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Research Article

Sustainable Urban Management in Bursa

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Abstract

The concept of sustainable city is to create livable and people-oriented cities for today and for the future. Bursa is economically the fifth largest city in Turkey. Agriculture, industry, trade and tourism are carried out, the city also constitutes a wealth of minerals. An increase in urban population, industrialization; lack of housing and infrastructure; difficulty in accessing work, goods and services; unemployment, inequality and misuse of natural resources negatively affect urban sustainability. In order to serve the purpose of urban sustainability as well as to determine new policies; the central government should coexist and work with local administrators, urban planners, academics, non-governmental organizations and the public. With this study measurements of air quality, noise complaints, quantity of solid waste and it's composition, land usage and greenhouse gas inventories were examined in Bursa. Parameter changes over the years for the purpose of the study is explained by tables and graphs, and sustainability indicators have been developed recommendations for the adverse change in the accepted parameters.

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1. INTRODUCTION

Cities should be inherited over from past generations with a quality life to their present guests and should be delivered to future generations in a usable and sustainable way. The sustainable city should not only include the city where the environment is protected also contains the economic and social changes and developments. Bursa is one of our rare cities which carry the characteristics of agriculture, trade, tourism, industry and culture with a total area of 10,819 km^2 and 17 districts. Long-term and short-term policies should be identified and implemented to achieve the goal of urban sustainability. In this study, air pollution, noise, waste quantity and composition, land use and greenhouse gas issues in Bursa were investigated. Primarily general information is given about these issues and then information about the current situation in Bursa was assessed. Lastly, recommendations were developed about the environmental issues.

2. AIR POLLUTION

Air pollution is a condition which causes life and physical harms and causes economic losses due to the increase in the emissions which are not normally found in the air or in amounts which are normally not harmful [1].

2.1 Air Quality Index

Air quality index is an important indicator showing air pollutant's level in the atmosphere to protect human health, short-term and long-term negative effects in the environment. The air quality index is used to monitor the air pollution and to inform the public in terms of health effects.

It gives information about the air pollution of the region whether it is clean or not and health effects as can be seen. It indicates the health effects that may occur within a few days or a few hours after the inhalation of the polluted air.

The air quality index is arranged between the range of 0-500 as shown in Table 1 according to EPA. The higher the air quality index value is the higher risk of air pollution and the health risk. When the air quality index value is 50, the air quality is designated as good and the air quality index value over 300 shows bad quality reflecting with colors [1]. Table 2 shows the national air quality breakpoints. It has been shown that SO_2, NO_2, CO, O_3 and PM_{10} will have good, medium, sensitive, unhealthy, bad and dangerous effects.

Table 1. EPA (Enviromental Protection Agency) Air Quality Index [2]

Air Quality Index (AQI) Values	**Health Concern Levels**	**Colors**	**Meaning**
Air Quality Index Ranges	Air Quality Conditions	The colors symbolized	Meaning of Colors
0-50	GOOD	GREEN	Air quality is satisfactory and air pollution is low risk or no risk.
51-100	MİDDLE	YELLOW	Very few people are susceptible to air pollution, but are unusually susceptible to air pollution, so there may be moderate health concerns for some pollutants.
101-150	SENSİTİVE	ORANGE	Health effects can occur for sensitive groups. In general, it is not possible for the public to be affected.
151-200	UNHEALTHY	RED	Anyone can start experiencing health effects, serious health effects for sensitive groups may be in question.
201-300	BAD	PURPLE	Can create an emergency in terms of health. The entire population is likely to be affected.
301-500	DANGEROUS	BROWN	Health alarm. Everyone may experience more serious health effects.

Table 2. National Air Quality Index Breakpoints [2]

Index	**NAQ**	**SO_2(µg/m^3) 1h mean**	**NO_2(µg/m^3) 1h mean**	**CO(µg/m^3) 8h mean**	**O_3(µg/m^3) 8h mean**	**PM_{10}(µg/m^3) 24h mean**
Good	0-50	0-100	0-100	0-5.500	0-120[L]	0-50
Medium	51-100	101-250	101-200	5.501-10.000	121-160	51-100[L]
Sensitive	101-150	251-500	201-500	10.001-16.000[L]	161-180[I]	101-260[W]
Unhealthy	151-200	501-850	501-1000	16001-24.000	181-240[W]	261-400[W]
Bad	201-300	851-1.100	1.001-2000	24.001-32.000	241-700	401-520[W]
Dangerous	301-500	>1.101	>2001	>32.001	>701	>521

L: Limit Value I: Information Threshold W: Warning Threshold

2.2 Bursa Province and Air Pollution

Table 3 shows the average measurements of SO_2 and PM_{10} between the years of 2000 and 2014 in Bursa.

