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Air Quality and Happiness in Turkey[1]

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Abstract

This paper explores the relationship between air pollution and life satisfaction in Turkey. Using cross sectional data, based on data from the TUIK Life Satisfaction Survey (196203 observations) -which provides location of the participants at the city level for the year of 2013- this study aims at investigating the role of objective air pollution on life satisfaction by taking into account individual, location and climate heterogeneity. After controlling personel characteristics, and local variables (climate variables and province dummies), according to ordinary least square regression analysis, a robust negative impact of air pollutions on life satisfaction is found.

Keywords: *Life satisfaction, Happiness, Environment, Air Pollution, Turkey*

JEL Codes: *I31, D60, Q51, Q53*

Türkiye'de Mutluluk ve Hava Kalitesi

Öz

Bu çalışma Türkiye'de hava kirliliği ve yaşam memnuniyeti arasındaki ilişkiyi incelemektedir. Çalışmada TÜİK tarafından 2013 yılında ilk kez il bazında ve 196203 katılımcı ile gerçekleştirilen ve yatay kesit veriye dayanan Yaşam Memnuniyeti Anket araştırması kullanılmıştır. Bireye, mekana ve iklime özgü farklılıklar kontrol edilerek objektif hava kirliliğinin yaşam memnuniyeti üzerindeki etkisi değerlendirilmiştir. Kişisel özelliklerin ve lokal değişkenlerin (iklim ve şehir kukla değişkenleri) etkisi kontrol edildikten sonra, en küçük kareler tahmin yöntemi ile elde edilen regresyon sonuçlarına göre, hava kirliliğinin yaşam memnuniyeti üzerinde güçlü ve negatif bir etkisinin olduğu bulunmuştur.

Anahtar Kelimeler: *Yaşam Memnuniyeti, Mutluluk, Çevre, Hava Kirliliği, Türkiye*

Jel Kodları: *I31, D60, Q51, Q53*

1 This study was derived from the PhD thesis study "An Examination on Happiness and Environmental Quality", which ended 2021 at the Institute of Social Science of the University of Marmara.

1. Introduction

Happiness, life satisfaction, and subjective well-being notions have been introduced into the economics literature[2] following Esterlin's seminal work[3]. This field has referred to as "happiness economics". The happiness economics literature has made various contributions to understanding and measuring utility functions. Firstly, starting from Esterlin (1974), the impact of economic growth on human welfare has been scrutinized. Secondly, the role of environmental quality in welfare has been established empirically. Finally, the trade-off between consumption and protection of the environment has been measured[4] (Welsch, 2020).

As a widely-used tool to measure the well-being of people, GDP (Gross Domestic Product) makes no distinction between quality and quantity, the desirable and undesirable, or cost and improvement. Therefore, using GDP as a measure of well-being can be misleading. Because what GDP measures is solely the total market value of all goods and services produced in a country in a given period. That is, any economic activity causes GDP growth, regardless of whether it is beneficial or harmful. For instance, expenditures due to natural disasters, sickness, pollution, and pandemics can stimulate an increase in GDP. Simon Kuznets, the developer of GDP, cautioned that GDP growth should not be used as a measure of well-being (Kuznets, 1934). However, for a long time, the concepts of GDP and economic growth have regularly been referred to by leading economists, politicians, top-level decision-makers, and the media as though they represent overall progress (Bernanke, 2010; Stigliz, Sen, & Fitoussi, 2009). The core assumption behind the link between GDP and economic well-being is that the satisfaction people take from their economic resources is simply assumed to depend on income and expenditure.

2 In this study, the life satisfaction, subjective well-being and happiness notions refer to the same thing (i.e. an overall assessment of an individual's well-being made by the individuals themselves). (See, for example, Rehdanz and Maddison 2005; Caporale et al. 2009 and Cunado and Gracia 2013).

3 "Does Economic Growth Improve the Human Lot? Some Empirical Evidence"

4 Measuring the trade-off between consumption and environmental protection enables us to calculate the marginal willingness to pay fort he protection of the environment. This method is called the Life Satisfaction Approach (LSA). (See, more detail about LSA, Frey, Luechinger, & Stutzer, 2010).

There has been a search for broader well-being measurements since GDP does not reflect different dimensions of life such as social life, health, community, the environment, and subjective well-being (Deaton, 2008; Fleurbaey, 2009)[5]. Among these broader welfare dimensions, economists have paid special attention to subjective well-being (that comprises life satisfaction and happiness) as a direct measure of utility and hence a welfare indicator in economic models (Frey & Stutzer, 2002b). Subjective well-being relies on the judgment of the persons directly involved and interprets this judgment as a direct measure of utility or well-being. Although one can criticize that people cannot tell for sure the level of their life satisfaction or happiness levels, empirical checks show that self-reports on life satisfaction can represent the well-being of people properly (Veenhoven, 1991).

The empirical studies of subjective well-being typically employ a standard micro-econometric happiness function. Ordered models such as probit and logit or least squares estimation are the most frequently used methods. An individual's reported satisfaction is regressed on a wide number of controls such as socio-demographic (e.g. age, gender, marital status) and socioeconomic (e.g. income, education, unemployment) characteristics as well as on the environmental and institutional variables to be analyzed by using available datasets (Di Tella, MacCulloch, & Oswald, 2001; Easterlin, 1995; Frey & Stutzer, 1999, 2010; Frijters, Haisken-DeNew, & Shields, 2004).

Other than the above-mentioned correlates of subjective well-being, as an important policy issue, environmental quality has also been shown to be an important determinant of subjective well-being. There is a both direct and indirect relationship between environmental quality and subjective well-being (Darçın, 2017; Dolan & Laffan, 2016; Streimikiene, 2015). The direct relationship emerges from the impacts of environmental quality on the aesthetics and visibility of the local environment. The indirect relationship arises from the impacts of environmental quality on people's health. Besides the direct and indirect relationship, subjective well-being is also influenced by the perception of the severity of environmental issues, which may vary from person to person. One person may be more sensitive to environmental issues, whereas another may not be sensitive at all (Ferrer-i-Carbonell & Gowdy, 2007a).

