EFFECTS OF THE ODOUR FROM WASTEWATER TREATMENT PLANTS ON RESIDENT'S LIVING COMFORT AND PROPERTY VALUES: CASE OF NARLIDERE-İZMİR

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by
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I am grateful to my family for their support and encouragement during all of my life.

Finally, I dedicate this study to the memory of my dear father…

ABSTRACT

EFFECTS OF THE ODOUR FROM WASTEWATER TREATMENT PLANTS ON RESIDENT'S LIVING COMFORT AND PROPERTY VALUES: CASE OF NARLIDERE – İZMİR

Wastewater treatment plants are one of the important technical infrastructure systems in cities. The location of these facilities is at least as important as themselves. Because these facilities can create negative externalities and these externalities can negatively affect people and the environment.

The aim of the study is to examine the odour impacts from the wastewater treatment plants on people living around and on property values in surrounding area. In the theoretical framework, the effects of the wastewater treatment plants and similar locally unwanted land uses are examined. In this scope, some examples from the world are searched about the impacts of the negative externalities from this kind of facilities on the health of people living around, their daily life and on property values. Wastewater treatment processes, location criteria of the treatment plants in Europe and in Turkey are analyzed. News published on the internet and complaints on odour impact from wastewater treatment plants are searched both in the world and in Turkey. Compensation forms in accordance with environmental ethics and environmental justice are examined.

In this scope, Southwestern Advanced Biological Wastewater Treatment Plant in İzmir is examined. Survey studies were conducted with residents living in the immediate vicinity of this facility. Interviews by questionaries with headman of Limanreis neighborhood, with an environmental engineer working in the treatment plant, and with real estate agents were conducted. At the same time, the effects of the unpleasant odour on the real estate values around the treatment plant were examined with the Hedonic Price Method. End of the study, effects of the unpleasant odour emitted from the Southwestern Advanced Biological Wastewater Treatment Plant in Narlıdere district in İzmir are revealed. It is observed that the odour influences negatively people's daily life activities, the health of the individuals, quality of the living environment, and property values in the nearby environment.

ÖZET

ATIKSU ARITMA TESİSLERİNDEN KAYNAKLANAN KOKUNUN YAŞAYANLARA VE GAYRİMENKUL DEĞERLERİNE ETKİSİ: NARLIDERE - İZMİR ÖRNEĞİ

Bu tez çalışması atıksu arıtma tesislerinden yayılan kokunun çevresinde yaşayan insanlara ve yakın çevrede bulunan konut değerlerine olan etkisini araştırmaktadır.

Literatür taramasında atıksu arıtma tesisleri ve benzeri tesislerin çevrelerinde yarattıkları sorunlar incelenmiştir. Atıksu arıtma tesislerinin türleri, atıksuyu arıtma süreçleri, atıksu arıtma tesislerinin yer seçim kriterleri, Avrupadaki ve Türkiyedeki yasal çerceveleri tanımlanmıştır. Hem dünya ülkelerindeki hem de Türkiye'deki atıksu arıtma tesislerinden yayılan kokular nedeniyle gösterilen tepkiler internette yer alan gazete haberleri üzerinden araştırılmıştır.

Bu kapsamda, İzmir ili Narlıdere ilçesinde yer alan Güneybatı İleri Biyolojik Atıksu Arıtma Tesisi'nden kaynaklanan kokunun çevresinde yaşayanlara ve yakın çevrede bulunan gayrimenkul değerlerine olan etkisi incelenmiştir. Bu araştırmada arıtma tesisinin yakın çevresinde yaşayan insanlarla anket çalışması yapılarak koku nedeniyle yaşadıkları olumsuzluklar ortaya konmuştur. Aynı zamanda mahalle muhtarı ile, bu atıksu arıtma tesisinde çalışan bir çevre mühendisi ile ve üç farklı emlakçı ile görüşülerek bu sorunun boyutları, kendi düşünceleri, çözüm önerileri ifade edilmiştir. Hedonic Price yöntemi kullanılarak konut fiyatlarına olan etkisi incelenmiştir.

Bu çalışma sonucunda, kokunun insanların yaşam kalitesini, sağlığını, konut değerlerini olumsuz yönde etkilediği gözlenmiş olup, tesiste uygun ve gelişmiş teknolojinin kullanılması, kamulaştırma yapılması, tampon bölge oluşturulması gibi önerilerde bulunulmuştur.

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CHAPTER 1

INTRODUCTION

The issue of air quality is increasing in recent years. Solid waste landfill sites, wastewater treatment plants, a wide variety of industries involving chemical manufacturers, plastics, painting, refining operations, and locally unwanted land uses create some negative externalities and one of the externalities is odours which are generated by process of these activities.

Odours influence the human health, quality of life, economic investments, social activities, and environment negatively. So that the odour problem has become an important subject of many studies and also in the management of the urban environment. In recent years under favor of increased awareness of both environment and individual rights, the public indicates more reactions to odour by complaining, protesting, and filing a lawsuit. For instance, the United States National Research Council Committee on Odors indicated that while there were more than 50 % complaints related to odours in 1979, this ratio increased more than 60 % complaints related to odours in 1994 (Nicell, 2009). It was informed that the population between % 13 and % 20 in some European countries was disturbed by environmental odours (Nicell, 2009).

In Turkey also odour complaints are increasing in recent years so that the public reacts to odour from wastewater treatment plants and landfill sites by protesting, complaining. Odours derived from wastewater treatment plants affect the exposed population adversely. Human health impression is one of the unfavorableness. People exposed to odour may have health issues such as a headache, annoyance, insomnia, respiratory problems, nausea, loss of appetite, psychological stresses, unease, tearfulness, etc (Nicell, 2009; Gostelow et al., 2001).

Impact on property values is another issue. Unpleasant smells may decrease local property values. For instance, one study reveals that depending on distance, property values which are exposed to odour decreases up to %3.4 (Saphores & Aguilar-Benitez, 2005). Residents could not stay in their homes, and could not sell. The other impacts of odour from wastewater treatment plants and other sources are closed

windows, reduced amenities, avoiding outdoor activities, economic losses, degradation of the environment, etc.

Some compensation policies which are generally categorized as monetary compensations and non-monetary compensations are applied in order to compensate for the losses of hosting communities or to affect the public acceptance for siting of locally unwanted land uses or to solve the unfairness within the local public. Some individuals consider these compensatory policies, especially monetary incentives, as a bribe and the individuals consider that these incentives are not morally appropriate. Frey, Oberholzer-Gee, and Eichenberger stated that compensation does not an effective mechanism for siting a facility because these financial incentives are considered as a bribe (Kunreuther & Easterling, 1996).

Environmental ethic also is an important subject in the management of the urban environment. Environmental ethic conceptualizes favorable and unfavorable action towards the environment which means as a part of the wider moral community (Hens & Susanne, 2014). Odour impacts of the wastewater treatment plants on human health, property values, quality of life and environment reveal the environmental ethical problems because environmental justice requires the equal justice and equal protection under the environmental regulations, without distinction based on ethnicity or socioeconomic status (Middleton, 2010).

1.1. Aim of The Study

From this point, this study aims to investigate, by way of the case study, the socio-economic impacts of odour from wastewater treatment plants. From this perspective, the odour impacts of wastewater treatment plants on the daily life of the people who live around a wastewater treatment plant, on the health of the people, and on property values in surrounding area will be investigated. Within the framework this study primarily concerns with these research questions:

- What are the impacts of wastewater treatment plants on close residents?
- What reactions have the people exposed to the odour effect?
- What are the negative impacts of wastewater treatment plants on property values?
- How can the compensation policies be evaluated from the ethical background?

Taking these questions into account this study mainly aims to clarify how can be provided quality wastewater treatment plants without odour impact to all people in the management of the urban environment in the planning process.

Within this framework, as a case study, impacts of odour from the Southwestern Advanced Biological Wastewater Treatment Plant in Narlıdere district in İzmir on the people living around the facility and on the property values in surrounding area will be investigated. The results of the study intend to give ideas to reveal that there is such an issue and attract notice to this subject in the planning process.

1.2. Methodology

This study is started with the theoretical research about odour impacts from wastewater treatment plants and other similar land uses on people, on property values, and on the environment. Types of wastewater treatment plants and treatment of wastewater are identified. Legal perspectives both in Europe and in Turkey about location criteria of wastewater treatment plants are examined. Complaints and news published on the internet are researched in order to learn the reactions of the local residents. Compensation policies in the environmental ethics perspectives and environmental justice movement are examined.

Survey study and interviews via questionnaires are conducted. Survey study is conducted with the residents living around the Southwestern Advanced Biological Wastewater Treatment Plant in Limanreis neighborhood. Interviews via questionnaires with the headman of the Limanreis neighborhood, with an environmental engineer working in the Southwestern Advanced Biological Wastewater Treatment Plant, and with three different real estate agents are carried out. In this study, Hedonic price method is used to understand the odour impact on the property values around the wastewater treatment plant.

In the final chapter, deductions from the theoretical researches and the results of the case study in İzmir are evaluated.

1.3. Scope of The Study

A basic information about wastewater treatment plant process, types of wastewater treatment plants, location criteria and space requirements in Europe and in Turkey are explained in chapter 2. In chapter 3, odour subject is held which contains contributing factors to odour, odour measurements, odour impacts like on human health, property values, other impacts. Protests, complaints on odour impacts of wastewater treatment plants are revealed. From this perspective, examples related to odour complaints all over the world and news on odour impacts of wastewater treatment plants in Turkey are held. In chapter 4, compensation methods are described and their impacts on human decisions are clarified. Compensation policies in the context of environmental ethics and environmental justice are examined. In chapter 5, the case of Southwestern Advanced Biological Wastewater Treatment Plan in Narlıdere district, İzmir is studied and in chapter 6, the results of the study are clarified.

1.4. Literature Review

Undesirable land uses such as landfills, treatment plants, refineries, power plants, heavy industrial areas, hazardous manufacturing facilities, waste disposal facilities, and so on have a big importance in waste management in terms of environmental, social, economic and sustainable development in urban and rural areas.

Eshet et al. (2005) state that waste management has become more notable since the 1990s. Because people began to become more sensitive to the environment and raise of awareness of individual rights (Gostelow et al., 2001; Eshet et al., 2005). These undesirable land uses may produce negative externalities during a process to reach the aim of the facilities. These externalities can be reflected as noise, unpleasant odour, dust, non-aesthetic view, traffic congestion, air pollution, water and soil pollution (Eshet et al., 2005; Saphore et al., 2005; Zarra et al., 2008). These impacts may lead to health effects on close residents, for instance, living near landfill sites may cause risk of birth defects and cancer (Giusti, 2009). These impacts may damage to soil, plants, animals, may affect property values negatively, may create negative influences on social life, and may reduce possible economic activities (Freeman, 1979; Farber, 1997; Eshet et al., 2005; Giusti, 2009).

Odour impacts from wastewater treatment plants are also one of the major environmental issues. Odour may have significant adverse influences on the natural environment and surrounding communities of wastewater treatment plants. As noted in Nicell' s article (2009), quality of the environment may be deteriorated. Brennan (1993) cited in Gostelow et al. (2001)'s article states that quality of life may be negatively affected. According to Gostelow et al. (2001) odour complaints have been increasing in recent years. For instance, it is estimated by the United States National Research Council Committee on Odors (1979) that more than 50 percent of the complaints about air pollution were related to odour (Nicell 2009). Leonardos(1995) cited in Nicell' s article states that conducted a survey in 1994 in the USA indicated that more than 60 percent of the air pollution complaints were related to odours with a predictive more than 12.000 registered complaints. Hudon et al.(2000) cited in Nicell' s article express that between 13 percent and 20 percent of the population in some European countries has been irritated by environmental odours. Gostelow et al. (2001) compile some reasons to understand the increasing complaints which are the close settlement to wastewater treatment plants, privatizations of water companies, increasing sensitiveness to the environment, awareness of individual rights, insufficient legislation, lack of controls (Giusti 2009).

Odour Measurement and Impacts of Odour on Human Health

Odours are difficult to measure but generally, two different methods have been applied. These are analytical techniques which search physical or chemical features of the odour compounds and the other one is sensorial analysis with other names olfactometry or sociological questionnaires (Zarra et al., 2008; Gostelow et al., 2001; Nicell, 2009). However, Zarra et al. (2008) state that olfactometric method is substantially uncertain and unreliable due to based on human sense because individual's response to an odour is excessively nominative (Gostelow et al., 2001). Similar to Zarra et al. (2008), Nicell (2009) also studied the odour measurement methods besides the factors causing odour impacts. These are the frequency that measures how often a personal exposure to odour, intensity refers to individual perception, the duration is a period of exposure to odour, offensiveness refers to individual pleasantness level and lastly is location at which odour is experienced (Nicell, 2009).

One of the complaint reasons about odour is negative effects on human health exposed residents. National Research Council Committee on Odours (1979) states that long-term exposure to odour may lead to insomnia, lack of appetite, irrational

behaviour, annoyance, headaches, nausea, respiratory problems, sensory irritations (Nicell, 2009; Gostelow et al., 2001; Saphores et al., 2005; Zarra et al., 2008). And the odour also affects social life such as problems in greeting the guest, deprivation of outside activities, constantly experiencing home ventilation problems (Nicell, 2009).

Ulutaş et al. (2017) investigated the perceptions and experiences of people living around the Biological Wastewater Treatment Plant, which discharge treated wastewater into the Marmara Sea, and the effect of the odour on people and on the odour pollution in the environment. End of the study Ulutaş et al (2017) observed that 97 percent of the respondents of their survey study had complained due to the odour. And they determined that the odour has negative impacts on the quality of life mainly daily activities of people and health of the people.

Impacts of Odour on Property Values

Besides the health impacts of odour on surrounding communities, there are also negative impacts on land and property values. Hedonic Price Method has been the most common technique to understand whether the exposure to hazardous waste sites and undesirable land uses have an adverse effect on adjacent property values. Freeman (1979) examined the existing empirical studies which used this technique in different cities in U.S. and Canada. These studies contain effects of environmental disamenities such as air quality, water quality and noise pollution on house prices. End of the study, Freeman (1979) states that the method is an explanatory technique as regards adverse effect on housing prices. However, Freeman (1979) suggests that new studies should be realized in detailed to understand the extent and seriousness of the encountered problems.

Flower & Ragas (1994) studied the effects of two petrochemical refineries on adjacent property values. The aim of their study was to understand distance variable effect and to make a comparison of the located areas. Because one of the refineries has buffer zone due to close location to highway. While using the hedonic price method, actual house prices, lot dimensions, street address, housing characteristics such as year of the sale, age of the house, number of bedrooms, bathrooms, living area, type of heating, type of condition, the presence of a fireplace, presence of patio, presence of swimming pool, etc. were used. Results of the study show that there is a positive relationship between the distance from the refineries and adjacent house prices. Another result is quality of buffer zone influences the property values. Larger buffer zones take advantage to diminish negative odour impacts.

For further research Ragas & Flower (1994) suggest establishing the maximum buffer criteria for undesirable land uses. Similar to Freeman (1979), Farber (1997) also examined the empirical studies related to effects of hazardous waste sites and National Priority List Sites in the U.S. on property values. Some of the studies show that after the announcement of NPL sites, negative property value effects were enlarged. But after clean up process property values increased and so Farber (1997) suggest that the situation can be used to estimate the "Localized benefits of site improvements." End of the examination, Farber (1997) states that even if there are some positive impacts like job opportunities, these facilities influence adjacent property values negatively and emphasizes the question " Who gains and who loses from these facilities" (Farber, 1997, pp. 13).

Deaton & Hoehn (2002) express that in literature most of the studies support the adverse effect of hazardous waste sites and desirable land uses on property values by using the hedonic price method. However, they also express that some studies show different conclusions concerning after Superfund clean up activities and new information on the hazard effect. They examine the area includes two Superfund sites and lots of areas zoned for highly industrial activity in the city of Lansing, Michigan. They found that people are willing to pay to become distant from the hazardous waste sites so when the distance from hazardous waste sites raise, housing prices are increased, all other variables constant. However, another model which examined the effects of proximity to areas of high industrial activity indicates that people are willing to pay a premium for diminished proximity to areas of high industrial activity. On the other hand, when the industrial effect is taken into account, proximity to one of the Superfund sites does not affect housing prices. Hence, Deaton & Hoehn (2002) express that the discrepancies in the literature may result from the differences in industrial activities in areas surrounding the toxic sites (Deaton & Hoehn, 2002).

Except for the impact of undesirable land uses on property values, a study was carried out to determine the impact area of a landfill and two different wastewater treatment plants based on geographic information systems (GIS) in Manisa, Turkey by Işık & Cagatay (2016). In this study, they tried to determine which districts and how much population may be affected by odour spreading from the landfill and from the wastewater treatment facilities located in Manisa city center by using GIS. In this study, buffer zones with the radius of 1500 m, 3000 m, 6000 m and 9000 m were created for the landfill. For the wastewater treatment plants, the radius of 1500 m and 3000 m

buffer zones were created. So that the odour spreading from the treatment plants and landfill almost influence the whole of the main settlement area of the city. Within the 1500 m, 3000 m, and 6000 m buffer zones respectively 3.948 residents, 15.075 residents, and 184.047 residents were affected by the odour from the landfill. The odour from the wastewater treatment plants affects 15.241 residents and 82.017 residents within in turn 1500 m and 3000 m buffer zones. There were 15.593 residents influenced by both the landfill and the wastewater treatment plants (Işık & Çagatay, 2016).

Compensation Methods and Ethical Views

Because there are some negative influences of the undesirable land uses, some compensation methods have been applied. These are monetary incentives, rebate on property taxes, providing new public services, improving health care services, making up any loses in property value, establishing a trustful fund and so on (Kunreuther & Easterling, 1996).

Kunreuther & Easterling (1996) mention some surveys about compensation impacts on the willingness to accept the construction of a municipal waste landfill and nuclear waste repositories at a proximal site. For instance, a survey on acceptance to the construction of a municipal waste landfill was conducted by Bacot & Bowen and Fitzgeral (1994). The survey indicated that acceptance of the facility with rebates on property tax for surrounding residents was 63 percent while toleration of the facility without any incentives was 30 percent. However, other surveys realized by Carnes et al. (1983) and Jenkins-Smith et al. (1993) indicate that there was no major acceptance of the radioactive waste repositories even if economical compensation methods were provided. For instance, Jenkins-Smith et al. (1993)'s survey shows that while the toleration of the nuclear waste repositories without any incentives were 22 percent, acceptance of the facilities with economic benefits was 26 percent. It is also stated that local culture often affects acceptance of the facilities. For instance, Dunlap and Boxter (1988) indicate that the acceptance of residents living in Hanford, Washington was 60 percent without any incentives because the city has long been accustomed to nuclear technology (Kunreuther & Easterling, 1996).

In Kunreuther & Easterling (1996)'s article mentioned that Frey, Oberholzer-Gee and Einchenberger suggest that individuals may consider financial incentives as bribes and so that individuals may opposite to host these kind of facilities (Kunreuther & Easterling, 1996). However, according to another point of view, for instance, Hermansson (2007) states that disadvantaged groups such as racial minorities and poor

communities may have the willingness to accept undesirable land uses for less compensation so that this situation may create exploitation of poor communities (Hermansson, 2007).

Our study differs from other researches because this study expresses that there are also such problems in Turkey. The study reveals the negative impacts of the odour emitted from wastewater treatment plants both with researches about the news published on the internet in Turkey and with the case study of the city of İzmir, Turkey. This issue has been examined in detail in chapter 3, chapter 5 and chapter 6.

In chapter 2 types of wastewater treatment plants, the collection of wastewaters, process of wastewater treatment, location criteria of wastewater treatment plants both in Europe and in Turkey is examined.

CHAPTER 2

TREATMENT METHODS AND LOCATION CRITERIA OF WASTEWATER TREATMENT PLANTS

Urban wastewater can be defined as a combination of the domestic wastewater, industrial wastewater, commercial wastewater, agricultural wastewater and rainwater flow from urban areas. Domestic wastewater consists of black water including excreta, urine and fecal sludge and greywater from bathing, dishwashing, laundry, and other household water uses. Industrial wastewater is discharged from industrial sources end of the industrial activities including processes, products, and cleaning. Untreated wastewater contains some pollutants such as heavy metals, plant nutrients, pathogenic microorganisms, organic pollutants and micro-pollutants like cosmetics, medicines. (UN-Water, 2015; UNEP, 2010; Butler & Davies, 2004).

Because of these harmful substances, wastewater needs to be treated effectively to reduce the impact on the environment and human health. For this reason, there is a considerable need for wastewater treatment systems in both rural and urban areas. Wastewater treatment plant removes the pollutants from wastewater before discharging to receiving water. A typical wastewater treatment plant involves a series of tanks, screens, filters, and biological-chemical treatment processes and as a result of these stages, the wastewater is purified.

If all of these effluents are not treated, It damages aquatic environment which leads to oxygen depletion, decreased biodiversity, fish kills, algal blooms, bacterial contamination, odour and can cause public health problems (EPA, 2004). World Health Organization (2002) cited in Massoud et al.'s article (2009) states that approximately 40 percent of the world's population is deprived of fundamental sanitation services. The lack of basic sanitation services can cause in several diseases such as diarrhea, hookworm, trachoma, bilharzia. Massoud et al. (2009) quoted from World Health Organization(2002) points out that 2.1 million people die in every year by the reason of diarrheal diseases. Corcoran et al. (2010) state in the document of the UNEP/UN-HABITAT (2010) that least 1.8 million children under five years-old die every year due to water-related diseases. It is pointed that in developing countries 90 % of all

wastewater is discharged directly into lakes, rivers, seas or oceans without treatment and estimated 245.000 m^2 of marine ecosystems are affected (Corcoran et al., 2010).

