problems in water, and decreasing treatment efficiency. Decreased dissolved oxygen leads to excessive costs during treatment due to reasons like excessive use of disinfection by-products.

3.3. Wastewater Management in Turkey

The total amount of water discharged in Turkey increased from 1.5 billion m^3 in 1994 to 4.5 billion m^3 in 2016 (Figure 11). Wastewater treatment increased from 10% in 1994 to 86% in 2016. Although the increase of treatment is a decent development, the fact that 14% is given to the receiving environment without treatment is a crucial problem. Particularly in order to maintain the quality of receiving environments, it is necessary to treat all of the wastewater. The most important receiving environments discharged are seas and rivers. While the amount discharged wastewater to the seas was 37% of the total in 1994, it is increased to 40% in 2016. Share of discharged wastewater to the rivers decreased from 53% to 48% (TurkStat, n.d.).

Figure 12: *Treated Wastewater Discharged by Municipalities in Turkey (*TurkStat*, n.d.)*



3.4. Mitigation of Emissions from Wastewater and Wastewater Management Adaptation Strategies

Wastewater treatment and discharge is classified under waste category according to IPCC's classification of greenhouse gas emissions and divided into two as domestic wastewater and industrial wastewater. Methane and nitrous oxide emissions are generated from wastewater via biological processes. In addition, management of sludge generated after treatment is also important for tackling climate change.

- Firstly, separate collection of storm water should be targeted. Transfer of storm water to the channels by mixing with the wastewater causes both additional loads on the channel system and wasted storm water which could be utilized with a pre-treatment. Separate collection will ensure water recovery. In addition, water could be collected without going to the channel system via methods like rain stores and rain gardens.
- As a result of severe weather events, overflows, problems in the channel systems and floods may occur. Infrastructure should be strengthened for adaptation, management of wastewater flood water infrastructure should be improved and emergency measures should be taken.
- Greenhouse gas emissions need to be reduced without affecting treatment efficiency. Process change could be made for this. More innovative applications could be used. For example, microalgae and photosynthetic bacteria culture practices both treat the wastewater and decrease greenhouse gas emissions (Yapıcıoğlu & Demir, 2017). Treatment by microalgae culture would reduce both CO_2 and N_2O. Addition of aerobic photosynthetic bacteria species into wastewater reduces the CO_2 content in water. Biochar application reduces CO_2 and N_2O by adsorbing carbon and ammonium.
- The impact of climate change on treatment systems is high. Sudden change of temperatures inhibits the treatment reactions. The bacteria performing the treatment can be

affected by temperature, so the treatment temperature must be under control.

- Rising sea level and flooding of treatment plants due to overflows is a very significant risk factor. Transportation of pathogens and microorganisms in the treatment plants due to floods is an important threat for health. In order to reduce the impact of temperature changes on the facilities, adaptation and optimization of the process models could be made in order to be used in design, optimization and real time automation process control charts (ibid).
- For the facilities on the coastline, emergency action plans should be prepared against the increase in sea level. In addition, if the service buildings are on the coastline, they should be moved to the inner regions.
- Dealing with sewage sludge management is also important in terms of climate change impacts. Sewage sludge, which is already sent to solid waste landfill facilities, places a big burden on these facilities and also causes greenhouse gases. Sewage sludges could be used to generate electricity by incinerating and thus energy recovery could be ensured. It could be applied to the soil as soil conditioner or compost in accordance with the "By-law on Utilization of Domestic and Urban Treatment Sludges in the Soil".

Regarding water resources, problems could be confronted such as drought, drinking water pollution, power cuts, water-borne diseases, high food prices, decrease in food safety. Water recycling, separate collection of the wastewater and improvement of treatment are important for adaptation. "Workshop on Wastewater Management in Turkey" was held in April 2017 and the decisions taken were published in the final declaration. Under Article 6, especially the decision namely; "New technologies should be used in wastewater treatment in case of reasons such as forcing factors arising from global climate change, water recovery becoming a need and the need for high quality water treatment in connection with the receiving environment based discharge standards being more strict, low energy requirement, technologies offering options for easy operation, treatment technologies generating lower sludge, need for smaller area, treatment of sludge filtrate waters, need for modular processes, and the need for integrated systems. It is recommended that new technologies are tested with pilot scale studies before real plant practices. Local production and development of these technologies should be supported", should be taken into account among the actions taken for tackling climate change.