Environmental challenges affect lives and economies in every country in the world. The qualities of the local living environment and air pollution have a direct impact on our health and well-being. Air pollution is a major environment-related health threat, especially to children and the elderly, as it can cause lung cancer, and cardiovascular diseases (Donaldson, 2017; Landrigan et al., 2018). Despite national and international interventions, nearly two-thirds of people in OECD countries are exposed to dangerous levels of air pollution that can be linked to a range of health problems such as asthma, cardiovascular disease, and lung cancer. More than half of this disease burden is borne by the populations of developing countries (OECD, 2017).

5 For alternative well-being measures please see OECD Better Life Index, The Happy Planet Index, Social Progress Index.

As environmental quality deteriorates, the research about the relationship between environmental indicators, individual environmental attitudes, and happiness significantly increased as well. Scholars examined the relationship between climate variables such as temperature, wind speed, and rainfall (Brereton, Clinch, & Ferreira, 2008; Carroll, Frijters, & Shields, 2009; Frijters & van Praag, 1998; Maddison & Rehdanz, 2011; Rehdanz & Maddison, 2005; Van de Vliert, Huang, & Parker, 2004), air pollution indicators (e.g. nitrogen dioxide, carbon monoxide, sulfur dioxide, a mixture of particulate matter [PM_{10}, $PM_{2.5}$] and lead concentration) (Barrington-Leigh & Behzadnejad, 2017; Dolan & Laffan, 2016; Ferreira et al., 2013; Ferreira & Moro, 2010; Levinson, 2012; Luechinger, 2010; MacKerron & Mourato, 2009; Menz, 2011; Menz & Welsch, 2010; Smyth, Mishra, & Qian, 2008; Welsch, 2002, 2006, 2007), noise (Rehdanz & Maddison, 2008; van Praag & Baarsma, 2005), and individual attitudes towards the environment (Ferrer-i-Carbonell & Gowdy, 2007b)[6].

These studies typically employ cross-sectional and/or panel data analysis that enables researchers to examine the relationship between subjective well-being and other factors. The results of the research suggest that several dimensions of environmental quality have a significantly negative impact on subjective well-being. Even though many studies examine the association of happiness with age, gender, education level, income, unemployment, trust in institutions, and religion (Caner, 2015; Dumludag, 2013; Dumludag, Gokdemir, & Giray, 2016; Eren & Aşıcı, 2017; Gitmez & Morçöl, 1994; Selim, 2008, 2012) in the contex of Turkey, studies on the relationship between happiness and environmental quality are limited. To the best of our knowledge, Özdamar (2016) and Taşkaya (2018) are the only ones that examine the effect of environmental quality on personal well-being in Turkey. Ozdamar (2016) examined the association between self-reported air pollution (i.e. how individuals perceive environmental quality in the neighborhood area), crime, and happiness in Turkey making use of the Health Survey data for the years 2010-2012. The results of the study suggest that people who said that they are exposed to air pollution report lower levels of life satisfaction in comparison with those who said that they are not exposed to air pollution. In the monetary valuation part of the analysis, the author found that people who are exposed to air pollution are willing to pay 13-19 Turkish Liras per month more compared to those who are not exposed to air pollution. Although micro-level data is utilized in the analyses, spatial differences are only controlled in the urban-rural context. Besides, the air pollution variable is not derived from an objective measure, rather it depends on the perception of the participant. Also, the question that measures happiness covers a particularly short period (i.e. last four weeks) rather than providing an overall evaluation of life satisfaction (Ozdamar, 2016). Unlike Özdamar (2016), Taşkaya (2018) utilizes provincial-level data. She examined the correlation of environmental quality with the well-being index of the provinces of Turkey. The data was prepared by the TUIK for the year 2015 (Better Life Index for The Provinces Study). Due to the nature of the data, individual heterogeneity originating from household income, age, gender, and marital status could not be con-

6 For a comprehensive summary see Welsch, 2007, 2009; Welsch and Kühling, 2009.

trolled. In the correlation analysis, the author found no significant association between the well-being index and objective air pollution, noise pollution, and waste services in Turkey (Taşkaya, 2018). This study did not include local factors that may be related both to happiness and air pollution such as climate change, economic activity, and population density in the analysis. However, the literature suggests that a biased relationship may occur because of not taking into consideration such local factors (Dolan & Laffan, 2016; Fleming, Manning, & Ambrey, 2016; Levinson, 2012).

This paper aims to contribute to the happiness and environment literature by providing empirical evidence of the relationship between air quality and happiness in Turkey. As a developing country, Turkey has experienced very rapid urbanization from 25 percent in 1950 to nearly 75 percent today. There is a strong correlation between rapidly increasing urban development and air pollution due to high-density human populations and increasing activities in urban areas (Arslan & Akyürek, 2018; Temiz Hava Hakkı Platformu, 2018). As a result, population exposure to fine particulates ($PM_{2.5}$) is particularly high in Turkey as well as in countries such as Korea, Poland, and Hungary (OECD, 2017). According to the European Environment Agency (EEA), 97.2 percent of the urban population in Turkey is exposed to unhealthy levels of PM_{10} (EEA, 2014)., HEAL estimates that in Turkey in 2012, 28,014 people died prematurely and 722,346 healthy life years were lost as a result of exposure to PM (both primary and secondary particles) (HEAL, 2014).

We believe that Turkey, as a rapidly urbanized developing country requires special attention. Because the number of studies that focus on the association between environmental quality and happiness are limited in numbers. To the best of our knowledge, this is the first study that matches individual data with province-level data on air pollution indicators such as particulate matter smaller than 10 μm diameter (PM_{10}), PM_{10} exceedance, and sulfur dioxide (SO_2) coupled with other controls (socioeconomic and demographic, province dummy and climate variables such as temperature and precipitation) to examine the relationship between air quality indicators and happiness in Turkey. Matching individual data with province-level data enables us to control for individual heterogeneity as well as city-specific characteristics at the same time. Controlling for heterogeneity at the individual and province level constitutes the uniqueness of the current study. Also, this study differs from the previous studies in terms of variables that are included in the analysis. For instance, as air quality indicators PM_{10} exceedance, and SO_2, which are widely used in the international literature, have not been used before in Turkey.

The empirical results reveal that there is a negative and statistically significant relationship between air pollution variables and happiness, after controlling sociodemographic, socioeconomic, and local variables (climate variables and province dummies). The findings for urban and rural areas are in parallel with the whole sample allowing for sociodemographic, socioeconomic, and climate variables. The paper also attempts to calculate monetary valuation of air pollution in Turkey provinces.

