Forecasting Carbon Emission For Turkey: Time Series Analysis

Mehmet Mercan1, Etem Karakaya2

1Hakkari University, Faculty of Economic and Administrative Science

2Adnan Menderes University, Faculty of Economic and Administrative Science

E-mail: *mmercan48@gmail.com; mehmetmercan@hakkari.edu.tr, ekarakaya@gmail.com*

Abstract

Within the context of sustainable development objectives, reducing greenhouse gas emissions (GHG) that cause climate change was first discussed and officially negotiated at the 1992 Rio Conference, which particularly emphasised developed countries to take serious measures. Then, it was followed by the Kyoto Protocol, which specified national ghg emission reduction targets for developed countries. With Kyoto Protocol, it was decided for these countries to reduce global emissions by 5% below 1990 levels compared to 2008-2012 emission levels. Turkey became a party to the Kyoto Protocol in 2009, yet due to their special circumstances they did not take any emission reduction commitments.. Negotiations on Post-2012 emission reduction obligations are still in progress under the UNFCCC umbrella and it is expected to have emission reduction targets not only by developed countries but also by developing ones. In this regard, it is important for Turkey to estimate its future ghg emissions, if they have to take a Nationally Appropriate Mitigation Actions (NAMA) for their strategy. There are various ghg emission estimations for 2020 and the results indicate different emission levels.

Objective of this study is to estimate ghg emission levels for Turkey for 2020 and afterwards by using time series and regression analysis. Then, appropriate policy implications are discussed with the result of these findings.

Keywords : Carbon Emissions, Time Series Analysis, climate change policy,emission projections

1.INTRODUCTION

Global warming and climate change is the common problem of the whole world and humanity, concerning many sectors including industry, trade, tourism andagriculture. Acting in coordination, analyzing the elements leading to the problem is important in solving this issue. As the development levels, energy resources and population structures of countries are not homogenous, the possible emission reduction rates due to their strategies to combat global warming, applicable tools and measures taken, would also be different. Tasking the same amount of green house gas reductionto a developed country and a developing country would have negative consequences on the economy of the developing country.

Turkeyhas reached a growth trend since 2002 following the introduction of strong economy programme, and is since among the group of developing countries. In line with her growing economy, greenhouse gas emission has increased, which is a source ofglobal warming.In her combat against global warming, it is important for Turkey to choose the most appropriate tools, which would not harm the economic growth, or keep the damage at a minimum level. At this point, the NationalGreenhouse Gas Emission Inventoryis the most important reference. This inventory needs to be prepared annually by each United Nations Climate Change Framework Convention (UNCCFC) signing country and submitted to the UNCCFC secretariat. Thanks to this inventory, countries are able to determine greenhouse gas emission amounts, sources and sectoral breakdown.

2. Climate Change negotiations and Turkey

A member of OECD since 1961, Turkey has been included to ANNEX-I countries group, primarily responsible for reducing greenhouse gas emissions, and at the same time, to ANNEX-II countries which shall be providing financial and technical assistance to reduce emissions from the underdeveloped countries. The economic development level of Turkey is generally lower than both OECD countries, and the other ANNEX II countries. It is not rational for Turkeyto have the same emission reduction commitment as economically developed countries. Therefore, Turkey has not signed the CCFC during the 1992 Rio Conference, even though she approved its principles, claiming she could not fulfil the commitments.

According to the Kyoto Protocol, ratified in1997 at theConference of Parties 3 and opened to signature on 16 March 1998, countries in the ANNEX I group are obliged to reduce their greenhouse gas emissions to under 5% of the1990 levels, between 2008-2012. This target set by the Kyoto Protocolis being regarded as one of the most important international steps taken towards limiting the greenhouse gas emissions.

During the 1997 Conference of Parties3 (COP3) in Kyoto, Turkey demanded for CCFC to be removed from both Annexes, however, as this demand was not accepted, Turkey did not become a party to Kyoto Protocol. During the Conference of Parties 6 held in the Hague in 2000, Turkey has stated that she would become a side to CCFC as an ANNEX-I country, on

condition that she is removed from ANNEX II and provided technical assistance, financial assistance and capacity development, just like the former socialist states transforming to fee market economies. As part of the decision taken at the Hague Conference, it was accepted for Turkey to be removed from ANNEX-II, by the following decision taken atConference of Parties 7 in Marrakech in 2001: "By recognizing the special conditions of Turkey compared to the other countries listed in ANNEX-I of the convention, it is decided to keep Turkey in ANNEX-I but remove form ANNEX-II, by decision number26/CP.7" (UNCCFC, 2001: 2).

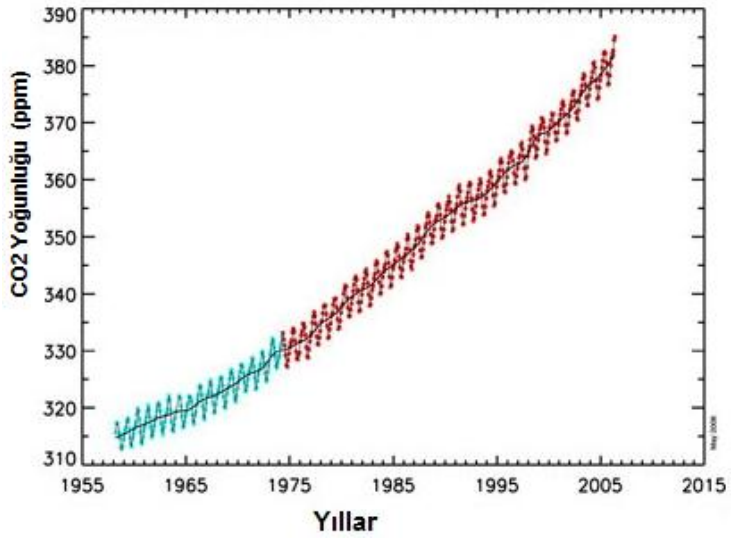
Following these developments, the law on Turkey to join Climate Change Framework Convention was signed on 24 May 2004 and Turkey became the 189th country to become a side to the Climate Change Framework Convention.

