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An Assessment Through Relationship Between Air Pollution and Climatic Parameters in City of Igdır

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ABSTRACT:

Air pollution problems due to the use of fossil fuels to meet the energy needs of large and small-scale cities, creates a negative impact on people and the urban ecosystem. Due to the bowl-shaped structure of Iğdır formed by Mount Ararat in eastern Turkey and the Caucasus Mountains, in the winter air pollution in the city center of Iğdır has increased in line with population growth. In this study, the relationship between air pollution and climatic parameters were analyzed statistically. The data obtained by the General Directorate of Meteorology in Iğdır. By the analysis, relationships between the climatic elements such as temperature, wind speed, wind direction, humidity, and the air pollution parameters such as particles and the amount of SO_2 in the air are examined. According to the results obtained from the research in city of Iğdır, there is a significant correlation between the climate and air pollution and also topographic factors and land use that affect both of them.

KEYWORDS:

Air pollution, climate elements, ordination analysis, city of Iğdır

Iğdır Kentinde Hava Kirliliği ve İklim Parametreleri Arasındaki İlişki Üzerine Bir Değerlendirme

ÖZET:

Büyük ve küçük ölçekli şehirlerin enerji ihtiyaçlarını karşılamak için kullanılan fosil yakıtlar sebebiyle oluşan hava kirliliği sorunları insan ve kent ekosistemine olumsuz bir etki yapar. Doğu Anadolu'da Ağrı Dağı ve Kafkas Dağlarının oluşturduğu kase şekli sebebiyle Iğdır kent merkezinde kışın hava kirliliği nüfus artışıyla artmaktadır. Çalışmada, hava kirliliği ve iklimsel parametreler arasındaki ilişki istatiksel olarak analiz edilmektedir. Veriler Iğdır'daki Meteoroloji Genel Müdürlüğü'nden elde edildi. Analizlerle, ısı, rüzgar hızı, rüzgar yönü, nem gibi iklimsel elemanlar ve havadaki partikül ve SO_2 miktarları gibi hava kirliliği parametreleri arasındaki ilişki incelenmektedir. Iğdır kentinde elde edilen sonuçlara göre iklim ve hava kirliliği ve ayrıca topoğrafik faktörler ve onları etkileyen arazi kullanım arasında önemli korelasyon vardır

Anahtar Kelimeler: Hava kirliliği, iklim elementleri Iğdır kenti, koordinasyon analizi

INTRODUCTION:

Air pollution is defined as increase of pollutants in the atmosphere composition result of men's activities. Raising of energy necessity ın parallel with developing technology and increasing world population also enhance the demand for fossil fuels. Depending on increasing the use of fossil fuels, in atmosphere the emissions of carbon-di-oxide (CO2), sulfur di-oxide (SO 2) and particulate matter (PM) pollutants, are fuel originated, have increased (Galloway, 1998). Indeed, in 2011 the amount of CO2 emitted in the world has reached to 34 billion tons and the value is more 50% than 2009 when the Kyoto Protocol was signed (Anonymous, 2012).

Air pollution is occurred with the emissions sources are emerged by human influence or various natural events (eg. volcanic eruptions) (Pitts and Pitts, 1986). Air pollution continues to increase especially in developed and developing countries and worldwide and also represent a major threat for human health and environment (Chak and Xiaohong, 2008; Moriarty, 1999). In terms of ecological perspective, organisms in the ecosystem is affected in different ways depending on the environmental pollutants (Moriarty, 1999). People's health problems increase due to increasing the pollutionof city air. It is possible to range various health problems in humans caused by air pollution such as lung diseases, respiratory tract diseases, shortness of breath, cough, wheezing, cardio-vascular diseases (Schwartz and Dockery, 1992; Smith et al., 1994; Bozkurt et al., 1998; Cohen, 2000; Vineis et al., 2006; Bisht et al., 2013). World countries have searched for solutions to eliminate or mitigate the effects of this problem and demonstrated remarkable progress about this issue (Erden, 1999; Altıntaş, 2004; Yalçın, 2009).