The paper is organized as follows. In section 2, the data, the main variables and the model used in the analysis are presented. Section 3 reports on the econometric results, and, Section 4 concludes.

2. Data, the Main Variables, and the Model

2.1 Dataset, and the Main Variables

This paper gathers three different datasets. The data are from the Turkish Statistical Institute (TUIK), the Ministry of Environment and Urbanization of the Republic of Turkey, and the Turkish State Meteorological Service.

Although The Life Satisfaction Survey has been carried out annually since 2003 by TUIK, we limit ourselves to using only the 2013 survey as this is the only year where TUIK provides province-level data with a much higher representative sample of 196,203 (125,720 households) in comparison to 7,368 respondents the previous year. The province-level information of the 2013 data enables us to match the individual-level data with certain environmental characteristics that may vary from region to region and a biased relationship may arise if these factors are not included in the analysis.

Following the literature, this study includes socioeconomic and demographic variables such as age, age-squared, gender, income, education, marital status, house ownership, health problem, household size, and room per person (Cuñado & de Gracia, 2013; Dumludag, 2013; Ferreira et al., 2013; Ferrer-i-Carbonell & Gowdy, 2007; Foye, 2017; Levinson, 2012; Rehdanz & Maddison, 2008). These variables are all micro-level variables obtained from the 2013 Life Satisfaction Survey of the TUIK.

Along with these variables, variables that represent air quality, namely SO_2, PM_{10} in μg/m^3, and PM_{10} exceedance (calculated by the number of days per year that the average daily PM_{10} concentration exceeds 100 μg/m^3 limit), were obtained from the published air quality reports of the Ministry of Environment, Urbanization and Climate Change of the Republic of Turkey. All three of the air quality variables are widely used in the literature because of their potential association with happiness and health. The choice between the air quality variables is mainly a data availability issue. Although there are other air quality measures we limited ourselves only to these three variables because of the data availability (Cuñado & de Gracia, 2013).

We also included climate variables that were obtained from the Turkish State Meteorological Service website.[7] The climate variables were necessary as these variables affect both happiness and air quality (Van de Vliert, 2008). For instance, higher rainfall may decrease PM_{10} concentration, and at the same time is associated with lower happiness levels (Ambrey, Fleming, & Chan, 2014). The diversity of climates in Turkey necessitates including climate variables in the analysis.

7 15 provinces have more than one station. We used the average of the values reported in these stations. These provinces are Adana, Ankara, Denizli, Hatay, Istanbul, Izmir, Kahramanmaras, Kayseri, Kocaeli, Konya, Manisa, Mugla, Samsun, Trabzon, and Zonguldak.

The inclusion of many variables that are relevant to happiness, air quality, or both, enables us to capture the association more accurately. Nevertheless, there may be many other factors that provinces differ such as the job market, housing quality, level of development, (natural) environment, and public services. Not controlling for these differences may yield a biased estimate (Brereton et al., 2008; Dolan & Laffan, 2016; Smyth et al., 2008). To control for location-specific differences, we also included the "province dummy" variable in the empirical models, with Istanbul being the reference category.

The main variable of interest is the happiness of individuals. The evaluation of happiness is based on the self-reported answer to a single question: "Thinking about your life as a whole, how happy would you say you are?" Answers are given on a scale of five where 1: very happy, 2: happy, 3: moderate, 4: unhappy, and 5: very unhappy. For ease of interpretation, the responses to these categories are rearranged as 1: very unhappy; 2: unhappy; 3: moderate; 4: happy, and 5 very happy. In the 2013 data, responses to these categories were 2.58%, 8.3%, 28.79%, 51.23%, and 9.09%, respectively.

The income variable is used as monthly household income.[8] Sociodemographic variables are age, age square, and gender. The gender variable takes 1 if the respondent is male. Among education variables "did not enroll in school" is the reference group. The marital status variable takes 1 if the respondent is not married. The employment variable takes 1 if the respondent is employed. The house ownership variable takes 1 if the respondent is not a homeowner. The health variable takes 1 if the respondent declared that he/she is experiencing health problems. In addition to the household size variable, we also used the number of rooms per person.

Air quality is continuously monitored in all 81 provinces by the monitoring stations operating within the "National Air Quality Monitoring Network". For the year 2013, we obtained measurement reports of 120 stations for PM_{10}, exceedances for PM_{10}, and SO_2. Air pollution is measured by the annual mean concentration of SO_2, PM_{10} in $\mu g/m^3$, and PM_{10} exceedance in the province where the respondent lives.[9] PM_{10} exceedance is calculated by the number of days per year that the average daily PM_{10} concentration exceeds the 100 $\mu g/m^3$ limit, in 2013.[10] The WHO guideline for maximum average annual pollutant concentrations is 20 $\mu g/m^3$ for PM_{10} and SO_2. Considering the year 2013 in Turkey, all provinces except Canakkale are exposed to unhealthy levels of PM_{10}. This means that 99.3% of the population in Turkey breathes air that is unsafe in terms of particulate matter (This ratio is 15% for SO_2, is 50% for PM_{10} exceedance). The five highest levels of particulate matter were Mus (109 $\mu g/m^3$), Hakkari (99 $\mu g/m^3$), Batman (97 $\mu g/m^3$), Igdir (96 $\mu g/m^3$) and Afyonkarahisar (94 $\mu g/m^3$). In the most crowded provinces of Turkey such

8 The original household income variable is reported five categories in the survey. To calculate MWTP, we estimated the average income from the open-ended income class using Henson's method. See: (Parker & Fenwick, 1983).

9 For PM10 pollutant with the National, European and WHO limits are 60 μg/m3, 40 μg/m3 and 20 μg/m3 respectively. For SO_2 pollutant with the National and European are 20 μg/m3.

10 The exceedance value was updated from 300 ug/m3 in 2008, to 100 μg/m3 (daily average) in 2013.

as Istanbul, Ankara, and Izmir, levels of particulate matter are 57 μg/m^3, 74 μg/m^3, and 55 μg/m^3, respectively. When analyzing SO_2 emissions, 21 of 81 provinces are exposed to unhealthy levels of sulphur dioxide.[11] (see Figures A1, A2, and A3 in the appendix for all the provinces of Turkey).