4. AIR QUALITY MANAGEMENT AND CLIMATE CHANGE

Air pollution is the presence of unwanted substances in the air at harmful level. Whereas air pollution causes damage on human health and ecosystems, it also causes certain greenhouse gases that lead to climate change. Many polluters that are harmful for human health could affect the absorbed or scattered amount of solar radiation, leading to warming or cooling. These short lived climate polluters (SLCPs) involve methane, black carbon, ground level ozone and sulphate aerosols. In particular, black carbon and methane are the polluters that have the greatest impact on global warming after carbon dioxide (IASS, n.d.).

7 million people lose their lives due to air pollution annually (WHO, 2018). According to a study conducted by the World Health Organization, nine out of ten people in the world breathe polluted air. In Turkey, combustion of fossil fuels that cause air pollution caused annually 2876 premature deaths, 4311 hospitalizations, and health care expenditure over 3 billion Euro (Sönmez, 2017). According to Turkey Air Pollution Report 2018 prepared by UCTEA Chamber of Environmental Engineers, 60 million people in Turkey breathe polluted air (UCTEA Chamber of Environment Engineers, 2019).

Since the sources of greenhouse gases and pollutants are generally the same, air pollution control is highly important in combatting climate change. SLCPs are responsible from almost half of global warming. Although many mitigation plans relate to reducing carbon dioxide levels, SLCPs should also be included in international climate targets.

SLCPs have shorter atmospheric retention time compared to carbon dioxide. Many aerosol particles, for example black carbon and ground level ozone among the pollutant gases, have a retention time between a couple of hours and a couple of weeks. On the other hand, methane could remain in the atmosphere for a minimum period of ten years. Since the pollutants have a short life, in case of a mitigation action taken, quick results would be achieved in reducing both air pollution and tackling climate change.

4.1. Pollutants

Pollutants could be categorized in various ways.

By the formation in atmosphere:

Primary Pollutants: Pollutants in hazardous form (CO, SO_x, NO_x, PM) directly released from a source into the air are called primary pollutants.
Secondary Pollutants: Pollutants which become hazardous (H_2SO_4, NO_3, HNO_3) with chemical reactions after being released into the air are called secondary pollutants.

By the emission sources:

Natural Sources: There are sources such as CO caused by natural fires, reactive sulphur compounds caused by sea spray and degradation of vegetation, volatile organic compounds (terpenes and isoprenes) caused by vegetation such as trees, shrubs and etc, allergies due to pollen, spores, viruses, bacteria and air-borne infections, dust clouds and dust transport by storms in arid regions, methane produced by animals during digestion, nitrogen oxides released due to lightning.

Anthropogenic Sources: Examples of anthropogenic sources are nitrogen oxides, sulphur dioxide, particulate matter from energy generation in thermal power plants, nitrogen oxides and carbon monoxide from transport, lead, particulate matter, nitrogen oxides, sulphur dioxide from industrial processes, sulphur dioxide and particulate matter from domestic and industrial fuel use, volatile organic compounds from the use of solvents.

By the type of source: It is divided as point sources (thermal power plant), area sources (residential areas, motor vehicles at residential areas) and line sources (motor vehicles outside the residential areas).

According to the air pollutants inventory guidebook of EMEP/EEA (European Monitoring and Evaluation Program/European Environment Agency), emission sources are divided into six categories as energy, industrial processes, agriculture, waste, natural resources and other (EEA, 2016). The point that needs attention here is that the greenhouse gases are not classified as air pollutant. However, the fact that a major part of the greenhouse gas sources is same with the air pollutants, demonstrates that air pollution control studies would provide benefits in mitigating greenhouse gases. The mitigation of greenhouse gases that cause climate change will also ensure reduction of air pollutants in the same way.