The law on Turkey to join Kyoto Protocolwas adopted on 26 August 2009 and Turkeybecame a side to the Protocol. Not being a side to UNCCFCon the acception date (1997) of the Protocol, Turkey was not included to the Protocol ANNEX-B list, which defines the numerical emission limiting or reduction commitments of ANNEX-I Parties. Therefore, there is no numerical emission limiting or reduction commitment for Turkey during the first commitment period of the Protocol, covering the 2008-2012 period. (http://climate.cob.gov.tr/climate/AnaSayfa/BMIDCS.aspx?sflang=tr Access: 07.12.2011).

3. Global Warming Trend, Projectionsand Scenarios

By looking at the data gathered from all the studies on global warming, it is possible to say that greenhouse gas emissions within the atmosphere are constantly on the rise. According to the fourth and latest assessment report published by IPCC in 2007; the temperature of the earth and oceans are increasing, glaciers are melting environmental transformation is taking place at a very fast speed. As well as the IPCC reports, studies are being held on climate change in many different countries. As an example; according to the measurements since 1958 by the Government of the United States of America National Oceanic and Atmospheric Administration's observatory located in Hawaii Island's Mauna Loa Mountain (3500m) in the middle of Pacific Ocean, carbon-dioxide accumulation within the atmosphere is rising at an incredible speed (Figure 1). Other than the Mauna Loa observatory, a number of fixed stations such as Law Dome, Adalie Land, South Pole and Siple, and aeroplanes for certain heights of the atmosphere, are being constantly used to measure greenhouse gas, and increases in greenhouse gas emissions are being scientifically set forth (Özçağ, 2011. s:12).

Figure 1: Development of CO2Density at the Atmosphere



Source: http://www.licor.com/env/newsline/tag/keeling-curve/, Access: 13.03.2012

The saw shaped graphic at the first part of Figure 1 is being called as the Keeling curve. The reason for the saw shape is representing the plants absorbing carbon-dioxide from the atmosphere during the summer months, and giving back during the winter (Madra and Şahin, 2007:30-33).

As it could be viewed from Figure 1, while the CO2 density in the atmosphere between 1750-1900 increased from 280 ppm (parts per million) to 285 ppm, an increase of just 5ppm, it increased from 280 ppm to 360 ppm between 1900-2000, an increase of 75 ppm. By industrialization since the 1900's, the increase in CO2 density is 15 times the level of the previous period (http://www.brophy.net/weblog/pivot/entry.php?id=10, Access:27.11.2011). The annual CO2 emissiondue to fossil fuel consumption was 6.4 GtC (Giga Ton Carbon) in 1990, but during the 2000-2005 period, it increased to 7.2 GtC. The atmospheric density of Methane, another greenhouse gas, was 715 ppb (parts per billion) in pre-industry period, and increased to 1732 ppb during the early 1990's, and in 2005, the figure was 1774 ppb. During the same period, nitric oxide levels rose from 215 ppb to 317 ppb (IPCC, 2007a: 2-3).

According to Assessment Report 4 (AR4) by IPCC; due to the great increases of the carbon-dioxide emissions, the average increase in surface temperatures until the year 2100 is expected to be approximately 3 Co, or somewhere between 2 Coand 4.5 Co. In addition, many scenarios anticipate that an increase of 0.2 Co/10 years would take place for the next 20 years (Türkeş, 2007: 50). And it is claimed that sea levels would rise by 0.1 -0.9 metres between 1990 and 2100 (EEA, 2003: 94).

As well as the reports prepared by Intergovernmental Panel on Climate Change to give insight on the current situation, various scenarios are being prepared on the future of global warming and on emission reduction. IPCC's greenhouse gas emission reductionscenarios were included in its first assessment report in 1990. These initial scenarios, prepared for the 1990-2100 period, were updated with a greater scope and published in 1992. These emissionscenarios known as "IS92",deal with atmospheric composition and it's effects on the climate. The aim of these studies is; to determine the expected greenhouse gas emission increases until 2100 and the related green house gas rates in the atmosphere; to determine the regional distribution of changes caused by global warming and rain regimes stemming from increased greenhouse gasses, by employing these values in various climate models, to determine land and sea temperatures and to determine the possible consequences of climate change.

Following the initial scenarios, IPCC has accepted to prepare a new emissionscenario in1996. These new scenarios are named Special Report on Emission Scenarios (SRES). In IPCC'sSRES Report published in2001 and 2007, there are four different scenariofamilies. The details of these scenarios were explained in the 2001 report, and updated in the 2007 report. These scenarios are A1, A2, B1 and B2 scenarios.

A1 Scenario Group is based on the assumption that the world economy would develop rapidly by the use of new and more effective technologies, population increase would reach its highest value at mid-centuryand then decrease. The emphasized areas in thisscenario family are such issues as the interregional intimacy due to the important decreases in regional differences on income per person, capacity growth, and increase in cultural and social relations. A1 Scenario group includes sub scenarios on different developments in energy systems such as A1FI (fossil intense energy technologies), A1T (non fossil-sourced energy use) and A1B (a balanced distribution between all sources) (IPCC, 2007a: SPM, s:18).