Turkey experiences different climates because of its irregular topography. A major difference is also observed between seasonal rainfalls. Therefore, we used climate mean temperature and precipitation in the hottest/driest and coldest/wettest months rather than annual average mean levels as suggested by Cushing (1987) and Rehdanz and Maddison (2005). For January precipitation levels, we used the average monthly precipitation from 1981 to 2010 in the city where the respondent lives. July precipitation is the average monthly precipitation from 1981 to 2010 in the city where the respondent lives. For July and January minimum/maximum temperature variables, we used the average values from 1981 to 2010 in the city where the respondent lives. Average annual sunshine (hours/day) is the total duration of bright sunshine from 1981 to 2010 in the city where the respondent lives. The humidity variable represents the average annual humidity in 2013 in the city where the respondent lives. The descriptive statistics of the variables are presented in appendix Table A1.

2.2. The Model

Subjective well-being can be used as a proxy for utility, which enables researchers to measure environmental conditions along with income and other covariates (Frey & Stutzer, 2002a). The linear micro-econometric model of happiness, where happiness is a function of sociodemographic, socioeconomic variables, and environmental indicators, is shown below:

$$Happiness_{i,k} = \propto + \beta x_{i,k} + \gamma lnY_{ik} + \delta Z_k + \varepsilon_{i,k} \quad (1)$$

In the microeconometric happiness function, *Happiness* is the answer to the happiness question, i represents the individual, and k represents Turkish cities. $x_{i,k}$ is a vector of individual sociodemographic and socioeconomic characteristics, γlnY_{ik} is the natural logarithm of household income, Z_k is a vector of variables at regional level describing the environmental characteristics i.e. air pollution and climate, and $\varepsilon_{i,k}$ is an error term.

We utilized ordinary least squares estimation to estimate our cross-sectional models. Given the ordinal nature of the dependent variable, one can argue that an ordinal estimation technique such as ordered logit would fit better. Nevertheless, most of the time ordered models are used to confirm that regression results are robust to estimation techniques. Generally, both estimation techniques yield similar results (Ferrer-i-Carbonell & Frijters, 2004). In this paper, we run the regressions using both techniques. As the results were quite similar, we choose to proceed with OLS results due to ease of interpretation and its intuitive nature (ordered logit model results are available upon request).

11 Especially in cities such as Sırnak (149 μg/m3), Hakkari (84 μg/m3), Tekirdag (72 μg/m3), Afyonkarahisar (68 μg/m3) and Mugla (58 μg/m3) it is seen that it is well above the permissible limit value for SO_2 emission.

The estimated coefficients for the environmental good and income can be used to calculate the implicit willingness to pay (WTP) for the constant trade-off ratios between the environmental good and income (Frey, Luechinger, and Stutzer, 2010). Following Moro (2010) and the marginal change of *Z*, the marginal WTP (MWTP) can be derived from differentiating Equation (1):

$$MWTP = -\frac{\partial Happines\,s/\partial\, Z}{\partial Happines\,s/\partial\, Y} = -\bar{y}\frac{\hat{\delta}}{\hat{\gamma}} \tag{2}$$

where $\bar{y}$ is the annual mean value of household income.

3. Estimation results

We estimated six different regressions of the model as presented in equation 1. In the first three estimations (1, 2, and 3), presented in Table 1, climate variables are excluded. The set of climate variables incorporated in estimations 4, 5, and 6 include precipitation (January and July), maximum and minimum temperatures (January and July), humidity, and average annual sunshine. Air pollution variables (PM_{10}, PM_{10} exceedance, and SO_2) are introduced into the estimations separately because of multicollinearity problems.[12]

The main finding of the estimations in Table 1 is that air pollution variables are negatively correlated with happiness in a statistically significant way. The coefficients and the signs of socioeconomic variables are the usual findings discovered in the happiness literature. For instance, among statistically significant variables, age is negatively, and age square is positively correlated with happiness. The association of age with happiness is in line with some studies (Atay, 2012; Dumludag et al., 2016; Eren & Aşıcı, 2017; Selim, 2012) and contradicts some (Dumludag, 2013).

In most of the studies conducted in Turkey, women were found to be happier compared to men. (Atay, 2012; Caner, 2015; Eren & Aşıcı, 2017; Selim, 2008, 2012). On the other hand, there are studies with the opposite findings (Akın & Şentürk, 2012; Dumludag, 2013). According to the results of this study, the sign of the coefficient of the male variable is negative, that is, everything else being equal on average women are happier than men in Turkey in 2013.

Regarding the relationship between happiness and education status in Turkey, some studies established a positive relationship (Atay, 2012; Dumludag, 2013; Eren & Aşıcı, 2017), whereas others found an opposite and non-significant relationship (Akın & Şentürk, 2012; Dumludag et al., 2016). We find a non-linear association between education level and happiness. While individuals with primary school degrees are happier than those who did not enroll in school, which is the reference category, it is found that individuals with secondary and under-postgraduate degrees are more unhappy. High school degree has a non-significant coefficient.

12 The estimations that include both PM_{10} and SO_2 are presented at appendix table A2.

The size of the coefficient is 0.146 for the household income (ln) category. The value of the coefficient of income remained the same in all six estimations. The relationship between income and happiness is positive at a given point in time. This result is consistent with the literature. (Dumludag, 2013; Dumludag et al., 2016). Employment and rooms per person variables are positively correlated as expected. The strong association of happiness with employment complies with the previous studies (Dumludag, 2013; Dumludag et al., 2016; Selim, 2008, 2012). As the previous literature found for Turkey, we also find that not being married, reporting a health problem, not owning a house and large household size are negatively correlated with happiness (Akın & Şentürk, 2012; Dumludag, 2013; Dumludag et al., 2016; Eren & Aşıcı, 2017; Selim, 2008). To our knowledge, this study is the first to examine the effect of room per person and owning a house on happiness in Turkey.