Although atmosphere generally deactivates the toxin agents, involved in, by melting, speed of deactivation changes depending on meteorological and topographic conditions (İbret and Aydınözü, 2009). In other ways, present land use generally effects on the concentration of pollutants in the atmosphere and change of this intensity in time (Nişancı, 1988; Güler, 1994; Çiçek, 2004). In addition to the usage of low polluting fuel sources (as natural gas), air stream corridors for cities in the figure of settlement planning is one of the best methods to fight against air pollution (Güler and Çobanoğlu, 1994).

Movements of the atmosphere has an impact on air pollution. Increasing air movement over the city are quite effective in distributing the polluted air (Eser et al., 1999). Indeed, studies on air pollution in the city of Igdir (Şahin, 1987, Boncukoğlu et al., 1992; Turaloğlu and Bayraktar, 2004; Bayraktar et al 2005; Sever 2008; Kopar and Zengin, 2009) point out suggestions for solutions after exploiting the seasonal patterns of air pollution. The aim of this study is to describe through statistical analysis the relationship between climatic parameters and air pollution prevailing in Igdir and offer solutions related to urban planning based on the results.

1. Materials and Methods

In this study, records of climate and air pollutants in the city center of Igdir since 2009 and 2010, are evaluated by computer. (Table 1, Figure 2-3 and 4). Iğdır is located between east longitude 44° 49-45° and north latitude 39° 38-40° in the part of Erzurum-Kars at East Anatolia Region (See. Figure 1).

Igdir is located between the Mount Ararat with its extensions at south and the Caucasus Mountains at north, also it is settled on a plain is situated in the valley where the Aras River passes through. The total surface area of Igdir Plain where the city is installed, is 83,211 ha and it is above nearly 850 m from sea level. The plain is settled in the valley which narrows from east and west, has a feature in terms of geomorphological, is defined as a pot.

Climatic data were obtained from the General Directorate of State Meteorological Station and air pollution data were obtained from the Igdir Provincial Directorate of Environment and Urbanization for the years 2009 and 2010. Relationships between climate and air pollution were evaluated by analysis method of the ordination that is done with computer program as CANOCO version 4.5 (Ter Braak and Milau, 1998). Relationships between climate and air pollution follow almost linear trend. ıf there is trend like this, generally RDA (Redundancy Analysis) is prefered in the ordination analysis, so in this study RDA is used.