A2 Scenario Group is based on an unbalanced and slow economic growth with a rapid increase in population, a non-homogenous world, with a structure where no special measures are taken against global warmingand environmental change issues.

B1 Scenario Group, is based on the same assumptions as A1 scenarios but anticipates an economic growth which does not need over consumption of energy, with an emphasis on service sector. In this scenario, clean technologies based on more effective use of sources shall be used.

And finally, B2 Scenario Group; it has an approach where economic, social and environmental capacitiesare mainly solved at a local scale (IPCC, 2007a: SPM, s:18).

IPCC scenarios' anticipations on world population and economy are given in the below table:

Table1: Economic Estimates of SRES 2001 Scenarios

Scenario	Population (Billion People)		Gross Product (Trillion Dollar)		Per Capita Income (Developed/Developing Countries)	
	2050	2100	2050	2100	2050	2100
A1	8,70	7,04	164,5	518,8	2,8	1,5
A2	11,29	14,71	111,3	248,5	6,6	4,2
B1	8,7	7,04	135,6	328,4	3,6	1,8
B2	9,8	10,3	75,7	198,7	4	3

Source: http: //www.ipcc.ch/ipccreports/sres/emission/data/allscen.xls, Data: 27.11.2011.

In the Special Report on Emission Scenarios (SRES) prepared by IPCC, carbon-dioxide andothergreenhouse gasemissions are predicted to be increased at important levels during the next century. According to the report, global temperature would rise by 0.2 C 0per 10 years, for the next 20 years (IPCC, 2007a: 12). Temperature increases and sea level changes projected for the 21st century are given in Table 1.3.

Table 2: SRES 2090-2099 Estimations by 1980-1990 Data

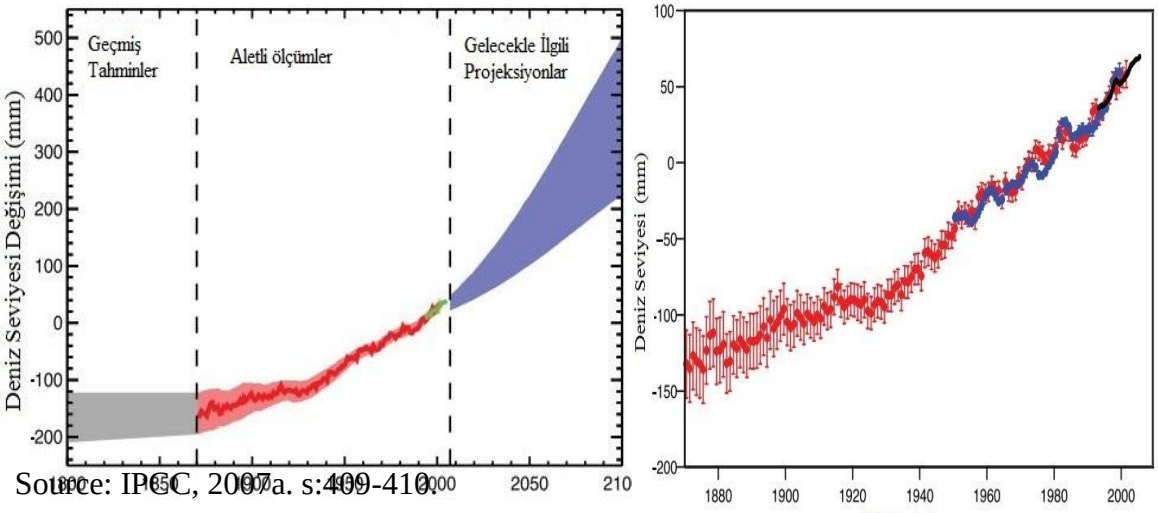
Scenario	Temperature Change (C 0)		Change in Sea Level (mt)
	Estimate	Range	
B1	1.8	1.1 - 2.9	0.18 - 0.38
A1T	2.4	1.4 - 3.8	0.20 - 0.45
B2	2.4	1.4 - 3.8	0.20 - 0.43
A1B	2.8	1.7 - 4.4	0.21 - 0.48

A2	3.4	2.0 - 5.4	0.23 - 0.51
A1FI	4.0	2.4 - 6.4	0.26 - 0.59

Source : IPCC, 2007a. SPM, s.13.

According to (B1) scenario where global warming level is the lowest, it is estimated that the temperature increase in 2090-2099 period would be 1.8 C0when compared to 1980-1990 period. The temperature increase during the period in subject is expected to be in the range of 1.1 C0and 2.9 C0. According to this scenario, it is calculated that the sea level would rise between 0.18 - 0.38 metres. And according to the A1FI scenario where global warming level is at its highest, world surface temperature isexpected to rise by 4 C0, while an increase of 0.26 - 0.59 metres is anticipated in the sea level. This has been shown in Figure 1.6.

Figure 2: Change Trend in Sea Levels



Source: IPCC, 2007a. s:409-410.

In the first part of Figure 2, changes in the sea level based on 1980–1999 are given. The period covering the years 1800 - 1870 is an estimation, while the figures for the period 1870–2000 is based on apparatus measurements (Tide Gauge). Sea level change values for the 2000–2100 period have been estimated by using the SRES A1B scenario. The second part of the panel has been acquired by using the annual mean sea level values. Values for 1870 - 1950 period have been extracted from Church and White (2006)'s work, while post-1950 values have been extracted from Holgate and Woodworth (2004), and Leuliette et. al. (2004)'s work, and they are within 90%confidence interval.