Table 1. OLS estimates of coefficients of air pollution, climate, and all control variables

Dependent Variable: Happiness Variable name	**Estimation 1**	**Estimation 2**	**Estimation 3**	**Estimation 4**	**Estimation 5**	**Estimation 6**
Age	-0.0442***	-0.0442***	-0.0442***	-0.0442***	-0.0442***	-0.0442***
	(0.000750)	(0.000750)	(0.000750)	(0.000750)	(0.000750)	(0.000750)
Age^2	0.000422***	0.000422***	0.000422***	0.000422***	0.000422***	0.000422***
	(7.63e-06)	(7.63e-06)	(7.63e-06)	(7.63e-06)	(7.63e-06)	(7.63e-06)
Male	-0.0925***	-0.0925***	-0.0925***	-0.0925***	-0.0925***	-0.0925***
	(0.00455)	(0.00455)	(0.00455)	(0.00455)	(0.00455)	(0.00455)
HHold income (ln)	0.146***	0.146***	0.146***	0.146***	0.146***	0.146***
	(0.00288)	(0.00288)	(0.00288)	(0.00288)	(0.00288)	(0.00288)
Education*						
Primary	0.0186***	0.0186***	0.0186***	0.0186***	0.0186***	0.0186***
	(0.00611)	(0.00611)	(0.00611)	(0.00611)	(0.00611)	(0.00611)
Secondary	-0.0164**	-0.0164**	-0.0164**	-0.0164**	-0.0164**	-0.0164**
	(0.00828)	(0.00828)	(0.00828)	(0.00828)	(0.00828)	(0.00828)
High school	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115
	(0.00815)	(0.00815)	(0.00815)	(0.00815)	(0.00815)	(0.00815)
Under-Postgraduate	-0.0187**	-0.0187**	-0.0187**	-0.0187**	-0.0187**	-0.0187**
	(0.00914)	(0.00914)	(0.00914)	(0.00914)	(0.00914)	(0.00914)
Not married	-0.348***	-0.348***	-0.348***	-0.348***	-0.348***	-0.348***
	(0.00547)	(0.00547)	(0.00547)	(0.00547)	(0.00547)	(0.00547)

Employed	0.00804	0.00804	0.00804	0.00804	0.00804	0.00804
	(0.00503)	(0.00503)	(0.00503)	(0.00503)	(0.00503)	(0.00503)
House ownership (no)	-0.122***	-0.122***	-0.122***	-0.122***	-0.122***	-0.122***
	(0.00429)	(0.00429)	(0.00429)	(0.00429)	(0.00429)	(0.00429)
Health problem (yes)	-0.219***	-0.219***	-0.219***	-0.219***	-0.219***	-0.219***
	(0.00552)	(0.00552)	(0.00552)	(0.00552)	(0.00552)	(0.00552)
Household size	-0.00255*	-0.00255*	-0.00255*	-0.00255*	-0.00255*	-0.00255*
	(0.00142)	(0.00142)	(0.00142)	(0.00142)	(0.00142)	(0.00142)
Room per person	0.0591***	0.0591***	0.0591***	0.0591***	0.0591***	0.0591***
	(0.00427)	(0.00427)	(0.00427)	(0.00427)	(0.00427)	(0.00427)
Air quality						
PM_{10}	-0.0340***			-0.00790***		
	(0.00437)			(0.00133)		
PM_{10} exceedances days		-0.0194***			-0.00558***	
		(0.00250)			(0.000941)	
SO_2			-0.0136***			-0.0169***
			(0.00175)			(0.00285)
Climate variables						
January precipitation				-0.00341***	-0.00342***	-0.00867***
				(0.000885)	(0.000887)	(0.00162)
July precipitation				-0.000971	-0.000178	0.00786***
				(0.00158)	(0.00167)	(0.00278)
January min. temperature				0.0821***	0.0700***	0.00596
				(0.00589)	(0.00520)	(0.0112)

July max. temperature				-0.0583***	-0.0425***	-0.0257**
				(0.00911)	(0.00959)	(0.0108)
Humidity				-0.0267***	-0.0191***	-0.0144***
				(0.00285)	(0.00281)	(0.00307)
Average annual sunshine				0.149***	0.121***	0.0288**
				(0.0142)	(0.0113)	(0.0142)
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.629***	4.372***	3.787***	6.850***	5.802***	6.009***
	(0.254)	(0.0949)	(0.0320)	(0.373)	(0.381)	(0.373)
Observations	196,203	196,203	196,203	196,203	196,203	196,203
R-squared	0.076	0.076	0.076	0.076	0.076	0.076
Willingness-to-pay						
PM_{10}	€1774***			€412***		
PM_{10} exceedances days		€1012***			€291***	
SO_2			€710***			€882***
WTP (% of hhold income)	23.3%	13.3%	9.3%	5.4%	3.8%	11.6%

Robust standard errors in parentheses, Significant at the level 10%, ** Significant at the level 5%, *** Significant at the level 1%*

The findings of the six specifications of the model presented in Equation 1 reveal that the air pollution variables are negatively correlated with the happiness of individuals allowing for sociodemographic, socioeconomic, and with (and without) climate variables. In estimation 1, PM_{10} emerges with a negative and statistically significant coefficient (0.034). This result confirms previous findings in the literature (Dolan & Laffan, 2016; Ferreira & Moro, 2010; Menz, 2011; Orru, Orru, Maasikmets, Hendrikson, & Ainsaar, 2016). However, in the context of Turkey Taşkaya (2018) found no significant relationship between PM_{10} and happiness for the year 2015. On the other hand, Ozdamar (2016) found negative association between air pollution and life satisfaction in Turkey in 2010-2012. Given the differences between the cited studies for Turkey and our study, a direct comparison of the results of the studies can be misleading. Allowing for climate variables, the size of the coefficient diminishes to (0.0079) indicating that climate variables have explanatory power on the dependent variable happiness. An increase in PM_{10} concentrations by 1 μg/m3 is associated with a reduction in happiness of between 0.034 and 0.0079 points on the 5-point happiness scale. Similarly, the PM_{10} exceedance variable is statistically significant and negatively correlated with happiness with a coefficient of 0.0194. Our results are in accordance with the previous studies (Ambrey et al., 2014; Cuñado & de Gracia, 2013; Laureti, 2014). The size of the coefficient drops to 0.0055 in estimation 5 when climate variables are introduced to the model. The results of estimations 3 and 6 demonstrate that there is a statistically significant and negative correlation between SO_2 and the happiness variable. In contrast to the PM_{10} and PM_{10} exceedance variables, the coefficient of SO_2 rises from (0.0136) in estimation 3 to (0.0169) in estimation 6. Another contribution of the present study is that it is the first study that adresses the association between SO_2 and happiness in Turkey. The results for SO_2 are in prallel with the previous findings in the literature (Di Tella & MacCulloch, 2008; Ferreira et al., 2013; Luechinger, 2010; Smyth et al., 2008).