Table 3. Changes in the average value of SO_2 and PM_{10} amounts in Bursa [2]

YEARS	**SO_2 (Average)**	**PM_{10} (Average)**
2000	62	45
2001	57	35
2002	60	71
2003	74	34
2004	95	44
2005	40	21
2006	66	118
2007	59	55
2008	46	30
2009	80	24
2010	61	13
2011	61	12
2012	56	34
2013	29	77
2014	17,2	80,6

In Table 4 and 5, monthly average values of SO_2 and PM_{10} parameters of Bursa Station are indicated.

Table 4. Bursa Station Monthly Average Values of SO_2 Parameter [2,3,4,5,6]

SO_2	1. M.	2. M.	3. M.	4. M.	5. M.	6. M.	7. M.	8. M.	9. M.	10. M.	11. M.	12. M.
2012	72	82	58	124	275	290	22	36	27	51	52	55
2013	-	-	-	6	5	2	4	4	9	8	14	17
2014	14	10	6	6	2	2	2	2	4	4	7	11
2015	14	10	6	6	2	2	2	2	4	4	7	11
2016	10	6	4	4	3	3	2	3	5	4	16	12

M: Month

Table 5. Bursa Station Monthly Average Values of PM_{10} Parameter [2,3,4,5,6]

PM_{10}	1. M.	2. M.	3. M.	4. M.	5. M.	6. M.	7. M.	8. M.	9. M.	10. M.	11. M.	12. M.
2012	-	-	-	-	-	-	-	-	-	-	-	-
2013	34	17	13	22	41	63	57	63	72	99	111	88
2014	81	77	66	98	86	84	78	87	96	96	151	155
2015	81	77	66	98	86	84	78	87	96	96	151	155
2016	124	121	99	98	66	66	53	65	68	83	131	146

2.3 Some measures to be taken on Air Pollution

In the light of these measurements and to list the precautions to be taken for air pollution, fuel has to be controlled in the first choice for the short term. For this purpose, fuels for heating with low sulfur content have to be used. Control of the vehicles is also very important. For this purpose, the use of catalytic converters in order to ensure the maintenance of engine maintenance with the aim of increasing the combustion efficiency of the vehicles, the use of catalytic converters in order to minimize the pollutants in the exhaust, and the use of suitable catalysts to ensure full combustion are the main preventions. Maximum use of thermal insulation techniques are advised in order to save fuel. Another prevention is to concentrate on public awareness about the combustion technology and energy saving. It is necessary to ensure good quality fuel distribution in all housing, including the stove houses, whose negative contribution to air pollution is difficult to control. The availability of good quality fuel reserves to be used in periods when pollution is extremely high is another measure to be considered. Prevention of unnecessary heating can be regulated by using a heat

meter in buildings which use fuel oil for heating. In order to avoid high increases in the pollution concentration, the heating hours of the heaters should be adjusted according to the districts. Cleaning the flame pipes of the stoves and boilers also increases the combustion efficiency. Yet another prevention can be the application of sanctions by the municipalities for the control of the buildings that generating more fumes from their chimneys.

In the medium term, the use of appropriate technologies to minimize the contamination of existing fuels can be advised. Improvement of combustion systems, implementation of necessary standards and legal regulations, technical control and documentation for this purpose are the things to be considered. In buildings to ensure maximum thermal insulation, determination and implementation of economic isolation measures has to be conducted. City master plan and story height of buildings has to be made in a way that does not prevent dominant wind direction of the city.

In the long term, extension of heating with natural gas or central system in districts where contamination is very intensive has to be evaluated from the point of view of economic and technical aspects. On the other hand, gas and dust control, creation of green belts around the city are the important preventions directed to reduce air pollution. Considering that solar energy which is one of the renewable energy sources, alternative plans can be put into practice by holistic approaches [1].