Besides the negative impacts of untreated wastewater, it is stated that there is also water quality crisis recent years resulting from urbanization, population growth, technological developments, and many other factors (UN-Water, 2015). In recent years many studies on water policies emphasize that sustainable management of wastewater has an important role to promote future water sustainability in regard to both preventing damages of the environment and providing effective management as a water resource.

The reuse of treated wastewater has become an important option to solve water scarcity problems, especially in the climate change process. For instance, treated wastewater can be used for irrigation in agriculture, in recreational areas such as parks, gardens, and in industrial areas. In UN-Water wastewater management analytical brief report (2015) quoted from Sato et al. (2013) is stated that in southern Europe treated wastewater is used mainly for agricultural irrigation and for urban applications, in northern Europe treated wastewater is used predominantly 51 % for environmental applications. Besides the irrigation use, treated wastewater and its sludge can be used as a soil conditioner on agricultural land or gardens, as a source of energy due to anaerobic digestion (UN-Water, 2015). So that treatment allows the wastewater to be returned to the environment.

In outcome document of the United Nations Conference on Sustainable Development held in 2012 at Rio is drawn attention to the importance of reduced water pollution, increased water quality, and improved wastewater treatment (UN-Water, 2014). To achieve this goal, three elements are highlighted. The first element is the reduction of untreated domestic and industrial wastewater. The second element is the increase of reuse of wastewater safely. The suggestion of the element is to provide reuse of wastewater for other purposes and to ensure as a valuable source of water. The third one is the reduction of nutrient pollution in wastewater because if there is an effective wastewater management, the quality of water bodies improve over time (UN-Water, 2014).

For sustainable development, some indicators to ensure effective wastewater management and to prevent pollution are proposed in the outcome document of the mentioned conference. The following indicators are highlighted:

- Public health protection
- Protection of the environment

- Promote the reuse of wastewater and sludge
- Support the multiple opportunities for water, nutrient, and energy recovery (UN-Water, 2014)

Wastewater treatment systems are affected by climate change. Related to the increase in sea level, coastal flooding can increase and so that plants and collection networks can be damaged by flooding. This situation leads to increasing costs of maintenance and repair of the pipelines, tanks, outfalls. The heavy rainfall can affect the functionality of the wastewater treatment capacity in combined systems because of the overflow. Another impact of the coastal flooding is the increase in the salinity of the effluent which affects the reuse of the treated wastewater. Increased water temperature impacts the wastewater treatment process because the reduction of oxygen level in receiving require additional wastewater treatment in order not to disrupt the ecosystem balance. High temperature and the decrease in rainfall lead to the reduction of soil moisture and as a result, the wastewater pipes are deteriorated (Ware, 2016; Loftus et al.,2011; WERF, 2009).

2.1. Types Of Wastewater Treatment Plants

Because the qualities of wastewater are different depending on their sources, the treatment methods vary according to these differences. For instance, industrial wastewater treatment plants and domestic wastewater treatment plants are designed in different ways. The treatment of wastewater is generally carried out by means of physical/mechanical treatment, biological treatment, chemical treatment, conventional treatment (biological and chemical treatment are used together), advanced treatment and natural treatment (Republic of Turkey Ministry of Education, 2012; Swedish EPA, 2016).

2.1.1. Physical/Mechanical Treatment

The physical treatment method removes the solids and debris like stone, grit, paper pieces, wood pieces, tins, pet bottles, all kinds of plastic materials, sand, hair, textiles from wastewater by physical processes. The physical process involves screens, grit chambers, grinders, sand holders, oil holders, balancing pools, flotation systems,

settling tanks and mixers. Screens remove rags and larger objects. In the grid chamber section, heavier particles settle to the bottom and most of the material is removed from the grit chamber. Primary sedimentation separates remaining particles that settled to the bottom called as sludge and the sludge is removed for separate treatment (Republic of Turkey Ministry of Education, 2012; EPA, 2004; Swedish EPA, 2016).

2.1.2. Biological Treatment

Biological treatment is the removal of organic substances with the aid of microorganisms contained in wastewater by separating them into carbon dioxide, water, and new microorganism cells. In this stage, 90 % of the organic substances are removed. With the addition of oxygen to wastewater, masses of microorganisms grew and rapidly metabolized organic pollutants. The microorganisms flocculate into larger clumps called as sludge. Some part of the sludge returned to provide bacteria to aeration tank and some part is removed from sedimentation basin (EPA, 2004; Swedish EPA, 2016).

2.1.3. Chemical Treatment

Chemical Treatment provides removal of the dissolved or suspended substances primarily phosphorus from the wastewater through chemical precipitation so that some chemicals like lime or iron salts are added. In this process, 90 % of the phosphorus is removed and the resulting sludge is separated (EPA, 2004; Swedish EPA, 2016).

2.1.4. Advanced Treatment

Advanced Treatment is to increase the quality of water and to remove some contaminants like nitrogen, phosphorus after biological and chemical treatment. Advanced Treatment ensures the removal of the bacteria and viruses in the wastewater before discharging to receiving water (Republic of Turkey Ministry of Education, 2012).

2.1.5. Natural Treatment

Natural treatment in other words “artificial wetland” system is used for the treatment of domestic wastewater in recent years. This system is based on the ability of reed and swamp areas to destroy pollutants. For this purpose, artificial reed and swamp areas are built (Republic of Turkey Ministry of Education, 2012).

2.2. Types Of Wastewater

Urban wastewater contains a combination of domestic wastewater, industrial effluent, and rainwater runoff from surfaced areas.

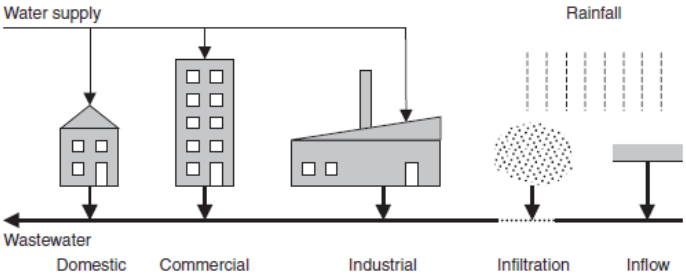


Figure 1. Sources of wastewater
(Source: Butler & Davies, 2004)

2.2.1. Domestic Wastewater

Domestic wastewater contains grey water from kitchens, baths, washing machines, bathroom sinks and contains black water from toilets which has a great number of nutrients such as nitrogen, phosphorus, urine, fecal sludge (UNEP, 2017; UN-Water, 2015). Domestic wastewater generated by homes, public restrooms, hotels, restaurants, motels, schools, etc. and they all produce high volumes of wastewater.

2.2.2. Rainwater And Urban Runoff

Rainwater runoff from roads and other impermeable surfaces roofs, pavements is a major problem in cities. The flooding damage result from inadequate coverage and capacity of stormwater drainage create serious health problems especially arise with

open channel surface water drains in cities. These open channels collect wastewater and garbage so when becoming a direct contact, this can lead to serious health problems. Another problem is the pollution load from urban surface waters. It has not only organic loads but also much of the polluting is toxic (UN-Water, 2015).

2.2.3. Industrial Wastewater

Industrial wastewater is diffused from mining, agri-industries, end-of-pipe point discharges and mostly illegal discharges from tankers. Before industrial wastewater is very polluting and difficult to treat, but the latter can be controlled and treated in sufficient regulatory power and resources (UN-Water, 2015). Large end-of-pipe discharges can be controlled and treated. However, some wastewaters coming from small enterprises discharge wherever they can. Industrial wastewaters are highly polluting which contains acids and toxic metals for instance from small metal finishing developed in specific localities. Such discharges lead to both considerable environmental damage and also lead to human health problem.

2.2.4. Agricultural Wastewater

Agriculture is one of the water pollution sources which contains fundamental problems because of sediment discharge, nutrient discharge, microbial and chemical discharge. For instance, sediment flow may lead to siltation issues and raise flood risk. One of the main pollutants in agricultural runoff is nitrogen and phosphorus that are applied to farmland as fertilizer, municipal wastewater and this can be resulted in eutrophication in receiving waters. Microbial flow from livestock and chemical flow from pesticides and other agrichemicals can cause pollution of surface water and groundwater (UN-Water, 2015).

2.3. Urban Drainage

The wastewater generated every day is transported by collection systems. While designing the collection systems, gravity flow system is used but for low lying areas lift stations are used to receive the sewage and pumps are used to transport (City

of Guelph, 2017). The combined system carries rainwater runoff from roads, roofs, pavements and other impervious surfaces and wastewater from domestic, commercial and industrial sources together in the same pipe to the wastewater treatment plant (Butler & Davies, 2004). During rainfall sewage rate increases with the addition of the stormwater.

According to Butler & Davis combined system is not economically feasible in terms of providing capacity for this flow throughout the sewers and at the treatment plant, this is also not feasible to provide this capability in the treatment processes. So that during rainy times flows above a certain level is diverted out of the sewer system (CSO) into receiving water and retained flow continues to the treatment process (Butler & Davies, 2004).

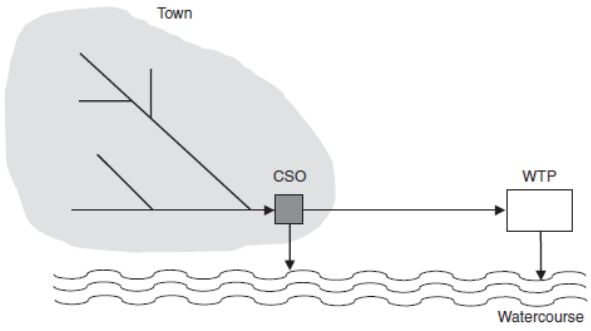


Figure 2. Combined system
(Source: Butler & Davies, 2004)

In the separate system, wastewater and stormwater are carried in separate pipes. At a suitable point, the stormwater can be discharged to the receiving water. In the separate system there is not combined sewer overflow (CSO) and the pollution is decreased. However, the pipework construct is expensive (Butler & Davies, 2004).

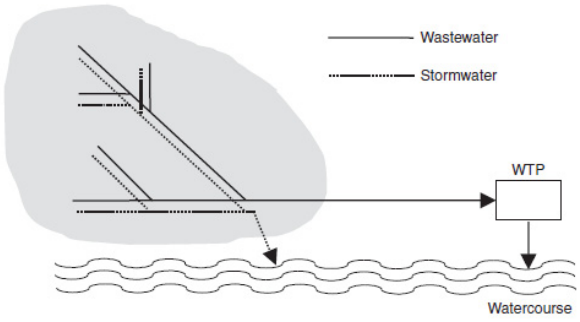


Figure 3. Seperate system
(Source: Butler & Davies, 2004)

2.4. Wastewater Treatment Plant Process

Domestic wastewaters, rainwaters from surface areas, industrial wastewaters, agricultural wastewaters are collected by collection systems and delivered to plants for treatment.

When collected wastewater enters a treatment plant, it encounters some processes which contain a separation of solids, removal, and biological stages to become purified water. While these processes take place, four basic techniques which are physical, mechanical, biological and chemical are applied. Physical and mechanical methods of treatment contain the physical structures such as tanks, screens, grit chambers and machines to remove contaminants (City of Guelph, 2017). In the biological process bacteria and micro-organisms are used to remove pollutants. In this method, microorganisms use the organic matter as a nutrition and end of this the organic matter is reduced and removed from the wastewater (Schultz, 2005). Chemical treatment methods ensure specialized treatment and improve the effectiveness of other treatment stages (City of Guelph, 2017). The basic procedure of the wastewater treatment plants involves respectively preliminary treatment, primary treatment, secondary treatment and tertiary treatment.

2.4.1. Preliminary/Primary Treatment

The first stage of the treatment process is a preliminary treatment. In this stage large materials such as pieces of wood, fabrics, plastics and other debris are removed by bar screens. After screening is completed, sewage passes into a grit chamber. Sand, cinders and gravel in wastewater are settled to the bottom of grit chamber by sedimentation. After these processes sewage is directed to a sedimentation tanks and this stage termed as primary treatment.

In sedimentation tanks sewage flow is reduced because of the lower sedimentation velocity of organic matters and the suspended solids sink to the bottom of the tanks and this separated solids called as primary sludge. In this treatment first clarification occurs. Floated materials such as oil, grease in wastewater skims from the tanks surface and are directed to other treatment stages. (City of Guelph, 2017).

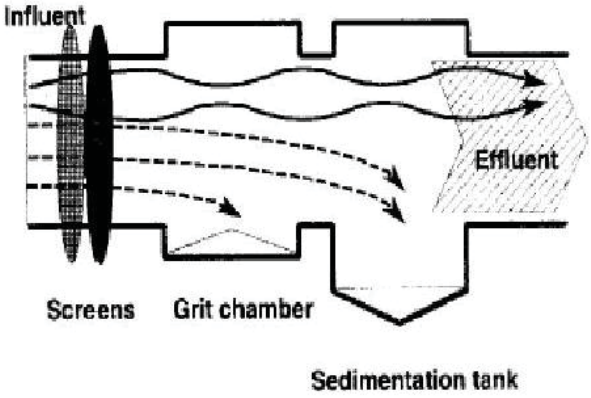


Figure 4. Preliminary/Primary treatment
(Source: EPA, 1998)

2.4.2. Secondary Treatment

The secondary treatment known as activated sludge process involves the biological methods and approximately 85 % of the organic matter in wastewater is removed. (EPA, 1998) In this process, aerobic microorganisms are used to break down the organic matter in wastewater in aeration tanks. The aerobic microorganisms use the organic matter as nutrient so that wastewater is directed to the aeration tanks. In these tanks, organic matters in wastewater are degraded by aerobic microorganisms. Because the aerobic microorganisms have suitable conditions to grow, the population of the microorganisms are increased as floct form and termed as activated sludge.

The mixed liquid in aeration tanks is directed to secondary clarification to separate the activated sludge. Part of the activated sludge is returned to the aeration tanks to oxidize more organic substances and this termed as return sludge and remaining sewage sludge is removed for further processing such as burning, using for landfill, fertilizer, etc. Before discharging the wastewater coming from sedimentation tanks, the disinfection is performed with chlorine to kill pathogens and to reduce the odor effect (EPA, 1998).

2.4.3. Tertiary Treatment

After secondary treatment is performed, tertiary treatment can be applied to improve the quality of the treated wastewater. The tertiary treatment known as a chemical process involves disinfection to remove parasites, bacteria, algae, viruses and

fungi, nitrification and chemical precipitation to remove nitrogen and phosphorus and filtration to remove suspended solids (NAP, 2017). Eventually, the treated wastewater from tertiary treatment is discharged to a watercourse or it can be reused in agricultural, recreational and industrial areas (EPA, 1998).

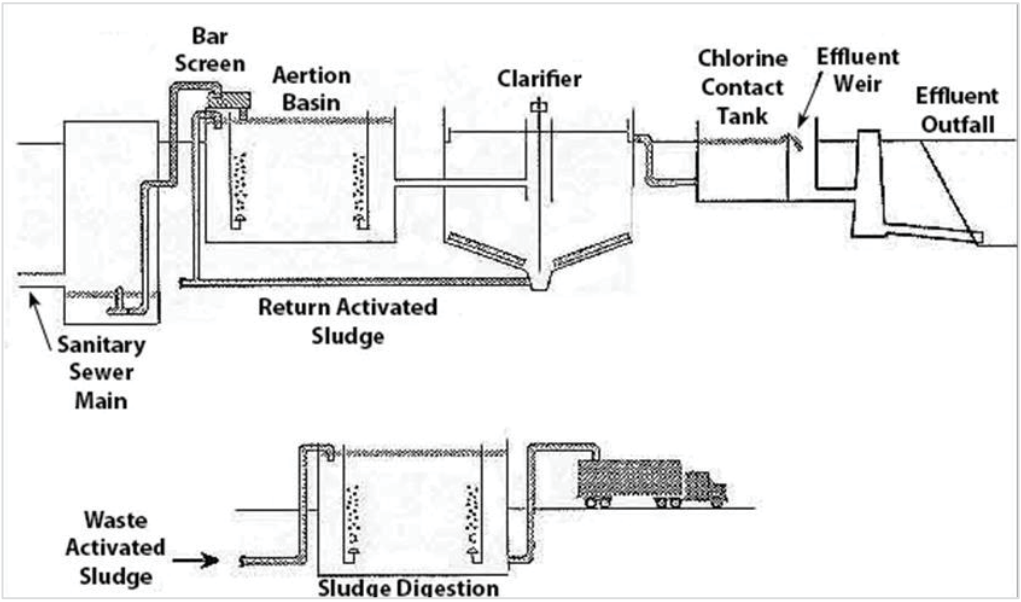


Figure 5. Wastewater Treatment Process
(Source: Northampton, 2018)

2.5. Sludge And Water Reuse

Because of the current water scarcity and climate change impacts, treated wastewater is seen as a considerable opportunity in terms of a potential new resource. Reusing of the treated wastewater is important for social, economic and environmental sustainability and is also important for water-scarce areas (Asia-Pacific Regional Report, 2018).

In report of the Habitat III 2016 it is stated that " We commit ourselves to promoting the conservation and sustainable use of water by rehabilitating water resources within the urban, peri-urban and rural areas, reducing and treating wastewater, minimizing water losses, promoting water reuse and increasing water storage, retention and recharge, taking into consideration the water cycle." (Habitat III 2016, article 73, 2017).

Treated wastewater and its sludge can be used for environmental applications when it is treated properly. The treated wastewater can provide environmental benefits

when used in such ways; avoiding the discharge of wastewater into surface waters, preserving groundwater resources in areas especially in agriculture, soil conservation by humus build-up, in recreational activities by means of irrigation and fertilization of green spaces such as gardens, parks, and sports facilities (Helmer & Hespanhol, 1997).

Treated wastewater can be used in urban areas following uses;

- Irrigation of public parks, recreation centers, athletic fields, schoolyards and playing fields,
- Irrigation of landscaped areas surrounding public, residential, commercial and industrial buildings,
- Irrigation of golf courses,
- Ornamental landscapes and decorative water features, such as fountains, reflecting pools and waterfalls,
- Fire protection,
- Toilet and urinal flushing in commercial and industrial buildings.

The treated industrial wastewater is commonly used as evaporative cooling water, especially for power stations, boiler-feed water, process water, irrigation of grounds surrounding the industrial plant. And industrial reuse is highly cost-effective for industries located near urban centers where secondary effluent is readily available for reuse (Helmer & Hespanhol, 1997).

The sludge from wastewater treatment with the new approaches is considered as a valuable resource. Because it can be used to generate electricity, recover nutrients, and reduce landfill disposal (Asia-Pacific Regional Report, 2018). For instance, according to the implementation report (2017) of the Directive (91/271/EEC), 58 % of the generated sludge was reused in the EU. It is used in soil and agriculture with the rate of % 45. 27 % of the sewage sludge is disposed of by incineration. And 8 % of the sewage sludge is disposed of in a landfill.

2.6. Location Criteria Of Wastewater Treatment Plants

When improperly or untreated wastewater is discharged into the environment, ıt may damage public health and the environment. So that people need to remove the wastewater pollutants to protect the environment and protect public health and in this scope, countries define some standards takes place at various levels for water and

wastewater management. In this part, the legal framework of wastewater management and location criteria of wastewater treatment plants will be addressed in Europe and in Turkey.

2.6.1. Location Criteria Of Wastewater Treatment Plants In Europe

European Union Member States have adopted the Directive (91/271/EEC) concerning with urban wastewater treatment since 1991 and still, it is valid. The aim of the Directive is to protect the environment from the negative impacts of the wastewater. The Directive draws a framework about the collection, treatment, and discharge of wastewater.

In the Directive, it is stated that the wastewater collection system and secondary treatment should be provided for agglomerations of more than 15.000 p.e. until the 2000 year. Until the 2005 year agglomerations of between 2.000 and 15.000 p.e. should be provided only with wastewater collection systems. Until the 2005 year agglomerations of between 10.000 and 15.000 p.e. should be provided with secondary treatment or equivalent treatment (Directive 91/271/EEC).

(p.e.)	0-2000	2000-10,000	10,000-15,000	15,000-150,000	>150,000
Sensitive areas	if collection 31/12 2005 appropriate treatment	collection 31/12 2005 secondary* treatment	collection 31/12 1998 more advanced treatment	collection 31/12 1998 more advanced treatment	collection 31/12 1998 more advanced treatment
Normal areas	if collection 31/12 2005 appropriate treatment	collection 31/12 2005 secondary* treatment	collection 31/12 2005 secondary treatment	collection 31/12 2000 secondary treatment	collection 31/12 2000 secondary treatment
Less sensitive areas (coastal waters)	if collection 31/12 2005 appropriate treatment	collection 31/12 2005 appropriate treatment	collection 31/12 2005 primary or secondary treatment	collection 31/12 2000 primary or secondary treatment	collection 31/12 2000 primary (exceptional) or secondary treatment

* appropriate treatment if discharge to coastal waters

Figure 6. Requirement treatments and deadlines of implementation of articles 3, 4, 5 and 7 of the Directive 91/271/EEC (Source: European Commision, 2016)

According to ninth report (2017) on the implementation of the Directive, the European Union reached a high level of compliance with the rate of 94.7 % for

collection system, 88.7 % for secondary treatment and 84.5 % for more stringent treatment (European Commission, 2017). Another important point mentioned in the Directive is the identification of sensitive and less sensitive areas.