In estimations 4, 5, and 6, we control for provincial differences in climate variables. Among climate variables, January precipitation is statistically significant in estimations 4, 5, and 6 with a negative coefficient. July precipitation is statistically significant only in estimation 6. The coefficient is positive. The minimum temperature of January variable is statistically significant in estimations 4, and 5, whereas the maximum temperature of July variable is statistically significant in all estimations with a negative coefficient. These results imply that people would be happier if they live in warmer weather in the winter and cooler weather in the summer. Humidity is statistically significant in all estimations with a negative coefficient. This result is in line with existing evidence (Ambrey et al., 2014; Frijters & van Praag, 1998; Murray, Maddison, & Rehdanz, 2013). Average annual sunshine has the highest (positive) coefficient among climate variables and is statistically significant in all estimations (4, 5, and 6). Some studies found similar results (Frijters & van Praag, 1998; Murray et al., 2013) whereas Brereton et al. (2008) found a negative relation between average annual sunshine and happiness.

3.1. Monetary Valuation

We also calculate the monetary valuation of air pollution in Turkey provinces. MWTP is calculated from the formulation in Equation 2 by using the coefficients of the air pollution and household income variable in Table 1. For the MWTP calculation, the average household income is evaluated as €7617.[13] The average household is willing to pay €1774 per year to decrease the amount of PM_{10} by a single percent point. In other words, a one percent increase in PM_{10} levels is equivalent, in happiness terms, to a 23% drop in household income. If MWTP for PM_{10} is expressed as per capita, this rate is €452 per year.[14] The MWTP for a one percent decrease in the number of exceedances of the daily limit of PM_{10} is calculated as €1,012 per year. In per capita terms, this implies €258 per year. The MWTP between a single percent point reduction in SO_2 and income is €710 per year. In per capita terms, this implies €182 per year. In terms of estimates (4), (5), and (6) involving climate variables, we obtain a MWTP equal to €412, €219, and €882 for PM_{10}, PM_{10} exceedances days, and SO_2, respectively. If it is expressed as per-capita, this rate is €105, €56, and €225 for PM_{10}, PM_{10} exceedances days, and SO_2, respectively.

3.2. Robustness Checks

To check the robustness of the findings, we began by comparing ordered logit estimations to those obtained using ordinary least squares. We found little qualitative difference between the results of the two approaches (Ordered logit model results are available upon request).

We also estimated regressions according to the data availability for air pollution variables (Table 2). Three cities (Bursa, Hakkari, and Mus) were removed from the estimations since the validated daily average values (where data were available) were below 75% for these cities. As a result, the number of stations diminished from 120 to 114 for PM_{10} and PM_{10} exceedance and from 120 to 107 stations for SO_2.

13 The survey was carried out by TUIK in 2013. So, we converted to Euros using the average rate €1 = 2,53 TL in 2013.

14 In our sample, on average, 3.92 people live in each household.

Table 2. OLS estimates of coefficients of air pollution, climate variables (where data were available above 75%)

Dependent Variable: Happiness Variable name	**Estimation 1**	**Estimation 2**	**Estimation 3**	**Estimation 4**	**Estimation 5**	**Estimation 6**
Air quality						
PM_{10}	-0.0340*** (0.00437)			-0.0079*** (0.00133)		
PM_{10} exceedances days		-0.0194*** (0.00249)			-0.00559*** (0.00094)	
SO_2			-0.0679*** (0.00874)			-0.0145*** (0.00244)
Socio-demographic v.	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic v.	Yes	Yes	Yes	Yes	Yes	Yes
Climate variables	No	No	No	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	187,191	186,051	182,084	187,191	186,051	182,084
R-squared	0.076	0.076	0.076	0.076	0.076	0.076

*Robust standard errors in parentheses, * Significant at the level 10%, ** Significant at the level 5%, *** Significant at the level 1%*

Table 2 demonstrates the findings for the correlation between air pollution, climate variables, and happiness allowing for sociodemographic and socioeconomic variables. All air pollution variables are statistically significant. The coefficients of PM_{10} and PM_{10} exceedance are almost the same as the findings presented in Table 1. The coefficient of SO_2 presented in Table 2 is 0.0688, yet when climate variables are introduced to the model the size of the coefficient diminishes to 0.0145. The coefficients are negative in both estimations.

Individuals in urban areas may be much more exposed to air pollution (especially to PM_{10}) than those in rural areas. Unfortunately, the Life Satisfaction Survey data do not include information on urban/rural areas. Law no. 6360 adopted in 2012 considered the administrative areas of the provinces governed by 30 metropolitan municipalities as urban areas. In 2014, this method expanded to include the remaining 51 municipalities. Therefore, it is difficult to establish the populations of settlements by dividing them into towns and villages.

To capture people living in rural areas, we used the question in the "TUIK Life Satisfaction Survey" asking whether the settlement of the respondent is within the administrative borders of the provinces governed by municipalities. According to our estimations, the share of respondents in rural areas is 20 percent, which is quite close to the 23 percent for the Turkish population as a whole estimated by TUIK in 2012 (Özçağlar, 2016).

Table 3. OLS estimates of coefficients of air pollution variables (rural and urban areas)

Dependent variable: Happiness	Urban			Rural		
Variable name	**Estimation 1**	**Estimation 2**	**Estimation 3**	**Estimation 1**	**Estimation 2**	**Estimation 3**
PM_{10}	-0.0406*** (0.0051)			0.0269 (0.0405)		
PM_{10} exceedances days		-0.0232*** (0.00291)			0.0154 (0.0231)	
SO_2			-0.0162*** (0.00204)			0.0107 (0.0162)
Socio-demographic v.	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic v.	Yes	Yes	Yes	Yes	Yes	Yes
City dummies (ref: Istanbul)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	157,916	157,916	157,916	38,287	38,287	38,287
R-squared	0.079	0.079	0.079	0.073	0.073	0.073

*Robust standard errors in parentheses, * Significant at the level 10%, ** Significant at the level 5%, *** Significant at the level 1%*

We divided the sample into two parts as urban and rural areas and estimated separate regressions for these categories as presented in Table 3. As expected, in the urban sample, all air pollution variables are statistically significant with a negative coefficient. Also, these coefficients are higher than the coefficients derived from the main sample which means that the relationship between air pollution and happiness is no coincidence. For the rural sample, none of them are statistically significant. This result is no surprise as the air pollution indicators are measured only in urban areas. In the analysis, we had the same air pollution measures for the urban and rural areas within the same city. However, air pollution in urban and rural may differ. The non-existence of accurate air pollution measures for rural areas may explain why the coefficients are insignificant in the rural sample.