3. NOISE

Noise is a problem that affects everyone. A lot of studies have shown that there are permanent hearing problems in persons exposing to high noise levels in long durations. Table 6 designates the ranges of noise levels.

Table 6. Noise Levels [7]

Ranges of noise (Desibel)	Noise Level
0-30	Very Silent
30-50	Silent
50-60	Moderately Noisy
60-70	Noisy
70-80	Very Noisy

3.1 Effects of Noise on Human Health

In the case of lower levels or in short durations, it is not easy to determine a significant damage to hearing. But, many research has shown that noise has negative effects on human health, behavior and happiness. In the report published in 1996 by the Organization for Economic Co-operation and Development (OECD), health effects of noise level were indicated [8].

Table 7. Noise Level and its Effects on Human Health [8]

Noise Level	Exposure Range (dBA)	Effects on Health
1st degree noises	30-65	Confusion, discomfort, anger, sleep disorder and concentration disorder.
2 st degree noises	65-90	Physiological reactions; increased blood pressure, acceleration in heartbeat and respiration, decreased pressure in brain fluid, sudden reflexes.
3 st degree noises	90-120	Physiological reactions, headaches.
4 st degree noises	120-140	Permanent damage to inner ear, disturbance of balance.
5 st degree noises	>140	Serious brain damage, eardrum explosion.

3.1.1 Physical Effects of Noise

The negative effects of noise on hearing can be examined temporarily and permanently in two sections. The most common transient effects are temporary hearing loss known as hearing fatigue. Hearing loss is persistent in cases where the effects are very high [8].

3.1.2 Physiological Effects of Noise

These are changes in the human body due to noises. Main physiological effects are; muscle stresses, stress, increased blood pressure, heart rate and blood circulation changes, pupil growth, respiratory acceleration, circulatory disorders and sudden reflexes [8].

3.1.3 Psychological Effects of Noise

The psychological effects of noise are nerve disorder, fear, discomfort, uneasiness, fatigue and slowness in mental effects. The sudden increase in noise levels can cause fear in humans [8].

3.1.4 Effects of Noise on Performance

The effects of noise on performance are termed as reduction of work efficiency and unrecognition of voices. The prevention of functions such as being able to detect and understand speech is largely related to the level of background noise. Studies on the effects of noise on work efficiency and productivity have shown that the complex workplace environment has required quiet and simple noise. In summary, in the case of more background noise for a particular job or function in the workplace, work efficiency was decreased [8].

3.2 Noise in Bursa Province

Table 8 shows the distribution of noise complaints in the province of Bursa between 2013 and 2016.

Table 8. Distribution of Complaints on Noise in Bursa between 2013 and 2016 (Bursa Metropolitan Municipality, Osmangazi Municipality, Nilüfer Municipality, Yıldırım Municipality) [2,3,5,6]

BURSA	2013	2014	2015	2016
Workplace	125	125	125	125
Entertainment	67	67	67	67
Industry	19	19	19	19
Building site	11	11	11	11
Traffic	9	9	9	9
Other	13	13	13	13

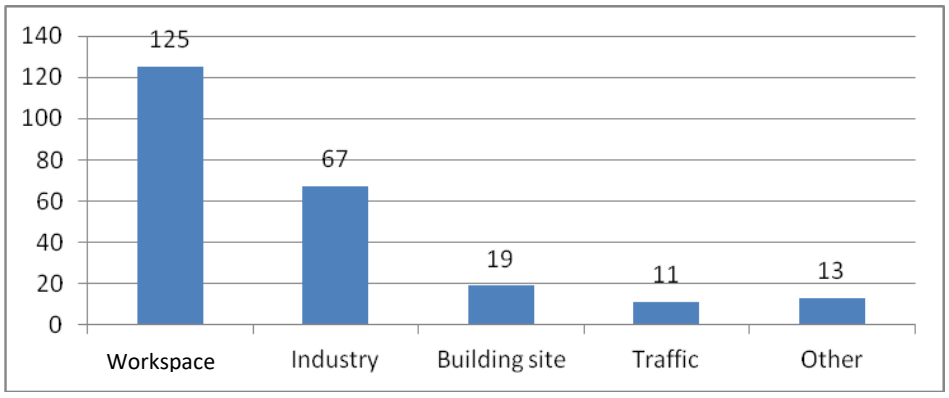

Figure 1. The Distribution of Complaints on Noise in the City of Bursa between 2013-2016 (Bursa Metropolitan Municipality, Osmangazi Municipality, Nilufer Municipality, Yıldırım Municipality) [2,3,5,6]