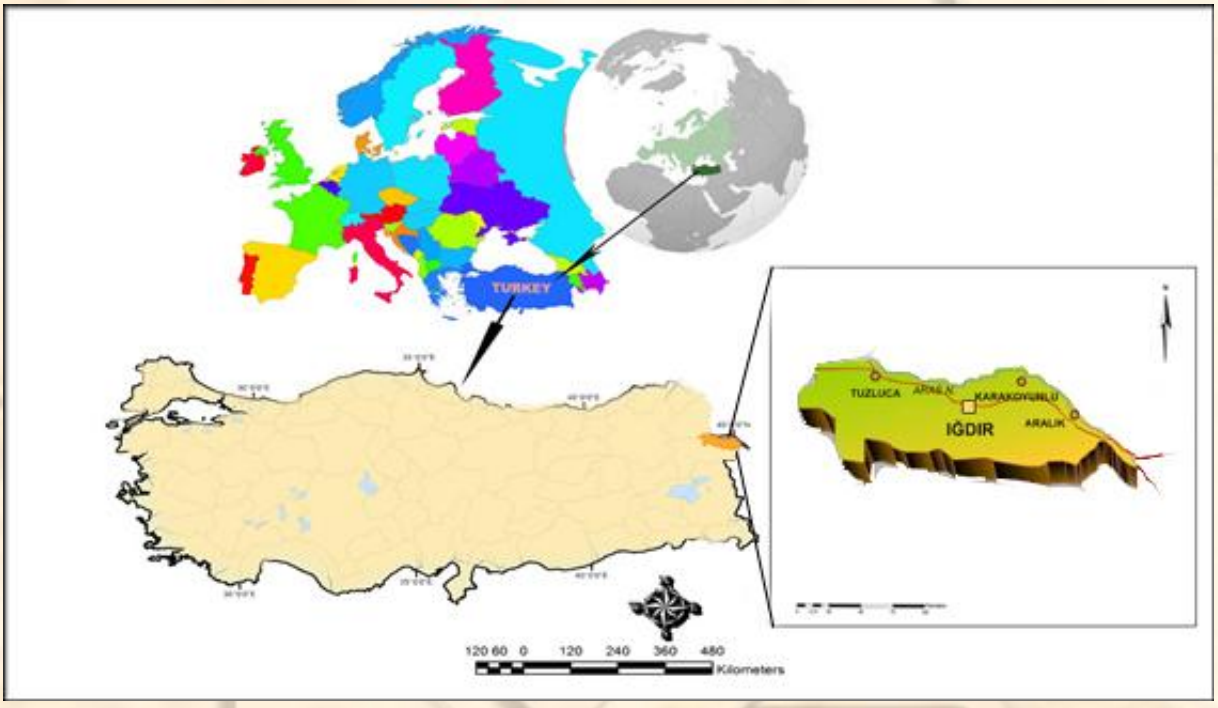

Figure 1. Location of Igdir

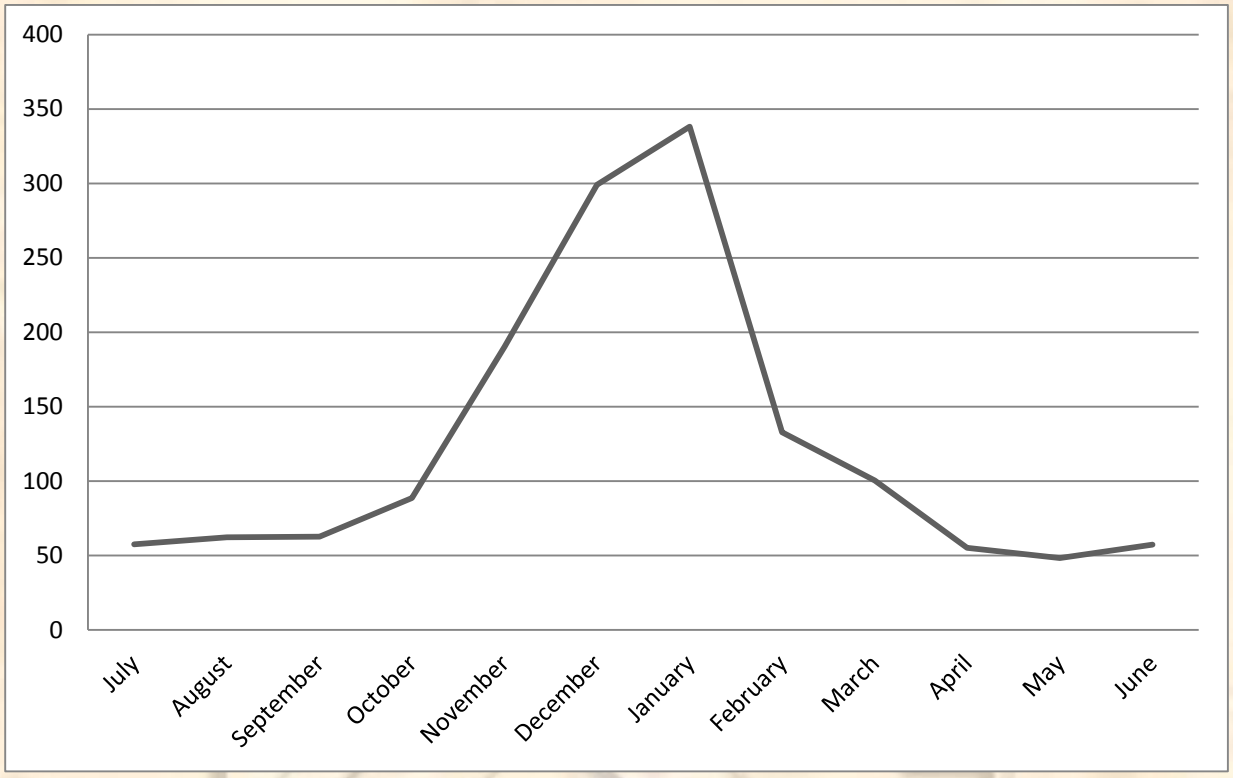

Figure 2. Annually changing of amount of particulate matter in the air of Igdir (Source: The Igdir Provincial Directorate of Environment and Urbanization)