Sensitive areas are defined as natural freshwater lakes, estuaries and coastal waters which are determined to be eutrophic or may become eutrophic in the future if protection measures are not taken and less sensitive areas are defined as marine water bodies which discharging of wastewater is not negatively affect the water body in terms of morphology, hydrology or specific hydraulic conditions of the area. Not only marine water bodies but also open bays, estuaries and other coastal waters with a good water exchange which are not eutrophic or considered not to become eutrophic because of discharge of urban wastewater can be identified as less sensitive areas (Directive 91/271/EEC).

Another stated point in the Directive is the reusing of sludge from wastewater treatment and reusing of treated wastewater when it is appropriate to use. According to ninth report (2017) on implementation of the Directive, depend on the 2014 data, 58 % of the generated sludge in the EU was reuse mostly in agriculture but reusing of treated wastewater is limited only eight Member States have a regular reuse of part of their treated wastewaters (European Commission, 2017).

Countries generally set a number of criteria in terms of the geographic, environmental, socio-economic and technical evaluation for the selection of the site for wastewater treatment. There are basically following principals for the selection of the site for wastewater treatment (Pan, 2005; Chelsea Municipal Council, 2011);

- The site should be as close as possible to an important river,
- In order to utilize gravity flow, the site location should be at a low elevation,
- The site should be situated near the zones to be served in order to reduce the construction costs of the planned sewers,
- The site should be fairly isolated from (buffer zones) presently built-up areas or areas that have a potential for future developments,
- Access to the site by an existing road is important and railroads also may be helpful for delivery of bulk chemicals and transport of sludge from large facilities,
- The site location should be away from protected zones
- The site should be as far as possible from wetlands to protect them,

- The site should be located outside a flooding zone because it may affect water treatment,
- Site location should be suitable with municipal zoning plans,
- Site location should be suitable for standards in terms of proximity to residences. For instance, Chelsea Municipal states the standard that proximity to a residence should be 100 m from aerated lagoons according to treatment type,
- Control of odours, noise, and lighting should be provided,
- The architecture of the treatment plants should be integrated and harmonized with the existing architecture,
- Traffic and dust pollution should be minimized within the area,
- Construction of conduits, collectors, and outlets should be the shortest possible distance in order to reduce costs,
- The topography of the site should be relatively flat to facilitate construction,
- A large land area may be helpful in maintaining isolation and fulfills the needs for future expansion,
- Type of soil should be at a reasonable cost for the construction of a treatment plant,
- Geotechnical stability of the site should be stable,
- Landscape layout of the site should be integrated into the surroundings and harmonized with local architecture,
- The site should be checked because archaeological, historical, or other properties can be found,
- The site should be investigated because endangered or threatened species of flora or fauna can exist,
- Preservation of shorelines should be provided particularly in urban areas by public pathways along the shore, public parks, recreation facilities.

2.6.2. Location Criteria Of Wastewater Treatment Plants In Turkey

As in other countries, there are some legal acts and regulations related to wastewater management in Turkey. In this scope, current regulations are as following;

- Urban Wastewater Treatment Regulation (Kentsel Atıksu Arıtımı Yönetmeliği) (08.01.2006 date and Official Journal No. 26047)

The aim of the Urban Wastewater Treatment Regulation is the collection, treatment, and discharge of urban wastewater and protecting the environment against adverse effects of wastewater discharge from certain industrial sectors. The regulation involves the technical and administrative bases for the collection, treatment, and discharge of urban and certain industrial wastewater, monitoring, reporting, and supervision of wastewater discharge.

The regulation states that the relevant administration shall ensure that the collection sites with an equivalent population of more than 2000 are equipped with the sewage system. The relevant administration shall ensure that wastewater from collection sites with less than 2000 equivalent population is subjected to appropriate treatment when discharged into freshwater and estuary. And wastewater from collection sites with less than 10.000 equivalent population is subjected to appropriate treatment when discharged into coastal waters. The relevant administration shall ensure that wastewater from collection sites with the equivalent population between 2000 and 10.000 are subjected to secondary treatment or equivalent treatment when discharged into freshwater and estuary. And all discharges of made from collection sites with more than 10.000 equivalent population are subjected to secondary treatment or equivalent treatment.

In the regulation like other regulation (Directive 91/271/EEC) in Europe, sensitive and less sensitive areas are defined. And it is stated that primary treatment is essential in less sensitive areas if the environment is not adversely affected. In sensitive areas, it is essential to use advanced treatment.

- Water Pollution Control Regulation (Su Kirliliği Kontrolü Yönetmeliği) (31.12.2004 date and Official Journal No. 25687)

The aim of the Water Pollution Control Regulation is to specify the legal and technical basis necessary to achieve the prevention of water pollution with the sustainable development objectives, in order to ensure the protection and optimum use of the underground and surface water resources of the country. The regulation involves the wastewater disposal principles and the principles related to wastewater infrastructure facilities.

- Implementing Regulation on the Procedures and Principles to be followed in the Determination of Wastewater Infrastructure and Domestic Solid Waste Disposal Facilities Schedules (Atıksu Altyapı ve Evsel Katı Atık Bertaraf Tesisleri

Tarifelerinin Belirlenmesinde Uyulacak Usul ve Esaslara İlişkin Yönetmelik) (27.10.2010 date and Official Journal No. 27742)

The regulation involves the procedures and principles to be followed in the determination of full cost-based investments for the collection, treatment, discharge or recovery of urban and industrial wastewater, operation, maintenance and repair of wastewater systems, disposal or recovery of the treated sludge.

- Implementing Regulation on the Use of Household and Urban Treatment Sludge in Soil (Evsel ve Kentsel Arıtma Çamurlarının Toprakta Kullanılmasına Dair Yönetmelik) (03.08.2010 date and Official Journal No. 27661)

The aim of the Implementing Regulation on the Use of Household and Urban Treatment Sludge in Soil is to specify the principles for taking the necessary measures for the use of sewage sludge in the soil in accordance with sustainable development objectives

- Annunciation on Technical Procedures for Wastewater Treatment Plants (Atıksu Arıtma Tesisleri Teknik Usuller Tebliği) (20.03.2010 date and Official Journal No. 27527)

Aim of the Annunciation on Technical Procedures for Wastewater Treatment Plants is to establish the basic technical procedures and applications to be used for the selection of technology of wastewater treatment plants, design criteria of wastewater treatment plants, disinfection of treated wastewater, reuse of treated wastewater, disposal of waters during deep-sea discharge and disposal of sludge.

In the planning of wastewater treatment plants, which methods to use in wastewater treatment depends on the nature of the wastewater. For instance; physical and biological methods are generally preferred for domestic wastewater, chemical methods are applied for the treatment of industrial wastewater. Wastewater that is generated as a result of production in industrial facilities needs to be treated in the discharge standards specified in the regulations. Industrial wastewater treatment plants are differed according to sizes and units, industrial type, amount of wastewater, pollution values of wastewater and receiving environment.

There are basic following principals for the selection of the site for wastewater treatment in Turkey (Republic of Turkey Ministry of Education, 2012; Republic of Turkey Ministry of Forestry and Water Affairs, 2012);

- When selecting the location for wastewater treatment plants, gravity flow should be utilized,

- The site should be close to a large amount of water or agricultural land where irrigation can be done,
- The site should be located outside of the zoning plan as much as possible,
- The cost of land at the site must be low or belong to public property. More precisely, it should not be a problem of expropriation,
- Underground water problem should be considered at the site,
- Ground handling and excavation problems should be considered at the site,
- The site should be at a sufficient distance from the city drinking water catchment area in terms of contamination,
- The treatment plant should not be located in the area of flood effect and should be fully protected from flood for at least 100 years. Site selection from flood impact areas should be strictly avoided without the necessary conservation measures,
- The site should be easy to access due to maintenance and operation,
- The site should meet the population growth of the settlement in the future and protection band requirement,
- The site should be kept as far away from existing and planned residential neighborhoods as possible. And treatment plants should be designed with aesthetic elements and risk of odor formation,
- When choosing the site, care should be taken first to protect and not to affect the coastal areas in the residential areas.

Although there are regulations in Turkey about the collection and treatment of wastewater, treatment, discharge, design criteria of the treatment plant, reuse of wastewater and sludge, legal and technical requirements for prevention of water pollution, the regulations do not contain specific criteria for the site location of the treatment plants.

On the other hand, in design guide of the Republic of Turkey Ministry of Forestry and Water Affairs, it is stated by Koyuncu (2012) that the safety/protection band that surrounds the wastewater treatment plant from a certain distance should be provided. This protection band ensures that the installation is isolated from the surrounding settlements. In this context, the provisions of the Water Pollution Control Regulation determine the general framework. These defined rules should be in harmony

with the Zoning Plans and the Environmental Regular Plans (Republic of Turkey Ministry of Forestry and Water Affairs, 2012).

In the chapter 3, contributing factors to odour, odour measrements, complaints and news published on the internet are mentioned.

CHAPTER 3

ODOUR AND IMPACTS ON LIVING ENVIRONMENT

Many people may be exposed to odour for many reasons and odour from sewer systems, wastewater treatment plants and many other sources may lead to a severe nuisance (Frechen, 2009). The odour problem arising from wastewater treatment plants has become increasingly important in urban areas (Balling and Reynolds, 1980; Gostelow et al., 2001) because the odour may cause severe impacts on the nearby environment and human health.

The unpleasant odour can induce deterioration of the quality of the natural environment and can generate human health problems such as stress, headache, irritated eyes, nose and throat, nausea, anxiety, respiratory problems (Palmiotto et al., 2014). Besides the health effect, the odour also influences the human life. For instance, residents cannot open the windows of their houses, cannot attend outdoor activities, are reluctant to host guests due to the odour, cannot enjoy spending time in the garden, can not hang laundry out to dry. Children cannot sleep due to the odour and the odour creates an uncomfortable situation for elderly people (EPA, 2010).

Besides the negative effects of the unpleasant odour on the daily life and health of the people living around a wastewater treatment plant, it also negatively affects the real estate values in the surrounding area. For instance, Batalhone et al. (2002) in their article examined the impact of odour emitted from a wastewater treatment plant on property values in the city of Brasilia, Brazil. As stated in the article, the Hedonic Price Method was used to estimate the impact of the odour on the real estate values in the surrounding area and it was found that there is an important reduction in property values due to the unpleasant odour. So that the apartments located near this wastewater treatment plant have a much lower price than the apartments located farther away (Batalhone et al., 2002).

Another example is related to impacts of industrial odours on surrounding residential houses in four cities (Costa Mesa, Newport Beach, Huntington Beach and Seal Beach) located in Orange County, California (Saphores and Aguilar-Benitez, 2005). Saphores and Aguilar-Benitez (2005) states in their article that unpleasant odours

originated from industrial activities including oil firms, boat building and repair, manufacturers, auto paint shops and metal finishing companies affect the house prices in surrounding area. As a result of the Saphores and Aguilar-Benitez's work (2005), using the hedonic price method and GIS, they observe that the housing values have decreased by 3.4 percent due to the unpleasant odour (Saphores and Aguilar-Benitez, 2005).

Residents are generally worried about the construction of a wastewater treatment plant in their backyard due to odour impact from the facility (Fries, 2016). Because of increased awareness of both the environment and human rights, stricter environmental regulations, encroachment of residential areas on wastewater treatment plants negative impacts on the nearby environment and human health, the odour complaints are increasing in recent years (Gostelow et al., 2001; Lebrero et al., 2011). Lebrero et al.(2011) citing from Leonardos (1995) in their article state that many public complaints about odour were received from European and North American Environmental regulatory agencies. In the article, it is also stated that between 13 % and 20 % of the population in Europe has been affected by odour annoyance and in some Spanish cities such as Madrid or Barcelona odour annoyance effect can reach up to 25 % of the population (Lebrero et al., 2011).

A public survey about a potential site for a wastewater treatment plant in a western Canadian City states that more than 65 percent of the respondents in nearby residential areas of the site were most worried about possible odour impact from the facility (Fries, 2016). Curren (2012) states that 50 % - 60 % of all air quality complaints from community members during 2000-2009 years in California is related to odour. These complaints are reported by the South Coast Air Quality Management District (AQMD) which is an air pollution control agency responsible for enforcing the air quality regulations in California.

All of these examples indicate that unpleasant odour affects human life and the surrounding area in a negative way. Communities are generally concerned about possible odours from wastewater treatment plants, landfills, etc. if this kind of facilities is built in their backyard. So that necessary measurements on this issue must be taken by governments. As stated in the document of World Health Organization (2000) on The Right to Healthy Indoor Air, Principle I. The Human Right to Health, everyone has the right to breathe healthy indoor air (WHO, 2000). " The quality of indoor air not only has a bearing on health, but also on the quality of life. This interpretation derives from

the 1977 World Health Assembly, which resolved that by the year 2000, all people should attain a level of health permitting them to lead socially and economically productive lives. Exposure to pollutants that qualitatively decrease the health, functioning or comfort of occupants is, therefore, unacceptable " (WHO, 2000, p. 6).

Puget Sound Clean Air Regulation I, Article 9.11(a) (Adopted 03/13/68 (12), Revised 06/09/83 (536), 03/11/99 (882)) states that "It shall be unlawful for any person to cause or allow the emission of any air contaminant insufficient quantities and of such characteristics and duration as is, or is likely to be, injurious to human health, plant or animal life, or property, or which unreasonably interferes with enjoyment of life and property." (Puget Sound Clean Air Agency, 2017, p. 9-5)

3.1. Contributing Factors To Odour

Contributing factors to the formation of odour impact that effects individuals negatively and occurs in receiving environment are basically defined as a combination of frequency, intensity, duration, offensiveness, and location factors and this combination is known as FIDOL (Freeman and Cudmore, 2002; Nicell, 2009; Brancher et al., 2017).

Frequency factor of odour occurrence refers to the frequency of odour exposure of an individual in the ambient environment. Odour emission source and characteristics, the prevailing wind conditions, the location of the source and the topography of the area affect the frequency. The frequency of odour exposure is generally very high when the odour source is in the wind direction, particularly under stable conditions with low wind speeds (Freeman and Cudmore, 2002; Nicell, 2009). Nicell's article states that many regulations about odours around the world have been adopted that restrict an odour impact at or beyond the property line of a facility (Nicell, 2009).

The intensity factor of odour occurrence is related to the individual's perception of its concentration. There are various ways to quantify the strength of an odour and common approach is based on the dilution-to-threshold principle. Another approach involves the intensity scales in which the perceived intensity of an odour is matched to intensity scales. There are different intensity scales. For instance, in German, the descriptor scale is identified as 0 = not perceptible, 1 = very weak, 3 = distinct,4 = strong, 5 = very strong, 6 = extremely strong. In Japan, intensity scale is identified as 0=

no odour, 1 = barely perceptible, 2 = faint but identifiable, 3 = easily perceivable, 4 = strong, 5 = repulsive. These intensity scales are important tools to understand if there is any odour issue in the surrounding area of a facility (Nicell, 2009).

Duration factor of odour occurrence refers to the period of exposure to odour. Individuals can expose to odour discontinuously for short periods or discontinuously for long periods and continuous periods. The factor is related to the type of odour source, the location of the source and local weather conditions (Freeman and Cudmore, 2002; Nicell, 2009; Brancher et al., 2017)

Offensiveness also called as hedonic tone factor is related to the subjective rating of an odour as pleasantness or unpleasantness and odor characteristics such as sweet, sour, musty, floral, garbage, etc. are assessed to understand the odour origin in an impacted region (Freeman and Cudmore, 2002; Nicell, 2009). Individuals rate a value based on their personal feelings, beliefs, life experiences and sensitivities. Generally, numeric scales are used to quantify the offensiveness of odour and common approach is the use of 21-point scale which is a score of +10 corresponding to a pleasant odour, 0 corresponding to neutral, and -10 corresponding to unpleasant odour (Nicell, 2009).

Another important factor is the location at which an odour is experienced and in that area, human life and the environment may be possibly affected negatively. In Freeman and Cudmore's article (2002) the sensitivity of the receiving environment is categorized according to land use. For instance, odours associated with an industrial area are less likely to be thought offensive by people working on neighboring industrial premises. However, odours occurring in evenings especially in summer times in residential areas may significantly affect the residents negatively. Odours which are acceptable to most rural people and fit to the description of a rural odour occurring in rural areas generally can be tolerated. On the other hand, odours associated with wastewater treatment, landfilling, composting, large-scale intensive factory farms are much less acceptable because the odours have an adverse effect on residents living surrounding area of the facilities (Freeman and Cudmore, 2002; Nicell, 2009).

Besides the FIDOL factors contributing to odour, Freeman and Cudmore (2002) state that cultural issues and perception may also be considered as influencing factors. Writers explain the cultural issues with an example. For instance, it is known that wastewater treatment plants generate odour and people are more likely to find the odour itself offensive. Perception can be considered another factor, for instance, odours result from rural activities generally are not considered as offensive so that a significant

adverse effect is less likely to occur. However, if the odour is associated with treatment plants, landfilling, composting, etc. the odour more probably causes negative reaction of people (Freeman and Cudmore, 2002).

3.2. Odour Measurements

There are generally four parameters of an odour to be measured. These are the concentration of odorants, intensity, characteristic properties of odour and hedonic tone. In general, there are two approaches for odour measurement. One of them is the analytical methods and the other one is sensory methods. The concentration of odorant is measured analytically and other parameters are measured by sensory methods (Gostelow et al., 2001).

Because the odour perception is subjective, odour measurement is not easy. An individual's reaction to an odour is subjective so that different people perceive odours at different concentrations and people react differently to the odour (Zarra et al., 2008; Gostelow et al., 2001). Besides the personal feelings, some general factors related to odour perception are mentioned in Gostelow et al.'s article. In the article it is stated that odour sensitivity declines with age and smokers or unhealthy people's odour sensitivity are worse, prolonged exposure to odour reduces the sensitivity to the odour and repeated exposure to odour increases sensitivity to the odour (Gostelow et al., 2001).

Another reason for the difficulty in odour measurement is that many odour emissions, including from wastewater treatment facilities, consist of many different substances. The complex structure of the components causing odour impact, weather conditions, the subjectivity of the odour perception make odour measurement difficult (Zarra et al., 2008; Gostelow et al., 2001).

3.2.1. Analytical Measurements

Analytical measurements are related to the concentration of odorant which are the compounds responsible for odour impact and chemical properties. Analytical measurements are more objective and accurate. Odours from wastewater treatment plants are measured analytically either by the quantity of a single odorant or by the quality and quantity of a range of odorants. But in many cases for odours emitting from wastewater treatment H_2S is a dominant odorant and has generally high concentration

than other odorants (Gostelow et al., 2001). Lebrero et al. (2011) citing from Vincent (2001) state that primary settlers, sludge-digestion tanks, and sludge thickening and dewatering facilities are the main reasons of the odour issue from sewerage and wastewater treatment plants. (Lebrero et al., 2011).

3.2.2. Sensory Measurements

Sensory measurements are related to people's odour perception. Sensorial techniques contain the dynamic olfactometry method (objective measurement) and subjective sensory method. As mentioned earlier in this chapter; odour character, intensity and hedonic tone may be measured subjectively (Gostelow et al., 2001; Lebrero et al., 2011).

Dynamic olfactometry method is based on odour concentration and it is a very common technique to decide odour concentration. (Gutierrez et al, 2014; Lebrero et al., 2011). Odour concentration is defined as the number of dilutions required to reduce an odour to its threshold concentration. It is the lowest concentration at which odour can be detected. (Gostelow et al., 2001; Lebrero et al., 2011). Olfactometry method can be applied three different ways. One of them is the Yes/No method that is used to measure odour concentration (Gutierrez et al, 2014; Lebrero et al., 2011). Another way is the Forced Choice method that is used to evaluate the level of odour at different two or three sniffing ports (as certainty, inkling, or guess) by different persons. The other way is the Forced Choice Probability method. It is more systematic and statistical method for the implementation of the Forced Choice method (Lebrero et al., 2011).

Because the odour measurement techniques described in this section are not directly related to this thesis, these techniques have not been described in detail in this section. The main theme of this thesis is to research the effects of odour emitted from wastewater treatment plants on the health of people living in the nearby environment, on their daily life and on the housing values in the vicinity of the plants.

3.3. Protests & Complaints On Odour Impact From Wastewater Treatments

As mentioned in the first sections, exposure to the odor emitted from wastewater treatment plants affects the life and health of the people who live in the nearby environment and the surrounding housing values in a negative way. Because of such negative effects, people exposed to these conditions show their reactions in different ways such as protesting, verbal complaints to relevant authorities, complaint petitions, social media use, etc. In this context, the reactions to the odour emitted from wastewater treatment plants both in the world and in Turkey are examined in the following sections.

3.3.1. Complaints & News On Odour From Wastewater Treatment Plants Over The World

Many articles and news on the internet have been examined within the scope of this thesis and it has been observed that the life of the people living around the wastewater treatment plants is affected negatively. In this section, complaints related to odour issue and news published on the internet about protests against to odour emitted from wastewater treatment plants in the world is mentioned.

