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C O N T E N T S

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Research Paper

Pumped-Hydro Energy Storage Alternative Site Evaluation: A Case Study in Turkey

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Abstract: Among various energy storage methods pumped-hydro storage systems have been developed rapidly over the last decades because of their capability of the large-scale energy storage, time shift and the ability of being integrated with renewable energy. The component of system is an upper and lower reservoir connected with a pump/turbine. The technique works as pumping water from down to up during low demands on electricity and releasing back through the turbine to produce electricity during the pick hours. however, the availability of suitable places for such projects has difficulties for various reasons. The aim of this study is to investigate the principles and factors affecting the alternatives for site selection. The locations and topography of dams and lakes of Turkey have been explored using Google Earth to search for suitable locations, and the locations listed and ranked by factors that affect the applicability, efficiency, sustainability, and environmental friendliness of the projects.

Keywords: *Pumped Hydro Storage, Dam, lake, Energy Storage, energy, electricity.*

Introduction

Due to the limitations in the sources of fossil fuels as well as their environmental adverse effects, the implementation of renewable energy sources and the more efficient use of existing systems became critical to fulfill the increasing demands of our global for energy consumption. For managing the existing energy sources and their effective usages, energy storage systems are the most promising options due to their capability of being integrated by wind power plants, solar and other renewable energy systems.

PHSS (Pump-hydro storage systems) is the most suitable energy storage system that can be applied on large scales. The system consists of two reservoirs with different elevations connected with pump / turbine system in which water pumped to upper reservoir when electricity is not needed. During periods of high electricity demand, water is drawn from the turbine in a similar way to conventional hydropower plants to rotate generator. The amount of energy stored is proportional to the height difference between the two reservoirs and the volume of water stored (Steffen, 2011).

In all other energy storage systems such as thermal, gravity, electrochemical and chemical energy, which are supposed to store existing electricity by converting it into mechanical energy, the pumped hydro energy system is the only widely used storage technology today (IEA, 2014).

Pumped-hydro storage systems have many advantages by serving the grid system in wide ranges such as peak shaving, load balancing, frequency regulation, back-up reserve, spinning reserve, voltage support, quick start and black start capability (Yang, 2015). Despite all the advantages, geographical constraints have been identified as the most disadvantageous factor for many projects. In order to provide relatively large water reserves and sufficient capacity, a high difference in elevation of the upper and lower reservoirs is required. Since the construction of PHSS has taken many years, net investment in construction is high and regain can only be possible in decades, so it is difficult to persuade the private sector to invest (IHA, 2018).

According to master plan of DSI (Turkish State Water Works) by year 2023, dams and hydropower systems were planned to be constructed will be completed and the energy sourced from hydropower systems will be stay stable forward (DSI, 2014). Adding PHSS to the existing hydropower systems will be a promising choice for storing energy which also can be found in contribution to a stable energy supply by integrating with rapidly developing renewable energy like solar and wind power plants.

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The purpose of this study is to investigate the factors which affect the feasibility of the project considering the site selection. Therefore, some dams and lakes were taken into consideration and two were selected as the study area for a comparative feasibility assessment by preliminary assessment of their topography.

Materials and Method

Consideration of Alternative Project Sites

The topographical conditions of a high elevation gap with shorter distance makes the Project site attractive and viable for a PHSS development. After finding the suitable topography the applicability of the project to the specific site will be identify comparatively according to the followings:

1) Economic efficiency (unit construction cost)
   The pumped-hydro storage systems have many components such as upper and lower reservoir, water tunnels, central building for mechanical facilities and electric transmission line and center; many activities like relocations, land acquisitions, building roads, excavation and dumping are included in project which effect the cost of the project (Dinglin *et al*., 2012). Therefore, economic efficiency conditions of the system considering the parameters effect the site location for the project.
2) Engineering feasibility
   Since pumped-hydro storage systems are function as hydro powers like dams and dikes the geology and geomorphology of the site which includes the earthquake condition and rock shearing strength and rock mass condition are crucial for appropriate site selection for this project (Kusakana, 2015)
3) Proximity of environmental sensitivities, such as nature reserves
   Pumped hydro storage system can have impacts on environment like regional climate changes due to evaporation and humidity; impacts on ecosystems and natural resources consequently the flexibility of the legislations and regulations will affect site selection alternatives (Serhat, 2014)
4) Necessity of resettlements
   Resettlements and relocation of human and properties is one of the challenges of all hydraulic projects like dams, dikes and pumped-hydro storages systems due to their need for large areas and long-term construction period. The number of people, properties and villages need to be relocated will affect the prioritization of the alternative's locations (Nazari *et al*, 2010)
5) Presence or absence of limestone caves in the limestone distribution area
   The geological stability of the location and their interaction with water and water reservoir is important for safety and efficiency of the project. Water can be losing due to evaporation and infiltration hereby the geological structure and characteristics of soil and rocks are considerable for site selection alternatives (Dimitris *et al*., 2013).
6) Distance from the nearest 400kW substation (power line length)
   Stabilization of electricity grid of large cities through pumped-hydroelectric storage systems is essential. The capability of being integrated by wind and solar and other renewable energy power plant of the storage systems, made their location critical to be optimized according to industrial cities, wind and solar performance of the geography and distance of the project from existing electric substation for suitability and economic of the project (Steffen, 2011).

Alternative for Upper Reservoir and Excavation Sites

- Upper reservoir

When determining a location for the upper reservoir of a PHSS, 1) enough elevation difference with lower reservoir for energy generation; 2) suitable topographical features depending on dam type, and; 3) Minimum environmental and social adverse impact shall be secured as pre-conditions (Telford, 1990).

- Excavated material storage areas

Excavation and dumping have huge effect on feasibility and economy of the project. Sometimes it requires additional land acquisition which needs understandings of neighboring residents and local administrative organizations, and countermeasures as appropriate, expansion of the affected area caused by dump trucks loading excavated materials (traffic congestions, accidents, noise, vibration and air pollution), or a sharp increase of project cost caused by reclamation of the outside disposal sites and longer-distance transportation (Telford, 1990).

Alternatives for Access Roads to Construction Sites, Disposal Sites, Quarry Sites and for existing Connecting Road for Neighborhoods

The construction of the project may require relocation of the existing roads, construction of new roadways for access to construction sites, disposal sites and quarry. Constructing and relocating roads will put impacts on citizen, farmlands and environments as well as affect the project to become out of economic. Therefore, the road alternatives have their role for selecting the right place. The impacts of the road can be categorized as, no impacts, a small impact but not serious, serious impact but not irreversible and irreversible; the locations with lower impact can be selected as alternative places (Frilz, 1984).

Alternative Route for Transmission Line

Grit connection is another important factor affecting the site selection for the project. The impact of the selected alternative existing dam, protected areas, migratory bird, waterfowls and landscapes must be lower and no serious for suitability, economic and environmental friendliness of the project (Melhem, 2013).

The project also has effects on air, water and soil quality and climate change of the area; can be referred as unsuitable location if effect ecosystem, protected areas and cultural heritages; effects of project on environment and society like waste production, changing hydrology of the area, disturbance to water usage, disturbance to the exiting social infrastructure and services land, land acquisition and deterioration of local economy also considerable (Henderson, 2018).

Criteria for priority of ranking

When evaluating the study area, the criteria and impacts stated in the table 1. Were taken into consideration. no impacts, a small impact but not serious, serious impact but not irreversible and irreversible

Table 1. criteria and impacts used for feasibility and prioritization of the project

Features	**Impacts**
Topography	Impact on houses built along the road
Natural Environment	Impact on agricultural land
Resettlement	Impact on grazing land for sheep, cows
Upper Reservoir and Excavation Sites	Impact on topography (erosion, landslides)
Proximity of main city	Impact on Landscape
Route for Transmission Line	Impact on Flora Impacts on natural and social conditions
Total Evaluation Scores	

The criteria which are given in table were evaluated and scored according the situations which are stated in table 2. The scored were sum up together and compared which each other. The alternative which took the highest score was identified as the most feasible location.

Table 2. scoring system and criteria determining the values of the scores

2	It is economically superior and there are no significant natural/social environmental impacts expected/ no impact
1	It is economically superior, and there are natural/social environmental impacts or technical problems/small impact but not serious
- 1	It is economically feasible and there are natural/social environmental or technical problems expected/ serious impact but not irreversible
- 2	It is uneconomical or there are significant natural/social environmental impacts or technical problems expected/ irreversible

In this study the location of Gokcekaya dam in Eskisehir, Sariyar dam in Ankara, were investigated using Google earth for feasibility of pumped-hydro storage projects. According to the available data the probabilities of the projects were perused based on affecting parameters were in literatures. The possible downfall height of the Gokcekaya and Sariyar's PHSS could be 960m and 430 m, respectively in case of implementation. The ranking evaluation is done considering elevation between

tow reservoirs, length of penstocks, hydro-morphological condition of the current reservoirs, land acquisition, resettlement and distances from electric grids, substations and major cities and their impacts.

Figure 1. Gokcekaya dam reservoir Eskisehir google map image

Figure 2. Sariyar dam reservoir Ankara google map image

Results and Recommendation

It was figured out that Gokcekaya dam in located in Eskisehir with the highest elevation and its proximity to the major cities and electric grids is more feasible. Sariyar dam located in Ankara province due topography, it is effects on agricultural lands, roads and houses and insufficiency of its upper reservoir was figured out as the second to be feasible.

Big industrial countries like USA, China, Japan and Germany recognized the important of energy storage and role of pumped hydro storage systems, therefore they have started investigation on them over decades before. İt is recommended that Turkey government should carry out a large investigation and provide a dataset on it. İdentify the feasible locations and classify them. İn parallel with them the integration possibility of the projects should be studied with respects of the natural conditions of the selected locations and in case of positivity the plans for wind and solar power also should be prepared.