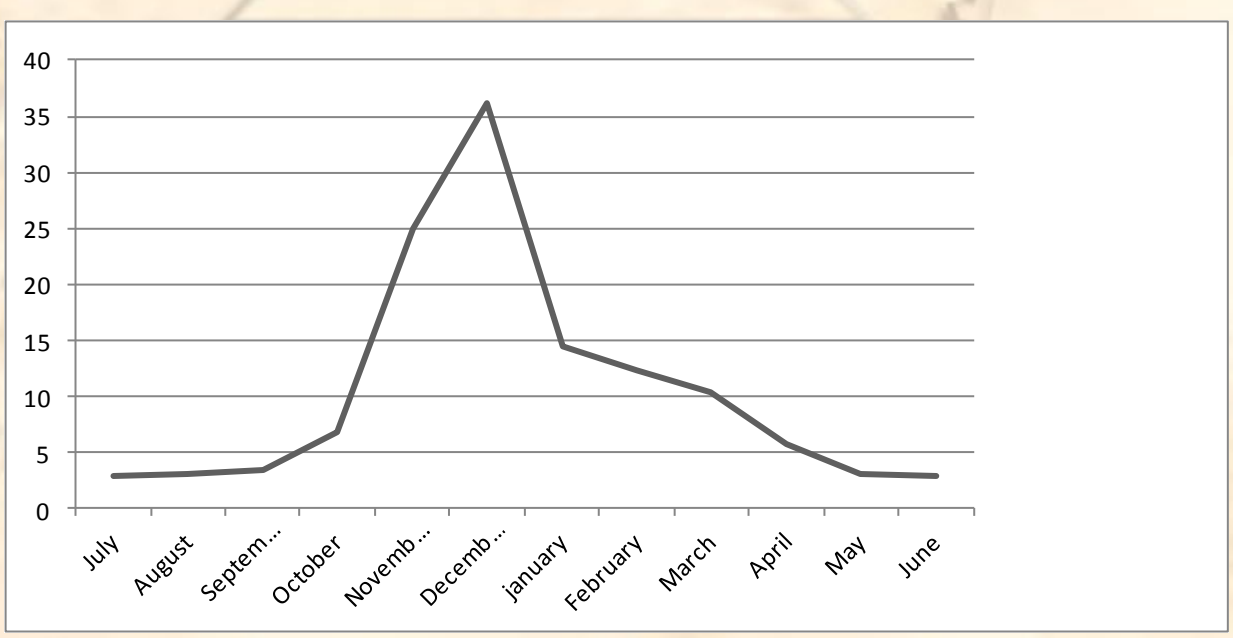

Figure 3. Annually change of amount of sulphur dioxide in the air of Igdir (Source: The Igdir Provincial Directorate of Environment and Urbanization)

	Months												
	January	February	March	April	May	June	July	August	Semptember	Ocober	November	December	Avarage/total
Rains (mm)													
2009	8,2	24,7	21,8	34,3	26,3	55,2	47,7	13,5	27,4	10,4	22,2	12,2	25.3/303.9
2010	24,2	34,1	8,6	88,2	91,9	18,7	12,7	4,6	0,9	61,1	0,0	1,3	28.9/346.3
UYO	13.2	18.1	21.6	36.5	48.1	32.3	14	9.2	10.1	26.4	17.7	11.6	21.56/258.8
Temperature (ºC)													
2009	-5,8	4,2	7,3	12,0	18,6	22,3	25,6	23,6	19,1	15,0	7,7	3,8	12.8/153.4
2010	2,4	5,0	10,5	12,5	17,2	25,0	28,2	26,8	23,4	15,0	6,6	2,4	14.6/175
UYO	-3.3	-0.5	6.4	13.1	17.7	22.1	25.8	25.1	19.9	12.7	5.7	-0.1	12.05/144.6
Wind Speed (m/sec)													
2009	0,9	1,3	2,1	2,0	1,9	1,8	2,1	2,0	1,6	0,9	1,1	0,8	1.5/18.5
2010	1,3	1,1	2,4	1,5	1,3	1,6	1,8	1,6	1,3	1,1	0,6	0,7	1.4/16.3
UYO	1	1.3	2.1	1.9	2	2.3	2.3	1.9	1.6	1.2	0.9	1.1	1.63/19.6