According to SRES Scenarios, the increase in atmosphericdensity of carbon-dioxide emission, increases the acidity levels of the oceans. According to estimates, PH values of the oceans would decrease during the 21st Century by 0.14 and 0.35. Lowered pH values of the oceans means an increase in the acidity levels. With an increased acidity level and temperature, oceans would lose their ability to absorb carbon over time (IPCC, 2007a. SPM, s:14).

4. Worldwide Trend and Reasons for Increase of Greenhouse Gas Causing Climate Change

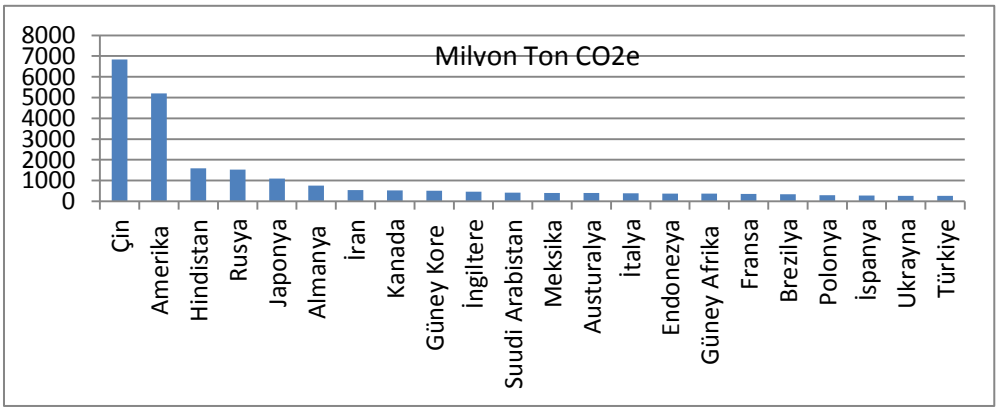
Humankind is faced with the enigma of global warming and climate change, by using the nature to acquire the raw materials for his never ending demands, using fossil sourced energy

during production phase, wastes released to the nature during production and consumption phases, increase in world population, damages occurred to the environment and forests. When evaluating these situations as a general, global warmingandclimate change issues are human sourced issues.

In Table3, human sourced distribution of greenhouse gas emissions per country, and the total amount in a world scale in 2009 have been given. As Table 3 indicates, the top five countries with highest greenhouse gas emissions are China, America, India, Russia and Japan. These countries have a total emission of 16,235 Million Tonnes of CO2e, and their share in total greenhouse gas emission is 51.9%. Turkeyon the other hand, had a CO2e emission of 256 Million Tonnes in2009, and in total greenhouse gas emissions, Turkey's share is eight per mille (% 0.8).

Table 3: Countries with High CO2 Emission Levels in 2009 (Mt CO2e)*

1-China	6,831	12-Mexico	399
2-America	5,195	13-Australia	394
3-India	1,585	14-Italy	389
4-Russia	1,532	15-Indonesia	376
5-Japan	1,092	16-South Africa	369
6-Germany	750	17-France	354
7-Iran	533	18-Brazil	337
8-Canada	520	19-Poland	286
9-South Korea	515	20-Spain	283
10-England	465	21-Ukraine	256.39
11- Saudi Arabia	410	22-Turkey	256.31
World Total	28,999		



Source : IEA, KWES, 2011, s. 48-57. Values in the table have been created by the authors.

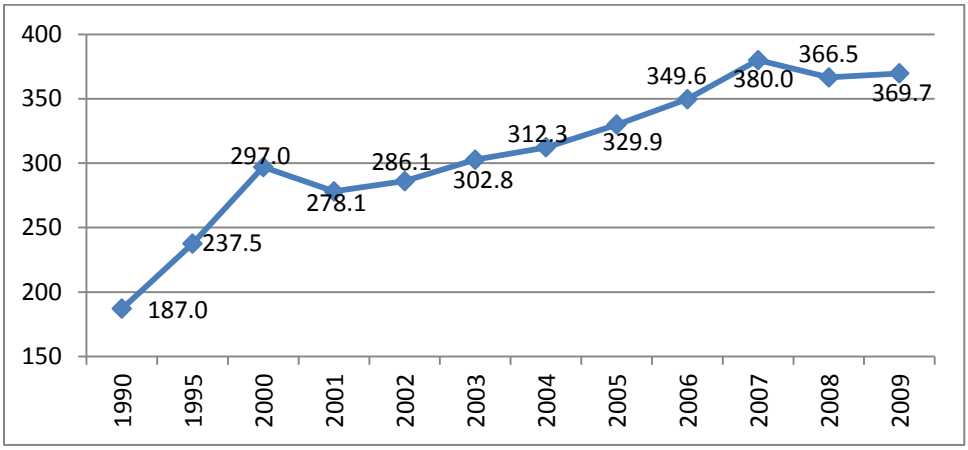
*:Including land use, land use differences, and green house gas reductionchanges of the forestry sector.

Humanity's will to damage the nature for a wealthier life, as well as the above mentioned human sourced factors, are leading to global warmingand climate change. Among the human sourced environmental issues, we may count fossil sourced energy use, industrialization and urbanization, population increase, land use changes and agriculture-stock breeding activities.

5. Carbon EmissionScenarios

In this part of the study, before starting with thescenarioimplementations, 2011 macroeconomic variables data for Turkey and general and sectoral carbon emission projections for the 2011-2020 period will be given.