According to Gostelow et al. (2001) odour complaints have been increasing in recent years. For instance, it was estimated by the United States National Research Council Committee on Odors (1979) that more than 50 percent of the complaints about air pollution were related to the odour (Nicell, 2009). Lebrero et al. (2011) citing from Leonardos (1995) in their article state that many public complaints about odour were received from European and North American Environmental regulatory agencies. In the article, it is also stated that between 13 % and 20 % of the population in Europe has been affected by odour annoyance and in some Spanish cities such as Madrid or Barcelona odour annoyance effect can reach up to 25 % of the population (Lebrero et al., 2011). A public survey about a potential site for a wastewater treatment plant in a western Canadian City states that more than 65 percent of the respondents in nearby residential areas of the site were most worried about possible odour impact from the facility (Fries, 2016).

In this context, news about reactions to odour emitted from wastewater treatment plants in the world has been researched over the internet. This news can be summarized as follows:

According to a news site on the internet (www.bbc.com) published in 2011, residents in an East Yorkshire town started a petition against odours from a wastewater treatment plant (BBC, 2011).

Figure 7. Petition to stop odour from a wastewater treatment plant
(Source: BBC, 2011)

In this news, it is stated that the wastewater treatment plant emits putrid odours and it affects the surrounding area. The mayor of Hedon claimed that it was making residents physically sick. The company, which owns the plant, apologized for the problems and said that they were investing in new anti-odor technology. They hoped that new technology would solve the problem. After a town council meeting, it was stated that the plant to be reclassified as a statutory nuisance, which allows the local authority to enforce measures to reduce the problem. One of the supporters of the campaign, Hedon mayor Anne Suggitt stated that “The problem had been going on for more than a decade. It's rotten eggs, all day, every day, and has been since 2000 when the plant was first put in. We were told there would be no odour from that plant, but there has been nothing but odours.” (BBC, 2011)

According to a news site (www.independent.co.uk) published in 2016, residents of Hedon and adjacent villages intend to litigate water firm over the stink emitted from

a sewage works near Hull. It is stated that families living in a historic Yorkshire market town for years have put up with a pungent odour emitted from a sewage works near Hull. Approximately a hundred families have enlisted a law firm specializing in environmental law to win compensation for the very bad situation, suffering for nearly a decade.

One of the residents living for 18 years in Hedon states that " The odour is terrible. It's appalling. We have a patio at the back. But we can't have a barbecue in the summer. It just smells too much. People have signed petitions and have held protests, but it seems the only way to get their attention is to hit them in their wallets. " After collecting more than 2.000 signatures on a petition, an abatement order was decided against the plant's operators. The order was that the firm until this coming summer to stop the bad odours or face a substantial fine. (Independent, 2016)

According to a news site on the internet (www.foxnews.com) published in 2009, in eastern China, a protest was held by villagers from Fujian province' s Fengwei town due to a powerful stench from a sewage treatment plant. The protest turned to violence and at least 10 people injured. It is stated that the treatment plant had damaged local air and water. One of the residents living in 100 meters away from the factory stated that "The stench was unbearable. People would puke or faint when they smell it " (Foxnews, 2009)

3.3.2. Complaints & News On Odour Impacts From Wastewater Treatment Plants In Turkey

Due to the site selection of wastewater treatment plants and the effects of the odour emitted from wastewater treatment plants, many reactions have been shown by the residents exposed to the negative impacts on the nearby environment. In this context, news about reactions to odour emitted from wastewater treatment plants in Turkey has been researched over the internet. This news can be summarized as follows:

According to a news site on the internet (www.haberler.com), a protest was held in 2014 near Poyraz port in Bozcaada. According to the news, because of the wrong location choice of the ongoing construction of the wastewater treatment plant, it was protested. Approximately 40 people gathered in front of the wastewater treatment plant and acted with slogans and banners in their hands. It was stated that the wastewater

treatment plant jeopardizes the nature of the region and the right of people living around the facility to live healthily and freely. One of the most important reasons why the wastewater treatment plant is not being wanted is its negative effect on the nearby environment and on the health of people who live there. Other reasons are clean and silent cove turning into a pile of concrete, losing all attraction of the important cove which contains natural, historical and cultural beauties. It was stated that because of these reasons, this non-sustainable project should be stopped (Haberler, 2014).

Figure 8. Protest on wastewater treatment plant in Bozcaada in 2014
(Source: Haberler, 2014)

According to a news site on the internet (www.bafraajans.com) in 2016, local people in Yakakent district in Samsun opposed to the construction of wastewater treatment plant around the living area. It was also stated that the place where the facility is made is one of the most beautiful seasides of Samsun so that this area can be affected negatively (Bafraajans, 2016).

According to a news site on the internet (www.milliyet.com.tr) in 2016, residents living around the Ambarlı Advanced Biological Wastewater Treatment Plant in Beylikdüzü district in İstanbul are preparing to apply to court due to the odour emitted from that plant. It is stated that residents in the vicinity of the treatment plant became unable to go out to their balconies during the summer days when extreme temperatures were experienced. Residents reacted to the fact that despite there were repeated complaints to the authorities, they could not get any results. One of the residents stated that " We can not breathe in quality air and wake up nauseously at night

because of the odour. The odour threatens our children, our elderly people and our health in very serious manners. Our children are constantly sick. We do not have to take this odour. We are talking about a distance of 2 kilometers radius. I even think of selling my house and so many people in the vicinity have the same idea." (Milliyet, 2016)

Another resident stated that " The place was used as a sanatorium in the Ottoman times. There was a very clean air flow and people who suffered from asthma would be treated in 10-15 days. Even before these facilities were built, our relatives would come to us for fresh air. " (Milliyet, 2016)

Figure 9. The Ambarlı Advanced Biological Wastewater Treatment Plant in İstanbul (Source: Milliyet, 2016)

According to a news site on the internet (www.antalyagazetesi.com.tr) published in 2014, residents living in the vicinity of the Hurma wastewater treatment plant in Antalya reacted due to the odour emitted from the treatment plant. The residents state that the odor increases even more over the night, that they can not sleep at night, and that they can not open the windows due to the odour, and therefore they continuously operate the air conditioner (Antalyagazetesi, 2014). The residents express their complaints as follows:

One of the residents states that " We are in a very bad situation because of the odour. We are constantly voicing this message and denounce to the authorities. But we can not get any answers anywhere. A mechanic came here yesterday. And he asked how we live here in this odour. Nearly 1.500 people live here and they all complain."

One of the residents emphasizes that the odour also affects property values. The resident states that those who want to buy a house in the surrounding area are asking whether the odour comes here.

One of the residents states that " The odour coming from the treatment plant is quite uncomfortable. The odour is felt more especially in the evening. We can not sleep at night. We have been living here for 5 years. We would not buy a house from here if we knew that odour was in this area. We moved here in the daytime and there was no odour. But the odour starts at night. Everyone falls into the same mistake. We can not open our windows. "

One of the residents states that " There is an unbearable odour. Sometimes the odour is rising, sometimes not at all. But we can not stand when it coincides with the meal time. Since we can not open the windows, we are constantly operating the air conditioner. We have been living here for 1.5 years. We got home without hesitation because it was said that the treatment plant would be removed and the stream reclamation work would be done in the area. But still, no work has been done. "

One of the residents states that " We continuously report our complaint to the treatment plant. We bought the house in the daytime and there was no odour. The odour usually starts in the evening. I am ashamed to invite guests to the house in the evening. Who is wrong? The one who did the wastewater treatment plant here? the ones who allowed the settlement? or are we the ones who bought the house here? "

One of the residents states that " Last year we gathered signatures from nearly 100 people and complained to the municipality, but could not get a result. There is a decrease in odour compared to the old, but it is still disturbing. It also affects the real estate market here. The sales value of the houses and the rent value are also lower."

One of the residents states that " Sometimes very heavy odour comes from the treatment plant. We can not open our windows due to the odour and constantly operating air conditioners. I personally applied to the Metropolitan Municipality because of the odour issue. I made applications online. The odour diminished in comparison to the old days, but still disturbing from time to time. The odour also affects the values of the houses. While the prices of the houses in the same qualities as here are 250 thousand tl, the houses near the treatment plant are sold 120 thousand tl hardly. Anyone who is aware of the odour coming from the treatment plant does not buy a house from here. I have lived here for a year and I was not aware of the odour when I was buying a house." (Antalyagazetesi, 2014)

According to a news site on the internet (www.5ocaknews.com) published in 2012, Yüreğir Wastewater Treatment Plant in Adana, which has been operating since 2007, is constantly reacting from the residents due to the odour. It is stated that the

odour emitted from the treatment plant influences nearly 8 neighborhoods around it and the odour has been one of the most important problems of the residents for about 5 years. Residents stated that they could not open the windows of their homes due to the odour and even hosted guests in their homes. Residents state that they just want their rights (5ocaknews, 2012).

According to a news site on the internet (www.haberturk.com) published in 2015, a group of Turkish and foreign residents living in Kemer district in Antalya closed the road and protested due to the odour emitted from the treatment plant in the surrounding area (Habertürk, 2015).

Figure 10. Protest in Antalya due to the odour from wastewater treatment plant (Source: Habertürk, 2015).

A group of Norwegians and Russians and Turks protested due to the odour emitted from the treatment plant to the surrounding area and due to pollution of the stream passing through the region. The group opened a banner written in Norwegian 'We do not want to odour'. A Norwegian resident living for ten years in that area states that " There is a disgusting odor every morning and evening. When we open the windows, the odour comes in and we know it is dangerous. Our children are coming here but maybe we will not bring them anymore. Kemer is a beautiful place, but this is the very bad situation." (Habertürk, 2015)

All in all, both in the literature survey and in the media scanning on the internet it is stated that unpleasant odour originated from wastewater treatment plants affects

daily life and health of the people living around that treatment plant and affects the real estate values in the surrounding area. All of the complaints about the issue in the world and in Turkey mentioned above have also been encountered in the field work and it is mentioned in chapter 5.

Some compensation methods are applied in order to compensate for the losses of the people facing these negativities. In section 4 it is mentioned these compensation methods. However, the attitude of the thesis, everyone has the right to a healthy life, and for that reason, people should not be exposed to the unpleasant odour, noise, visual pollution and unhealthy living environment.

CHAPTER 4

DISCUSSION OF COMPENSATION POLICIES IN THE CONTEXT OF THE ENVIRONMENTAL ETHICS AND ENVIRONMENTAL JUSTICE

Everybody has the right to a healthy life. However, people are sometimes confronted with adverse situations due to the lack of adequate measures against odours emitted from undesirable land uses. Both in the literature review and in scanning news on the internet as well as our case study it is stated that unpleasant odour emitted from a wastewater treatment plant influences daily life and health of the people who live around the treatment plant and influences the property values in surrounding area. Not only wastewater treatment plants but also landfills, refineries, industrial areas or hazardous waste sites create negative externalities and affect the human life and environment negatively.

Because of these adverse effects, some compensation policies are applied in order to compensate for the losses of hosting communities or to affect the public acceptance for siting of locally unwanted land uses or to solve the unfairness within the local public. Some individuals consider these compensatory policies, especially monetary incentives, as a bribe and the individuals consider that these incentives are not morally appropriate. In this part, some compensation policies are discussed in the context of the environmental ethics.

However, the attitude of this thesis is that everyone has the right to a healthy life and people should not be confronted with such negativities. If such losses are experienced, local government or central government have to develop some technical measurements to stop the negative effects or have to relocate the surrounding residents who are affected negatively. As stated in the Article 56 of the Constitution of the Republic of Turkey that " Everyone has the right to live in a healthy and balanced environment."

Another focus of this chapter is the environmental justice movement. Site selection of the undesirable land uses in racial and ethnic minorities and other disadvantaged groups predominantly in African American, Latino or other minority

neighborhoods in the United States caused reactions and this led to birth of environmental justice movement. The environmental justice requires that " The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies " (EPA, 2018).

4.1. Compensation Policies

Siting of environmentally unwanted technical infrastructure facilities is a controversial planning issue in local communities (Gallagher et al., 2008; Wolsink and Devilee, 2009). Societies generally do not want land uses such as wastewater treatment plants, landfills, refineries, nuclear waste repositories, industrial areas, etc. in the vicinity of their living areas because of possible negative impacts. In Kunreuther and Easterling's article, it is stated that the negative impacts can generally be categorized as the impact on human health, economic losses, reduced quality of life, and damage to the physical environment (Kunreuther and Easterling, 1996). Compensation programs are provided for the losses of the communities that are exposed to the negative impacts due to the negative externalities of this kind of facilities. Mors et al. (2012) state that the compensations provided host communities may be used to solve the unfairness within the local public. Kunreuther and Easterling (1996) state that compensation can affect the public acceptance for siting of the undesirable land uses. Some of the studies in the literature are given below:

Kunreuther and Easterling (1996) in their article examine the effectiveness of compensation programs both by looking at the practical examples and by looking at the answers given to the survey studies. It is stated in the article that some compensation programs were successful and some failed. For instance, Kunreuther and Easterling (1996) citing from Simon (1990) state that local support for the construction of a solid waste landfill was provided by offering an advantage package by the developer of the facility to residents in Charles City, Virginia, U.S. The package involves a tipping fee which provides annual revenues of nearly $1 million for the city and it has been used for lower property taxes and for rebuilding the city's ailing school system. Besides the tipping fee, the garbage of the county is collected free of charge by the operator (Kunreuther and Easterling, 1996).

In Kunreuther and Easterling's article (1996) it is stated that in the United States so many survey studies were conducted to understand the effects of compensation programs on the willingness of residents to accept undesirable facilities such as municipal waste landfill and radioactive waste repositories. One of the survey studies shows that 30 percent of respondents accepted the possible construction of a landfill which is 5 miles away from the residents' living area without any incentives. However, 63 percent of the respondents accepted this facility with economic assistance such as reductions of property tax. Economic incentives such as state money for schools and for roads also greatly affected the acceptance of the facility by the respondents. According to another survey result conducted in the United States, while 25 percent of respondents accepted the landfill without any incentives, the rate of acceptance was 50 percent with the provision of economic incentives which were provided to residents within 50 miles of the facility (Kunreuther and Easterling, 1996).

On the other hand, public acceptance of compensations for hazardous waste sites such as radioactive waste repository is not so high. For instance, according to another survey results, while 22 percent of those who responded to the survey in Wisconsin agreed to locate a nuclear waste repository in their community without any incentives, the rate of acceptance was only 26 percent with substantial payments. According to another survey, while 10 percent of respondents to this survey in the United States agree to locate a nuclear waste repository 10 miles or 50 miles away from their living area, the rate of acceptance increased only 14 percent with economic incentives (Kunreuther and Easterling, 1996).

Besides the direct payments to residents who have affected adversely from locally unwanted land uses, public goods compensations (nonmonetary compensations) are considered more appropriate than the direct payments to residents (Kunreuther and Easterling, 1996; Mors et al., 2012; Claro, 2007). Kunreuther and Easterling (1996) state that providing nonmonetary compensations such as protection of property values, large grants for community facilities, high-tech project with new jobs, new public services, payment medical costs for residents who expose negative health effects, tax rebates to all residents living nearby environment of that facilities, establishing reliable fund for any harm of the residents, etc. affect the public acceptance of the undesirable technical infrastructure facilities. For instance, results of their survey studies for acceptance of a repository conducted in Nevada residents state that 60 percent of the Nevada sample accepted the protection of property values measure, 47.1 % accepted the

large grand for the community facilities measure, 42.3 % accepted the high-tech project with new jobs measure near the repository (Kunreuther and Easterling, 1996). Claro (2007) states that nonmonetary compensations can be explored besides offering green areas, medical services, and education facilities. Claro (2007) suggests that clandestine waste disposal sites can be removed, damaged streets can be restored, education scholarships for the children of the negatively affected residents can be provided.

Claro (2007) points out that according to a survey result conducted in Santiago in 2001, monetary compensation is not effective as public goods compensation for the willingness of respondents for hosting a sanitary landfill within their municipality. For instance, while the acceptance rate of the respondents for the landfill without any compensation was only 10.6 percent, this rate dropped to 6.5 percent with proposed monetary compensation. And this acceptance rate of respondents without any compensation (% 10.6) increased to 14.9 percent with public goods compensation. One of the respondents of the survey stated that " Money has nothing to do with it. It is an absurd offer. As it is good for everyone, damages should not be compensated." (Claro, 2007). Payment incentives are less acceptable than public goods compensation. In our survey results conducted in Limanreis neighborhood, Narlıdere district, İzmir it has been observed that most of the respondents prefer to regulate the environmental quality rather than monetary compensation.

On the other hand, the attitude of the study is that people should never be encountered such negativities because all people are equal and all people have a right to live in a healthy environment and money or public goods compensation cannot compensate the damages of the people.

4.2.Discussion Of The Compensations In Accordance With Environmental Ethics

As mentioned in the compensation policy part, monetary incentive for local acceptance of siting the undesirable land uses is less favorable than public goods compensation. In literature, this tendency is expressed as bribe-effect and as the idea of crowding-out of civic duty for individuals (Mors et al., 2012; Claro, 2007; Kunreuther and Easterling, 1996; Frey et al., 1996). Different views on monetary compensation policy in the ethical background are evaluated in this section. Besides this situation,

siting of the environmentally unwanted technical infrastructure facilities in the nearby environment of the minority groups and low-income groups caused reactions and this situation led to birth of environmental justice movement.

Monetary compensation for siting an environmentally undesirable facility is not very acceptable for individuals in terms of moral behavior. Because individuals consider money incentive as a bribe. In the Claro (2007) study, it is stated that people tend to feel more offended when monetary compensation is offered than public goods compensation. In the Kunreuther and Easterling (1996)'s article, it is given an example from Taiwan. Villagers in Taiwan forced for the closure of all of the 23 petrochemical firms in the Lin Yua Industrial Park after an overflow from wastewater treatment plant which polluted the nearby streams and affected negatively the fishing in the area. After that, the Minister of Economy offered considerable amounts of money to each of the residents living in nearby villages for reopening of the firms. However, this situation created the outcry in the country to whether this kind of monetary compensation was morally appropriate (Kunreuther and Easterling, 1996).

In the Claro (2007) experimental survey, the majority of the respondents rejected to host the sanitary landfill within their nearby environment even if monetary or public goods compensation was offered. It was asked a closed-ended question using a scale from 1 'not influenced at all' to 5 'influenced very much' if the reason for the rejection was the feeling of being bribed. Results of the question indicated that compensation was seen as a bribe. And monetary compensation with a mean of 3.9 was seen more bribery than public goods compensation with a mean of 3.4 (Claro, 2007).

Another reason why monetary compensation is less favorably than public goods compensation is the idea of crowding out of civic duty (Frey et al.,1996; Mors et al., 2012). Frey et al. (1996) state that publicly spirited citizens may accept the noxious facilities as a civic duty to support the welfare of their region. However, financial incentives may diminish the intrinsic motivation of individuals to possible toleration for siting the facilities and thus monetary compensation may crowd out the public spirit and decreases the willingness for hosting the facilities (Frey et al., 1996; Mors et al., 2012). For instance, In the Frey et al. (1996) empirical study, it is pointed out that while 50.8 percent of the residents living in Wolfenschiessen, Switzerland supported siting a radioactive nuclear waste repository in their community according to their current siting procedure, this rate decreased to 24.6 percent as a result of offering of financial incentives. Majority of the respondents stated that they could not be bribed. And when

financial incentives introduced to them, the willingness of the residents to contribute to the public good ceased and the possibility of rejecting the project had significantly increased for the individuals who concern for procedural fairness.

All in all, as stated in the Frey et al. (1996) study, the financial incentives are not an effective way for siting of locally unwanted facilities as long as moral views are dominant (Frey et al., 1996). Because it is considered as a bribe and is the idea of expelling the civic duty. As stated in the Kunreuther and Easterling (1996) study, by referring to the example of Taiwan, individual monetary compensation would not be accepted in the future (Kunreuther and Easterling, 1996).

The placement of locally unwanted land uses such as hazardous waste landfills, solid waste landfills, chemical plants, contaminated industrial sites, incinerators in minority communities and low-income populations predominantly in African American, Latino or other minority neighborhoods caused reactions and this led to birth of the environmental justice movement (Kevin, 1997; Been, 1993; Bullard, 2001).

Environmental justice advocates point out that minority groups expose to great effects from locally unwanted land uses and such supporters assert that these impacts may stem from pervasive racism in society (Kevin, 1997). For instance, African-American homeowners in Houston in 1979 showed a violent reaction to keep a sanitary landfill out of their suburban middle-income neighborhood. Another example is that in Warren County a landfill was protested and there were over 500 arrests (Bullard, 2001). According to the United States General Accounting Office study, three out of four hazardous waste landfills in the Southeast were located in predominantly in African-American communities although African- American constituted only twenty percent of the region's population (Bullard, 2001; Been 1993).

These reactions led to the emergence of the environmental justice movement in the United States. In the 1994 year, President Clinton signed executive order 12898 'Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations.' (Bullard, 2001; Kevin, 1997; Environmental Health Perspectives, 1995). The environmental justice includes the principle of protection of all individuals from environmental degradation. The aim of the Environmental justice is " The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (EPA, 2018). This order try to ensure that no population should endure a disproportionate share of adverse human health and

the negative environmental impacts of pollution or other environmental hazards (EPA, 2018; Environmental Health Perspectives, 1995). The environmental justice framework would necessitate proving for permission to operate such uses as landfills, incinerators, chemical plants, smelters, refineries that these operations are not harmful to human health and that they will not disproportionately affect racial and ethnic groups and other protected groups (Bullard, 2001). It is also stated in the Article 56 of the Constitution of the Republic of Turkey that " Everyone has the right to live in a healthy and balanced environment."