Table 3. evaluation and scoring of the alternatives considering their features and different impacts

Factors/ Alternatives	**Sarıyar**	**Gokcekaya**
Topography	1	2
Natural Environment	2	2
Resettlement	1	2
Upper Reservoir and Excavation Sites	1	1
Proximity of main city	2	2
Route for Transmission Line	1	2
Impact on houses built along the road	-1	1
Impact on agricultural land	-2	-1
Impact on grazing land for sheep, cows	1	1
Impact on topography (erosion, landslides)	1	1
Impact on Landscape	-1	-2
Impact on Flora	1	1
Impacts on natural and social conditions	2	2
Total score	**9**	**14**

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Research Paper

The Importance of Healing Gardens in terms of Palliative Care Center

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Abstract: Palliative care centers and quality of life approach has come up as interesting designs today. Especially in recent years, the importance of the designs made with medicinal plants has emerged with research on the psychological impact of the structural environment on human health. Healing garden designers have positive effects on users by creating spaces with natural and artificial elements. Created spaces ensure that people are physically and mentally healthy. Recently, in Tokat, projects related to the importance of medicinal aromatic plants as well as their development have been carried out. However, the design of healing gardens is a fairly new topic today and there is no public healing garden in Tokat. The purpose of this research was to determine the appropriate areas for the palliative care center in Tokat in the light of the available research and to explain the design principles and benefits for visitors. In conclusion, this study was described the role of the history of the region and plant diversity in planning in the design of the healing garden.

Keywords: *Medical plants, plants design, landscape, healing plants*

Introduction

With the industrial revolution, population growth began in the cities. Therefore, the number of people living in cities has increased rapidly. Today, as a result of rapid urbanization, people's interactions with nature have decreased (Akca & Yazici, 2017; Birisci *et al*, 2017a; Asur, 2019) Therefore, the idea of living a healthy life has been begun increasingly important by getting rid of the stress of daily life (Gulgun *et al*., 2014; Pouya et al., 2014; Asur, 2018; Temizel et al., 2019; Yazici et al., 2018). So much so that people flee from the dense gray fabric of the cities and they turn to green spaces that give them happiness. At this point, green spaces are a center of activity (passive and active recreation needs of people) and have positive effects on their health. Therapy gardens especially have designed for finding health in old age, when health problems are gradually increasing. Therapy gardens have positive effects on the mental and physical health of the elderly people who are defined as "living encyclopedias in of communities''. Therapy gardens have been used as places where people treatment healing since the Middle Ages and today it has become an important part of hospitals, rehabilitation centers, nursing homes and nursing homes for the elderly and disabled (Serez, 2011). Arslan and Ekren (2017) stated that therapy gardens began in 1798 at the Institute of Medicine and Clinical Practice in the United States by highlighting the healing effects of horticultural activities for individuals having mental disorders in the modern perspective. Later, in 1879 'a greenhouse was used for the first time for this purpose in the Philadelphia Friends Hospital'. The American Horticultural Therapy Association, the first professional institution in this field, was established in 1973 (Arslan and Katipoglu, 2011).

In summary, throughout history, people have used nature to treat mental and physical illnesses. Since the early ages, nature has been a guide in which people get rid of their troubles in their lives and attain inner peace and believe in healing power. This is a valid case for Tokat in Turkey. Tokat had high level of cultural and artistic life in BC between the years 4000-2000 due to established Hittite and Phrygian along Kelkit, Yesilirmak and Cekerek Rivers. For this reason, Gok Madrasah and Yagıbasan Madrasah had an important place in history for the health (Figure 1; Figure 2)

It was built between 1157-1158 by Nizameddin Yagıbasan. It was known as the first mediator of Anatolia, which was built in Tokat Niksar Castle and given medical education (Figure 1). Gok Madrasah, was a 13th-century Anatolian Seljuks Madrasah Tokat, Turkey. This splendid piece of Seljuk architecture today hosts the "Tokat Müzesi" (Museum of Tokat), an archaeological and

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ethnographical museum. This historical monument, which was used as a museum for many years, was one of the Seljuk Works in Gaziosmanpasa Boulevard, near Tashan. The structure without a book, XIII. It was built by Suleyman the Prophet Pervane in the 12th century (1277). The Anatolian Seljuks bear the most prominent features of architecture and art.

a) **b)** **c)**

Figure 1. Yagıbasan Madrasahs (**a,** Yagıbasan Madrasah Tokat Center; **b,** and **c,** Yagıbasan Madrasah Niksar Center)

a) **b**)

Figure 2. Gok Madrasah –Tokat (**a**: Gok Madrasah building, **b**. Gok Madrasah garden)

Researches have been made for new solutions to find healing from past to present. The study 'Looking through a Window Can Affect Postoperative Recovery' was concluded by Ulrich (1984). As a result; 23 patients staying in the room with a window with a natural landscape view had decreased postoperative complaints, duration of hospital stays and painkillers in the same conditions but compared to 23 patients who were matched in window rooms facing a brick building wall. As a result, 23 patients in the room with a window with a natural landscape view had a decrease compared to the 23 patients in the room with windows facing the wall of complaints after surgery. Another study was conducted by Koura et al. (2009) on ''Use of Plant Breeding Therapy for Elderly People in Urban Environment". As a result of their work; they thought that garden therapy activities would be effective in many diseases. Tennesen and Cimprich, (1995); Hartig et al., (1991); Predny, (1999) argued the beneficial effects of therapy gardens on elderly patients in need of care.

Palliative care centers were began new dissemination in Turkey. In this study, the functions of therapy gardens that can be established in palliative centres are mentioned. The garden of Tokat Gaziosmanpasa University Palliative Care Application and Research Center was taken as an example area. It was also emphasized the importance of the therapy garden designed with appropriate medicinal aromatic plants in the city. In this study, which includes literature researches, it is aimed to contribute to the green areas to be established in palliative care centres.

Material-Method

Material

Palliative Care Research and Application Centre Garden located in Tokat Gaziosmanpasa University hospital campus was researched as the study area (Figure 3). Palliative Care Center was opened by the General Secretariat of Tokat Public Hospitals Association In order to ensure that patients who do not have the chance of medical and surgical treatment spend their last days in a better environment, in a better way, and at the same time meet the intensive care needs of patients in need of intensive care. The unit of Palliative Care Research and Application Center has started its activities in the form of a working group since 2010 and continues to function until today by creating a multidisciplinary structure based on volunteering. The World Health Organization (WHO) firstly described the concept of palliative in 1989. The definition made in 2002 that ıt is as follows: "Palliative care is an approach that improves the quality of life of patients and their relatives who encounter problems arising from life-threatening diseases by preventing or eliminating all physical, psychosocial and mental problems, especially pain, by early detection and effective evaluation (Anonymous, 2018).

Figure 3. Tokat Gaziosmanpasa University Hospital

Method

In this study, literature review was conducted about the therapy gardens. Also a therapy garden was designed for Palliative Care Research and Application Center located in Tokat (Turkey) Gaziosmanpasa University hospital. Appropriate medicinal aromatic plants were identified and appropriate planning was made for the palliative care center Autocad 2018 of Autodesk was used in the project. Besides, the determination of therapy garden for palliative care centers offered suggestions for the construction. The method flow chart is given in Figure 4.

Results

Ways to design a therapy garden

According to Aslan and Erek (2017) therapy gardens should be specially designed areas, elderly nursing homes, health institutions gardens, city parks and green areas. Medicinal and aromatic plants have very important aesthetic and functional functions in these gardens (Arslan and Peng, 2013). Medicinal and aromatic plants used in therapy gardens and various activities are used to stimulate the senses of elderly people. For example; The senses are stimulated with the smell of pleasantly smelling plants that bloom in different seasons, with touches with different textures, with the species of plants having aesthetically valuable leaves, flowers and fruits, with the collection and taste of herbal tea and the collection and tasting of cultivated products.

Therapy gardens design principles can be summarized as follows:

1- The user profile should be determined and the designs to be made should be an area where the patients and their relatives and the hospital staff will cooperate.
2- There should be areas where patients can socialize and feel the positive energy of nature.
3- Noise, poor view pollution should be minimal
4- The balance principle should be taken into consideration in plant designs. Designs should be made away from the complexity close to naturalness.
5- Therapy gardens should be used in four seasons.

6- The winter garden should also be used in places where weather conditions are not suitable during the winter season.
7- Patients should be comfortable in designed areas.
8- The therapy garden should be physically and safety-protected.
9- Natural areas should be selected where patients feel safe.
10- Reinforcement elements should be natural wood, stone, etc.
11- It should be rich in plant diversity.
12- Wheelchair-accessible patients should be easy to access.
13- Plant-oriented activities should be carried out in therapy gardens.
14- In the palliative care center should be separated greenhouse production parcels for patient individuals.

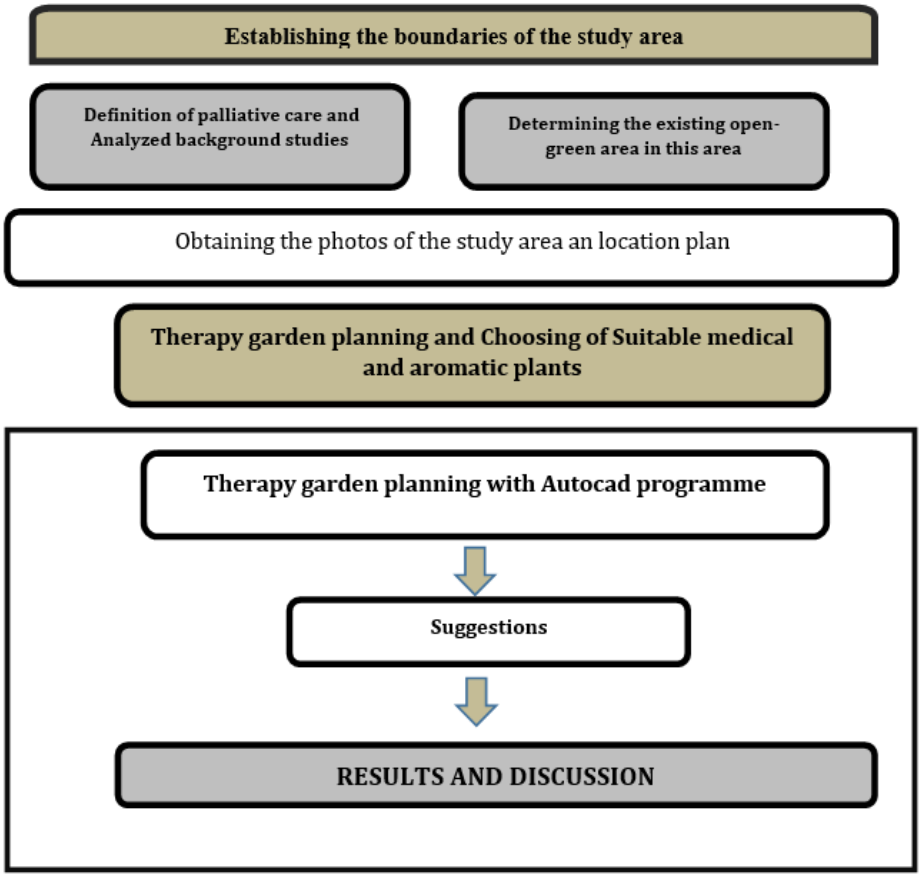

Figure 4. The diagram of the methodology

Therapy gardens design principles can be summarized for palliative care centres as follows:

1- Palliative current centre should be built in areas far from the city centre.
2- It should be established in areas that may be intertwined with nature and away from hospital psychology.
3- Activities that will positively affect the psychology of the patients should be organized.
4- Since the patients in the palliative care centre are mainly chemotherapy patients; more importance should be given to hygiene
5- Chemical fertilization and spraying should not be done in plants.
6- Activities such as planting, production, harvesting and motivating activities for patients and their relatives should be carried out.
7- Determining the visual quality value in the planning of an area and determination of the aesthetic value are always important in the studies about evaluation of landscape quality. (Asur & Alphan, 2018). Therefore, the selected living and non-living materials are important in therapy gardens.