Figure 3: 1990-2009* TotalEmissions (Mt CO2e)



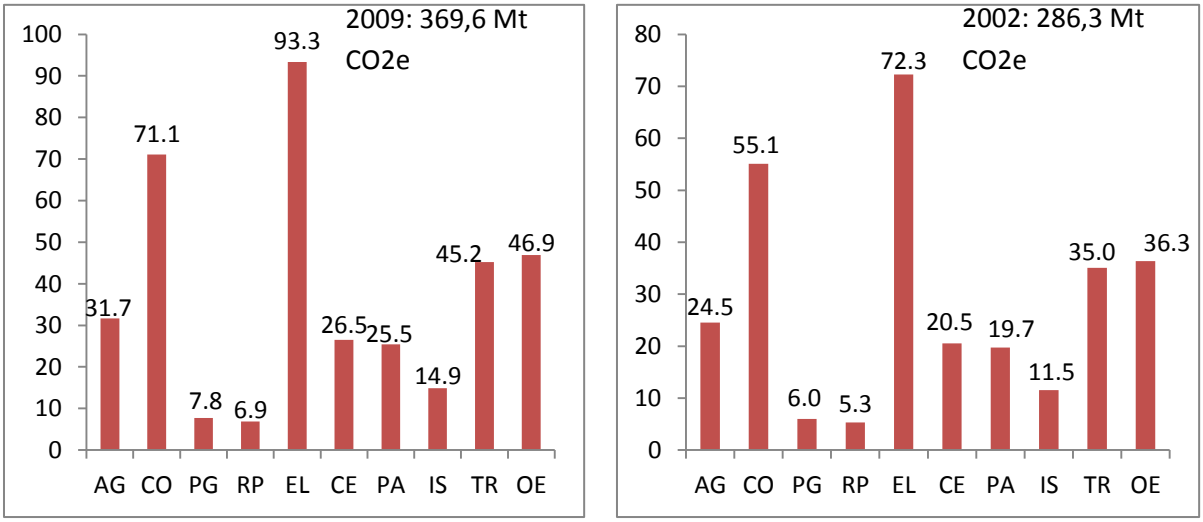
Source: TUİK (2011) NationalGreenhouse GasEmission Inventory Reportdata have been consolidated by the authors.

*: Emission values exclude Lulucf.

As Figure 3 indicates, Turkey's carbon emission of 187 Mt CO2e in 1990 has increased by 58% and became 297 Mt CO2e in 2000. The rate of increase has slowed down since 2000and it became 369,7 Mt CO2e in 2009, an increase of 24%. Since 2000's, with the introduction of "transition to the strong economy program", there have been great increases in GNP, export and import values (for instance; export increase 255%, import 154%andGNP 471% running, and 34%fixed), but still, emissionincrease was highly reduced in 2000-2009, compared to 1990-2000. We may assume that this decrease was contributed by efficient use of energy, use of renewable energy, and use of natural gas as fuel type.

In Figure 4, greenhouse gas emissions per sector to be used for the 2009 analysis are given. These values were prepared by TUİK (2011) for the "NationalGreenhouse GasEmissionInventory Report". Electricity production sector (EL) is leading the table with a 93,3 Mt CO2e emission, and makes up 25% of the total emissions. Coal mining (CO) sector is in second place with 71,1 Mt CO2e emissionand makes up for 19% of the total emissions. Sectoral transportation (TR) on the other hand has an emission of 45,2 Mt CO2e. When we look at the top three sectors; electricity production, coal mining and transportation sectors produce 57% of total emissions. 2002 data indicate that, electricity production, coal mining and transportation sectors are again occupying the top three places in emissions.

Figure 4: 2009 and 2002* Secoral Emissions (Mt CO2e)



2009 Sectoral Emissions (369,6 Mt Co2e)

Source: TUİK (2011) NationalGreenhouse Gas EmissionInventory Report data have been created and classified by the authors per sector. *:Emission values exclude Lulucf.

Considering Turkey's TUİK (2011) National Greenhouse Gas EmissionInventory Report,average greenhouse gas increase rates for the 1990-2009 period is 97.64%and annually 5.13%.With the help of 2002 and 2009 sectoral greenhouse gas distribution, calculated from "National Greenhouse Gas Emission Inventory Report" in Figure 4, we may be able to calculate sectoral greenhouse gas distributionfor 1990. If we apply the 5.13% increase for the 1990-2009 period to the calculated emissionvalues, we may acquire the sectoral and general greenhouse gas emissions for the period leading up to 2020, which is given in Table 4.