3.3 Actions to be taken in regard to Reduce Noise

In environmental policy, reduction and prevention are important recognized rules. First of all, the formation or presence of a source of noise should be controlled or prevented, and then the emissions and the resulting locations should be minimized as far as possible. Countermeasures should be taken for the existing emissions. In the planning and improvement of commercial and industrial facilities, it should also be checked whether the roaring machines or machine parts can be replaced by the quiet ones. The emissions of the machines are also depended on the condition of maintenance. Noise formation can be considerably reduced by the removal of inadequate lubrication, imbalance, loose parts, worn parts (bearings, guides, wheel gears) and the like.

Due to the noise generated by entertainment areas cannot be distinguished easily from the noise generated by industrial facilities; the abatement measures specified for industrial facilities should also be implemented for such facilities. Precautions should be harmonized noise reduction measures should be considered in the planning phase and should be included in the approval documents.

In order to reduce the noise generated by traffic, individual motor vehicle use can be limited in some areas and carrying capacity of public services can be increased, pedestrian walk can be encouraged and attractive and safe bicycle lane can be constructed [9].

It is an important measure to create noise sensitive areas with a good urban planning and away from areas where traffic is intense. Motor vehicles without silencer and other parts of noise-attenuating are not being allowed to hit the roads. Other prevention is to comply to speed limitations in urban areas.

Noise generated by road or building construction equipment at the evening hours in residential areas has not been allowed. Other prohibition to be put on noise pollution is to impose restriction to street weddings and fireworks in residential areas. Also, noise level of television and musical instruments in these areas should be reduced. Construction of airports and industrial areas has to be planned on non-residential areas [9].

4.WASTE MANAGEMENT

Waste is a substance generated by production and consumption activities and harmful to human and environmental health with direct or indirect discharge to receiving environment. Waste types are classified as domestic wastes, medical wastes, hazardous wastes, industrial wastes and construction wastes [10].

Waste management is a form of management which includes reduction of waste at its source, separation according to its property, collection, temporary storage, intermediate storage, recovery, transportation, disposal and disposal control and similar operations [6]. When integrated waste management approach in Turkey is analyzed, ‘Solid Waste Control Regulation’ is the starting point of the concept and emphasizes the waste.

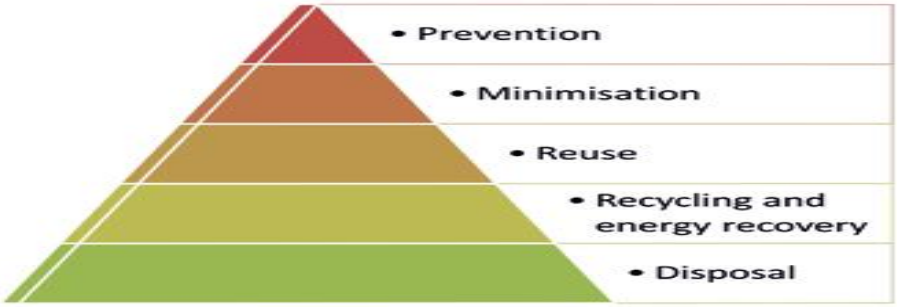

Figure 2. Waste Management Pyramid [10]

The issue of waste management in Turkey has gained momentum with the regulations which started to be published in 2003, and nowadays it has turned into integrated waste management strategy. Figure 2 shows the main steps in waste management pyramid [10].

Solid waste management can be defined as a discipline covering the control, collection, accumulation, transportation, transportation, processing and final disposal of solid wastes taking into account the production and consumption habits of the society. It is related to human and environmental health, economy, engineering and conservation. The main purpose of the concept is the ultimate disposal of the unwanted material. Beside, for the best or appropriate waste management system, ‘’Solid Waste Management’’ target should include the following objectives in a way to maintain environmental health, to improve urban environmental quality, to support the efficiency and adequacy of the economy, to generate employment and income, and to ensure the establishment of sustainable solid waste management systems [11].