When climate variables are introduced to the model, air pollution variables become statistically significant in all estimations for urban and rural samples. This may mean that air pollution has an influence on happiness in rural areas, too. Nevertheless, higher-resolution

data for the air pollution indicators are required to evaluate the association of air pollution with happiness in urban and rural areas.

Table 4. OLS estimates of coefficients of air pollution and climate variables (Urban and Rural Areas)

Dependent variable: Happiness	Urban			Rural		
Variable name	**Estimation 1**	**Estimation 2**	**Estimation 3**	**Estimation 1**	**Estimation 2**	**Estimation 3**
PM_{10}	-0.0081*** (0.00144)			-0.0085** (0.0040)		
PM_{10} exceedances days		-0.0057*** (0.00102)			-0.006** (0.00286)	
SO_2			-0.0174*** (0.0031)			-0.0182** (0.00867)
Socio-demographic v.	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic v.	Yes	Yes	Yes	Yes	Yes	Yes
City dummies (ref: Istanbul)	Yes	Yes	Yes	Yes	Yes	Yes
Climate Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	157,916	157,916	157,916	38,287	38,287	38,287
R-squared	0.079	0.079	0.079	0.073	0.073	0.073

*Robust standard errors in parentheses, * Significant at the level 10%, ** Significant at the level 5%, *** Significant at the level 1%*

4. Discussion and Conclusion

This paper aims to contribute to the happiness literature by analyzing the impact of air quality variables on happiness in Turkey. To our knowledge, this paper is the first study that uses microdata to provide evidence for correlations between objective air pollution, climate variables, and happiness in Turkey. Our results confirmed the findings of previous research studies suggesting that there is a negative correlation between air pollution variables and happiness. It is noticeable that most climate variables were found to be significant. In the paper, we also calculated the monetary value of air pollution in Turkey. Based on our specifications, we discovered that people would be willing to pay between €452 - €105 for PM_{10}, €258 - €56 for PM_{10} exceedances days, and €225 - €182 for SO_2 per capita per year to reduce the amount air pollution by a single percentage point.

However, due to the cross-sectional nature of the dataset, the study has some limitations. Panel or longitudinal survey data are particularly useful in controlling individual heterogeneity and provide evidence for the direction of the causality. Therefore, we refrained from using the term "effect" when in fact we only found correlations. Secondly, to allow for spurious correlations, the datasets do not provide sufficient time-invariant omitted variables like personality characteristics. The TUIK datasets do not provide sufficient variables related to personal characteristics. Third, the TUIK Life Satisfaction Survey provides information only by province without going into detail about districts, towns, and villages. With the lack of settlement information, it is not possible to estimate the distance between the locations of respondents and the stations. Regarding willingness to pay, a difficulty with the value of non-market goods is the estimation of the marginal effect of income as an instrument with the paucity of exogenous instruments. Furthermore, in the studies that use repeated cross-sections or use panels of daily data, willingness to pay values fall into a reasonable range. Here, we again see the disadvantage of a cross-section dataset.

There is growing interest in environmental concerns as part of sustainable development in many countries. Turkey is no exception. Air quality is a severe environmental problem for Turkey. Especially in terms of PM_{10}, WHO limits have been overrun in all cities except for Canakakkale. Air pollution is a public health and quality of life issue. Therefore, demonstrating the association between air pollution, health, and happiness is of great importance. Environmental policies can be more accurate and responsive to the needs of the people if the empirical evidence is taken into consideration during the policy-making process. We believe that the results of the study highlight the significance of air pollution abatement strategies for maintaining life satisfaction. The findings in this paper provide the public and policy-makers with important information on the relationship between happiness and environmental quality. With the increase in new research on the subject with better datasets and methodology, we may expect that one of the goals of environmental policies will be to reduce air pollution so as to increase happiness of individuals in Turkey.

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Appendix

Table A1. Descriptives

Variable	Percent	Mean	S.D.	Min./Max.
Happiness: How happy you are as you consider your life as a whole?		3,56	0,865	1-5
Very unhappy	2,58			
Unhappy	8,31			
Moderate	28,79			
Happy	51,23			
Very happy	9,09			
Age		44,28	16,381	18-99
Gender			0,494	0-1
Female	57,66			
Male	42,34			
Household Income (monthly, TL)		1606	1475,06	540-5661
Employment status			0,463	0-1
Working	31,30			
Not working	68,70			
Education			1,297	1-5
Did not enroll	19,89			
Elementary	39,43			
Secondary	12,31			
High School	16,20			
Undergradure, post praduate	12,18			
Marital status			0,425	0-1
Married	76,20			
Single	23,80			
Health problem			0,385	0-1
Yes	18,16			
No	81,84			
House ownership			0,471	0-1
Yes	66,70			
No	33,30			
Household size	3,92		2,169	1-29
City (81 cities)				
Room number per person		1,15	0,691	0,08-10
Air quality				

PM_{10}	Average annual PM_{10} emissions ($\mu g/m^3$) in 2013 in the city which respondent lives.	60,94	16,061	18/109
PM_{10} exceedance	Number of days per that average daily PM_{10} emissions exceeds 100 $\mu g/m^3$, in 2013.	41,64	27,800	0/127
SO_2	Average annual SO_2 emissions ($\mu g/m^3$) in 2013 in the city which respondent lives.	19,5	19,025	3/149
Climate				
January precipitation	Average monthly precipitation from 1981 to 2010, in the city which respondent lives.	87,23	48,635	15,1/241,9
July precipitation	Average monthly precipitation from 1981 to 2010, in the city which respondent lives.	17,18	18,957	0,6/152,1
January minimum temperature	January minimum temperature from 1981 to 2010, in the city which respondent lives.	-0,6	4,859	-16,9/6,2
July maximum temperature	July maximum temperature from 1981 to 2010, in the city which respondent lives.	30,78	3,34	23,8/39,1
Average annual sunshine (hours/day)	Average annual total duration of bright sunshine from 1981 to 2010, in the city which respondent lives.	6,78	0,934	2,3/8,2
Humidty	Average annual humidity in 2013, in the which respondent lives.	59,43	8,937	41/86