Table 4: Carbon Emissions (Mt CO2e)* of Sectors per Year

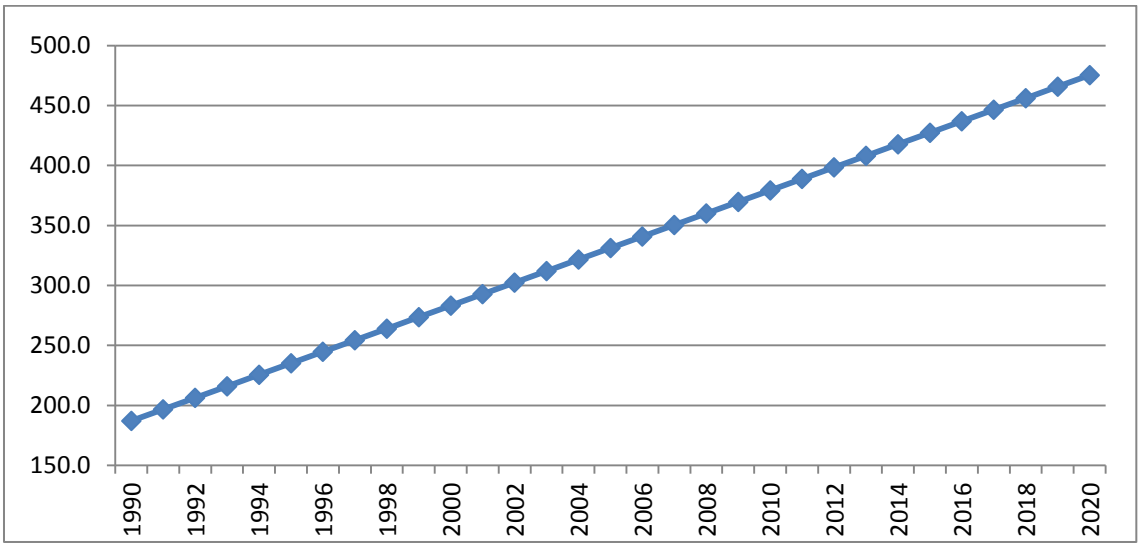
	AG	CO	PG	RP	EL	CE	PA	IS	TR	OE	Total
1990	16,0	36,0	3,9	3,5	47,2	13,4	12,9	7,5	22,9	23,7	187,0
1991	16,8	37,8	4,1	3,6	49,6	14,1	13,5	7,9	24,1	25,0	196,6
1992	17,7	39,7	4,3	3,8	52,1	14,8	14,2	8,3	25,2	26,2	206,3
1993	18,5	41,5	4,5	4,0	54,5	15,5	14,9	8,7	26,4	27,4	215,9
1994	19,3	43,4	4,7	4,2	56,9	16,2	15,5	9,1	27,6	28,6	225,5
1995	20,1	45,2	4,9	4,4	59,3	16,9	16,2	9,5	28,8	29,8	235,1
1996	21,0	47,1	5,1	4,5	61,8	17,5	16,9	9,8	29,9	31,1	244,7
1997	21,8	48,9	5,3	4,7	64,2	18,2	17,5	10,2	31,1	32,3	254,3

1998	22,6	50,8	5,5	4,9	66,6	18,9	18,2	10,6	32,3	33,5	263,9
1999	23,4	52,6	5,7	5,1	69,1	19,6	18,8	11,0	33,5	34,7	273,5
2000	24,3	54,5	5,9	5,2	71,5	20,3	19,5	11,4	34,7	35,9	283,1
2001	25,1	56,3	6,1	5,4	73,9	21,0	20,2	11,8	35,8	37,2	292,8
2002	25,9	58,1	6,3	5,6	76,3	21,7	20,8	12,2	37,0	38,4	302,4
2003	26,7	60,0	6,5	5,8	78,8	22,4	21,5	12,5	38,2	39,6	312,0
2004	27,5	61,8	6,7	6,0	81,2	23,1	22,2	12,9	39,4	40,8	321,6
2005	28,4	63,7	6,9	6,1	83,6	23,7	22,8	13,3	40,5	42,0	331,2
2006	29,2	65,5	7,1	6,3	86,0	24,4	23,5	13,7	41,7	43,3	340,8
2007	30,0	67,4	7,4	6,5	88,5	25,1	24,1	14,1	42,9	44,5	350,4
2008	30,8	69,2	7,6	6,7	90,9	25,8	24,8	14,5	44,1	45,7	360,0
2009	31,7	71,1	7,8	6,9	93,3	26,5	25,5	14,9	45,2	46,9	369,7
2010	32,5	72,9	8,0	7,0	95,7	27,2	26,1	15,3	46,4	48,1	379,3
2011	33,3	74,8	8,2	7,2	98,2	27,9	26,8	15,6	47,6	49,4	388,9
2012	34,1	76,6	8,4	7,4	100,6	28,6	27,4	16,0	48,8	50,6	398,5
2013	35,0	78,5	8,6	7,6	103,0	29,3	28,1	16,4	49,9	51,8	408,1
2014	35,8	80,3	8,8	7,7	105,4	29,9	28,8	16,8	51,1	53,0	417,7
2015	36,6	82,2	9,0	7,9	107,9	30,6	29,4	17,2	52,3	54,2	427,3
2016	37,4	84,0	9,2	8,1	110,3	31,3	30,1	17,6	53,5	55,5	436,9
2017	38,3	85,9	9,4	8,3	112,7	32,0	30,8	18,0	54,6	56,7	446,5
2018	39,1	87,7	9,6	8,5	115,2	32,7	31,4	18,3	55,8	57,9	456,2
2019	39,9	89,6	9,8	8,6	117,6	33,4	32,1	18,7	57,0	59,1	465,8
2020	40,7	91,4	10,0	8,8	120,0	34,1	32,7	19,1	58,2	60,3	475,4

Source: TUİK (2011) From the National Greenhouse Gas Emission Inventory Report data, sectoral emissions have been calculated by the authors, and simulation has been applied.*: Emission values exclude Lulucf.

As Table 4 indicates, 2009 emission rate was 369,7 Mt CO2e, and according to the 1990-2009 increase scenario of 5.13% (As of 2012, the latest emissionwas given for 2009), this emission rate is anticipated to become 475,4 Mt CO2e in 2020. This is much lower than 604 Mt CO2e, foreseen by the Ministry of Environment and Forestry (Ministry of Forestry and Hydraulic Works) by using the MAED/ENPEP model, however, it is in accordance with the 421 Mt CO2e value, foreseen by the European Commission using PRIMES model. Considering that the MAED/ENPEP model does not reflect the energy assumptions reality and that the model results are different than the actual values, it would be more realistic to use European Commission's PRIMES model.