4.1 Bursa Province Waste and Waste Management

4.1.1 Waste Amounts

The amount of wastes generated in the province of Bursa are shown in Table 9.

Table 9. Bursa Province Waste Amount [12]

Years	Population	Amount of waste (ton / year)	Amount of waste (ton / day)
2015	2.819.423	1.075.822	2.947
2018	2.923.359	1.192.522	3.267

2023	3.100.754	1.413.811	3.873
2035	3.499.772	2.084.393	5.711
2050	3.933.533	3.271.467	8.963

4.1.2 Amount of Solid Waste

The amount of solid waste collected in Bursa are shown in Table 10 and the composition of collected solid wastes is also shown in Table 11 respectively.

Table 10. Solid Waste Amount in Bursa Province [2,3,4,5,6]

	Population		**Collected Avg. Solid Waste Mic. (ton / day)**		**Recovered Avg. Waste Mic. (ton / day)**		**Produced per capita Waste Mic. (kg / day)**	
Years	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
2012	2 431782	2358727	10344,7	12194,6	152,9	150,6	17,16	16,54
2013	2 740970	2 740970						
2014	2 740970	2 740970	2352	2270			1,03	0,93
2015	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-

Table 11. Bursa Province Annual Percentage of Solid Waste Collected by Municipalities [2,3,4,5,6]

Years	**Kitchen Waste**	**Paper**	**Plastic**	**Glass**	**Metal**	**Other Non-Flammable / Other Burners**
2012	% 45	% 28	% 10	% 4	% 2	% 6 - % 5
2013	% 43	% 29	% 11	% 6	% 3	% 5 - % 3
2014	% 43	% 29	% 11	% 6	% 3	% 5 - %3

Years	**Organic**	**Paper**	**Plastic**	**Glass**	**Metal**
2015	% 87,88	% 6,47	% 2,12	% 2,68	% 0,85
2016	% 81	% 10	% 4	% 4	% 1

4.1.3 Packaging waste quantities

The quantity and recovery percentages of packaging wastes in Bursa province are given in Table 12.

Table 12. Bursa Province Between 2012-2016 Packaging Waste Amount And Recovery Percentages [2,3,4,5,6]

Years	2012	2013	2014	2015	2016
Amount of Packaging waste Produced (Kg)	319.747.380	372.362.974	253.440.849	649.408.258	1.866.061.831
The amount of package put on the market (Kg)	193.241.541	283.151.378	329.047.058	76.632.574	403.209.998
Recovery rates (%)	40	42	44	48	---

4.1.4 Amount of hazardous waste

The amount and management of hazardous waste in the province of Bursa is shown in Table 13.

Table 13. Hazardous Waste Management According to TABS [2,3,4,5,6]

Years	Total Recovery	Total Disposal	Total On-site	Total Stock	Total Exports	TOTAL
2012	25.288,390	4.006,005	100,311	87,340	2,228	29.484,27
2013	31.786,902	29.756,000	492,399	80,981	0,000	61.623,88
2014	52.441,275	22.713,072	197,159	155,93	3,922	75.314,19
2015	58.652,7	9.250	39,9	1946,8	217	68.354,7
2016	91.338	7.744	0	2876	711	102669

4.1.5 Amount of waste oil

Table 14 shows the amount of waste oil recovery and disposal in Bursa province.

Table 14. Waste Oil Recovery and Disposal Amount in Bursa Province (TABS, 2017) [6]

Years	Recovery (ton)	Additional fuel (ton)	Final disposal (ton)
2011	1.839,268	1.650,742	121,782
2012	2.093,420	1.094,015	157,672
2013	2.836,067	1.041,825	36,006
2014	3.746,553	661,676	247,168
2015	4.154.8	7.71,7	678.3
2016	3.734.3	2.77.5	81.6

4.1.6 Amount of waste batteries and accumulators

The amount of waste battery and waste batteries collected in Bursa between 2011-2016 is given in Table 15.