Medicinal and Aromatic Plants for Use in Therapy Gardens for Tokat City

Turkey has a rich flora of the large number of medicinal and aromatic plants. The number of plant taxa in our country is 11,707, of which 3649 are endemic (Avcı, 2005). Vegetative wealth in our country; located at the intersection of three phytogeographic regions. The reasons for this are the diversity of climate, bridges between South Europe and Southwest Asia flora, altitude differences between 0-5000 meters, different types of bedrock, and the origin and differentiation of many genera and sections (Donmez et al., 2016). Besides, Anatolia has a very important potential for the presence of highly aromatic and aromatic plants. Anatolia, which is the place where the grains that feed humanity, spread to the world; also contains plants have used in pharmaceutical manufacturing for thousands of years (Aslan and Peng, 2013).

In landscape design studies, planting design occupies an important place and even appears as the main element in some theme parks. In the designs, even if they belong to a theme, plant preferences are taken into consideration as well as their ecological demands and functional uses as well as their aesthetic appearance. The color and shape of the leaves, flowers, fruits, branches and shells of plants determine their use in design and enable effective compositions to be designed.

Tokat City; Due to its location in the Middle Black Sea Pass zone, it is rich in plant diversity, especially medicinal aromatic plants. The fact that the region is among the authorized regions in the production of plants such as poppy and hemp has a positive effect on the production of medicinal aromatic plants (Yazici et al., 2016; Yazici & Yılmaz, 2017).

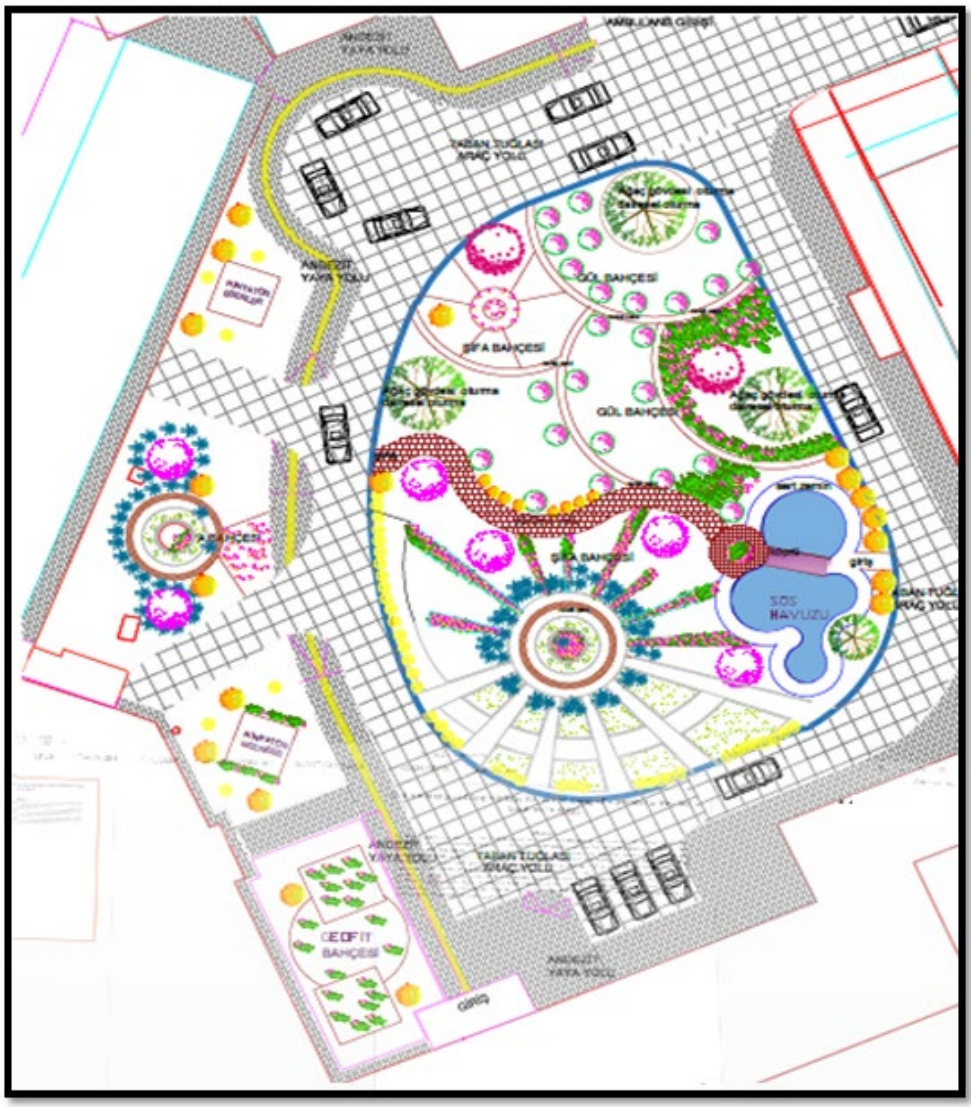

Figure 5 Therapy garden model project of Palliative Care Research and Application Center in Tokat Gaziosmanpasa University (1/100 plan)

Table 1. Suitable Medicinal aromatic plants for Tokat

Latin Name	Usage	Latin Name	Usage
Artemisia vulgaris	Leaf	*Achillea spp*	Herba
Carum carvi	Seed	*Coriandrum sativum*	Fruit
Curcuma longa	Rhizome	*Cinnamomum zeylanicum*	Fruit peel
Eucalyptus globulus	Leaf	*Eugenia caryophyllata*	Bud
Eletteria cardamom	Fruit	*Foeniculum vulgare*	Fruit
Hibiscus syriacus	Flower	*Juniperus nana*	Leaf
Lavandula angustifolia	Flower	*Jasminum grandiflorum*	Flower
Laurus nobilis	Leaf	*Matricaria chamomilla*	Flower
Menta piperita	Leaf	*Melissaoffi cinalis*	Leaf
Nigella sativa	Seed	*Myrtus communis*	Leaf
Origanum majorana	Flower, Leaf	*Ocimum basilicum*	Seed, Leaf, Flower
Pimpinella anisum	Seed	*Piper nigrum*	Fruit
Pimenta officinalis	Leaf	*Salvia officinalis*	Leaf
Rosa hp.	Flower	*Rosmarinu sofficinalis*	Leaf
Sinapsis arvensis	Seed	*Rosa damascena*	Flower
Tillia domestosa	Flower	*Thymus vulgaris*	Leaf

Designing a model project

The Palliative Care Research and Application Center which was established in Tokat Gaziosmanpasa University hospital is located in the campus. Its location and the hilly terrain of the city center have restricted the area. However, it was found appropriate to turn the green areas around the building into a therapy garden in order to avoid the negative appearance and stress of the patients in the care center. The patients and their relatives in the Palliative Care Center were evaluated as the area to provide socialization with the care center employees. The model project for the study area was given in Figure 5.

The Palliative Care Research and Application Center in Tokat Gaziosmanpasa University offers many activities. Some pictures on the official website of the study area are given in Figure 6.

a) **b)** **c)**

d) **e)** **f)**

Figure 6 The Palliative Care Research and Application Centre Activities (a, b, c, d, e, f) (Url 1).

Conclusion

Open-green spaces have an important role in balancing the deteriorating relationship between humans and nature and improving urban living conditions. (Asur & Yazici, 2019; Birisci et al., 2017b;

Birisci et al., 2017c). Designing a "green" system within the city and ensuring continuity is important both in terms of being an urban element and a social area. (Temizel *et al*. 2018; Gulgun *et al*., 2016).

As a result of the acceptance of the garden as a healing factor, therapy gardens have become a serious topic for academic research in many countries and have been included in health systems. However, unfortunately, therapy gardens have not been able to demonstrate the development abroad in terms of academic or practice in our country. In this study, some principles and strategies had been determined by examining areas where healing garden design could be applied. Healing gardens have no purpose to cure. Only patients feel better during the healing process. Today, although given to importance the healing gardens in Turkey have increased, it has not yet reached a sufficient level (Figure 7).

Figure 7 The sample of healing garden (closed area) (Url 2)

Palliative care centers are important in terms of providing socialization services to the patients they host. Therefore, the work of different disciplines in beer will contribute to palliative care centers. In this context; physiotherapists, psychologists, physicians, landscape architects, architects and engineers etc. being in common work is very important for the garden to achieve the desired effect and to be sustainable. In this study, a sample project with medicinal aromatic plants in a limited area of the palliative care research and application center in Tokat is given.

Examined hospital garden is not yet fully responsive to the needs of the users. Therefore, it is not could contribute to the treatment of patients at the required level. Hospital buildings should be designed together with the surrounding area and the availability of outdoor therapy garden units should be made a necessity.

The following suggestions can be made in the therapy gardens for palliative care in Tokat:

- Social responsibility projects should be increased for palliative care centers
- Horticulture activities should be done by experts
- Expert trainers should be sensitive against patients and they communicate well them
- Therapy gardens should be accessible for everyone
- Therapy gardens should be concepts of the sustainable urban landscape and environmental sustainability
- Many professional disciplines should work together as a volunteer

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Research Paper

Problem Investigation of Konya Flood Protection Structures

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Abstract: Floods events occur frequently in Turkey. Therefore, like earthquake and other natural disasters, floods also should be taken in to measure in advance as well. Therefore, with all other operations, constructing flood protection structures with a good planning and project, their proper using and their protection is important for ensuring that floods do not become a disaster. With lack of precaution listed above sometimes flood put huge effects on areas where are not identified as risky areas on flood risk assessment maps. In this study, primarily, the concept of flood, the effects, causes, types and the principles of protection from flood are discussed. Secondly, the problems in the flood protection structures located in Konya province, Turkey, were exemplified by photographs and evaluated. Lastly the sources of the problems, their effects on infrastructures, farmlands and domestics identified and some suggestion are made.