Figure 5: Sektoral and General Emission Forecasts* for the 1990-2009 Period, According to 5.13%EmissionIncrease (Mt CO2e)



Source: TUİK (2011) National Greenhouse Gas Emission Inventory Report data have been consolidated by the authors. *: Emission values exclude Lulucf.

The increase in greenhouse gas is slower in 2000-2009 when compared to the 1990-2000 period. In 2000-2009 period, greenhouse gasincrease rate was 24,45%, while annual increase rate was 2,71%'dir. If we were to estimate 2020 emissions based on annual increase rates of 2,71%, we reach the findings given in Table 7.3. As Table 5 indicates, 2009 emission rate was 369,7 Mt CO2e, and by using the 2000-2009 period's 2.71% increase scenario, this emission value would reach 458,4 Mt CO2e by 2020.

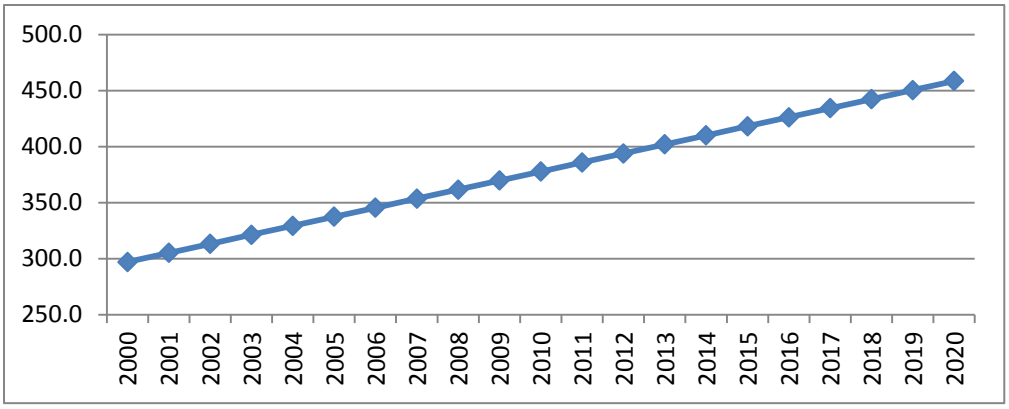
Table 5: Carbon Emissions (Mt CO2e)* of Sectors per Year

	AG	CO	PG	RP	EL	CE	PA	IS	TR	OE	Toplam
2000	25,4	57,1	6,2	5,5	75,0	21,3	20,5	11,9	36,3	37,7	297,0
2001	26,1	58,7	6,4	5,7	77,0	21,9	21,0	12,3	37,3	38,7	305,1
2002	26,8	60,2	6,6	5,8	79,1	22,4	21,6	12,6	38,3	39,7	313,2

2003	27,5	61,8	6,7	6,0	81,1	23,0	22,1	12,9	39,3	40,8	321,2
2004	28,2	63,3	6,9	6,1	83,1	23,6	22,7	13,2	40,3	41,8	329,3
2005	28,9	64,9	7,1	6,3	85,2	24,2	23,2	13,6	41,3	42,8	337,4
2006	29,6	66,4	7,2	6,4	87,2	24,8	23,8	13,9	42,3	43,8	345,4
2007	30,3	68,0	7,4	6,6	89,2	25,3	24,4	14,2	43,3	44,9	353,5
2008	31,0	69,5	7,6	6,7	91,3	25,9	24,9	14,5	44,2	45,9	361,6
2009	31,7	71,1	7,8	6,9	93,3	26,5	25,5	14,9	45,2	46,9	369,7
2010	32,4	72,6	7,9	7,0	95,4	27,1	26,0	15,2	46,2	47,9	377,7
2011	33,0	74,2	8,1	7,1	97,4	27,7	26,6	15,5	47,2	49,0	385,8
2012	33,7	75,7	8,3	7,3	99,4	28,2	27,1	15,8	48,2	50,0	393,9
2013	34,4	77,3	8,4	7,4	101,5	28,8	27,7	16,2	49,2	51,0	401,9
2014	35,1	78,8	8,6	7,6	103,5	29,4	28,2	16,5	50,2	52,0	410,0
2015	35,8	80,4	8,8	7,7	105,5	30,0	28,8	16,8	51,2	53,1	418,1
2016	36,5	82,0	8,9	7,9	107,6	30,5	29,4	17,1	52,2	54,1	426,2
2017	37,2	83,5	9,1	8,0	109,6	31,1	29,9	17,5	53,1	55,1	434,2
2018	37,9	85,1	9,3	8,2	111,7	31,7	30,5	17,8	54,1	56,1	442,3
2019	38,6	86,6	9,4	8,3	113,7	32,3	31,0	18,1	55,1	57,2	450,4
2020	39,3	88,2	9,6	8,5	115,7	32,9	31,6	18,4	56,1	58,2	458,4

Source: TUİK (2011) From the National Greenhouse Gas Emission Inventory Report data, sectoral emissions have been calculated by the authors, and simulation has been applied.*: Emission values exclude Lulucf.

Figure 6: Emission Forecasts for the 1990-2009 Period According to 5.13% EmissionIncrease * (Mt CO2e)



Source: TUİK (2011) NationalGreenhouse Gas EmissionInventory Report data have been consolidated by the authors. *: Emission values exclude Lulucf.

6. Carbon Emission Projections

In this part of the study, greenhouse gasemission projections would be made by mathematical models. By using the 1990-2009 period greenhouse gas amounts published by TUİK, linear, parabolic, cubic andexponential forecasts have been made and given in Table6. It is clearly seen that different methods produce different emissionvalues.