Criteria Air Pollutants:

Criteria air pollutants are the pollutants of which limit values are determined so that the air quality remains within the limits which will not affect human health. In this section, criteria pollutants having relation with climate change will be mentioned.

Ground Level Ozone (O_3)

Ground level ozone is released by natural or anthropogenic sources. It is resulted through photochemical reactions in bright air under high temperatures between the nitrogen oxides and volatile organic compounds, which are among the main reasons of air pollution. Temperature, wind, solar radiation, atmospheric moisture and etc. affect the formation of ozone precursors and ozone. Since its formation is dependent on sunlight, its concentration could rise especially in summer months.

Climate change is a factor that increases ozone formation. Similarly, ozone works as a greenhouse gas and increases greenhouse gas impact. For that reason, the mitigation of this pollutant, which causes climate change and has an increasing risk of existence in the atmosphere, is highly important.

Ozone control could be achieved principally by controlling the nitrogen oxides and volatile organic compounds, which are ozone precursors. The methods to be used should include limitation of nitrogen oxides in particular in energy production and industrial combustion plants, utilization of clean combustion technologies in order to reduce volatile organics, nitrogen oxides and other pollutants arising from gasoline, performing vehicle maintenances, limiting the use of solvent, and steam recovery for the control of volatile organics released in gasoline stations. Besides, it is necessary to take measures such as preferring environment-friendly transportation, fuelling up the vehicles during evening hours so that volatile organic compounds are not released at hours when the sun is bright, decreasing the travels with private cars, not leaving the vehicle engine at idle mode, and not using chemicals evaporating and mixing into the air.

Nitrogen Oxides (NO_x)

Nitrogen oxides are brown or orange pollutants. They could be emitted to the atmosphere from various sources such as combustion of fuels in motor vehicles, electricity generation, heating of plants and industrial processes. They have an irritating impact on the respiratory system. Nitrogen oxides cause ozone pollution, acid rains and formation of particulates in secondary forms and have harmful impacts on crops and vegetation.

Sulphur dioxide (SO_2)

Sulphur dioxide is a colourless gas and is caused by the combustion of fossil fuels. In particular, it is caused by sectors where fossil fuels are used, such as thermal power plants, industrial plants and residential heating. They cause problems such as coughing, changes in lung functions, respiratory system damage, corrosion of stone buildings and other materials, acid rains and formation of secondary particles.

Particulate Matters (PM)

They arise through mechanical abrasion as big solid or liquid particles from primary sources (PM10, with diameter smaller than 10 μm), and through combustion, evaporation and condensation as small particles (PM 2.5) from secondary sources. They have significant impact on human life. They particularly cause diseases such as asthma and allergy. Small particles known as PM2.5 are much more dangerous to human health. Black carbon, a largest share of which is under PM2.5 class, is identified as the most important pollutant having greenhouse impact after carbon dioxide (C2ES, 2010). They arise as a result of traffic, in particular from diesel engines, combustion of fossil fuels, and forest fires. In addition to the impacts on human health, it is a type of particle that increases air pollution and causes climate change.

Black carbon affects climate in two ways. When it is suspended in the air, it absorbs the sunlight and heats the air. It decreases the reflectivity by decreasing the surface albedo on the surface of snow and ice. It heats both air and snow and ice mass by absorbing the sunlight. Different from greenhouse gases, it is short-lived. It remains in the atmosphere for 1-4 weeks; therefore its impacts are regional. Being short-lived ensures that if this pollutant is reduced, its impacts are easily mitigated. For that reason, it is quite important to control at the local. Preferring clean energy in industrial facilities and domestic energy consumption, using diesel particulate filter in transportation vehicles, transition to Euro 6 vehicles, using buses and trucks which do not cause carbon black, prohibiting the burning of wastes in the open area could be recommended as mitigation strategies (Climate and Clean Air Coalition, n.d.).