Keywords: *Floods, flood protections, flood risks, open channels, culverts,*

Introduction

Due to urbanization process brought by industrialization and sector diversity which greatly increases the diversity and intensity of human activities in various parts of river basins and destroys the balance in the whole watershed, it is possible to express flood disasters only as a result of meteorological occurrences. Since the earliest civilizations embracing established life, humanity tends to settle in the rivers center due to its proximity to water resources, ecological conditions, biodiversity, and its advantages for agricultural activities. As a result, most of the world is living in floodplains. Most of the floodplains around the world are large urban areas. This explains why millions of people are affected and expected to be affected by floods. The United Nations Development Program (UNDP, 2004) reported that between 1980 and 2000, approximately 196 million people in more than 90 countries were exposed to floods. The economic effect of flood phenomena to European Union from 1986 to 2006 estimated as 100 billion euro (Reducing the social and economic impact of climate change and natural catastrophes – insurance solutions and public-private partnerships, CEA, Brussels, Belgium, 2007).

The average annual flood damages in Turkey estimated as 100 million dollars, where the average investment on flood phenomena is estimated 30 million dollars per year. According to DSI reports in the last 20 years Turkey experienced over 300 flood phenomena which cause about 500 people to lose their life (DSI, Turkish state water works). In other to reduce the socio-economical risk and losses due to floods is important to state strategies such as modifying floods by structural means like dams, dikes, levees, channels, high flow diversion and land treatments in which the mean idea is keeping water away from potential damage areas; by flood forecasting which help to identify potential risky areas and keep human and movable properties away from inundated areas; lastly modifying susceptibility to flood damages (Ghosh , flood control and drainage engineering). However only a good approach for planning and designing flood protection structures and implying them fit with the plan can make structures effective.

One of the mean components of water resources structures design is estimation design flood. For this reason, accurate data on flood magnitude and flood frequency is vital. Hydrological design, which aims to estimate the expected maximum average or minimum flood handling by structures, is necessary for safety economy and proper functioning of all water structures (Ghosh, flood control and drainage engineering). Yet there are many uncertainties with different sources which effect projects negatively and make them to function in an ineffective way.

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Rainwater which causes flood in urban areas must be carried away from the region by channels and streets in a short period of time. Design of these channels considers both the channels hydraulic capacities and their future sustainability. In urban areas fitting the flood channels in an appropriate relative position are subjected to many constrains to compromise with existing utilities. Therefore, for comparison different alternatives should evaluate. The final selection generally identified by cost-effectiveness and public safety (ASCE and WEF, 1992).

Flood protection channels types and components

A proper design in the framework of standards and flood legislations will increase the effectiveness of the channels. Selection of an optimized bottom slope considering the topographic conditions, sizing cross section and to accommodate waves and jumps adjustment of freeboard heights are critic for accurate design of channels.

Grade control

In flood channel due to concentrated and high velocities, erosion in channel bed and severe back scours can be observed. To protect channels, it is imperative to setup proper lining and grade controls across the channel bed where the energy dissipation is necessary. Drop structures commonly used as grade control especially in channels with steep slope. In order to optimize grade control its building materials, degree of protection, its height and width and the force which is applied by flow is important.

Natural waterway

Natural waterways have taken their shapes with long-term erosion caused by flood flows and the hydraulic characteristic them varied related with the sections along the channel reach. Identifying and publishing floodplain along the natural waterway for avoiding inadvertent development on floodways; identifying roughness coefficient for water surface profile and velocity for scours on grade-control structures alongside the waterway is crucial here.

Grass channel

Grass-covered channels are one the most attractive waterway in urban area. Grass protects channel bed and bank from erosion by providing hydraulic resistance and lowering the velocity of the flow. The maximum and minimum permissible flow velocity should be considered in order to use channel effectively.

Riprap channel

It suitable for short and steep in the slope of waterway reach. Considering to applications and usage it vital to design it with right method (stream power-based or shear stress-based method)

Composite channel

Composite channels such as low-flow trickle and wetland channels provide detention storage volume during intense storm besides of being aesthetic. An accurate design considering channel capacity, flow depth, flow velocity and freeboard is needed for sustaining the habitat, future sediment storage capacity and safe passing of flow with different conditions.

Culvert

Culverts are structures which are designed to pass a stream flow under a barrier. Designing culvert with a right alignment and slope, with respect to head and velocity of the flow and cleaning sedimentation time to time is important for effectives of their functions. Furthermore, the capacity and performance of culvert most identify considering the hydrological properties of the channels and basins where they are located.

Methodology

In this study a total 146 flood protection facilities build and commissioned by Turkish state water works (DSI) in Konya province, were used. The problems such as sedimentation, narrow sections,

intervention of channels by citizens or any other problem caused by lack of coordination between institutes and expropriation aim to be observed and identified. As a method, all flood protection facilities were visited from the upstream to the downstream channel and the identified problems were included in the study.

Figure 1. Konya Güneysınır district

Figure 2. Konya Selçuklu Sızma region

Figure 3. Konya Guneysinir district

Figure 4. Konya Cihanbeyli, İnsuyu region

As seen in Figure 1 and 2, rectangular open channel form for flood protection was built under the control of DSI and culverts by Konya municipality. The cross sections of channels and culverts are looking insufficient. As shown In Figure 3 the flood facility constructed by DSI in accordance with its project, intersects with the historical arch bridge at a certain point of its route, it has not rightly allowed to build up to 7-8 m to the historical bridge under the law of not touching the cultural assets by the Provincial Directorate of Culture and Tourism. In figure 4 in order to cross the water pipe KOSKI (Konya Water and Sewerage Administration) did demolish flood protection facility's wall which affects the function of the structure during flood flow.

Figure 5 shows the flood control structures which effected by flood water because of the lack of cadastral width on the route for building the flood protection channel.

Figure 5. Flood protection plain of Kulu

Figure 6. Narrowing the flood protection structures by construction of infrastructures (a) Konya Bozkir district, b) Konya Yarasli region, c) Konya Yarasli Region, d) Konya Kutukkusagi Region)

By the building roads by citizen over the flood channels as shown in Figure 6, a narrow section created and due to the change in section of channel they would not function proper to project and plan during the flood flow. In some of the flood facilities in Konya province as shown in the Figure7 narrowing of the section in the flood route prevents the efficient operation of the plant and also creates serious problems in terms of life and property security.

Figure 7. Narrowing the flood protection structures of a) Kirkpinar region, b) Gevrekli region, c)Yesilyurt region), Yeniceoba region

Figure 8. Konya Cihanbeyli District İnsuyu Region

In some of the flood facilities in the province of Konya, in order to reach the project criteria during the project phase, sometimes the structures do not comply with the environment and negatively affect the citizen's life as seen in Figure 8.

Figure 9. Narrowing of the cross-section by planting in a) Akcalar region, b) Harmanpinari region, c)Esence region, d) Bagbasi region

In some of the flood structures in the province of Konya, it is observed that the channels are filled with sediments or natural grasses grows in the bed both of which descrease the flow velocity, causes overflow and prevents the efficient operation of the flood facilities.

Result and Recomentdations

The problems and problem sources of the observed areas can be listed as follows:

- Due to lack of the coordination between isntitutes, problems such as building culverts with narrow and insuficient cross section on flood channels roate, crossing water pipes by demolishing channel wall and inhibiting of constructing channel near to the point that historical bridge located were observed.
- Problems due to nationalization of the parcels in which the channels planed to pass were observed in Konya where the 3 parcel owner citizen did not allow the project to be implemented over their lands and the channel roate has been changed.
- Problems like intervention of citizen to channel like building bridges and crossing pipes which affect the channel by narowing the cross section and demolishing of their walls, were observed in many protection structures.
- Because of some regional constrictions, land expropriation and condition narrowing in the section of channel were observed in many structure and cause the channels to function properly.
- Lastly in many channels sediments and grasses which narrow the cross section, increase the roughness and decrease the flow velocity of the flood and a result because overflow was observed.

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Optimization of Micro Algal Biomass Production by the Method of Experimental Designs (Case of *Dunaliella salina* Teodoresco)

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Abstract: *Dunaliella salina* is a unique species of endemophilous microalgae. The objective of this work is to find the best conditions for the development of this microalga by optimizing four main parameters that directly influence the production of its biomass using the experimental design method. This statistical method, which results in the ordered sequence of trials of an experiment, each one acquiring new knowledge by controlling one or more input parameters to obtain results validating a robust model to produce this microalga of the *salines* in the western Algeria (salines of Arzew). For this purpose, this strain was grown under controlled conditions in a photo bioreactor. The results show that the alga *Dunaliella salina* grows and maximizes its yield for well-defined values of the four parameters.

Keywords: Dunaliella salina*, optimisation, biomasse production, parameters,*

Introduction

Algae are chlorophyll organisms that develop in water or in very humid environments. Though mostly abundant in the waters of the seas, lakes, ponds, running waters and thermal springs, they are also found on damp rocks and on land. Exceptionally, they may be endophytes of animal or plant tissues (Ilti, 1980).

Micro-algae and cyanobacteria, whose size varies from micron to hundreds of microns, are organisms that use light as an energy source to fix carbon dioxide (CO_2). Among these micro algae is *Dunaliella salina*, a halotolerant unicellular chlorophyceae that lives in saline waters (salinity close to 350 g /L) (Krinsky, 2005), because of the synthesis of a series of molecules which protect it against the extreme conditions of salinity, temperature and solar radiation.

It is a unique species of endemophilous microalgae, capable of accumulating β-carotene. This pigment of natural origin, which is ten times more active than that obtained by synthesis, is used as a food coloring agent, source of vitamin A, in the human diet and as an additive in cosmetology (Riahi, 2007) Our objective is to optimize the production of microalgal biomass. This production depends on four parameters: temperature, light intensity, salinity and nitrate concentration. For this purpose, we will use the experimental design method (Cochran, 1957).

Materials and Methods

The strain of *Dunaliella salina* used in our work comes from the *Salines* of Arzew. Figure 1. and Figure 2. We have cultivated *Dunaliella salina* for 20 days in a modified and aerated Johnson medium in a flat photo bioreactor shown in Figure.3, with a surface area of 1 m^2 and a thickness of 40 mm and therefore a volume of 40 liters. The starting concentrations are the same for each experiment since we have done a pre-cultivation of *Dunaliella salina* in a cylindrical reactor, the light is ensured by light type LED Day of last generation, in an air-conditioned hangar, all the parameters are controlled by of the probes with the aid of a specific software, while being content with atmospheric CO_2. The biomass is measured every two days in the laboratory using a glass fiber membrane filtration system.