Table 1. Monthly change of average precipitation, temperature and wind speed in Igdir for 2009 and 2010, also for long-terms (1960-2012). (Source: The General Directorate of State Meteorological Station in Igdir)

2. Results and Discussion

2.1. Air Pollutants

The amount of particulate matter of air in Igdir, starts to increase since October when heating system started to operate because of falling temperature and it reaches the highest value on January. After February the amount of particulate matter starts to decrease and it has minimum level on May. Change of the amount of sulphur dioxide in city air is similar to the amount of particulate matter. Both pollutants have critical value on November and February (Figure 1 and 2). The particulate matter and sulfur dioxide emissions from the chimney increase due to using of fossil fuels to meet the heating requirements depend on decreasing of temperatures and researchers' common idea is that if air movement is less in urban areas, it causes serious air pollution problems (Taşdemir, 2002; Türkeş et al., 2000).

2.2. Climate

When the meteorological records for Iğdir are examined, it is seen that according to the average rainfall for long-term (1960-2012) it rains 260.6 mm as annual. According to the average rainfall for long-term the most rainy month is May with the rainfall of 47.9 mm while the least rainy month is August with rainfall of 10.5 mm. At the researched years the total rainfall is 304 mm of in 2009 and the most rainy month is June with the rainfall of 55.2 mm and the least rainy month is January with rainfall of 8.2 mm. In the second year (2010) the total rainfall is 346 mm and and the most rainy month is May with the rainfall of 91.9 mm while the November has no rain. As shown in Table 1, a significant difference is emerged in terms of distribution and total of precipitation. This case shows an irregularity in the city in terms of rainfall. Researchers have expressed that irregularity of precipitation will increase depending on increasing effects of global warming (Simsek et al., 2010). Indeed, deviations emerged in researched years, can be interpreted as the effects of global climate change.

The average temperature is 12.05 ^{o}C for long-term (1960-2012) and July is the warmest month with 25.8 ^{o}C and January is the coldest month with -3.3 ^{o}C. Similarly, the average temperature for long-term, in 2009 the warmest month with is July (25.6 ^{o}C) while the coldest month is january (- 5.8 ^{o}C) (Table 1). In this year the warmest month is similar the average for long-term while the coldest month is less as 2.5 ^{o}C than average for long-term. In the second year the warmest month with is July (28.2 ^{o}C) while the coldest months are December and January (2.4 ^{o}C). In this year both average temperature and the warmest month and the coldest month is higher than average for long-term. According to the data in researched years, although the warmest and the coldest month are in the same period, a serious fluctuations is seen in terms of the recorded temperature values. There will be fluctuations as annual at the speed and direction of air flow with effects of global warming is expressed by experts (Türkeş, 1995; Türkeş et al., 1995; Türkeş et al., 2000; Kadıoğlu, 1997). Although there is no deviation in the data for The current temperature of warm and cold period, it is seen that in the middle of this period there is large deviation in terms of the lowest and

highest temperatures. These data can be interpreted as in the winter months extreme low temperatures will be rised due to global warming. In the first year of research January was more cold as -2.5 ^{o}C than average temperature of long-term.

Long-term average wind speed is 4 m/s in Igdir. July has The fastest winds and November has slowest winds (Table 1). According to avreage of researhed years, the dominated wind directions are respectively East, Northeast, Southeast and Northeast at the November-February period that air pollution is felt intensively. Also the wind direction is South at the July and August have warmest temperature.These results show that in Iğdır the dominated wind direction is east-west in the months which air pollution is felt intensively and the north-south in the summer months which temperature affects adversely human comfort.