Volatile Organic Compounds (VOCs)

VOCs are emitted to the atmosphere due to the chemicals such as paints, solvents, wood preservatives, cleaners, disinfectants, fuel depots, dry cleaning, and pesticides. They could cause serious diseases such as eye, nose, throat irritation, headache, coordination disorder, dizziness, kidney, liver, nervous system damages and cancer. Its control is of vital importance since it is one of the ozone precursors.

4.2. Air Quality Control

Urbanisation is one of the most important reasons of air pollution. Fossil fuels that are used for residential heating in Turkey have been the most important reason for air pollution in cities.

The first stage of air quality control is continuous monitoring. Continuous monitoring is conducted by means of air quality monitoring stations spread country-wide. The next step is the preparation of a systematic emission inventory which covers all pollutant sources in the country. Emission factors and activities should be clearly indicated in the inventory. The inventory should be clear and transparent, and its results should be comparable with other countries. Approval of the calculations is also a very important stage. In this way, the calculation process could be followed and verified.

With Air Quality Modelling, impact of the facilities on the environment could be controlled. For the modelling, it is necessary to have information on the sources, locations and time they are emitted to the atmosphere. Reporting after modelling is very important. In this way, follow up could be ensured regarding the impact of facilities on the environment. At the end of all these studies, air quality improvement studies could be carried out through clean air action plans prepared. Each study carried out for the improvement of air quality is highly important for the mitigation of greenhouse gases that lead to climate change.

4.3. Air Quality Limit Values

Turkey aims at mitigating impact of air pollution on environment and human health via "By-law on Air Quality Investigation and Management" (dated 06.06.2008 and No. 26898) (Republic of Turkey Ministry of Environment and Urbanisation, 2018a). With this by-law it was targeted to reach EU limit values in air quality limit values. Climate change is referred in certain parts of the by-law. Whereas it is appropriate to set one of the targets for ozone mitigation as the protection of human health and the other as protection of vegetation, the climate change aspect could be emphasized more. Ozone mitigation is important also for the mitigation of climate change. Besides, the black carbon constituting most of PM2.5 and affecting climate could be controlled via determining a limit value for PM2.5.

4.4. Strategies for Mitigating Air Pollution

First of all, air quality values should be taken to the limit values specified under "By-law on Air Quality Investigation and Management". Limit values should be re-evaluated by establishing relationship between ozone pollution and climate change. The limit values determined by EU for PM2.5 should be included in the by-law and PM2.5 measurements should be made widespread.

In order to mitigate air pollution, air quality control stages should be implemented and pollutant sources should be identified. Urgent mitigation studies should be conducted for the most important pollutant sources. It is highly important for the mitigation of greenhouse gases that cause climate change and of criteria pollutants to increase green fields in the cities, making public transportation widespread and using renewable energy sources through appropriate urban policies.

In energy sector, priority should be given to do correct planning on energy need, to take actions on energy efficiency and to make renewable energy generation widespread by leaving fossil fuels under the soil in a gradual and fair manner.

One of the most important strategies is to perform energy efficiency actions in buildings. The existence of insulation in the buildings decreases the need for coolers during summer and heaters during winter, thus provides energy saving. It is necessary to limit the use of fossil fuels, to make renewable energy widespread, to use environment-friendly paints and cleaning materials and to avoid excess electricity consumption.

In transportation, it is important to limit the private vehicles in the traffic, to make the use of electric cars widespread, to adopt transportation methods like carpooling, public transportation and bicycles, not to perform private cars with many start-ups and not to let the cars at idle mode, to perform vehicle maintenance, and to make sure that fuel tank is well closed and has no leakage.

In industry, it is necessary to integrate renewable energy systems to the facilities, to make correct site selection for the facilities, to make flues gas controls and to prevent raw material losses in processes. These measures will also mitigate the greenhouse gases that cause climate change.

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