Design of experiments (DOE) is inherently a multi-objective optimization problem (Box, 1951). It enables designers to determine simultaneously the individual and interactive effects of many factors that could affect the output results in any design (Goo, 2011). DOE also provides a full insight of interaction between design elements; therefore, it helps turn any standard design into a robust one (John**,** 1972). Simply put, DOE helps to pinpoint the sensitive parts and sensitive areas in designs that cause problems in Yield. Designers are then able to fix these problems and produce robust and higher yield designs prior going into production. In order to perform a DOE, it is necessary to define the problem and choose the

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variables, which are allied *factors* or parameters by the experimental designer. A design space, or *region of interest*, must be defined, that is, a range of variability must be set for each variable. The number of values the variables can assume in DOE is restricted and generally small. Therefore, we can deal either with qualitative discrete variables, or quantitative discrete variables. Quantitative continuous variables are discretized within their range. The DOE technique and the number of levels are to be selected according to the number of experiments which can be performed. By the term *levels* we mean the number of different values a variable can assume according to its discretization. The number of levels usually is the same for all variables. In experimental design, the objective function and the set of the experiments to be performed are called r*esponse variable.* In this particular case we want to evaluate the effect factors on the biomass production of algae in the reactors in order to optimize the yield.

Figure1. Localization of the *Arzew salines* (Google earth, 2016)

Figure 2. Harvesting of *Dunaliella salina*

Figure3. Photo bioreactor

These factors are; the temperature (A), the light intensity (B), the salinity (C) and the nitrate concentration (D). We assume that testing at two levels of each variable is enough. This means that the process is assumed linear with respect to continuous variables. The levels are chosen as:

Factor A: (-) level is 20 °C and (+) level is 32 °C
Factor B: (-) level is 18000 lux and (+) level is 45000lux.
Factor C: (-) level is 45 gr/l and (+) level is 250gr/l
Factor D: (-) level is 50 mg/l and (+) level is 250 mg/l.

We have thus made 16 experiments which constitute the total of the possible combinations of the four parameters mentioned above. We then apply the experimental design method to these results

Results and Discussion

The number of experimental set ups, corresponding to all the combinations of the four parameters, each of which affected with two levels are presented in table 1. Their number is equal to 4^2, hence 16.
For each set up we record the biomass produced every two days, during twenty days. The obtained results are presented in table 2. We apply the design of experiments to the obtained values of the sixth and sixteenth days. The results of the analysis are presented in table 3.

Table 1. Combinations of all parameters with their two levels

PARAMETRE					UNITE PARAMETRE			
Exp	Temp	Inten, L	Salin	Conc, Nit	°C	Lux	gr/L	mg/L
1	T1	I1	S1	C1	20	18000	45	50
2	T1	I1	S1	C2	20	18000	45	250
3	T1	I1	S2	C1	20	18000	250	50
4	T1	I1	S2	C2	20	18000	250	250
5	T1	I2	S1	C1	20	45000	45	50
6	T1	I2	S1	C2	20	45000	45	250
7	T1	I2	S2	C1	20	45000	250	50
8	T1	I2	S2	C2	20	45000	250	250
9	T2	I1	S1	C1	32	18000	45	50
10	T2	I1	S1	C2	32	18000	45	250
11	T2	I1	S2	C1	32	18000	250	50
12	T2	I1	S2	C2	32	18000	250	250
13	T2	I2	S1	C1	32	45000	45	50
14	T2	I2	S1	C2	32	45000	45	250
15	T2	I2	S2	C1	32	45000	250	50
16	T2	I2	S2	C2	32	45000	250	250

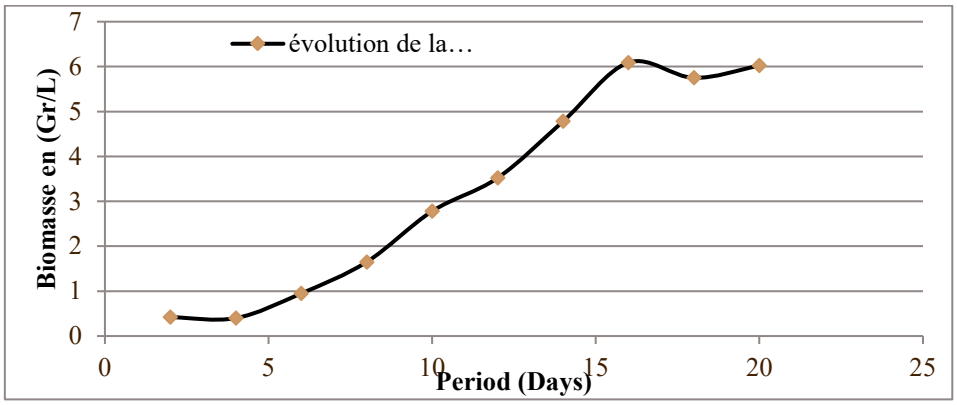

Figure 4. Evolution of the biomass (run n°1)

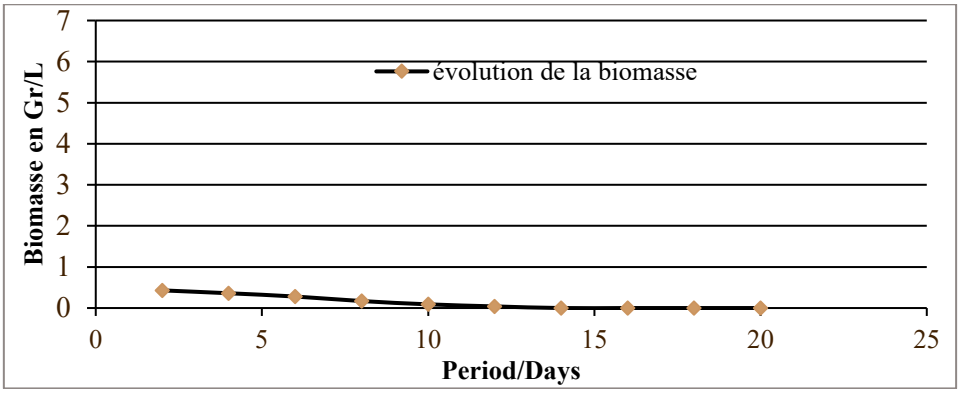

Figure 5. Evolution of biomass (run n 16)

Table2. Results obtained with all the combinations.

Temps/jour	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**
Biomasse en Gr/L For T1 I1 S1 C1	0.42	0.4	0.95	1.65	2.78	3.52	4.78	6.09	5.75	6.02
Biomasse en Gr/L For T1 I1 S1 C2	0.42	0.38	0.55	0.78	1.13	1.42	2.03	2.32	1.98	2.27
Biomasse en Gr/L For T1 I1 S1 C2	0.42	0.38	0.55	0.78	1.13	1.42	2.03	2.32	1.98	2.27
Biomasse en Gr/L For T1 I1 S2 C1	0.42	0.41	0.48	0.51	0.58	0.67	0.69	0.72	0.7	0.69
Biomasse en Gr/L For T1 I1 S2 C2	0.42	0.4	0.42	0.45	0.49	0.53	0.58	0.61	0.68	0.67
Biomasse en Gr/L For T1 I2 S1 C1	0.39	0.4	0.75	1.25	1.65	1.95	2.28	2.63	3.12	3.15
Biomasse en Gr/L For T1 I2 S1 C2	0.39	0.42	0.56	0.79	0.99	1.41	1.78	2.01	1.96	2.01
Biomasse en Gr/L For T1 I2 S2 C1	0.39	0.38	0.41	0.48	0.62	0.58	0.54	0.49	0.42	0.35
Biomasse en Gr/L For T1 IL2 S2 C1	0.39	0.39	0.38	0.36	0.34	0.28	0.26	0.24	0.23	0.19
Biomasse en Gr/L For T2 I1 S1 C1	0.41	0.65	0.92	1.21	1.78	2.5	3.13	3.67	3.82	3.99
Biomasse en Gr/L For T2 I1 S1 C2	0.41	0.43	0.51	0.65	1.01	1.18	1.42	1.68	1.73	1.78
Biomasse en Gr/L For T2 I1 S2 C1	0.41	0.41	0.43	0.46	0.49	0.53	0.57	0.59	0.61	0.58
Biomasse en Gr/L For T2 I1 S2 C2	0.41	0.41	0.42	0.39	0.36	0.32	0.28	0.28	0.27	0.28
Biomasse en Gr/L For T2 I2 S1 C1	0.43	0.41	0.4	0.38	0.38	0.36	0.36	0.37	0.36	0.36
Biomasse en Gr/L For T2 I2 S1 C2	0.43	0.4	0.36	0.34	0.32	0.28	0.28	0.24	0.26	0.25
Biomasse en Gr/L For T2 I2 S2 C1	0.43	0.4	0.4	0.38	0.36	0.31	0.28	0.25	0.25	0.26
Biomasse en Gr/L For T2 I2 S2 C2	0.43	0.36	0.28	0.17	0.09	0.04	0	0	0	0

Table 3. Effets of parameters and their interactions.

	Coefficient		
Factor	**Estimate**	**Low**	**High**
Intercept	-0.65	-0.78	-0.52
A-Temperature	-0.24	-0.37	-0.11
B-Intensité.lumi	-0.26	-0.39	-0.14
C-Salinité	-0.38	-0.51	-0.26
D-Nitrat.Constrat	-0.18	-0.31	-0.056
E-Temps Séjour	0.25	0.13	0.38
AB	-0.14	-0.27	-0.013
AC	0.027	-0.100	0.15
AD	-0.060	-0.19	0.066
AE	-0.25	-0.38	-0.13
BC	0.016	-0.11	0.14
BD	-0.023	-0.15	0.10
BE	-0.26	-0.39	-0.13
CD	-0.048	-0.17	0.078
CE	-0.37	-0.50	-0.25
DE	-0.17	-0.30	-0.048

As we can see the highest yield is obtained with the lowest values of the four parameters. And the lowest yield is obtained with the highest levels of these parameters. Figure 4 and Figure 5 show the evolution of biomass production with respect to time for these two cases.