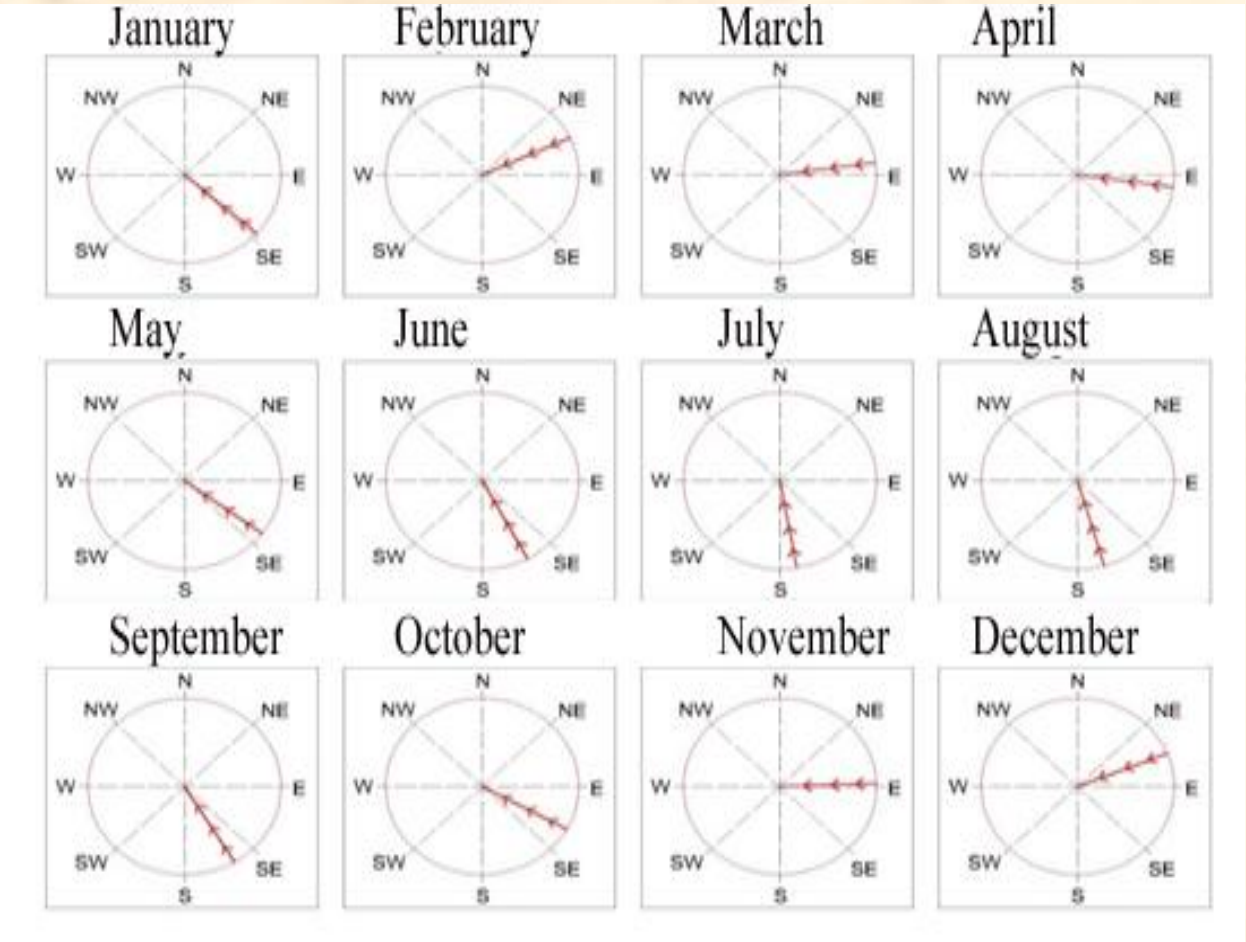

Figure 4. Monthly Average Wind Direction in 2010 (Source: The General Directorate of State Meteorological Station in Igdir)

3.3. Relationship Between Air Pollution and Climatic Data

Figure 5. by program CANACO, results of ordination analysis of relationship between air pollutants and meteorological data for the year 2009 and 2010 in Igdir