Table 15. Amount of Waste Battery and Waste Accumulator Collected in Bursa Province (Kg) [6]

Type	2011	2012	2013	2014	2015	2016
Waste Battery	22.220	13.845	21.798	19.472	20.277	25.786
Waste Accumulator	44.160	56.872	325.043	479.473	667.870	870.453

Recycling of these substances is of great importance. Recycling of wastes have the meaning of possibility of reassessment of wastes with various physical or chemical processes and convertion of them into secondary raw materials. It is defined as retrieval of recyclable waste materials into production proceses as a raw material by recycling technologies. It should be kept in mind that natural resources are finite sources and they will be exhausted if they are not used carefully. Some countries and manufacturers have improved various methods for recycling and reuse of wastes in order to prevent waste of resources and to cope with the energy crises [11].

4.3 Actions to be taken on Waste Management

Projects organized by municipalities, public institutions, private and educational institutions intended for solid wastes, packaging wastes, hazardous wastes should be taken into consideration rigorously. Cooperation and communication between municipalities and public institutions and organizations with the public is needed to develop. Contribution in the processes of collection, transportation and disposal of wastes as well as in the reduction of harm to public health and economy is the responsibility of all citizens. It is important to raise awareness among consumers about the recycled products and packaging materials in terms of sustainable consumption and environmental protection. At the same time, promotion of

consumers to buy recycled products labeled in the market is an important action to be taken in waste management [11].

5. LAND USE

Since land is the basic place of human activities, it has an important place both in individual and social life and being a finite resource. Therefore, sustainable management of land is needed. Sustainable land management can only be achieved with the existence of a healthy land policy developed in the long run. The most common implementation of land policies is carried out through laws and institutions in accordance with the adopted policies. Therefore, in assessing the effectiveness of a country's land policy, evaluation of the laws and corporate governance on land are the main indicators to be assessed [13].

5.1 Bursa Province and Land Use

In order to illustrate the annual variation in the use of land in the province of Bursa, the land use status and land use percentages between the years of 1990 -2012 were shown on Table 16. When the table is assessed, there is an increase in unnatural areas while a decrease in agricultural, forest and semi-natural areas.

Table 16. Land Use Status Between 1990 and 2012 (Ministry of Forestry and Water Affairs, Corine Database) [6]

BURSA	**1990**	**1990**	**2000**	**2000**	**2006**	**2006**	**2012**	**2012**
Land Class	hec	%	hec	%	hec	%	hec	%
1)Artificial Areas	16.963,21	1,57	27.326,73	2,53	33.088,70	3,05	36.545,6	3,38
2) Agricultural Areas	487.909	45,25	478.993,02	44,42	479.214.98	44,33	476.343,27	44,06
3) Forest and Semi-Natural Areas	523.724,74	48,57	522.059,54	48,42	519.302,95	48,04	517.241,19	47,84
4) Wetlands	4.075,48	0,38	5.731,16	0,53	5.643,25	0,52	5.643,25	0,52

5) Water Structures	45.592,56	4,23	4.4154,5	4,09	43.904,61	4,06	45.304,66	4,19
TOTAL	1.078.294,99	100	1.078.264,95	100	1.081.074,49	100	1.081.078	100

Land variety of Bursa province are shown in Table 17 and land use percentages is indicated in Table 18 between the years of 2012-2016. There can be seen a reduction in agricultural areas within five years.

Table 17. Bursa Province Land Use Status Between 2012-2016 [2,3,4,5,6]

AREA (ha)	**2012**	**2013**	**2014**	**2015**	**2016**
Farmland	365.217,2	365.217,2	343.872,7	340.912,5	-
Forest and Shrubbery	484.067,1	484.067,1	484.067,1	484.067,1	-
Meadow Pasture	24.345,2	24.345,2	24.345,2	24.345,2	-
Water Surfaces	54.912,4	54.912,4	54.914,5	55.291,6	-
a) Natural Water Surfaces	50.595	50.594	50.595,6	50.595,6	-
b) Stream Surfaces	1.466	1.466	1.466	1.466	-
c) Pond Surfaces	239,6	239,6	317,4	684.8	-
d) Dam and Pond Surfaces	2.611,8	2.611,8	2.535,5	2.545,2	-
Other	160.096,1	160.096,1	181.438,5	184.021,6	-
TOTAL	1.088.638	1.088.638	1.088.638	1.088.638	-