Let us now analyse the results obtained with the design of experiments procedure. Results presented in Table.2 show that salinity is the most influential parameter (0.38) followed by light intensity (0.26), residence time (0.25), temperature (0.24) and last concentration (0.18). It should be noted that the minus sign (-) indicates that the maximum is reached with the low level of the parameters and vis-versa. At the level of the interactions, the weight of influences is the following in descending order: salinity-residence time (0.37), luminous intensity-residence time (0.26), residence time-temperature (0.25), nitrate-residence time (0.17), and temperature-light intensity. The other interactions have rather a negligible role. It is interesting to note that the interactions that have a significant influence are all related to the period of time. These results are confirmed by the overlay graphs (Khuri, 1987) which clearly indicate that the best combinations correspond to the overlay presented in Figure 6-a and Figure 6-b.

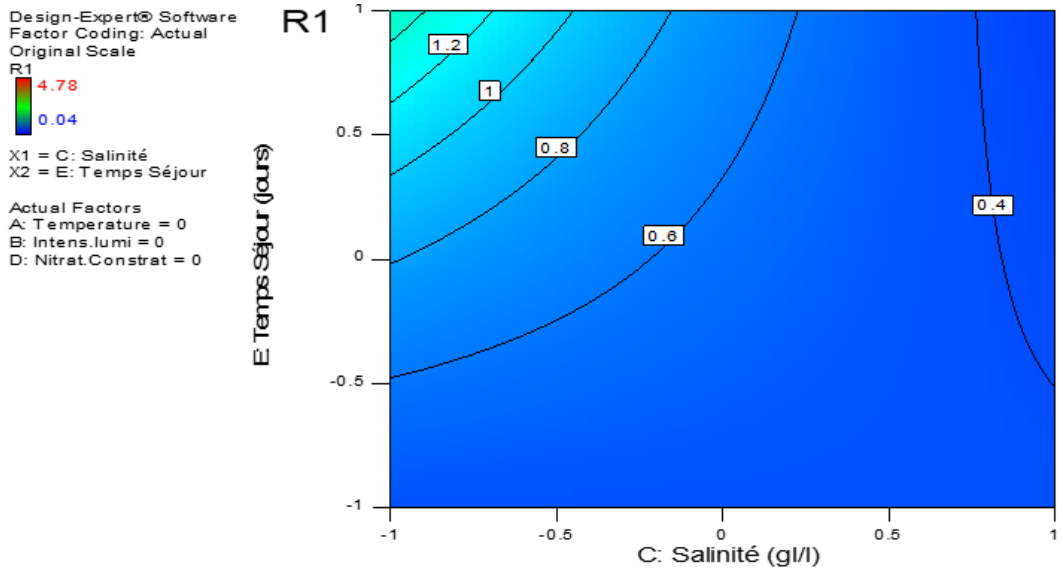

Figure.6-a. Projected yields overlay

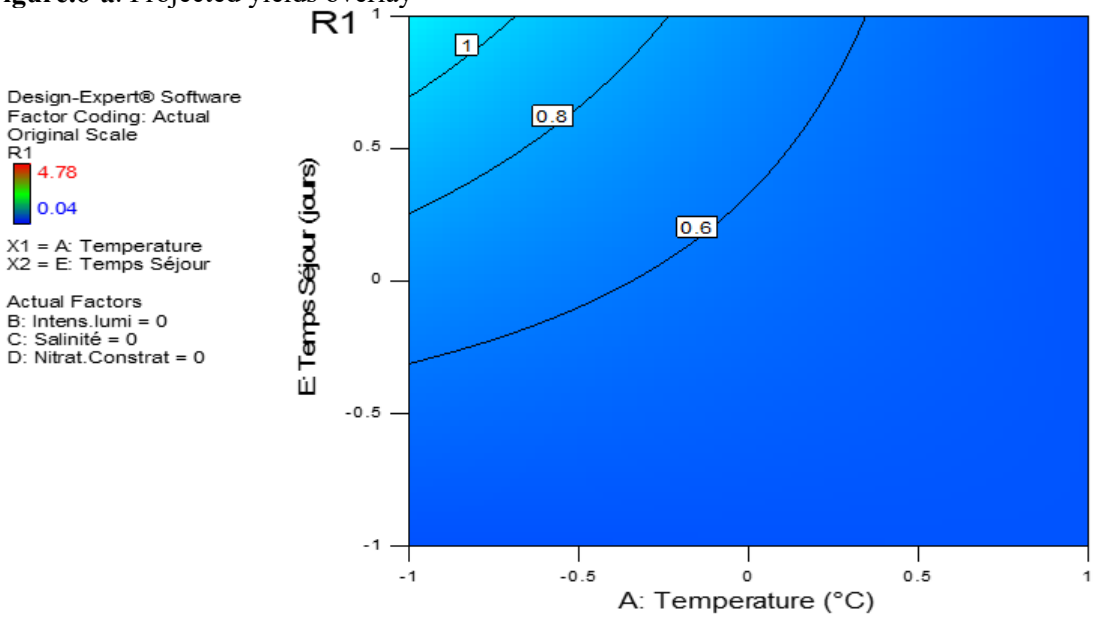

Figure 6-b. Projected yields overlay

These representations constitute the most important tool for determining the best conditions that allow the highest yields. By considering Figure 6-a, we can see that the yield will exceed 1.2 gr/L with the lowest degree of salinity and the medium values (between the lowest and highest values) of the temperature, the light luminosity and the nitrate concentration. However, if keeping the temperature at a lower level is not a big constraint, we can reach almost the same yield with the lowest temperature and medium salinity. This shows how this method allows us to adapt our parameters to existing constraints in order to obtain the desired result.

Conclusion

The optimal growth conditions deduced from the analysis of these experiments are: 20 °C for the temperature, 18000 lux for the luminous intensity, 45 gr / l for the salinity and 50 mg / l for the concentration of nitrate The culture of the microalgae with the optimized conditions confirmed that the maximum responses were reached for the minimum values of the four factors mentioned above. the maximum was recorded at the end of the 16th day for a production of 6.02 gr /L. This also allowed us to determine the factors acting directly on the response (biomass production), their interactions and their actions on the productivity of this alga. The production of biomass is a dynamic operation. We were able to determine the importance of each factor as well as the interactions between them. To improve this study, we will have to carry out a dynamic study that considers the rate of growth, using real-time control of this phenomenon.

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Research Paper

Impacts of Climate Change on Turkish Agriculture

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Abstract: The aim of this study was to review the effects of climate change on the agricultural sector of Turkey. The main policy documents and the literature related with climate change were used as main material in this study. According to the results, global average surface temperature had increased by 0.4-0.8 ºC since 1860s and it would increase by 1.4 to 5.8 ºC over the 1990-2100 period. In Turkey, it was estimated that the temperature would increase by 1.7 in 2050 and 5.1 in 2080. This climate estimation show also that the effects of climate change would occur severely in Turkey. Therefore, Turkey has tried to mitigate and adapt to the effects of climate change, its current actions could not be seen enough to meet the effects of future climate changes on the agricultural sector. Climate change in Turkey would cause considerable losses in the yield of crops at an increasing rate. Climate change should be an issue not only for the government and industry, but also for the scientists and farmers. Mitigation and adaptation strategies can help to minimize negative impacts of climate change and these need to be increased expenditures in research, technology, infrastructure, institutional innovation, data collection and policy support.

Keywords: *Climate change, impacts, agriculture, Turkey*.

Introduction

Global climate has changed especially since 1900s and it has been one of the most important challenges for global food security. As the world population grows to a projected 9 million by 2050, agricultural production must also increase by an estimated 70% (FAO, 2009). Climate change is defined by the Framework Convention on Climate Change as "*a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability over comparable time periods*" (Pielke, 2004). Climate volatility, more frequent extreme weather events and temperature changes increasingly threaten the viability of agriculture. By 2050, emissions should be reduced by 7% in order to keep the increase in global temperature below the crucial ceiling of 2 ºC. This can only be achieved with the contribution of the agriculture sectors (FAO, 2016) and global cooperation (Peker *et al.,* 2019).

Climate change may influence on crop production, markets, food prices and supply chain infrastructure (Gregory *et al*., 2005). The climate change is real, and it has led to significant impacts on the global food security. Forecasting the global and regional changes in the climate is very important to mitigate and to adapt with its possible future effects (Sen, 2018). Therefore, the issue of climate change has increasingly become a research topic among the scholars. Thus, Al-Amin and Ahmed (2016) examined climate change adaptation and its cost-benefits using an empirical dynamic commutable general equilibrium model for Malaysia and found that the food sustainability gap is rising over time due to climate change effects. Dawson *et al*. (2016) found that under no climate change scenario by 2050, based upon projected changes in population and agricultural land use only, 31% of the global population would be at risk of undernourishment if no adaptation or agricultural innovation is made in the intervening years. When climate change is considered, an additional 21% of the global population would be at risk of undernourishment. The future food security gap could not be solved via technological improvement in agriculture and this requires an integrated food system approach to adapting to additional threats on food security (Ericksen *et al*., 2009).

In Turkey, the possible effects of climate change on agriculture have been a research issue especially since 2000s. Kanber *et al*. (2008) investigated the impacts of climate change on the agriculture and estimated that precipitation would decrease significantly; the amount of snow and melting times would change; sowing or planting times and sown areas of some crops (wheat) would

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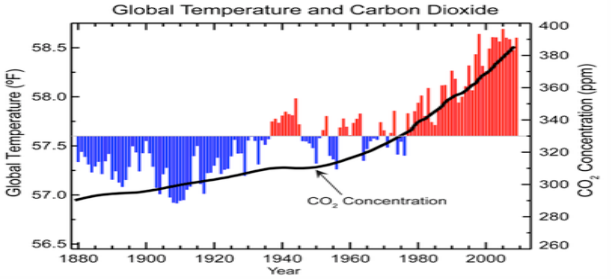
change in Turkey. Turkes (2006) evaluated the agreement of global climate change for Turkey. Kanat and Keskin (2018) evaluated the literature about climate change and stressed that there is a severe lack of data availability on climate change. There have been some empirical studies investigating the past period effects of climate change in Turkey. Thus, Dellal *et al*. (2011) assessed the yield and welfare effects of projected climate change on wheat, barley, corn, sunflower and cotton for Turkey. Akyuz and Atis (2017) investigated interaction between climate change and agriculture in Turkey. Bayrac and Dogan (2016) investigated the impacts of climate change on Turkish agricultural sector for a longer period (1980-2013) and stated that climate change negatively affected agricultural sector. Dumrul and Kilicarslan (2017) also evaluated empirically the effects of climate change on Turkish agricultural sector for the period of 1961-2013 and found that increase in temperature and decrease in precipitation negatively affected on agricultural gross domestic product and they recommended establishing necessary policies to mitigate and to adapt to climate change.