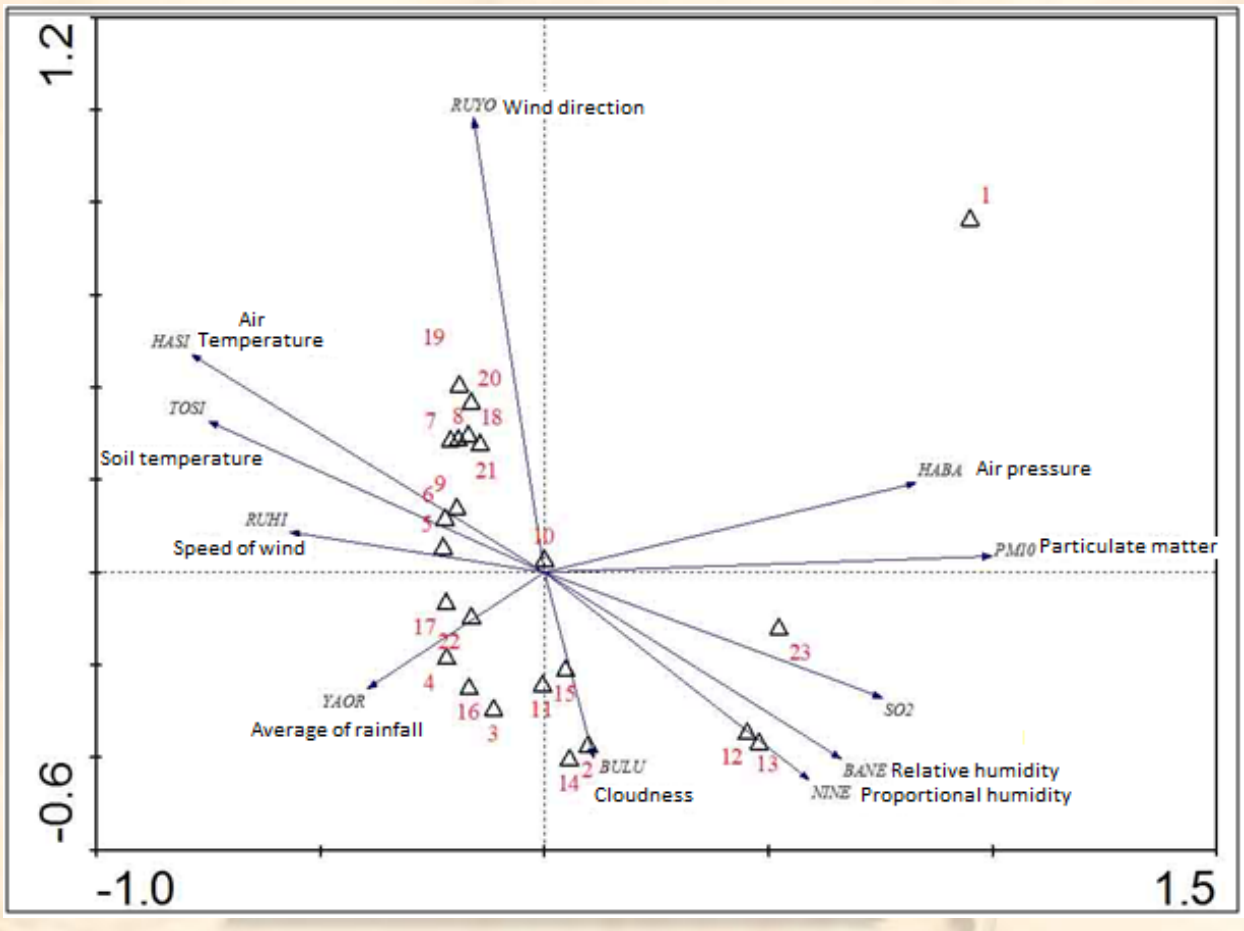

Figure 5. Results of Ordination Analysis

Results of ordination analysis for the purpose to determine relationships between air pollutants and meteorological data, is shown in Figure 5. The amount of particulate matter in the atmosphere of cities has close relationship with the air pressure, temperature and relative humidity. In addition, opposite relationship between sulfur di-oxide and air temperature and opposite relationship between wind speed and the amount of particles are drawn the attention.

According to results of ordination analysis, amount of particles increases depend on increasing wind speed and the sulfur dioxide decreases depend on temperature decrease. SO_2 emissions and particulate matter on fuel increases due to increasing usage of fossil fuels as result of the operation of the heating system depending on temperature decrease (Öztürk, 2002; Stellmana et al.,1998; McKenzie et al., 2002, Soysal et al., 2007). Temperature decrease causes increasing of intensity of these pollutants in the atmosphere by slowing the rare of pollutants into the same atmosphere. So air movement has important task to remove pollutants from urban air. Opposite relationship between pollutants and wind speed show this situation clearly. Indeed, there are studies to draw attention for the effect of the wind in the distribution of air pollution such as studies in Taşdemir, 2002 and Anıl et al, 2009. When the relationship between air pollution and atmospheric movements is realized, importance of this condition in the urban plans increases. ın this context. For example arrangements not preventing the wind and encouraging the wind stand out. One of the most remarkable applications in this regard, is the creation of urban air corridor.