Table 18. Bursa Province Land Use Percentages between the years of 2012-2016 [2,3,4,5,6]

Total Area(%)	**2012**	**2013**	**2014**	**2015**	**2016**
Farmland	33,53	33,53	31,6	31,3	31,1
Forest and Shrubbery	44,47	44,47	44,5	44,5	44,7
Meadow Pasture	2,25	2,25	2,2	2,2	2,2
Water Surfaces	5,05	5,05	5,0	5,1	5,1
Other	14,70	14,70	16,70	16,9	16,9
TOTAL	100	100	100	100	100

5.2 Land Use Measures

When the current situation of Bursa province land as indicated in the tables above, Bursa has urgently in need of an effective land use policy including viable land use planning. Land use policy has a strong relationship with agriculture and economic policy. The protection of land tenure is a necessary condition to support the development of the land. National land use policy should be in accordance with responsibility of local institutions and has an important role in the protection of environmental, economic and social costs of deterioration.

In order to meet the needs of the fast-growing population, there are some measures to be taken as to increase in efficiency of land resources, to encourage the sustainable use of land and to establish incentives in order to provide basic infrastructures. Also, the protection of the natural environment and public services supported by taxation and land-based income are other preventive measures to be applied [13].

6. GREENHOUSE GAS

Since industrial revolution, humanity has faced the problem of climate change with the intensive use of fossil fuels. The increase in the amount of greenhouse gases generated by the use of fossil fuels that are used directly in the production process has caused climate change. The amount and composition of greenhouse gases have started to change with the industrialization. With the increase in production, the energy requirement, one of the most fundamental inputs of the production process, has increased steadily. Increasing energy needs from fossil fuels such as coal, oil and natural gas has stimulated the climate change. As a result of the burning of fossil fuels, a significant amount of carbon dioxide gas has been released into the atmosphere as a reason increase of carbon dioxide concentration which has the largest share in greenhouse gases. Because of this situation, the composition and density

of greenhouse gases in the atmosphere has been changed and heat permeability of the atmosphere has been prevented leading to the global warming process. In this context, there is a strong connection between energy use, global warming and thus climate change [14].

6.1 Bursa Province and Greenhouse Gas

Total greenhouse gas inventory of Bursa are shown in Table 19. The percentage distribution of greenhouse gas inventory is plotted in Figure 3.

Table 19. Bursa Total Urban Greenhouse Gas Release Inventory [15]

BURSA	MWh	tCO_2e	%
Building Equipment/Energy Consumption in Facility and Industries	22.198.338	7.929.941	61,8
Energy Consumption in Transportation	9.374.422	2.491.541	19,4
Other Oscillations	0	1.565.373	12,2
Energy Production	4.143.326	838.290	6,5
TOTAL	**35.715.085**	**12.825.146**	**100**

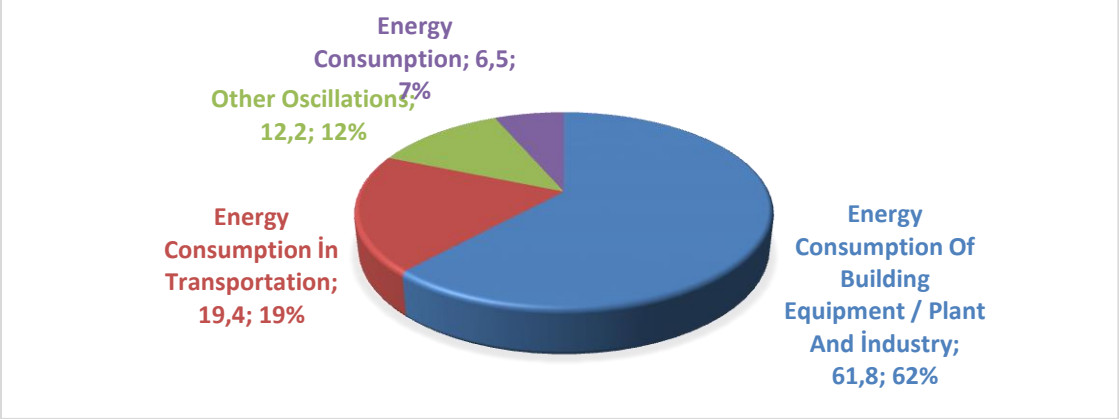

Figure 3. The percentage distribution of greenhouse gas inventory of Bursa [15]

The distribution of the greenhouse gas inventory in Bursa and the percentages in total share are shown in Table 20 and in Figure 4.