Table 6: Greenhouse GasEmission Projections (Mt CO2e)*

Carbon Emission Projections			
Year	Linear Model	Parabolic Model	Exponential Model
2010	382,65	386,54	398,16
2011	392,32	397,30	412,38
2012	401,98	408,17	427,11
2013	411,64	419,14	442,37
2014	421,31	430,20	458,17
2015	430,97	441,37	474,54
2016	440,63	452,64	491,49
2017	450,29	464,00	509,05
2018	459,96	475,47	527,24
2019	469,62	487,04	546,07
2020	479,28	498,71	565,58
2021	488,95	510,48	585,78

2022	498,61	522,34	606,71
2023	508,27	534,31	628,38
2024	517,94	546,38	650,83
2025	527,60	558,55	674,08
2026	537,26	570,82	698,16
2027	546,93	583,19	723,10
2028	556,59	595,66	748,93
2029	566,25	608,23	775,69
2030	575,92	620,90	803,40
Estimating Equations:			
LinearEstimating Equation: y = 9,6632x + 179,73			$R^2 = 0,96$
ParabolicEstimating Equation: y = 0,0501x2 + 8,612x + 183,59			$R^2 = 0,96$
CubicEstimating Equation: y = 0,0238x3 - 0,6996x2 + 15,064x + 170,94			$R^2 = 0,96$
ExponentialEstimating Equation: y = 190,52e0,0351x			$R^2 = 0,96$

Not:Mathematica and Excel Programs have been used for the estimations made by 1990-2009 data.

*: Emission values exclude Lulucf.

As Table 6 indicates, according to the results reached by the help of linearequation; Turkey's greenhouse gas emission would be 430MtCO2e in 2015, 479 MtCO2e in 2020 and575 MtCO2e in2030. According to the results reached by the help of parabolicequation; Turkey'sgreenhouse gasemission would be 441MtCO2e in 2015, 498 MtCO2e in 2020 and620 MtCO2e in 2030. And according to the findings reached by the help of exponential equation; Turkey'sgreenhouse gasemission would be474MtCO2e in 2020, 565MtCO2e in 2015 and 803 MtCO2e in 2030.

The acquired findings are much less than the 604 Mt CO2e value forecast by the Ministry of Environment and Forestry (Ministry of Forestry and Hydraulic Works) by using the MAED/ENPEP model, however, they are in accordance with the 421 Mt CO2e value, foreseen by the European Commission using PRIMES model. Considering that the MAED/ENPEP model does not reflect the energy assumptions reality and that the model results are different than the actual values, it would be more realistic to use European Commission's PRIMES model.

7. Result and Discussion

There is no emission reduction commitment for the first Kyoto period covering the 1998-2012 period for Turkey, who is on the full membership process for European Union. However, Turkey is expected to be committed for the Post-Kyoto period covering post-2012. Considering that emission reductions would have economic costs, anticipation of emission trend, the level of commitment and choosing the best policy for emission reduction would be highly important for the decision makers.

In our study, the anticipated emission trend for Turkeyhas been given by the help of different mathematical models. According to the findings reached by the help of linear equation; Turkey'sgreenhouse gasemission would be, 430MtCO2e in 2015, 479 MtCO2e in 2020 and 575 MtCO2e in 2030. This result is in line with the 421 Mt CO2e value for 2020, forecasted by the European Commission using the PRIMES model. Even though different methods produce different results, it is thought that the results acquired by the linear equation are more consistent.

REFERENCES

Church, J. A., and N. J. White, (2006) "A 20th Century Acceleration in Global Sea-Level Rise". Geophys. Res. Lett., 33, L01602, doi: 10.1029/2005GL024826.

EEA (2006) "Environmental Statement", European Environment Agency Report No 8/2006, Copenhagen, Denmark.

EEA (2007) "Greenhouse Gas Emission Trends and Projections in Europe 2007" European Environment Agency Report, October 2007, Denmark, (Forthcoming)

EEA (2011) "Greenhause Gas Emission Trends and Projections in Europe 2011: The Fourth Report", European Environment Agency, Report Nu: 4, 2011.

Holgate, S. J., and P. L. Woodworth, (2004) Evidence for enhanced coastal sea level rise during the 1990s. Geophys. Res. Lett., 31, L07305, doi:10.1029/2004GL019626.

IPCC (2007) "Climate change 2007: Mitigation.", Contribution of Working group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (2007a) "The Physical Science Basis", Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and NewYork.

IPCC (2007b) "Climate Change 2007: Mitigation", Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change", Cambridge University Press, Cambridge, United Kingdom and NewYork.

Keeling, C. D. ve Whorf, T. P. (2005) "Atmospheric CO2 concentration (ppmv) Derived From in Situ Air Samples Collected at Mauna Loa Observatory", Hawaii.

Leuliette, E. W., R. S. Nerem, and G. T. Mitchum, 2004: Calibration of TOPEX/Poseidon and Jason Altimeter Data to Construct A Continuous Record of Mean Sea Level Change. Mar. Geodesy, 27(1–2), 79–94

Madra, Ö. ve Şahin, Ü. (2007) "Küresel Isınma ve İklim Krizi", İdil Yayıncılık, İstanbul, 2007.

Özçağ, M. (2011) "İnsan Kaynaklı İklim Değişikliği ve Ekonomik Büyüme Türkiye Üzerine Bir Analiz", Adnan Menderes Üniversitesi Sosyal Bil. Ens. Yayımlanmamış Doktora Tezi, Aydın, s.12.

www.tuik.gov.tr

http://www.licor.com/env/newsline/tag/keeling-curve/, Access: 13.03.201