Table A2. OLS estimations - Air pollution variables regressed together

Dependent variable: Happiness Variable name	Estimation 1	Estimation 2
Socio-demographic v.	Yes	Yes
Socio-economic v.	Yes	Yes
Air quality		
PM_{10}	-0.016***	-0.012***
	(0.002)	(0.002)
SO_2	-0.007***	0,008***
	(0.001)	(0.008)
Climate variables	No	Yes
Province dummies	Yes	Yes
Observations	196,203	196,203

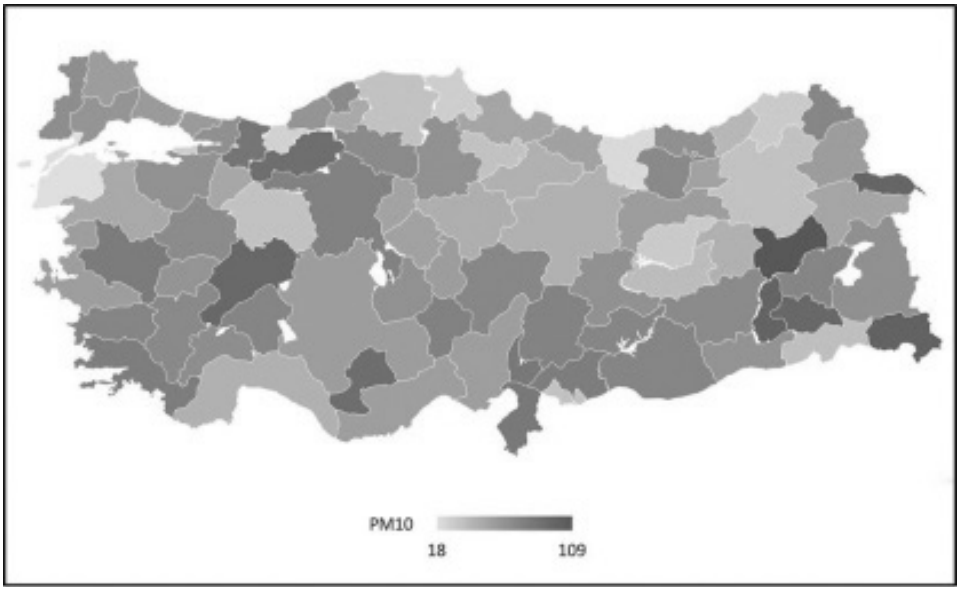

Figure A1. PM_{10} levels ($\mu g/m^3$) in 81 provinces in Turkey for the year 2013

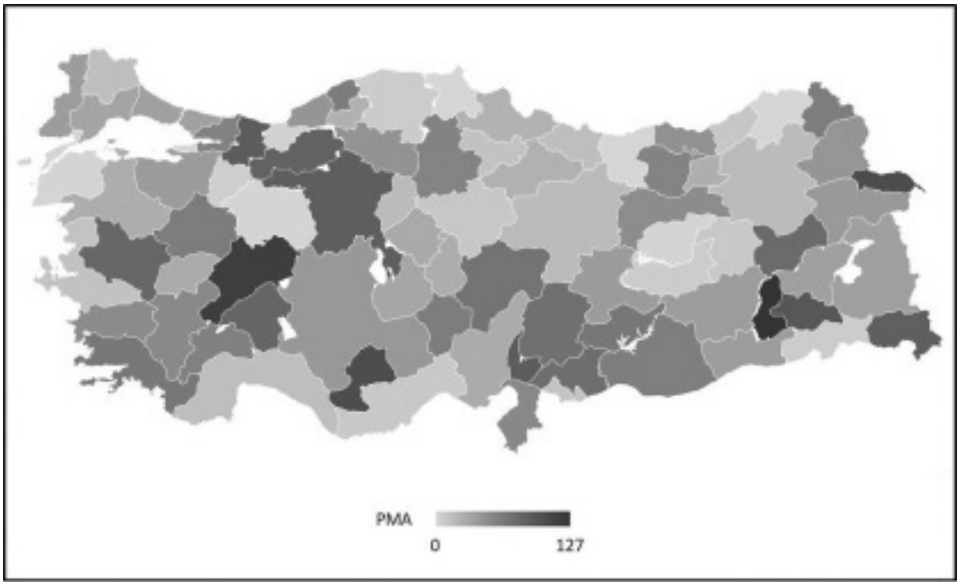

Figure A2. PM_{10} exceedance in 81 provinces in Turkey for the year 2013

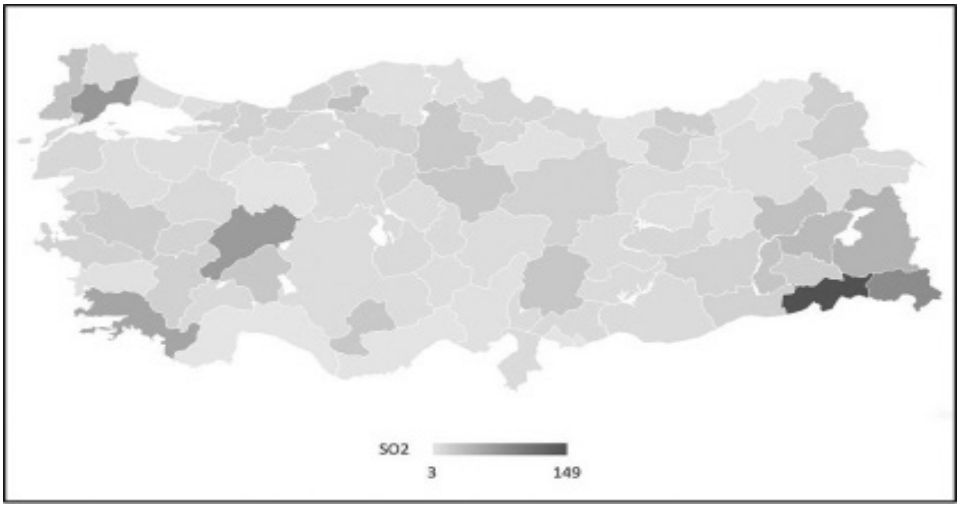

Figure A3. SO_2 levels ($\mu g/m^3$) in 81 provinces in Turkey for the year 2013