This thesis is the first study in resources which can be reached carried out in Turkey in relation to researching the odour impacts from the wastewater treatment plant on the health of the residents living around, their daily life activities, and on the property values in the nearby environment.

In the next section results of the case study are indicated. These results show that individuals just want to live in a healthy environment rather than a way of compensating.

CHAPTER 5

CASE OF SOUTHWESTERN ADVANCED BIOLOGICAL WASTEWATER TREATMENT PLANT IN NARLIDERE, İZMİR

In this chapter, the impacts of the odour emitted from the Southwestern Advanced Biological Wastewater Treatment Plant in Narlıdere district in İzmir on the residents living in the vicinity of the treatment plant and on the real estate values in the nearby environment is researched. One of the reasons for the selection of this research topic is that I have personally exposed this odour from time to time when passing through the facility. And it is the idea that the unpleasant odour can adversely affect the daily life of the people living in the nearby environment.

Within the scope of this study, survey studies were conducted with residents living in the immediate vicinity of this facility. Interviews by questionaries with headman of Limanreis neighborhood, with an environmental engineer working in the treatment plant, and with real estate agents were conducted. At the same time, the effects of the unpleasant odour on the real estate values around the treatment plant were examined with the Hedonic Price Method. This chapter consists of three parts including general information about the study field, questionnaires, and analysis of the questionnaire results and examination of the real estate values.

5.1. General Information About Study Field

In İzmir, there are 19 wastewater treatment plants under the responsibility of İZSU General Directorate. The total installed capacity of these 19 facilities is 765.647 m3/day and the total amount of wastewater treated in 2009 reached 257 million $m^{3.}$ These facilities have 9 Advanced Biological Treatment, 5 Classical Activated Sludge, 4 Natural Treatment and 1 Biodisk Process (İZSU, 2018). The Southwestern Advanced Biological Wastewater Treatment Plant is examined in detail among the treatment plants.

Figure 11. The wastewater treatment plants under the responsibility of İZSU (Source: İZSU, 2018)

The Southwestern Advanced Biological Wastewater Treatment Plant is a facility located in the smallest area within the same processes and capacities of our country with an area of 15 thousand m² (İZSU, 2018).

Table 1. Capacity and treatment methods of the wastewater treatment plants under the responsibility of İZSU (Source: İZSU, 2018)

No	Name of the Plant	Name of the district	Capacity m^3/day	Year of operation by İZSU	Treatment method
1	Çiğli	Çiğli	605.000	2000	Advanced Biologic
2	Güneybatı	Narlıdere	21.600	2001	Advanced Biologic
3	Havza	Menderes	21.600	2004	Advanced Biologic
4	Bağarası	Foça	2.100	2007	Activated sludge
5	Halilbeyli	Kemalpaşa	1.300	2007	Activated sludge
6	Kozbeyli	Foça	500	2007	Activated sludge
7	Aliağa	Aliağa	9.500	2008	Natural
8	Balıklıova	Urla	1.000	2008	Natural
9	Foça	Foça	9.763	2008	Advanced Biologic
10	Gümüldür	Menderes	960	2008	Activated sludge

Cont. on next page

Table 1 (cont.)

No	Name of the Plant	Name of the district	Capacity m^3/day	Year of operation by İZSU	Treatment method
11	Hacıömerli	Aliağa	250	2008	Biodiscs
12	İYTE	Urla	2.250	2008	Activated sludge
13	Selçuk	Selçuk	10.200	2008	Natural
14	Ürkmez	Seferihisar	2.000	2008	Natural
15	Urla	Urla	21.600	2009	Advanced Biologic
16	Bayındır	Bayındır	6.912	2009	Advanced Biologic
17	Ayrancılar-Yazıbaşı	Torbalı	6.912	2009	Advanced Biologic
18	Torbalı	Torbalı	21.600	2010	Advanced Biologic
19	Menemen	Menemen	21.600	2010	Advanced Biologic
Total	-	-	765.647	-	-

One of the 19 wastewater treatment plants under İZSU responsibility is the Southwestern Advanced Biological Wastewater Treatment Plant which is located in Limanreis neighborhood in the Narlıdere district in İzmir. The treatment plant purifies the residential and industrial wastewater collected from the urban area of Güzelbahçe district, a part of Narlıdere and the military area in the Narlıdere district.

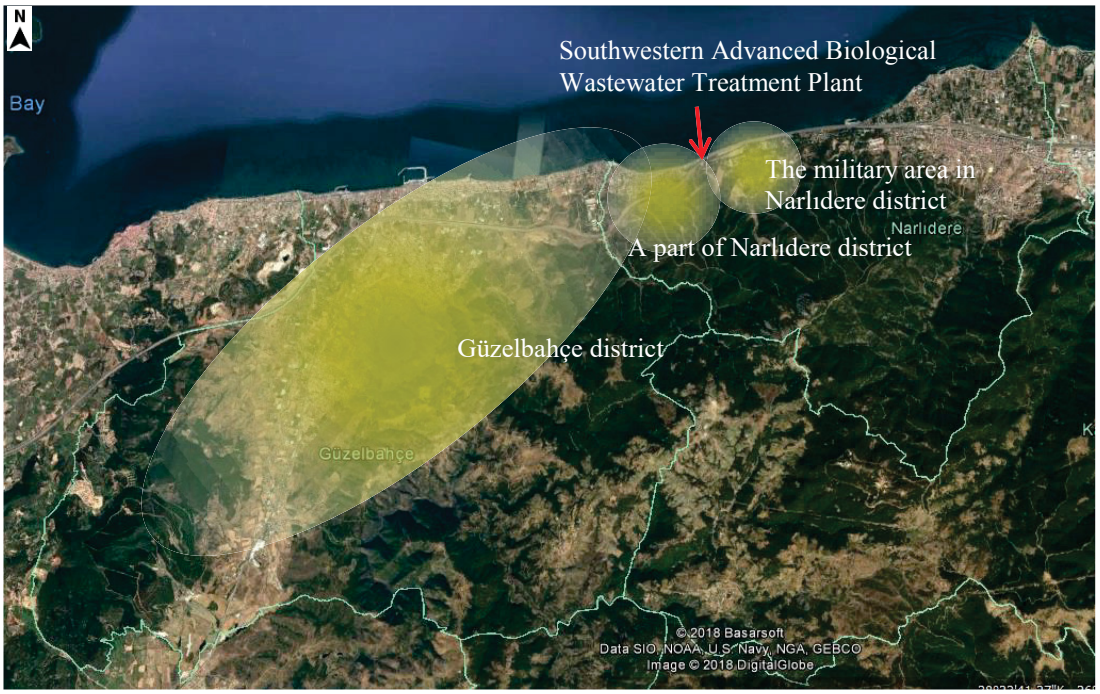


Figure 12. Settlements which of wastewaters treated by the Southwestern Advanced Biological Treatment Plant (Source: Google Earth, 2018)

Limanreis neighborhood is one of the 11 neighborhood under the responsibility of Narlıdere Municipality. The population of Limanreis neighborhood in 2017 was 2643 people (TÜİK, 2018) and this neighborhood is one of the neighborhoods with the lowest population.

Table 2. The population of the neighborhoods under the responsibility of Narlıdere Municipality in 2017 (Source: TÜİK, 2018)

Neighborhoods	Population
2. İnönü	9087
Altıevler	2195
Atatürk	5631
Çamtepe	6360
Çatalkaya	6903
Huzur	9735
Ilıca	8803
Limanreis	2643
Narlı	7441
Sahilevleri	1851
Yenikale	5620

Figure 13 shows the population distribution of Limanreis neighborhood between 2007 and 2017 years. In 2010, the population peaked by reaching 2.705 people, but after this year there were fluctuations and the population decreased in 2017 compared to 2016.

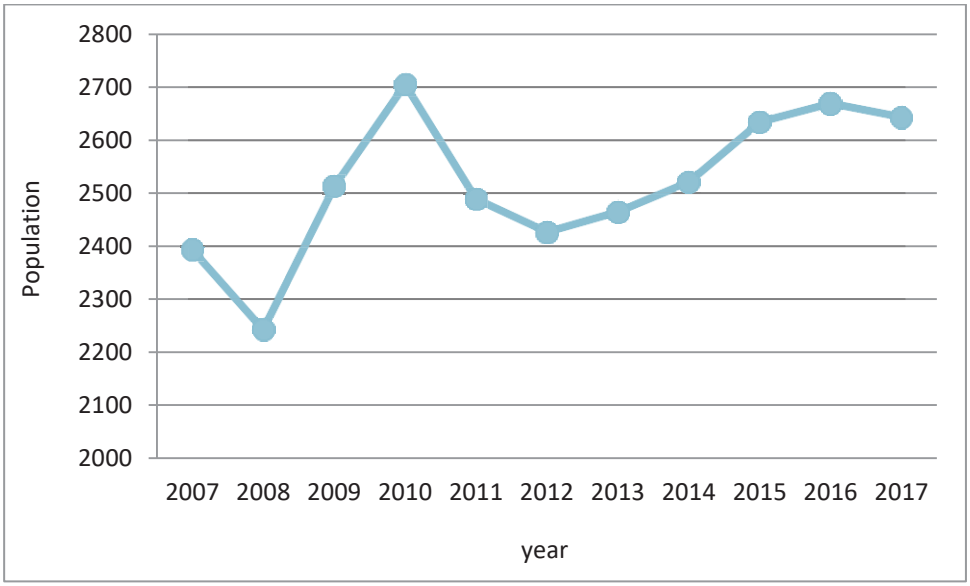


Figure 13. Population distribution of Limanreis neighborhood by years (Source: TÜİK, 2018)

The treatment plant is established on 1.5-hectare area and taken into operation in October 2002. The facility is the second wastewater treatment plant constructed within İzmir Grand Canal Project (İZSU, 2018).

Figure 14. Location of The Southwestern Advanced Biological Wastewater Treatment Plant (Source: Google Earth, 2018)

There is a military area to the east of the treatment plant. To the south of it a forest area and to the west of it residential areas are located. As seen in the Master Plan, residential areas are located very close to the wastewater treatment plant. The nearest residence is 300 m distance from this facility.

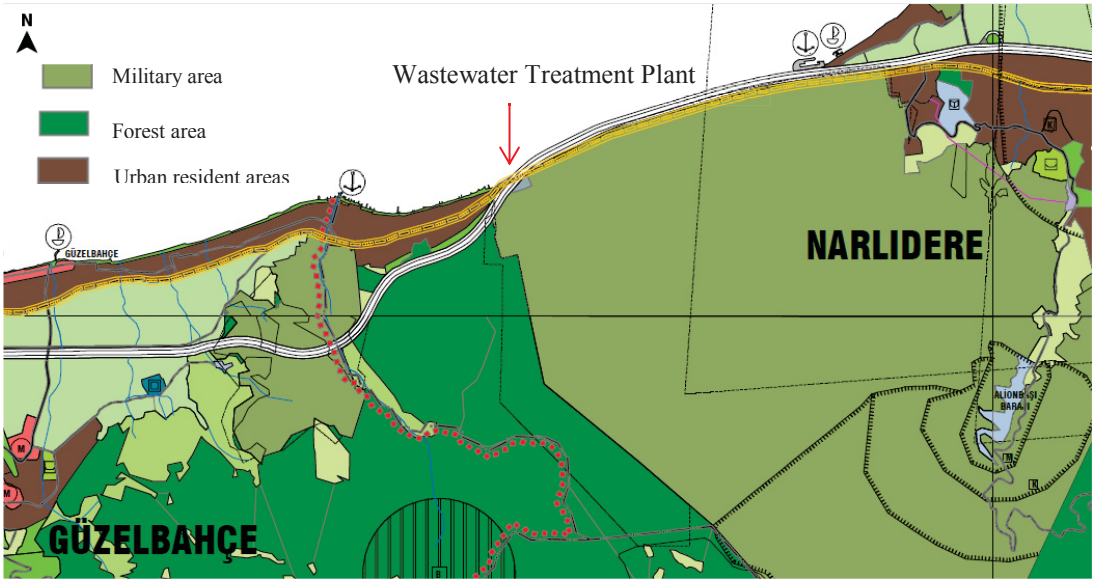


Figure 15. 1/25000 scale İzmir Urban Area Master Plan (Source: İzmir Metropolitan Municipality, 2009)

The treatment plant has a capacity of 21.600 m^3/day and currently treats 17.430 m^3/day of wastewater in dry air. The purified wastewater in the Southwestern Advanced Biological Wastewater Treatment Plant is discharged to a depth of 25 m in the middle bay area of the İzmir Gulf with a 600 m long sea discharge line. The treatment plan consists of coarse grid, wastewater pumping center, fine grid, ventilated sand and oil catcher, anaerobic tank, aeration tank, final settling tank, sea discharge structure and sludge dewatering system (İZSU, 2018).

Figure 16. Southwestern Advanced Biological Wastewater Treatment Plant Units (Source: İZSU, 2018)

In the wastewater treatment process, the wastewater which is collected from the Güzelbahçe urban settlement area and the Narlıdere military unit area is conveyed to the coarse grid and pumping center by collector lines. In coarse and fine grids, large particles in the wastewater are kept and separated from the wastewater. Solid materials held in coarse and fine grids are collected in containers and sent to Harmandalı Regular Storage Area (İZSU, 2018).

In the next stage, in the ventilated sand holder, the wastewater is prepared for biological treatment by keeping the sand and similar material in the wastewater which may damage the pump and other mechanisms and by keeping the oil in the wastewater that leads to clogging in the pipes. Then, in the anaerobic tank wastewater is suspended for 1.5 hours in non-aeration conditions, so that the phosphorus in the wastewater is dissolved and thus the phosphorus treatment efficiency is increased in the biological treatment unit. In case of insufficient removal of phosphorus by biological methods, the anaerobic tank is dosed with the $FeCl_3$ solution to remove excess phosphorus in the wastewater as $FePO_4$ and remove it from the wastewater (İZSU, 2018).

In the next stage, in the aeration tank, organic substances in wastewater are consumed as nutrients by microorganisms in the provided aerobic environment. In addition, in the nitrification-denitrification process, the nitrogen in the wastewater is given to the atmosphere in gas and thus nitrogen removal is also provided. Then, the mass of microorganisms formed in the aeration tank is separated from the water by sedimentation in the final settling tank. When the treated water is taken to the deep sea discharge structure, the settled sludge is returned to the anaerobic tank with the recirculation structure. Finally, the treated wastewater is discharged to the sea at a depth of 25 m with a discharge line 600 m long laid on the seafloor (İZSU, 2018).

5.2. Survey Studies & Interviews

Within the scope of this thesis, household survey studies were conducted in the residential areas located to the west of the Southwestern Advanced Biological Wastewater Treatment Plant in Limanreis neighborhood in the Narlıdere district. Because of the presence of a military area east of the treatment plant, no survey was conducted in that area. At the same time, interviews by questionaries with headman of Limanreis neighborhood, with an environmental engineer working in the facility, and with three different real estate agents were conducted. In this section, the results obtained from the household survey studies and from the interviews conducted through the questionnaires are analyzed.

5.2.1. Household Survey Studies

Between 25 December 2017 and 19 March 2018 survey studies were conducted on the residents who live within 1 km distance from the Southwestern Advanced Biological Wastewater Treatment Plant in Limanreis neighborhood. The aim of the survey is to understand the odour impacts emitted from the facility on the residents and real estate values in the surrounding area.

The reason for the study area boundary which is 1 km distance away from the wastewater treatment plant is that the odor is no longer felt by the residents. In the study area, there are mainly residential buildings. There are two hotels and a grocery store.

There is a science and art center and an education and rehabilitation center in the area. There are approximately 402 houses within a distance of 1 km.

Figure 17. Limanreis neighborhood boundary and the study area boundary
(Source: Author, 2018)

Figure 18. Land use in the study area
(Source: Author, 2018)

This survey study was conducted on people who are willing to answer the questionnaire. 31 people responded to this questionnaire. 28 people of the respondents

are residents and 3 people of the respondents are workers in trade units located in survey field which are two different hotels and a grocer. The surveys were conducted from Serdar Street that is the nearest street to the facility to Menekşeli Street that is the street 1 km away from the facility.

Figure 19. Location of surveyed residents relative to wastewater treatment plant (Source: Author, 2018)

The average age of residents who responded to this survey is 54.9. People in the age range of 41-50, 51-60 and 71-80 mainly answered the questionnaire. Especially the age range 71-80 residents who have been living there for approximately 30 years.

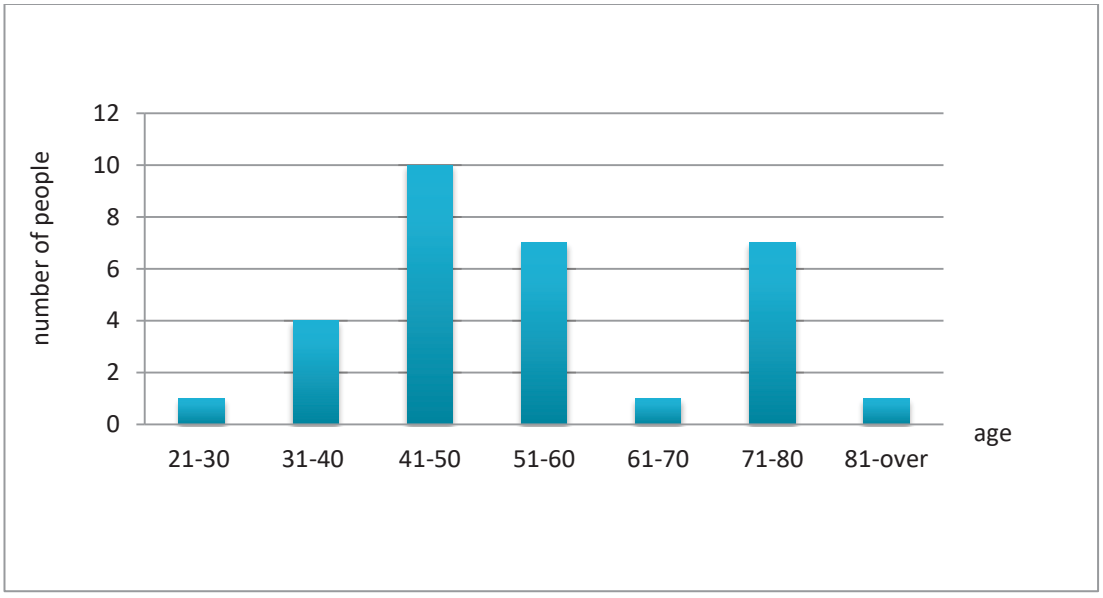
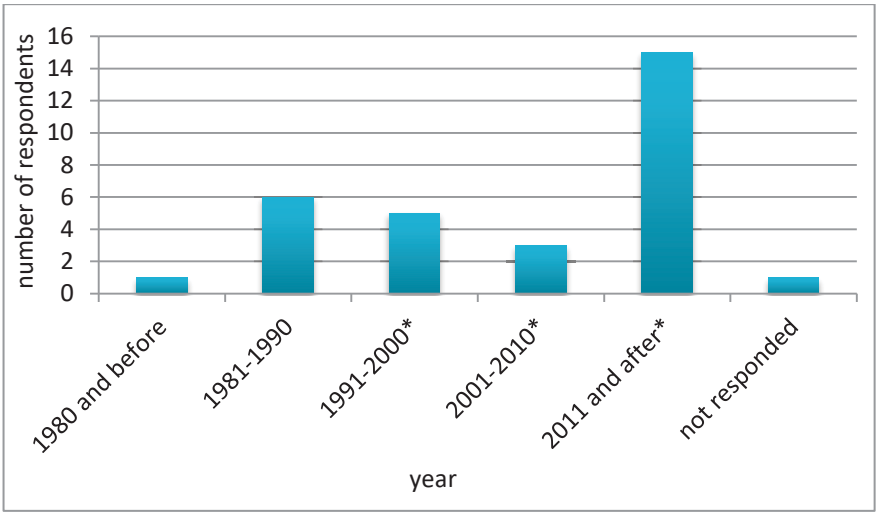


Figure 20. Age distribution of respondents (Source: Author, 2018)

Table 3. Professions of respondents
(Source: Author, 2018)

Profession	Number of people
Retired	10
Housewife	4
Engineer	2
Hotel and grocer employees	3
Freelancer (textile, canteen keeper)	5
Teacher	3
Sportsman	1
Gardener	1
Machine technician	1
Not responded	1

Half of the residents who responded to the survey settled in this area after 2010 year. At the same time, settlements in this area are quite common in the 1980s and 1990s.



*Three of the respondents are working in two different hotels and a grocer located in the survey field. For this reason, the years when the three respondents started working in that trade units are included. One of the people working there who responded to the survey is the person working in the market there since 1996. The other has been working in the hotel since 2001. Another one has been working in the other hotel since 2015.

Figure 21. Years of the settlement of the respondents to this place in Limanreis neighborhood (Source: Author, 2018)

Three of the respondents have lived constantly in the neighborhood. 21 respondents come from different districts of İzmir and most come from the districts of Konak, Narlıdere, and Karabağlar. There are also people from cities like Konya, Aydın, Balıkesir, Antakya and from the black sea region.