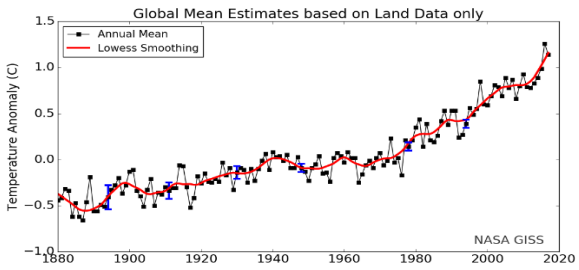
The aim of this study was to examine the possible effects of climate change on Turkish agricultural sector. The general concept of this study includes the evidences of climate change in the global and country-wide levels, the climate change policy of Turkey and the possible effects of climate change on Turkish agricultural sector.

The Evidences of Climate Change

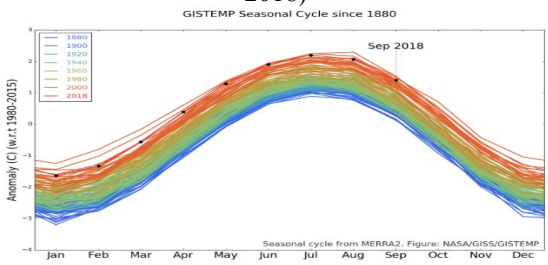
Observations show that the earth has indeed warmed as the atmospheric concentration of greenhouse gasses like CO_2 has increased. Figure 1a and 1b shows that there had been an upward trend in the global surface temperature anomalies since 1880s. Today, average temperature had increased by 0.4-0.8 ºC since 1860s. Figure 1c show that there had been about 1.5-2 ºC monthly or seasonal increase in global temperature during the period of 1880-2018. It was estimated that the global surface temperature would increase by 1.4 to 5.8 ºC over the 1990-2100 period. There have been evidences that other climate parameters such as rainfall distribution and extreme events have changed due to the activities of society and, particularly the combustion of fossil fuels. However, recent climate changes cannot be explained by natural causes alone. Unlike natural influences, human activities explain most observed warming especially since the mid-20th century (IPCC, 2013). Figure 1d also shows that global climate change has been caused by more human factors than natural phenomena.



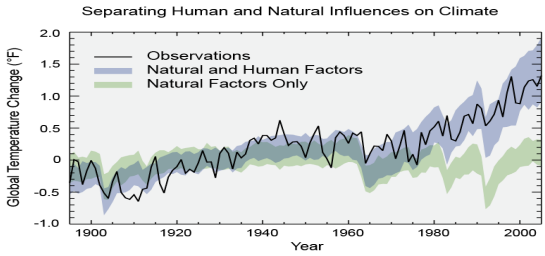
(a) Global CO_2 concentration and temperature (NOAA, 2018)



(b) The anomalies in the global temperature (NOAA, 2018)



(c). Global temperature seasonal anomaly (EPA, 2017a)



(d) Human and natural influences in climate (EPA, 2017b)

Figure 1. The annual anomalies in the land temperature and the human and natural influences

Figure 2 shows that, in Turkey, there had been a parallel trend in the temperature anomaly. While global trend seems to begin since 1980s, there had been an increasing trend in the temperature

anomaly of Turkey since 1990s. Despite this delay, the temperature increase in Turkey was higher than the global temperature increase for the same period.

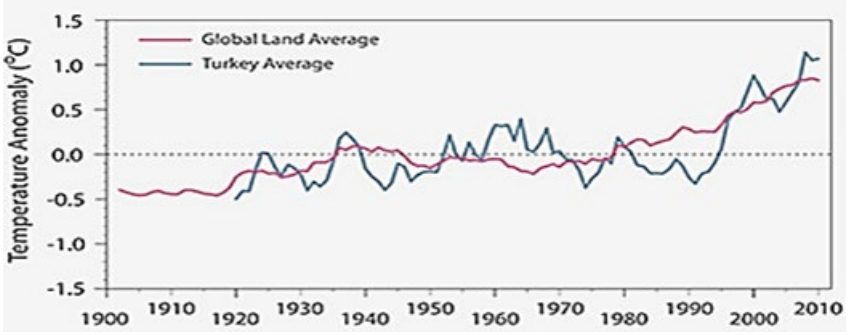
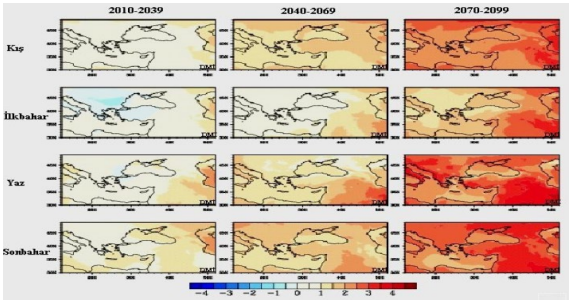
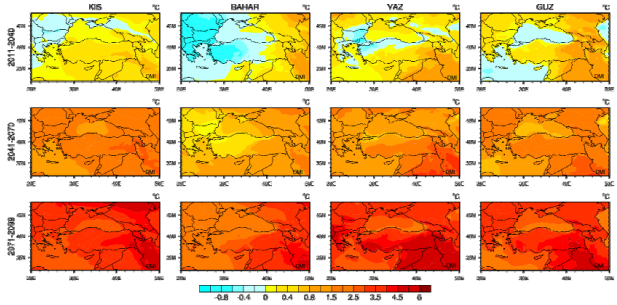


Figure 2. Developments in the average annual temperatures in Turkey (Sen, 2018).

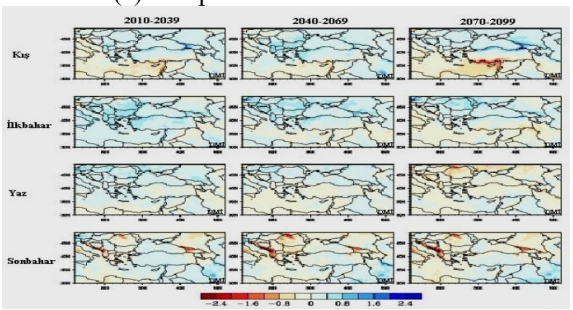
Figure 3 shows the estimated future changes in the annual temperature and precipitation of Turkey. Based on the average of 1961-1990, the estimated annual mean temperatures in Turkey for the periods of 2010-2039, 2040-2069 and 2070-2099 show that the temperature will increase in all over Turkey. The temperature increase from 1960s or 1970s to the 2000s was close to 1.5 ^{0}C. By 2050, it was estimated that while annual mean temperature would increase by 1.5°C and precipitation would decrease by 1.5 mm. At the end of this century, it was expected that temperature would increase 1.8°C at the low emission scenario and 4 °C at the high emission scenario and the temperature increases would rise the sea level about 26 cm and 59 cm, respectively (IPCC, 2007). However, Cline (2007) projected that there would be 5 ^{0}C temperature increase in 2099 compared with the base period of 1961-1990 and average daily precipitation would decrease from 1.57 mm to 1.33 mm. The scenario A1 indicates that economic and social developments in the world will be better in the future, while the A2 scenario represents a more pessimistic approach especially for rapid population growth.



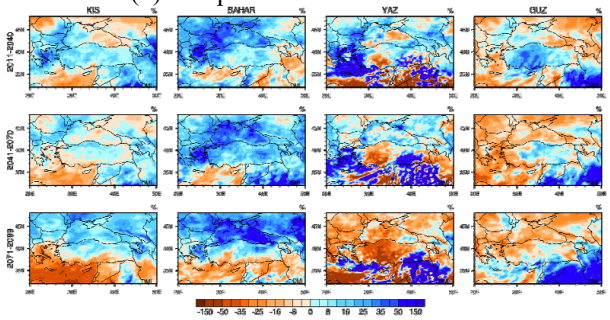
(a) Temperature for Scenario A1



(b) Temperature for Scenario A2



(a) Precipitation for Scenario A1



(b) Precipitation for Scenario A2

Figure 3. The estimated changes in annual temperature and precipitation in Turkey (MoFAL, 2018a)

The most drastic temperature change in the period of July and August was projected as 4.1°C for the Central Anatolia Region and 3-4 °C for the Mediterranean and Aegean regions. The least temperature change is projected as changing from 1.6 °C to 2.5 °C for the Black Sea Region. The highest and the least changes in precipitation were projected for the period of March and April in the Mediterranean Region and the South-eastern Anatolian Region, respectively (IPCC, 2007). The

summer season would witness the largest temperature increase and the temperature increase would affect more the South East, Central Anatolia, Aegean and Mediterranean regions. While the temperature would further increase, there would not be a single trend regarding prospective changes in precipitation patterns. Still the primary factors that shape the climate of Turkey can give us hints about prospective changes in precipitation patterns. Above estimation results show clearly that climate change will be intensified more in the future and Turkey will be one of the most effected country.

The Policy and Action of Climate Change in Turkey

Turkey has tried to mitigate and adapt to the effects of climate change through the programs and projects. International agreement and national legislation or strategic or action plan documents set out the main policy objectives and strategies of Turkey about mitigation and adaptation to the global climate change. First, Turkey has participated in the Climate Change Convention of United Nation in 2004. Constitution 1982 of Turkey, 10th Development Plan (2014-2018), Medium Term Program (2014-2018), Climate Change National Action Plan (2011-220), Turkey's Climate Change Strategy Document (2010-2023) the Strategic Plan of Ministry of Food Agriculture and Livestock (2018-2022), and National Rural Development Strategy (2014-2020) has consisted of the main climate change policy documents of Turkey.

According to the article 45 of 1982 Constitution, the government is responsible to prevent unintended use and destruction of agricultural lands and pastures (TBMM, 2011). The strategic objectives of Turkey's Climate Change Adaptation Strategy and Action Plan are to integrate climate change adaptation into the agricultural sector and food security policies, to determine natural disaster risks and the effects of climate change on agriculture, to protect soil and biodiversity, to plan sustainability of agricultural water use, to develop institutional capacity and inter-institutional cooperation or coordination, to improve information, monitoring and evaluation systems for decision-making processes and R&D capacity, to strengthen the management of intervention mechanisms, to organize education, information and public awareness activities and to improve mitigation and adaptation capacity of climate change (MoEU, 2012).