Table 20. Bursa City Urban Greenhouse Gas Inventory 2014, % [15]

Inventory Distribution of Bursa Province	**TonCO_2e**	**%**
Industrial, Electricity + Fuel	4.072.530	32
Housing, Electricity + Fuel	2.612.599	20
Transportation + Bus Station+ Airport	2.490.554	19
Commercial, Official, Electrical + Fuel	1.246.171	10
Energy Production Facilities	838.290	6
Enteric Fermentation and Fertilizer Management	769.007	6
Industrial, Process Emissions	604.662	5
Wastewater Treatment	105.381	1
Solid Waste	85.951	1
TOTAL	**12.825.146**	**100**

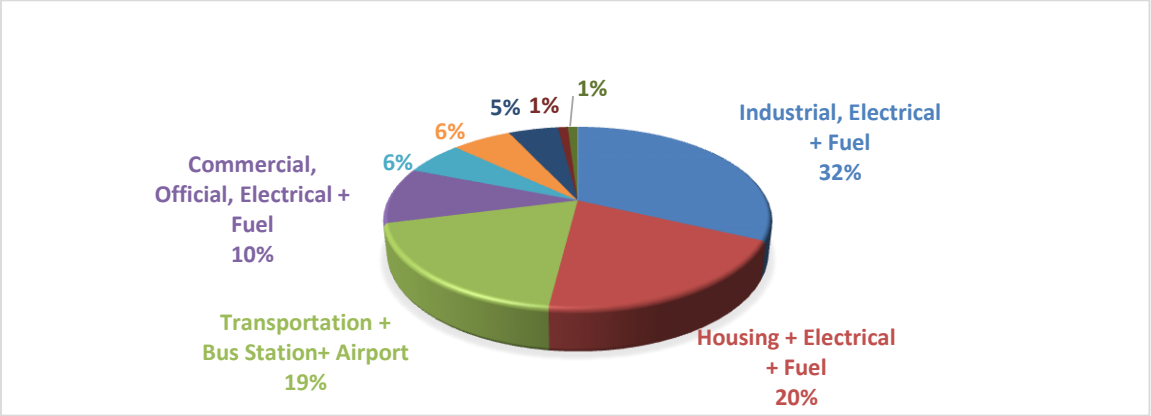

Figure 4. Bursa City Urban Greenhouse Gas Inventory 2014, % [15]

6.4 Actions to be taken on Greenhouse Gas Reduction

Some preventive measures to be taken in residential areas can be listed as follows; integrated building design, dissemination of photovoltaic systems in buildings, dissemination of distributed power generator applications in collective settlements, increasing energy efficiency in electrical tools and equipment, minimizing energy losses and leaks.

Sustainable transportation systems, dissemination of direct injection and diesel engines, development and dissemination of automotive fuel cells, reduction of emissions with full fuel cycle, development and use of biofuels, development and dissemination of hybrid electric vehicles and dissemination of lightweight building materials are also major precautions to be taken in transportation sector.

In the manufacturing and industrial sector, the expansion of fuel conversion, increase in energy efficiency and savings, use of renewable energy, CO_2 capture and improvement of material efficiency were determined as key issues. In waste management, landfill management, the importance of recycling and reuse, digestion process, wastewater management and preventive environmental management are the main actions proposed [16].

7. CONCLUSION AND RECOMMENDATIONS

This study has assessed the current situation of air quality, noise, waste management, land use and greenhouse gas problem in Bursa. The content of the research was supported by tables, graphs and figures. It can be concluded that there are studies and action plan taking place for the betterment but in order to comply with national and international standards, a more effective strategic plan is absolutely needed for the city. Both the environment and the related issues should be examined in detail. The stages of the plans should be investigated from the point of technical, social and environmental view in the short, medium and the long-term by the participants of public institutions and relevant partners. Under the leadership of the central government, relevant institutions and organizations, academics, NGOs and the public should be brought close together with participation and implementation.

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