Table 4. The places where respondents come from to this place in Limanreis neighborhood (Source: Author, 2018)

<table>
<tr><th colspan="5">Places</th><th>Number of People</th></tr>
<tr><td colspan="5">Abroad</td><td>1</td></tr>
<tr><td colspan="5">Out of İzmir</td><td>5</td></tr>
<tr><td rowspan="9">Districts of İzmir</td><td>Narlıdere</td><td>5</td><td>Limanreis neighbourhood</td><td>3</td><td rowspan="9">21</td></tr>
<tr><td>Gaziemir</td><td>1</td><td rowspan="8" colspan="2"></td></tr>
<tr><td>Urla</td><td>1</td></tr>
<tr><td>Güzelbahçe</td><td>2</td></tr>
<tr><td>Çiğli</td><td>1</td></tr>
<tr><td>Konak</td><td>4</td></tr>
<tr><td>Bornova</td><td>1</td></tr>
<tr><td>Karabağlar</td><td>4</td></tr>
<tr><td>Karşıyaka</td><td>2</td></tr>
<tr><td colspan="5">Not responded</td><td>4</td></tr>
</table>

Twenty-one of the twenty-eight residents surveyed are homeowners and seven of the twenty-eight residents are tenants. Due to the fact that the homeowners do not remember the purchase prices of their houses very clearly and because of the changes in the currency, only five residents stated the purchase price of their houses. This price range varies between 200 thousand TL and 850 thousand TL. For this reason, results of the question of " how much did you buy your home? " are not properly assessed.

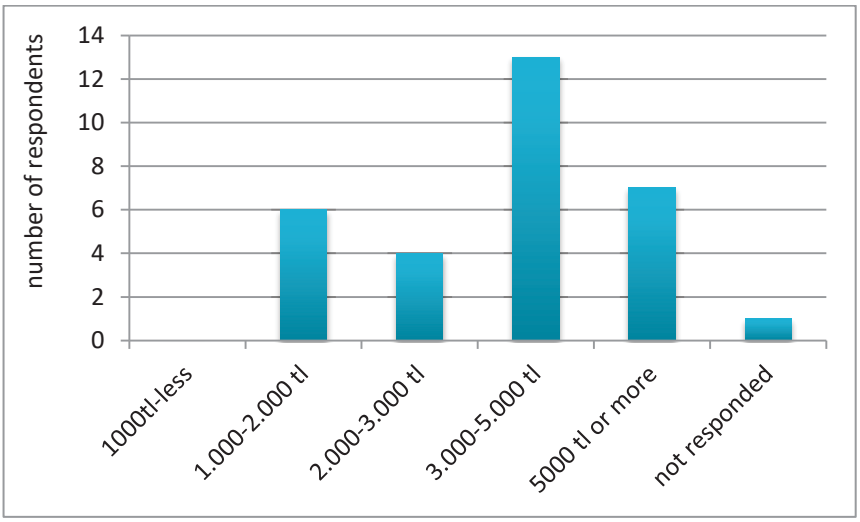


Figure 22. Distribution of income
(Source: Author, 2018)

The monthly income of the residents surveyed is mainly between 3.000-5.000 TL and seven of the residents have a monthly income of over 5.000 TL.

Table 5. Monthly rental fees
(Source: Author, 2018)

Tenants	Rental fees	Distance to the wastewater treatment plant
Tenant 1	860 TL	660 m
Tenant 2	1000 TL	480 m
Tenant 3	1500 TL	810 m
Tenant 4	1600 TL	825 m
Tenant 5	1750 TL	558 m

Note: Two of the 7 tenants did not specify the rental price

Seven of the residents surveyed are tenants. Five tenants of the residents surveyed stated the rent for their houses. Tenants who live 480 meters and 558 meters away from the wastewater treatment plant pay respectively 1.000 TL and 1.750 TL rental fee. Tenants who live 900 meters away from the facility pay 1.500 TL-1.600 TL rental fees.

Figure 23. Distance of tenants to the wastewater treatment plant
(Source: Author, 2018)

The sizes of houses of the residents surveyed vary from 70 m^2 to 450 m^2. 13 of the surveyed residents state that their houses are between 70-120 m^2 in size and 5 residents state the sizes of their houses are between 121-150 m^2. The houses of the residents who responded to the survey have predominantly 4, 5 and 6 rooms.

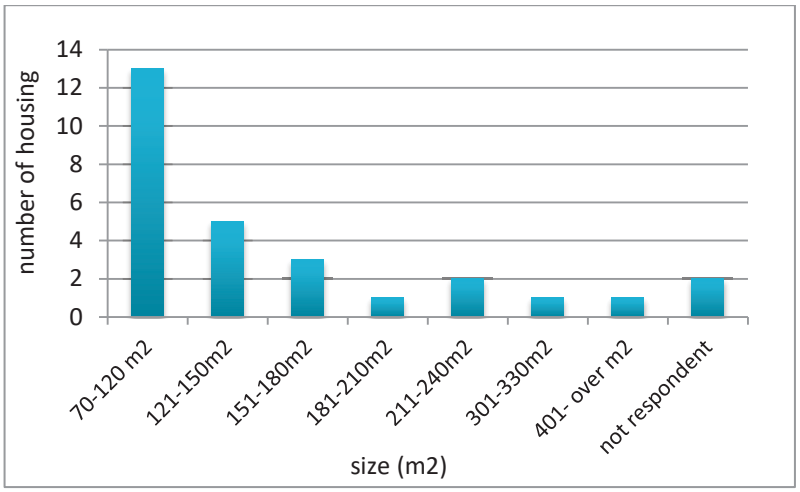


Figure 24. The size of houses of the residents surveyed
(Source: Author, 2018)

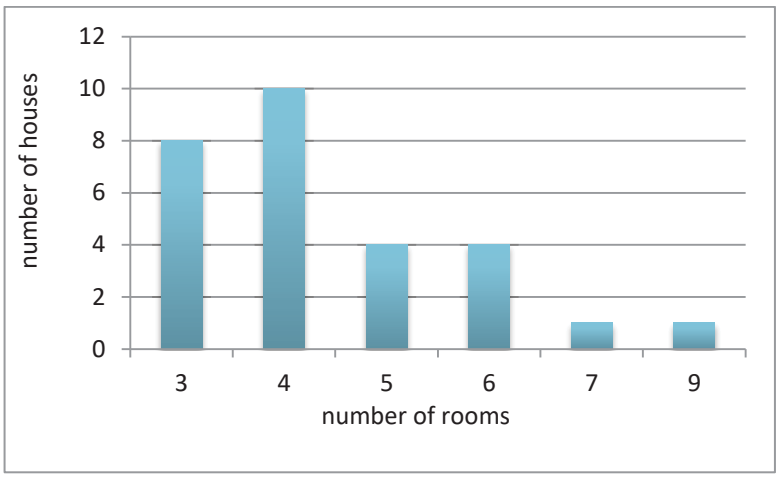
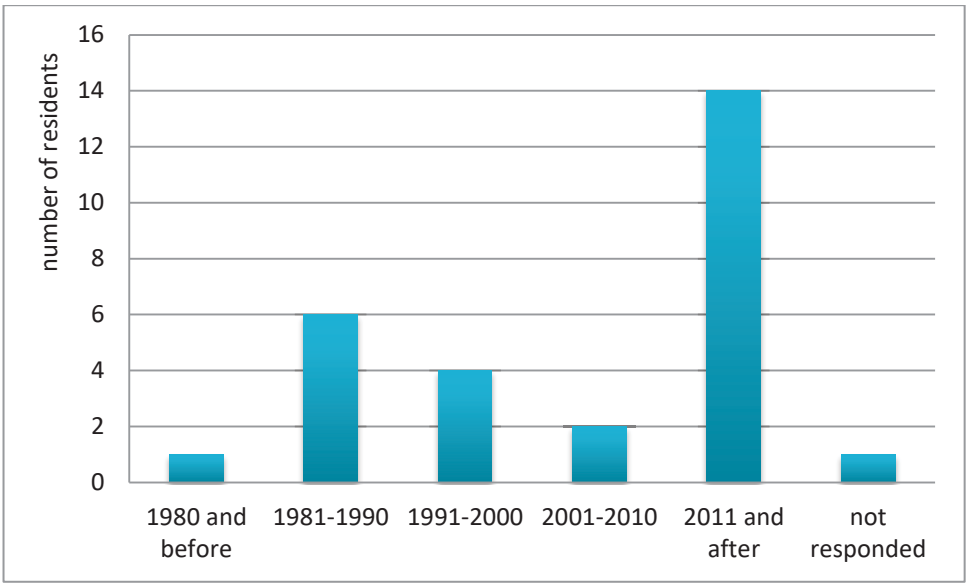


Figure 25. Distribution of number of rooms in houses of the residents
(Source: Author, 2018)

There is no central heating system in the houses in general. The heating is provided by an air conditioner, stove, heat pump. Only one house has pool among the houses of residents surveyed. Twelve of the 28 houses have been renovated. Only two of the houses are located on the slightly sloping street and the others are located on the flat streets. Nineteen of the 28 houses have the sea view.

Eleven of the 28 residents stated that there was no any wastewater treatment plant when they settled in this neighborhood. However, when seventeen of the 28 residents settled in this neighborhood, the facility had been already in operation since 2002. Figure 26 shows the settlement years of the residents in this place in the neighborhood.

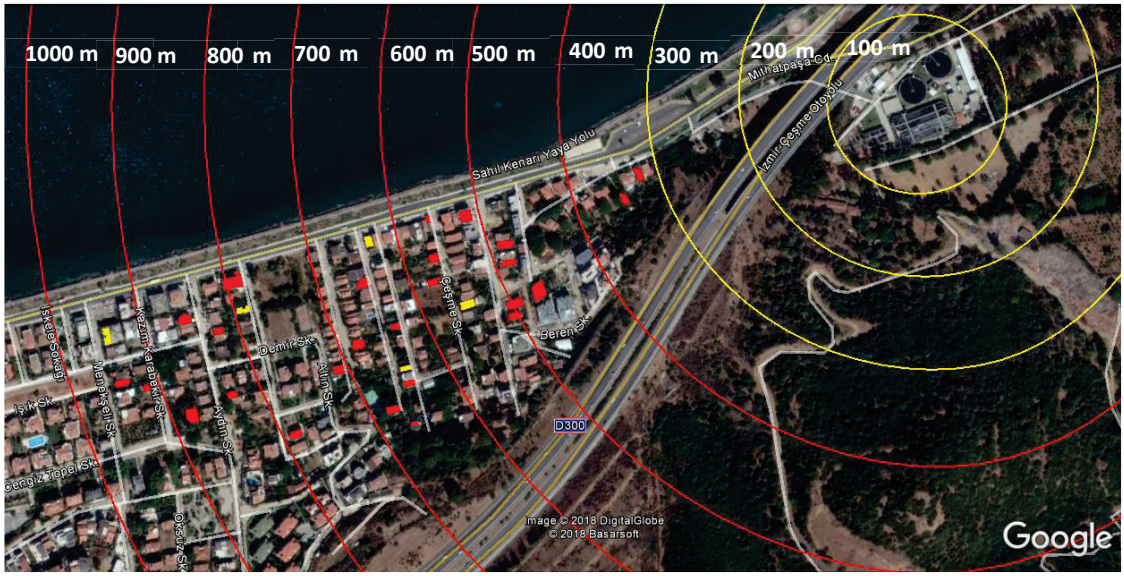


Note: Three employees working in trade units are not included in this data set. The graphic shows only answers of the 28 residents surveyed.

Figure 26. Years of the settlement of the residents to this place in Limanreis neighborhood (Source: Author, 2018)

The 26 respondents stated that the odour comes from the wastewater treatment plant to their living area. Only 5 respondents state that there is no odour from the facility to their living area. The 5 respondents are residents 500 m-1000 m away from the treatment plant. However, other residents living within these distances stated that odour from the treatment facility is felt. This situation reveals that the sense of odour changes from person to person. On the other hand, it can be deduced from the results of the survey studies that there is an odor in the living areas of residents living within 1 km of the wastewater treatment plant.

According to survey results, the unpleasant odour emitted from the facility is felt mostly in summer. Eleven respondents stated that the odour is rarely perceived in summer and 7 respondents specify that the odour is often felt in summer days. Twelve of the residents reported that they had heard of such a smell before moving this area. Some of them stated that they settled there because they thought that odour would not come to the location of their houses. Some of the residents specified that they settled there because of the odour is felt very rarely. One of the residents who has lived there since 1997 indicated that there was no such an odour before the construction of the treatment plant.



Note: Red colour shows that the odour emitted form the treatment plant is felt in their living area. Yellow colour indicates that odour from the treatment plant is not felt in their living area.

Figure 27. Location of the respondents who have felt the odour emitted from the facility in their living area (Source: Author, 2018)

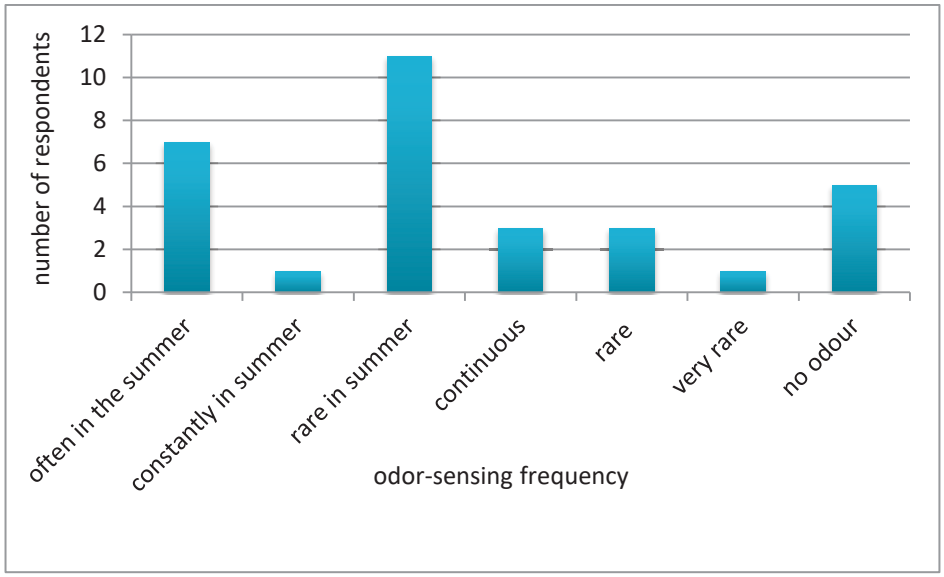


Figure 28. The perceived frequency of the unpleasant odour emitted from the treatment plant by respondents (Source: Author, 2018)

Because of the odour emitted from the treatment plant, residents living within the 1 km distance from the facility have been experienced some problems. Many people state that they could not open the windows, they could not attend outside activities, they could not host their guests, their children could not play outside. Some of the

respondents state that they have been exposed to some health problems such as nausea, nervousness, difficulty breathing, nasal combustion due to the unpleasant odour.

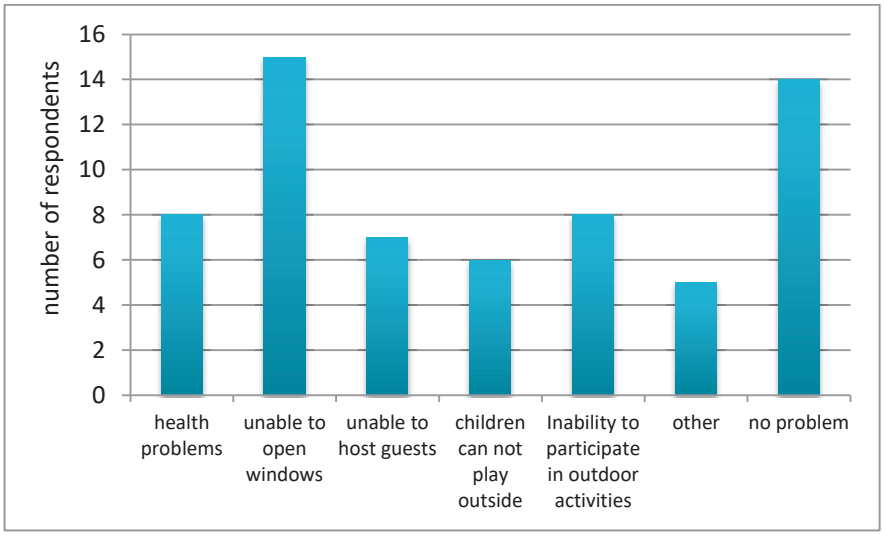


Figure 29. Problems experienced by the respondents due to the odour emitted from the treatment plant (Source: Author, 2018)

Those who responded to the survey expressed the following complaints due to the odour emitted from the wastewater treatment plant;

One of the residents stated that " We can not go out to the garden especially in summer times when there is an odour. We have settled the houses with gardens to feel the flower smell, but this odour even suppresses the flower smell."

One of the employees working in a hotel which is 518m away from the treatment plant stated that " Customers feel the odour. Those who come here to buy a house in this area accommodated in the hotel for a while, but because they feel the odour, they give up buying a house from this area."

One of the residents stated that " This makes a bad impression on the environment. We are asked questions such as "Are you sitting on the unpleasant odor area?"

One of the residents stated that " Those who come to buy a house in the area ask whether the odour is the field in this area or not. The odour decreases the value of the houses around. There are lots of sale, rental properties near the treatment plant. There are those who regret buying houses in this area without knowing, they try to sell their houses again or try to rent them."

One of the employees working in a hotel which is 772 m away from the treatment plant stated that " The customers are very uncomfortable and complaining. The odour is felt from the rooms of the customers and approximately 50 percent of the customers usually complain. A customer was thinking about opening a patisserie in this area, but he was disturbed by the odour and gave up his idea."

One of the residents stated that " The plant needs to be completely removed. The area is out for fresh air. We can not go to the beach. I complain a lot. Was there no other place for this facility? We can not get the child into the air, we are being poisoned. This area is one of the most beautiful places in İzmir, but the treatment plant influences very negatively the surrounding area. The odor affects the housing values. There are same rental and sale advertisements for many years in the nearby environment of the facility. Those who want to buy home ask if it smells. In fact, it is a very precious, very beautiful place, but this facility affects very badly."

One of the residents stated that " The odor is very uncomfortable. We knew the facility before we moved here, but we did not know it was so uncomfortable. The smell affects the coastal use. I do not want to sit outside. I did not complain to the authorities, but I want to collect signatures and complain. I expect a solution. My son wanted to take the house next door but he gave up his idea because of the unpleasant odour. There is no any problem except the odour. "

The results of the survey indicate that the odour affects the daily life of the residents and workers in that area and their health. People are quite uncomfortable with this situation because this situation reduces the quality of life of the residents.

Sixteen of the 28 residents are uncomfortable with the presence of the wastewater treatment plant in their living area. However, other 12 residents are not disturbed by the presence of treatment facilities around their living area. Respondents are most likely to complain of odour emitted from the wastewater treatment plant than other problems.

Seven of the residents surveyed have complained to the district municipality and to the headman of the Limanreis neighborhood because of the odour. These complaints have been performed by collecting signatures and verbally. But they state there is no any solution.

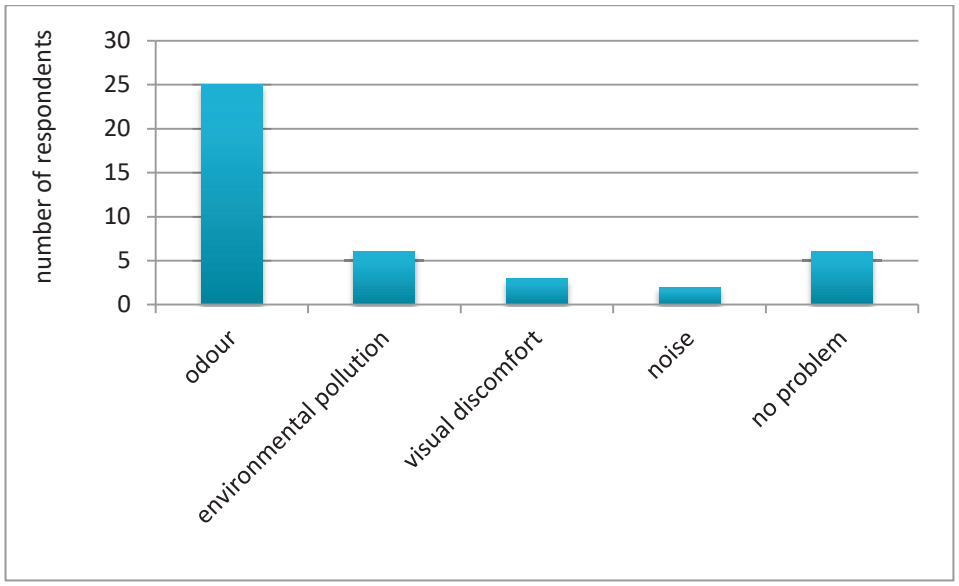
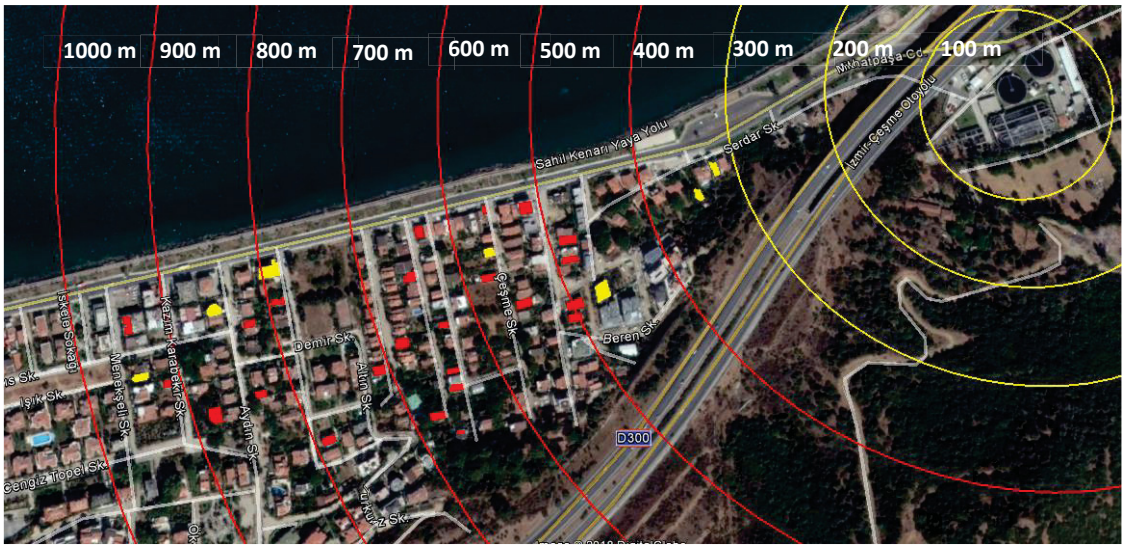


Figure 30. Problems that the facility creates in the nearby environment (Source: Author, 2018)

On the other hand, although there are so many problems and complaints, some people are pleasant to live in this area because they like the lifestyle in the area. Houses with garden, quiet environment, closeness to the city center, and nice coast are the reason for them to live in this area.