Results in this study show that air pollution in period of November-February and high temperature in period of July- August have negative effects on human health and comfort in Igdir. Dominated wind direction is east and close to east and it is south in period has disadvantage on human comfort by high temperature. In the light of these findings, city plans in Igdir, airflow corridor is necessary for decreasing the effects of air pollution at direction of east-west and decreasing the effects of high temperature in summer at direction of South-north and so creation of a more comfortable urban life.

As seen in Fig.4 air movement is from direction of South-East and North-East and East in Igdir. Air masses coming from these directions are blocked by buildings located in city and wind speed decreases. Decreased wind speed causes hanging of pollutants such as SO_2 and particulate matter and also affect human health negatively. Also they cause the temperature is felt more than it is by the greenhouse in the city.

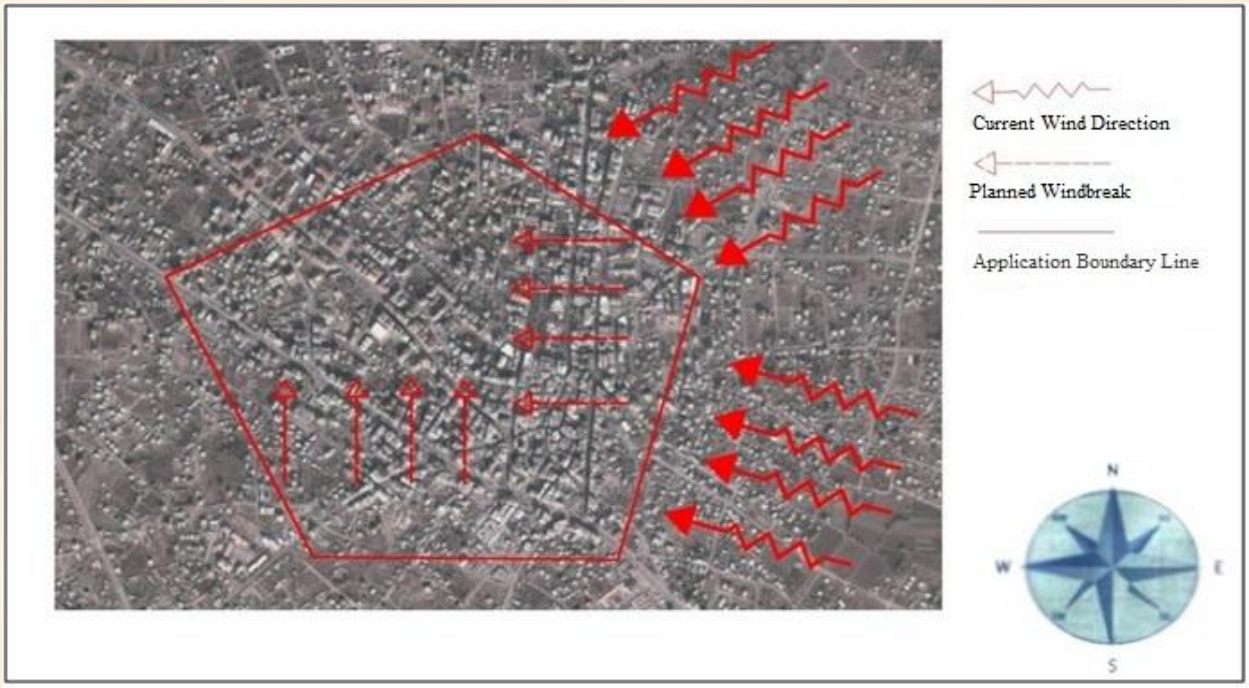

Figure 6. Proposed Wind Corridor as Planning

By means of proposed wind corridor (Figure 5) It is predicted that pollutant factors will be removed from the city by providing airflow from the East-West in winter, and sensible temperature within the city will reach an optimal level in terms of temperature and bioclimatic by providing airflow from the North-South in summer.

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