Note: Yellow colour shows the distance from the facility of residents who who complained to the local authorities due to the odour.

Figure 31. Distance from the facility of the residents who complained to the local authorities due to the odour (Source: Author, 2018)

Table 6. Odour impacts on the real estate values
(Source: Author, 2018)

Do you think that the wastewater treatment plant has an effect on the sale prices of real estates in the area?	number of respondents
yes	25
no	6

Twenty-five respondents think that the odour emitted from the wastewater treatment plant affects real estate values in the surrounding area. Nineteen respondents stated that because of the odour from the treatment plant, there are houses that have been advertised for sale or rent but can not be sold or leased. Some of the residents specify that there have been houses that can not be sold and cannot be rented nearly for 3 or 4 years.

Figure 32. Some of the houses for sale and rent in the study area
(Source: Author, 2018)

According to the tax base current land values (TL/m^2) received from the Narlıdere Municipality, there is no decrease in these values for residences located close to the facility, although the residents have losses.

Figure 33. Tax base current land value (TL/m^2) in Limanreis neighborhood (Source: Narlıdere Municipality, 2018)

According to answers of the respondents, there is no any reduction in the real estate tax due to the odour emitted from the wastewater treatment plant and there is no any compensation forms for the losses of the residents living in the nearby environment. The respondents only demand the removal of this odour rather than the compensation mechanisms.

In the questionnaire study, it was asked to the residents that " What kind of compensation forms you would like to apply for your losses due to the odour from the facility? " If compensations mechanisms are to be implemented, 18 respondents desire the regulation of the environmental quality, 12 respondents accept the tax reduction or tax rebate for their houses and 14 respondents accept the protection of their houses values or payment of the lost value of their houses. 5 respondents do not embrace any compensation method.

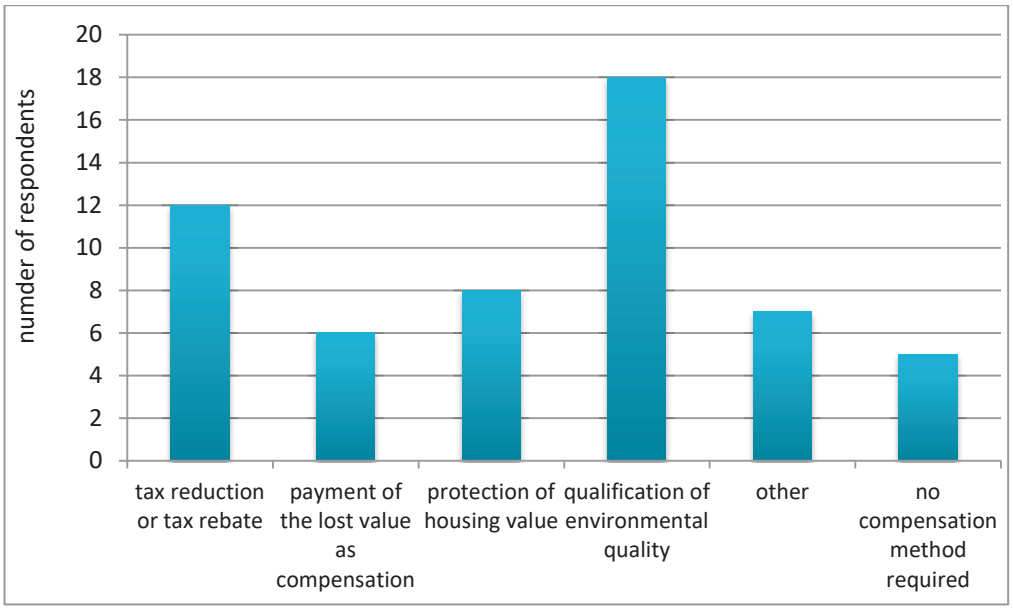


Figure 34. Compensation forms for the respondents who affected from the odour emitted from the facility (Source: Author, 2018)

On the other hand, attitude of the thesis is that people are never exposed to such an odour and it should not be allowed to affect the daily life of the people, the health of the people, the quality of the surrounding environment, and the values of the houses in the immediate vicinity of the treatment plant. Because as stated in the Article 56 of the Constitution of the Republic of Turkey that " Everyone has the right to live in a healthy and balanced environment."

5.2.2. Interviews

In this study, interviews were held with an environmental engineer working in the wastewater treatment plant, with the headman of the neighborhood, with three different real estate agents. First of all, it is mentioned the interview held with the headman of the neighborhood via the questionnaire on 25 December 2017. He has been headman in this neighborhood since 1999. So that when he was the headman of the neighborhood, the treatment plant had not been built yet. He states that the treatment plant started to service in 2002 and it purifies the collected wastewater from Güzelbahçe, Çamlı, Yelki, a part of Narlıdere settlements and military area.

The headman of the neighborhood specifies that he has received so many complaints so far due to the odour emitted from the wastewater treatment plant. He has

reported about 200 complaints from the residents since 2010 due to the odour. He expressed that the most complaints come from the residents sitting on the streets which are Serdar Street, Aziz Street, Beren Street, Şair Fuzuli Street, Çeşme Street and Beyazıt Street. These Streets are within 700 m from the treatment plant. He stated that the odor is most noticeable when the southwestern wind blows, over evenings and in summer times.

Figure 35. The streets which complained most to the headman of the neighborhood due to the odour (Source: Author, 2018)

The headman of the neighborhood pointed out that complaints had been reported to İzmir metropolitan municipality on 6 October 2017 and the municipality had stated that the issue would be resolved within 6 months. The headman of the neighborhood specified that the existence of the treatment plant disturbs the residents of the neighborhood. It adversely affects the real estate values in the surrounding area and the odour causes the depreciation of the houses near the facility.

The headman of the neighborhood reported that due to the odour from the facility, there have been sold, rented or vacant houses. Although the headman could not give an exact number, he estimates that about 15 houses have been advertised for sale or rental and about 6 or 7 houses are vacant due to the odour. He stated that these houses cannot be sold or rented due to the issue. The headman of the neighborhood also specified that no compensation forms have been applied to the residents who are affected negatively by the odour. When the opinion and proposals of the headman of the

neighborhood were asked, he stated that " if closed sewage trucks are used, the issue can be solved. The facility can be moved further if 1 or 2 km area from the nearest military area is obtained, but this facility cannot be removed completely."

An environmental engineer working at the treatment plant was interviewed on 26 December 2017 via questionnaire. She has been working since the 2011 year. She stated that the facility serviced in the 2002 year and it was built as part of the İzmir Grand Canal Project. It was established to purify the collected wastewater from the Güzelbahçe district and a part of the Narlıdere district. She specifies that the capacity of the treatment plant is 21.600 m^3/gün and the facility is currently operating at full capacity. It is located in 15000 m^2 area but this area it is not enough and more field is needed.

She stated that she is pleased to be working in the treatment plant. She mentioned that the wastewater treatment plant does not have any negative effects on the environment, contrarily the facility prevents the wastewater from flowing directly into the sea. However, she stated that there were 30 complaints by the residents of the neighborhood in the 2017 year due to the odour emitted from the facility. Most complaints come from the residents in the Limanreis neighborhood between May and October months of the 2017 year. She pointed out that these complaints mostly involve problems such as not being able to open the windows, not being able to host the guests and not go out to the balcony. She also specifies that compensation forms have not been applied to the residents who are affected negatively by the odour.

When the opinion and proposals of the environmental engineer working in the facility were asked, she stated that " The primary purpose is to resolve resident's discomfort. For this reason, a project will be carried out. The procurement of this project has been completed and the construction process will be completed within one year. According to this project, over the units which emit odour in the treatment facility will be covered. Units will be passed through odour units to understand which of the units emit the odour. Air induction fan systems will be used." According to her ideas, discrete sewer system can be implemented and over of the units, emitting odour should be covered. She expressed that treatment plants should be a part of the cities and people from different professions should work together so that better solutions emerge to live in a healthy environment.

Besides the headman of the neighborhood and the environmental engineer working in this facility, interviews were held with 3 different real estate companies. The

interviews were held with three different real estate agents via a questionnaire on 26 March 2018 in the Narlıdere district. The aim of the interviews is to understand the impacts of the odour emitted from the Southwestern Advanced Biological Wastewater Treatment Plant on the real estate values in its surrounding area.

These three real estate agents stated that the wastewater treatment plant affects the purchase and sale of the houses in the surrounding area of the facility. The three agents reported that the houses which are located in the nearby environment of the facility are not sold or not rented for a long time. Two real estate agents identified that values of the houses are lower than that of the houses located further away.

Table 7. Effects of the odour from the facility on houses in the surrounding area (Source: Author, 2018)

How does the wastewater treatment plant affect the purchase and sale of houses in the surrounding area?	**Real estate agent 1**	**Real estate agent 2**	**Real estate agent 3**
not sold for a long time	X	X	X
not rent for a long time	X	X	X
often advertises for sale	X		
often the tenant changes			X
value is less than other houses	X		X
not used	X		

One of the real estate agents stated that there have been sale announcements of the houses for 3 or 4 years in that area. The houses are generally sold to people who do not know İzmir and then the people try to sell the houses again due to the odour. The realtor identified that in fact, the area is very valuable, but nearly 50 houses are threatened by the odour emitted from the facility. There is at least 30 percent - 40 percent effect negatively on sales values of the houses in the surrounding area. Even though the sales values of the houses are so much affected, the houses still cannot be sold. The houses are rented more cheaply, but it is so difficult to find qualified tenants. Some tenants stay for 3 - 5 months and then leave without paying the rent. The realtor stated that it is rarely possible to sell a house in the Limanreis neighborhood. For instance, when 50 houses are sold in a year in Urla, 2 houses are hardly sold in a year in the neighborhood.

The realtor specified that most of the houses on the streets which are Serdar Street, Aziz Street, Beren Street, Şair Fuzuli Street and Çeşme Street are affected. When the opinion and proposals of the realtor are asked, he emphasizes that " The odour

problem changed the people profile that lives there. It is difficult to find qualified tenants. The municipality should expropriate this area and offer compensation forms for the residents. If I exposed to such a problem, I would apply to the Human Rights Court"

One of the other real estate agents stated that the odour affects adversely the sale values of the houses at least 30 percent - 50 percent. There have been many people who regret buying the house in this area. The realtor expressed that the values of the houses located within 700 m from the treatment plant are highly affected by the odour. When the opinion and proposals of the realtor were asked, the realtor stated that modern technology should be used in the facility and open units which emit odour in the facility should be covered.

Another real estate agent stated that those who want to buy a house from that region ask if it is close to the treatment plant. If the house is too close to the facility, people do not even want to see. There is at least 20 percent-30 percent effect negatively on sales values of the houses in the surrounding area. The realtor stated that the values of the houses located within 600 m from the treatment plant are highly affected by the odour.

As a consequence, it is revealed results from the household surveys, interviews with the headman of the neighborhood, with an environmental engineer working in the treatment plant, and with the real estate agents that the unpleasant odour emitted by the treatment facility affects negatively the health of the people living in the immediate vicinity, their daily life, their living environment and the values of their house.

5.3. Hedonic Price Method

As stated in the literature review, Hedonic Price Method is a common technique to understand whether the exposure to hazardous waste sites and undesirable land uses have an adverse effect on adjacent property values. In this study, the impact of the odour emitted from the Southwestern Advanced Biological Wastewater Treatment Plant on the housing prices has been pursued via the Hedonic Price Modeling. The housing prices required for this method were obtained from the residents and a real estate agent. However, since the dataset in the area is quite limited, we prefer rather a small number of variables in order to not lose too many degrees of freedom.

Table 8. Housing prices (TL) based on the distance to the wastewater treatment plant (Source: Data received from residents and a real estate agent, 2018)

Housing prices (TL) based on the distance to the wastewater treatment plant							
Houses	**300 m- 400 m**	**401 m -500 m**	**501 m -600 m**	**601 m-700 m**	**701 m-800 m**	**801 m-900 m**	**901 m -1000 m**
1	800-900 thousand						
2	1 million 250 thousand						
3		3 million 800 thousand					
4		600 thousand					
5		1 million 100 thousand					
6		1 million					
7		1million 500 thousand - 2 million					
8			4 million				
9			500 thousand				
10			1 million				
11			500 thousand				
12			800 thousand				
13				275 thousand			
14				700 thousand			
15				1 million			
16				275 thousand			
17				400 thousand - 500 thousand			
18				500 thousand			
19				1 million			
20				1 million 200 thousand			
21				1 million			
22					5 million		
23					800 thousand		
24					1 million 750 thousand		
25						1 million	
26						550 thousand	
27						1 million 500 thousand	
28						2 million	
29							800 thousand
30							850 thousand - 900 thousand
31							250 thousand - 300 thousand

Note: Pink colour represents the prices which are received from a real estate agent. Grey colour represents the prices which are received from the residents.

On the other hand, since the number of observations is small, the margin of error in the results may be high. In the table 9, we present the results of Ordinary Least Squares regression estimation. The first column represents the independent variables whereas the dependent variable is the price of the houses in Turkish Liras.

The results indicate two important points. The first one is the statistical importance of the house size in this district. Such that 1 metersquare more big house adds 5979 TL to the value. The second important result is that distance to the wastewater plant costs 652 liras fall in the value in every 1 meters closer to the wastewater plant. In other words, a house that is 100 metres away from the waste plant is 65.200 TL more valuable than the one which is just next to the plant. So, It has a quite big and detrimental effect on housing values. Finally, the estimated equation of the hedonic price model is the following:

$$Price = 591164 + 5979\ x\ size + 1162\ x\ distance\ from\ sea - 10066\ x\ age + 120 \text{ x parcel} - 652 \text{ x } \textit{distance from waste water}$$

Table 9. The results of Ordinary Least Squares regression estimation
(Source: Own calculations, 2018)

Variable	Coefficient	STD Error	T-Stat	Probability
Constant	591164	773802	0,76	0,46
Size (metersquare)	5979***	1359	4,40	0,00
Distance from Sea (meters)	1162	1918	0,61	0,55
Age (years)	-10066	8274	-1,22	0,24
Parcel (metersquare)	120	136	0,88	0,39
Distance from WasteWater (meters)	-652	657	-0,99	0,33
R-squared	0,681728			
N=23				

*** represents statistical significance at 1%

All in all, besides the results of the questionnaires and interviews, Hedonic Price Method indicates that the odour emitted from the treatment plant has a significant negative impact on housing values in the nearby environment.

CHAPTER 6

CONCLUSION

Wastewater treatment plants are one of the important technical infrastructure systems in cities. The location of these facilities is at least as important as themselves. Because these facilities can create negative externalities and these externalities can negatively affect people and environment.

The aim of the study is to examine the odour impacts from the wastewater treatment plants on people living around and on property values in surrounding area. In the literature review, it is deduced that environmentally unwanted infrastructure facilities have created some problems both on people and on property values as well as on the environment. And researches conducted have also shown that location choice of this kind of facilities is a controversial planning issue in local communities. Location criteria of wastewater treatment plants both in Europe and in Turkey were examined and some main principles for siting of the wastewater treatment plants were indicated.

Complaints related to odour issue and news published on the internet about protests against to odour emitted from wastewater treatment plants both in the world and in Turkey were explored. It is apparent from the results of this research and from our case study that people have been experienced relatively important and similar problems due to the unpleasant odour from the wastewater treatment plants. If a general framework is drawn, this issue influences negatively people's daily life activities, the health of the individuals, quality of the living environment, physical environment, property values and causes economic losses.

In this study, it was examined the compensatory mechanisms, different views on these compensations in the context of environmental ethics and environmental justice movement. It is deduced from the examination that monetary compensations are less favorable than nonmonetary compensations. Because monetary incentive is considered as a bribe and it does not seem appropriate as morally. Another deduction is that siting of the undesirable land uses in racial and ethnic minorities and other disadvantaged groups created reactions and this led to birth of the environmental justice movement. The environmental justice has revealed that environmental laws, regulations, and

policies for the operation of such uses should be fair irrespective of people's color, race, origin, or income.

As a case study, effects of the unpleasant odour emitted from the Southwestern Advanced Biological Wastewater Treatment Plant in Narlıdere district in İzmir are revealed. The study field encompassed residential areas within 1 km of the facility. End of the study following results are observed.

First of all, it can be said that unpleasant odour is emitted from the treatment plant and the odour is felt by the residents living within this distance. It is felt by the residents especially in summer times and the southwestern wind blows. It is stated that most complaints come from the residents on streets within 700 m from the treatment plant and there have been about 200 complaints from the residents since 2010 due to the odour.

Secondly, the odour creates negative impacts on the health of the residents and their daily life. The residents have been exposed to some health problems such as nausea, nervousness, difficulty breathing, nasal combustion due to the unpleasant odour. Daily activities of the residents are restricted by the odour. For instance; they can not open their windows constantly, they can not attend outside activities, they can not host their guests, their children can not play outside, they can not take fresh air. The odour prevents the coastal use. Residents can not sit in their gardens, or their balconies of the houses. There is a bad impression on their living environment. Those who come to buy a house in the area ask whether the odour is felt in this area or not. There are those who regret buying houses in this area without knowing, they try to sell their houses again or try to rent them. There are dwellings that cannot be sold for a long time, are not rented for a long time, and are vacant around the facility.

Although there are so many problems and complaints, some people are pleasant to live in that area because they like the lifestyle in the area. Houses with garden, quiet environment, closeness to the city center, and nice coast are the reasons for them to live in this area.

Thirdly, the odour from the wastewater treatment plant affects the purchase and sale of the houses in the surrounding area of the facility. The houses which are located in the nearby environment of the facility are not sold or not rented for a long time. The values of the houses in the nearby environment of the facility are lower than that of the houses located further away. For instance, according to the result of the Hedonic Price Method in the study field, a house that is 100 meters away from the waste plant is

65.200TL more valuable than the one which is just next to the plant. So that the odour has a quite big and detrimental effect on housing values.

According to results of the questionnaires and interviews, there is no any compensation forms for the losses of the residents living in the nearby environment. The residents only demand the removal of this odour rather than the compensation mechanisms. They only want to live in a healthy environment. If compensations mechanisms are to be implemented, residents can accept some compensations such as the regulation of the environmental quality, the tax reduction or tax rebate for their houses, the protection of their houses values or payment of the lost value of their houses.

On the other hand, the attitude of the study is that people are never exposed to such an odour and it should not be allowed to affect negatively the daily life of the people, the health of the people, the quality of the surrounding environment, and the property values. Because all people are equal and all people have a right to live in a healthy environment and money or other compensation mechanisms cannot compensate for the losses of the people. As stated in the Article 56 of the Constitution of the Republic of Turkey that " Everyone has the right to live in a healthy and balanced environment."

The following dimensions could not be addressed in this study due to the time and labor constraints. The number of observations in the questionnaire study could not be carried out more. Interviews could be conducted with the owners of the empty houses in that area. Real sale values of the houses could be reached. Odour impacts from the wastewater treatment plant could be compared with the similar land uses such as landfills or industrial areas.

As a result, appropriate and advanced technology should be used in the wastewater treatment plant. This area can be expropriated and can be arranged as a public space such as the urban forest. A buffer zone can be created by arranging the landscaping between the wastewater treatment plant and the residential areas. Local government or central government have to develop some technical measurements to stop the negative effects or have to relocate the residents who are affected negatively.

REFERENCES

Asia-Pacific Regional Report, Regional Process Commission Asia, 2018

Antalyagazetesi. Zehir Kokulu Hurma. 2014. http://www.antalyagazetesi.com.tr/6277guncel-zehir-kokulu-hurma.html (acessed july 29, 2016)

Bafraajans. Yakakent'te atıksu tesisine mahalle halkından tepki. 2016. http://www.bafraajans.com/bafra-spor/yakakentte-atik-su-tesisine-mahalle-halkandan-tepki-h108916.html. (accessed July 29, 2016)

Balling R.C., Reynolds C.E., A model for evaluating the Dispersion of Wastewater Plant Odors, Journal (Water Pollution Control Federation), Vol.52, No.10 (1980), 2589-2593

Batalhone S., Nogueira J., Mueller B., Economics of air polluton: Hedonic price model and smell consequences of sewage treatment plants in urban areas, Department of Economics Working Paper 234, 2002.

BBC. Hedon residents launch petition against 'putrit' odours. 2011. http://www.bbc.com/news/uk-england-humber-14377031(accesed July 29,2016)

Been V., What's Fairness Got to Do with It? Environmental Justice and the Siting of Locally Undesirable Land Uses, 8 Cornell L. Rev. 1001 (1993)

Brancher M., Griffiths K. D., Franco D., de Melo Lisboa H., A review of odour impact criteria in selected countries around the world, Chemosphere 168 (2017), 1531-1570

Bullard R.D., Environmental Justice in the 21st Century: Race Still Matters, Phylon (1960-), Vol. 49, No. 3/4 (2001), 151-171

Butler D.& Davies W.J., Urban Drainage, 2nd Edition, 2004

Chelsea Municipal Council, Selection of the site of the wastewater treatment plant,2011.Availablefrom:http://www.chelsea.ca/sites/default/files/selectionofthewastewatertreatmentplan_en_final.pdf

City of Guelph, Introduction to wastewater. Available from: http://guelph.ca/wp-content/uploads/IntroductionToWastewater.pdf (accessed September 29, 2017)

Claro E., Exchange relationships and the environment: The acceptability of compensation in the siting of waste disposal facilities, Environmental Values, 16 (2007), 187–208

Corcoran E., Nellemann C., Baker E., Bos R., Osborn D., Savelli H., Sick Water? The central role of wastewater management in sustainable development, UNEP & UN-HABITAT, 2010

Curren J., Characterization of Odor Nuisance, University of California, A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Environmental Science and Engineering, 2012.

Deaton B. J., Hoehn J.P., The Effect Of Hazardous Waste Sites On Property Values In Zones Of High Industrial Activity: A Hedonic Approach, 2002

Environmental Health Perspectives, Strategic Elements for Environmental Justice, Vol. 103, No. 9 (1995), 796-800

EPA (Environmental Protection Agency). Learn About Environmental Justice. https://www.epa.gov/environmentaljustice/learn-about-environmental-justice (accessed May 4, 2018)

EPA (Environmental Protection Agency), Office of Environmental Enforcement (OEE), Air Guidance Note 5 (AG5), Odour Impact Assessment Guidance for EPA Licensed, 2010.

EPA (Environmental Protection Agency), Primer for Municipal Wastewater Treatment Systems, 2004

EPA (Environmental Protection Agency), Office of Water, How Wastewater Treatment Works… The Basics, 1998

Eshet T., Ayalon O., Shechter M., Acritical review of economic valuation studies of externalities from incineration and landfilling, Waste Management & Research, 23 (2005), 487-504

European Commission. Urban Wastewater Legislation. 2016. http://ec.europa.eu/environment/water/waterurbanwaste/legislation/deadlines/summary3457_en.htm (accessed February 20, 2017)

Farber S., Undesirable facilities and property values: a summary of emprical studies, Ecological Economics, 24 (1998), 1- 4

Foxnews. Protests Turn Violent in China Over Sewage Plant Smell. 2009. http://www.foxnews.com/story/2009/09/01/protests-turn-violent-in-china-over-sewage-plant-smell.html (accessed July 29, 2016)

Frechen F-B., "10 Years of OEC Measurement: Methodologhy, Application, Results and Future Development" In Odour and VOCs: Measurement, Regulation and Control, Kassel University Press, 2009

Freeman A. M., Hedonic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues, The Scandinavian Journal of Economics, Vol.81, No. 2 (1979), 154-173

Freeman T., Cudmore R., Review of Odour Management in New Zealand, Air Quality Technical Report, No 24, 2002

Frey B.S., Oberholzer-Gee F., Eichenberger R., The old lady visits your backyard: A tale of morals and markets, The Journal of Political Economy, Vol. 104, No. 6 (1996), 1297-1313

Fries K., Controlling Odours from Wastewater Treatment Plants, From the March-April 2016 print edition, page 25, 2016.

Gallagher L., Ferreira S., Convery F., Host community attitudes towards solid waste landfill infrastructure: comprehension before compensation, Journal of Environmental Planning and Management, Vol. 51, No. 2 (2008), 233–257

Giusti L., A review of waste management practices and their impact on human health, Wste Management 29 (2009) 2227-2239

Gostelow P., Parsons S.A., Stuetz R.M., Odour Measurements for Sewage Treatment Works, Wat.Res, Vol.35, No.3 (2001), 579-597

Gutierrez M.C., Martin M.A., Chica A.F., Usual variables and odour concentration to evaluate composting process and odour impact, Environmental Technologhy, 35:6 (2014) 709-718

Haberler. Bozcaada'da atıksu arıtma tesisi protestosu. 2014. http://www.haberler.com/bozcaada-da-aritma-tesisi-protestosu-6339962-haberi/ (accessed July 29, 2016)

Habertürk. Kemer'de yabancılar arıtma kokusunu protesto için yol kapattı. 2015. http://www.haberturk.com/gundem/haber/1083281-kemerde-yabancilar-aritma-kokusunu-protesto-icin-yol-kapatti (acessed july 29, 2016)

Helmer R. & Hespanhol I., United Nations Environment Programme, the Water Supply &Sanitation Collaborative Council and the World Health Organization by E. & F. Spon, 1997

Hens L., Susanne C., Enivronmental Ethics, Global Bioetics, 11:1-4 (2014) 97-118

Hermansson H., The Ethics of NIMBY Conflicts,Ethical Theory and Moral Practice, Vol 10, No 1 (2007), 23-34

Independent. Yorkshire market town to sue water firm over 'stink' from sewage Works. 2016. https://www.independent.co.uk/news/uk/home-news/yorkshire-market-town-to-sue-water-firm-over-stink-from-sewage-works-a6882106.html (accessed July 29, 2016)

Işık F., Çağatay U., Determining Influence Area Of Rubbish Dump And Treatment Facilities Based On Geographic Information Systems: The Case of Manisa, Paradoks Economics, Sociology and Policy Journal, 11:1(2016), 68-86

İzmir Metropolitan Municipality, Department of Urban Development and Urban Planning, Master Plan Branch Office (İzmir Büyükşehir Belediyesi, İmar Ve Şehircilik Dairesi Başkanlığı, Nazım Plan Şube Müdürlüğü). 1/25000 Scale İzmir Metropolitan Entity Environment Plan Explanation Report (1/25000 Ölçekli İzmir Büyükşehir Bütünü Çevre Düzeni Planı Açıklama Raporu), 2012. Available from: http://izmimod.org.tr/docs/RAPOR_IBSBCDP.pdf

İzmir Metropolitan Municipality, Department of Urban Development and Urban Planning, Master Plan Branch Office (İzmir Büyükşehir Belediyesi, İmar Ve Şehircilik Dairesi Başkanlığı, Nazım Plan Şube Müdürlüğü). 1/25000 Scale İzmir Urban Area Master Plan Revision Explanation Report (1/25000 Ölçekli İzmir Kentsel Bölge Nazım İmar Planı Revizyonu Açıklama Raporu), 2009.

İZSU. Wastewater Treatment Plants, 7-Southwestern Wastewater Treatment Plant (Atıksu Arıtma Tesisleri, 7-Güneybatı Atıksu Arıtma Tesisi). http://www.izsu.gov.tr/Pages/standartPage.aspx?id=162 (accesed May 22, 2018)

Kevin D., Environmental Racism and Locally Undesirable Land Uses: A Critique of Environmental Justice Theories and Remedies, 8 Vill.Envtl.L.J., 121 (1997).

Kunreuther H. and Easterling D., The role of compensation in siting hazardous facilities, Journal of Policy Analysis and Management, Vol. 15, No. 4 (1996), 601-622

Lebrero R., Bouchy L., Stuetz R. & Munoz R., Odor Assesment and Management in Wastewater Treatment Plants: A Review, Critical Review in Environmental Science and Technology, 41:10 (2011), 915-950

Loftus A.C., Howe C., Anton B., Philip R., Morchain D., Adapting urban water systems to climate change, 2011

Massoud M.A., Tarhini A., Nasr J.A., Decentralized approaches to wastewater treatment and management: Applicability in developing countries, Journal of Environmental Management, 90 (2009) 652-659

Middleton J. D., Health, Environmental and Social Justice, Local Environment, 8:2 (2010), 155-165

Milliyet. Vatandaşlar atıksu tesislerinden gelen pis kokuyu yargıya taşıyor. 2016. http://www.milliyet.com.tr/vatandaslar-atiksu-tesislerinden-gelen-istanbul yerelhaber-1509834/. (accessed January 5, 2018)

5ocaknews. Arıtma değil koku üretme tesisi. 2012. http://www.5ocaknews.com/haberler/ozel-haber/aritma-degil-koku-uretme-tesisi.html. (acessed july 29, 2016)

NAP (National Academies Press). Municipal Wastewater and Sludge Treatment. https://www.nap.edu/read/5175/chapter/5#49 (accessed September 29, 2017)

Saphores J., Aguilar-Benitez I., Smelly Local Polluters and Residental Property Values: A Hedonic Analysis of Four Orange County (California) Cities, Estudios Economics, Vol. 20, No. 2 (40) (2005), 197-218

Ter Mors E., Tervel B., Daamen D., The potential of host community compensation in facility siting, International Journal of Greenhouse Gas Control, (2012). Available from: http://dx.doi.org/10.1016/j.ijggc.2012.07.002

Nicell J.A., Assessment and Regulation of Odour Impacts, Atmospheric Environment 43 (2009) 196-206

Northampton. Wastewater treatment systems. http://www.northamptonmud.com/wpcontent/uploads/2016/11/wastewater_diagram.jpg. (accessed january 5, 2018)

Pacific Water Forum, Theme: Urban Circular Economy, Reduce, Reuse, Recycle, 2012

Palmiotto M., Fattore E., Paiano V., Celeste G., Colombo A., Davoli E., Influence of a municipal solid waste landfill in the surrounding environment: Toxicological risk and odor nuisance effects, Environmental International 68 (2014), 16-24

Pan Y., The Sustainable Criteria for Evaluating the Planning Report of Wastewater Treatment Plants, Master of Science Thesis-Division Industrial Ecology,

Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden, 2005

Puget Sound Clean Air Agency Regulation I, December 1, 2017, page 9-5 https://www.pscleanair.org/219/PSCAA-Regulations (accessed May 16, 2018)

Ragas W. R., Flower P. C., The Effects of Refineries on Neighborhood Property Values, The Journal of Real Estate Research, 9:3 (1994), 319- 338

Republic of Turkey Ministry of Forestry and Water Affairs (T.C. Orman ve Su İşleri Bakanlığı Su Yönetimi Genel Müdürlüğü), Design Guide for Wastewater Treatment Plants (Atıksu Arıtma Tesisleri Tasarım Rehberi), 2012

Republic of Turkey Ministry of Education (T.C. Milli Eğitim Bakanlığı), Environmental Health Treatment Facilities (Çevre Sağlığı-Arıtım Tesisleri 850ck0045), 2012

Schultz T. E., Biological wastewater treatment, Chemical Engineering Magazine, 2005

Swedish EPA, Wastewater treatment in Sweden 2016, 2016

TÜİK (Türkiye İstatistik Kurumu). Adrese Dayalı Nüfus Kayıt Sistemi Sonuçları. https://biruni.tuik.gov.tr/medas/?kn=95&locale=tr (accessed july 26, 2018)

Ulutaş K., Pekey H., Demir S., Dinçer F., Çevresel Kokunun Atık Su Arıtma Tesisi Ykınında Kentsel Yaşam Kalitesine Etkisi, VII. Ulusal Hava Kirliliği Ve Kontrolü Sempozyumu, 2017

UN-HABITAT III 2016, New Urban Agenda, 2017

UN-Water, Wastewater Management, A UN-Water analytical brief, 2015

UN-Water, A Post-2015 Global Goal for Water: Synthesis of key findings and recommendations from UN-Water, 2014

UNEP (United Nations Environment Programme), Clearing the waters, A focus on water quality solutions, 2010

UNEP (United Nations Environment Programme). Wastewater and Stormwater Characteristics.http://www.unep.or.jp/ietc/Publications/Freshwater/SB_summary/2.asp (accesed january 22, 2017)

Ware D., Climate change impacts on coastal water supply and wastewater management, 2016

WERF(Water Environment Research Foundation), Implications of climate change for adaptation by wastewater and stormwater agencies, 2009

Wolsink M., Devilee J., The motives for accepting or rejecting waste infrastructure facilities. Shifting the focus from the planners' perspective to fairness and community commitment, Journal of Environmental Planning and Management Vol. 52, No. 2 (2009), 217–236

WHO (World Health Organization), The Right to Healthy Indoor Air, Bilthoven, The Netherlands, 15-17, 2000

Water Pollution Control - A Guide to the Use of Water Quality Management Principles

Zarra T., Naddeo V., Belgiorno V., Reiser M., Kranert M., Odour monitoring of small wastewater treatment plant located in sensitive environment, Water Science & Technologhy, 58, 2008

APPENDIX A

SURVEY QUESTIONS

Survey Questions For The Residents

Survey Information Form

Neigborhood/Street: Survey Date:

Building Number:

Structure:

Detached ☐

Apartment Block ☐

Number of floors: Apartment unit number: What floor:

Section One

1.Gender

Woman ☐ Man ☐

2.Age:

3.Profession:

4. How many people do you live at home?

5. Where did you come from?

6. When did you move here?

7.Are you a homeowner? ☐ Are you a tenant? ☐

8. If you are a landlord when you bought your home?

9.How many m^2 is your home?

10. What is the number of rooms in your house?

11. Do you have central heating in your home?

Yes ☐ No ☐

12. Does your house have parking?

Yes ☐ No ☐

13. Does your house have a pool?

Yes ☐ No ☐

14.Did alterations were done inside your house?

Yes ☐ No ☐

15. Where your house is located flat? ☐ sloping? ☐

16. When was your house built?

17. How far is your house away from the sea?

18. Does your house have a sea view?

Yes ☐ No ☐

Section Two

1. Were there any wastewater treatment plants when you moved to your house?

Yes ☐ No ☐

2. Does the odour come from the wastewater treatment plant?

Yes ☐ No ☐

3. When does the odour most often come from the wastewater treatment plant?

4. Were you aware of the effect of such an odor before you moved here?

Yes ☐ No ☐

5. What kind of problems do you experience from the odour?

Health problems ☐

Unable to open windows ☐

Unable to host guests ☐

Children can not play outside ☐

Inability to participate in outdoor activities ☐

Other

6. Does the existence of the wastewater treatment plant in your surroundings bother you?

Yes ☐ No ☐

7. What problems does the existence of the wastewater treatment plant create in the environment?

Visiual discomfort ☐ Environmental pollution ☐

Odour ☐ Noise ☐

Other

8. Do you have any complaints to the authorities about the problems arising from the treatment plant?

Yes ☐ No ☐

If yes, which authorities have you complained about this problem?

District Municipality ☐

Metropolitan Municipality ☐

İZSU ☐

The Southwestern Advanced Biological Wastewater Treatment Plant ☐

Other

What was the outcome of your complaint?

9. How did you show your reaction to the problems?

Complaint Petition ☐

Informing Journalits ☐

Social media sharing ☐

Other

10. Do you think that the wastewater treatment plant has an effect on the real estate sales prices in the vicinity?

Yes ☐ No ☐

11. Are there any leased, vacant, sold houses due to the wastewater treatment plant?

Yes ☐ No ☐

If yes, how many houses have been sold within your knowledge?

If yes, how many houses have you given to rent within your knowledge?

If yes, how many houses have been vacant within your knowledge?

12. Are there any houses that are advertised for sale or rent but can not be sold or leased because of the treatment plant?

Yes ☐ No ☐

13. Do you consider moving from the place because of the treatment plant?

Yes ☐ No ☐

14. Do you intend to sell your house?

Yes ☐ No ☐

15. How much did you buy your house?

16. How much do you sell your house?

17. How much is your property tax?

18. Is there any reduction in the real estate tax due to the negativity caused by the wastewater treatment plant?

Yes ☐ No ☐

19. Do you think that the value of your home is decreasing because of the wastewater treatment plant?

Yes ☐ No ☐

20. Have you been provided a compensation due to the problem caused by the wastewater treatment plant?

Yes ☐ No ☐

21. What kind of compensation forms would you like to apply to you due to the problem caused by the wastewater treatment plant?

tax reduction or tax rebate ☐

Payment of the lost value as compensation ☐

Protection of housing value ☐

Qualification of environmental quality ☐

Other

22. Which of the following ranges is included in your monthly income?

1000tl and below ☐ 1000tl-2000tl ☐ 2000tl-3000tl ☐ 3000tl-5000tl ☐

5000tl and above ☐

23. Do you have information you'd like to add?

Survey Questions For The Headman Of The Limanreis Neighborhood

1. How long are you the headman of the Limanreis neighborhood?

2. Did you have a wastewater treatment plant in this area when you were a headman?

Yes ☐ No ☐

3. Do you know the history of the establishment of the wastewater treatment plant?

4. Did you get any complaints about the wastewater treatment plant?

Yes ☐ No ☐

If yes, what are those complaints about?

5. Did you get any complaints about the odour spreading from the treatment plant?

Yes ☐ No ☐

6. How many complaints have you received about the odor problem resulting from the wastewater treatment plant?

7. When do the complaints about this issue come up most often?

8. What are the most affected streets from the treatment plant?

9.Has any work been done to resolve these complaints?

10. Do you think the presence of the treatment plant disturbs the residents of the neighborhood?

Yes ☐ No ☐

11. Does the odour come from the wastewater treatment plant in the area where the neighborhood office is located?

Yes ☐ No ☐

12. Do you think that the wastewater treatment plant has an effect on the sales prices of real estate?

Yes ☐ No ☐

13. Do you think there is any depreciation on the house values due to the odour near the treatment plant?

Yes ☐ No ☐

14. Are there any leased, vacant, sold houses due to the wastewater treatment plant?

Yes ☐ No ☐

If yes, how many houses have been sold within your knowledge?

If yes, how many houses have you given to rent within your knowledge?

If yes, how many houses have been vacant within your knowledge?

15. Are there any houses that are advertised for sale or rent but can not be sold or leased because of the treatment plant?

Yes ☐ No ☐

16. Have you been provided a compensation due to the problem caused by the wastewater treatment plant?

Yes ☐ No ☐

If yes, what kind of works have been done?

17. What are your opinions and suggestions about this issue?

Survey Questions For The Wastewater Treatment Plant

1. How long do you work in the treatment plant?

2. What is the history of the establishment of the wastewater treatment plant?

3. Are you pleasure to work at the treatment plant?

Yes ☐ No ☐

If no, what is the reason?

4. Does the wastewater treatment plant have negative effects on the environment?

Yes ☐ No ☐

If yes, what kind of problems does the wastewater treatment plant create in the environment?

Odour ☐

Visual discomfort ☐

loss in housing values ☐

Other ☐

5. Did you get any complaints about the odour or any other problem arising from the wastewater treatment plant?

Yes ☐ No ☐

If yes, is there any progress towards complaints?

Planting ☐

Technology renewal ☐

Report to the municipality ☐

Other

6. Does the odor from the treatment plant affect you?

Yes ☐ No ☐

7. Are you taking any measures against the odor?

Yes ☐ No ☐

8. When do the complaints about this issue come up most often?

9. What are the most affected streets from the treatment plant?

10. What is the content of the complaints received?

11. Have you been provided a compensation due to the problem caused by the wastewater treatment plant?

Yes ☐ No ☐

12. Do you have any future projects for the solution to the odor problem? What are they?

13. What are your opinions and suggestions about this issue?

Survey Questions For Real Estate Agents

Survey Information Form

Neigborhood/Street: Survey Date:

Building Number:

Structure:

Detached ☐

Apartment Block ☐

Number of floors: Apartment unit number:

Section One

1. How long have you been real estate agent?

2. Does the presence of wastewater treatment plant in the vicinity affect the purchase and sale of housing?

Yes ☐ No ☐

How does it affect?

not sold for a long time ☐

not rent for a long time ☐

often advertises for sale ☐

often the tenant changes ☐

value is less than other houses ☐

not used ☐

3. What is the number of houses for sale due to the odour originating from the treatment plant?

4. What is the number of houses for rent due to the odour originating from the treatment plant?

5. What is the number of vacant houses due to the odour originating from the treatment plant?

6. In your opinion, What is the effect of the wastewater treatment plant on the sale value of the houses for sale?

7. In your opinion, What is the effect of the wastewater treatment plant on the rental value of rented houses?

8. How many houses have you sold in 2017, where and how much did you sell?

9. How many houses have you rented in 2017, where and what is the rent price?

10. Do you have the effect of the treatment plant in the houses you can not sell or rent?

Yes ☐ No ☐

11. What should be done to make up for the depreciation of the houses?

12. What are the most affected streets from the treatment plant?

13. Do you have information you'd like to add?