The Medium-Term Program has envisaged to develop tax policies for combating with climate change (OGoTR, 2018). National Rural Development Strategy (OGoTR, 2015) has objected to improve rural environment and to sustain natural resources in Turkey. This strategy has foreseen some measures such as promoting environmentally friendly agricultural practices, improving organic agriculture, preventing environmental pollution caused by agricultural activities and improving pastures in order to ensure the sustainability of soil and water resources. However, the strategy also aims to develop irrigation infrastructure and income generating activities in the protected areas, to promote land consolidation and its surroundings in order to ensure efficiency of agricultural land use.

The Strategic Plan of MFAL emphasized that there has been decrease in water resources due to climate change whereas water demand has increased and, this is a significant threat for the sustainability of agriculture sector. The main strategic aims of the Strategic Plan of MoFAL are to determine the possible impacts of climate change on agricultural systems and to develop the measurements for monitoring-mapping droughts and yield estimation models and to develop strategies (MoFAL, 2018b).

The MoFAL have implemented some agricultural programs and projects to mitigate and adapt to the negative effects of climate change. Within this scope, the farms have supported by the programs of land consolidation, organic agriculture and good agricultural practices, and environmental protection of agricultural lands. The interest-free loans for five years have been provided to the farmers in order to protect the water resources and to ensure modernization of irrigation facilities and systems. However, Provincial Crisis Centres of Agricultural Drought were established within the scope of drought management strategy to fight with the droughts. The government has subsidized the insurance premium at a rate of 50% in order to compensate meteorological disasters such as frost, hoses, floods etc. MFAL has carried out agricultural R&D activities to mitigate and adapt with climate change such as reduction of energy use in agriculture, sustainable use of resources, development and rehabilitation of drought-resistant plants, improvement of degraded irrigation methods and tools in dry periods, development of land-processing methods and tools fixed carbon retention into the soil (MoFAL, 2018b). All these policy precautions are important and effective in terms of adaptation and mitigation

to climate change, they could not achieve the targeted effects due to some problems and impossibilities (Akyuz and Atis, 2016).

The Effects of Climate Change on the Agricultural Sector

Table 1 shows the possible effects of climate change and vulnerable sectors in Turkey. Thus, the climate change in Turkey will have a medium decreasing impact on surface waters and agricultural productivity (Mediterranean, Aegean), whereas this medium impact would be as increase in forest fires (West Anatolia), shortage of usage water (Afyon, Izmir, Kayseri, Mugla, Manisa), floods (Black Sea, Southeast Anatolia) and landlessness or loss of soil (Southwest Anatolia). However, climate change would have a low decreasing impact in disruption of marine ecosystem (Mediterranean, Black Sea and Aegean) and seafood production (Mediterranean), whereas this low impact would be as increase in river or basin regime changes (all regions), soil losses or salinity (Mediterranean, Black Sea and Aegean), migration of species and coastal erosion (Black Sea).

Climate change has been occurred as an increase in droughts, extreme rainfalls, floods and natural disasters. Therefore, in Turkey, the climate change would have an increase effect in deterioration of irrigation water quantity-quality, cost of water supply, degradation of agricultural ecosystem and pastures, plant diseases and pests, credit risk, unemployment, migration and risk of sustainability in the agricultural sector, whereas it will have a decrease effect in number of animal husbandry, quality and quantity of production or stocks of foods, incomes of farmers, tax revenues of the government, national economic growth and development.

Table 1. Impact levels of climate change on the regions and sectors in Turkey (MoEU, 2012)

Impacts	Severity	Region or Province	Sector or Theme
Declining of surface waters		West Anatolia	Agriculture, infrastructure of water distribution network
Forest fires		West Anatolia	Tourism, agriculture
Increase in shortage of usage water		Afyon, İzmir, Kayseri, Muğla, Manisa	Agriculture, industry, energy
Flood	Medium	Black Sea, Southeast Anatolia	Survival of farms, human health
Landlessness/loss of soil		Southwest Anatolia	Farms' survival, food security, shallow lakes and wetlands
Decrease in agricultural productivity		Mediterranean, Aegean	Agriculture (employment), food security
Change of river/basin regimes		All	Ecosystem services and biodiversity
Soil losses/salinity		Mediterranean, Black Sea, Aegean	Tourism, ecosystem services, biodiversity, seafood
Disruption of marine ecosystem	Low	Mediterranean, Black Sea, Aegean	Ecosystem services and biological diversity
Migration of species		Mediterranean	Tourism, agriculture, food security
Decrease in seafood production		Mediterranean	Agriculture, food security, water distribution network
Coastal erosion		Black Sea	Fishing, unemployment

Dellal *et al*. (2016) estimated that, with a decrease in precipitation, the average temperature in Turkey would increase 1.7 ºC in 2020, 2.9 ºC in 2050 and 5.1 ºC in 2080 based on 1971-2000. The temperature rise and precipitation decrease would cause considerable yield losses in the yields of main grains. Thus, while yield decrease would change from 1.7% (cotton) to 7.3% (paddy) in 2020, the yield losses in grains would be higher as 3-12.5% in 2050. The yield losses would increase at the range of 5-15.8% in 2080. However, the decrease in milk production would be 4.3% in 2020 and 20.3% in 2080 (Figure 4). However, Cline (2007) also found that, in Turkey, the yield of main cereals (paddy, wheat, maize, and soybean) and oilseeds would be decreased 11.8% in 2080s.

However, climate change would also increase crops' prices. Climate change would have a global price increases as 32-37% for paddy, 52-55% for maize, 94-111% for wheat and 11-14% for soybean in 2050. If effective climate change measures are taken, these price increases would be expected to be

less 10% (Nelson *et al*. 2009). However, Dellal *et al*. (2011) estimated that the prices increase in Turkey would be 12.6% for corn, 7.1% for barley, 6.3% for wheat and 0.1% for sunflower.

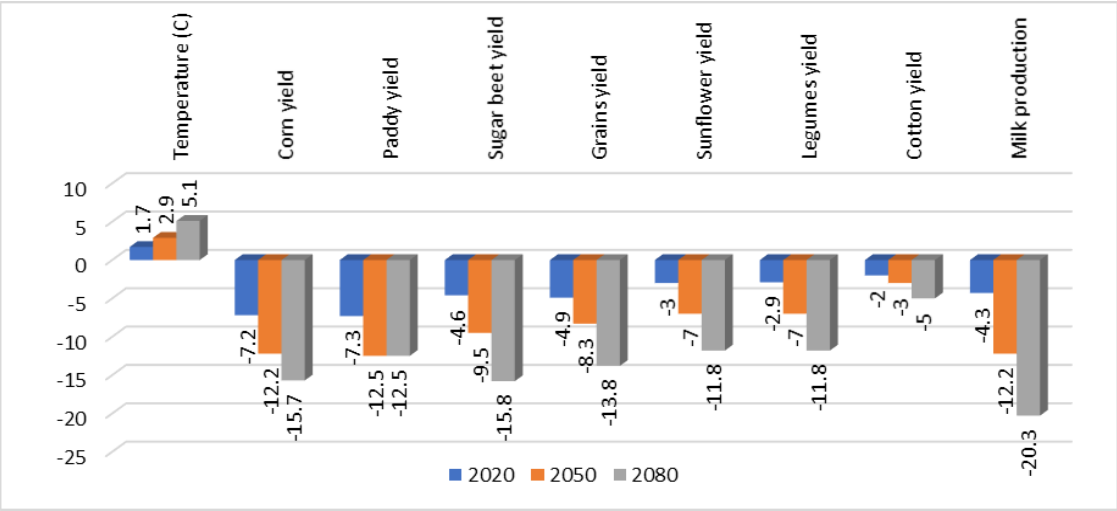


Figure 4. The climate change and its impacts on the yield of selected crops and milk production (Dellal *et al*, 2016)

Conclusions

Climate change is a reality and it is expected to continue. Thus, there has been increase in CO2, temperature, sea level, variability and extreme events such as floods and drought. Climate change will alter comparative advantages of the country and the direction and magnitudes of these changes should be investigated. Climate change should be the issue of farmers, industry, government and scientists in Turkey. Therefore, understanding of the interaction between climate change and agriculture should be a priority for all stakeholders. However, climate change impacts vary across the regions and this need region specific analysis and policy measures. Emissions of greenhouse gases should be reduced and alternative energy sources should be developed and used in the worldwide. Mitigation and adaptation strategies can help to minimize potential negative impacts of climate change and this need to increase expenditures in research, technology, infrastructure, institutional innovation, data collection and policy support. The measures such as changing of crop mixes from perennial plants to deep root ones, using of cultivation systems that leave residues reducing tillage and shifting land use from annual crops to perennial crops, pasture and forestry should be taken for the agricultural sector. However, regional drought action plans should be prepared and implemented. Water resources should be used efficiently and sustainably.

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Research Paper

Comparative Investigation of Traffic Emission Rates in Konya

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Abstract: This study aims to investigate the air pollutants including NO_X, PM and CO caused by motor vehicles in Konya province. The annual average daily traffic of the motor vehicles on Turkish state highways inside Konya borders considering their types and fuel were used for calculation the annual emission rates of the pollutants between 2010 and 2017. The emission values of each year comparatively evaluated and the effects of personal cars in total were identified. As a result, we found that the total taken pathways length increased by 67.8 % in 2017 according to 2010. Therefore, the increase in the amount of NO_X, CO and PM found as 18.2 %, 66.7% and 32.1% respectively in 2017 according to 2010. Lastly the length of the pathways traveled by personal cars was made %64.18 of the total in 2010 and increases to 68.14% in 2017. We understood from study that most significant vehicles with respect to the contribution in air pollutions are ranked as personal cars and then motor vehicles using diesel fuels. While the vehicles using LPG has a lower effect.

Keywords: *Air Pollution, Traffic Emissions, Pollutant Emissions, Konya*

Introduction

The increase in the population of the world brings the significant challenges of protection our environment and atmosphere from being polluted. In parallel with the increasing of the population demands for energy, industrialization and transportation increase. This increasing together with irregular urbanization and traffic network planning with lack of comfort will courage people to choose personal vehicles in their daily life and put the environment in danger with increasing the pollutants. As the economic growth and urban development of any city depends on transportation it's necessary to understand their negative impacts changing rates as well in order to optimize our traffic network planning.

Pollutants and particulates may be caused by artificial (such as domestic heating, industry, motor vehicles) or natural (forest fire, volcanic events) sources. These pollutants can be lost in the form of precipitation and dilution by exposure to different factors such as rain, wind and photochemical reactions in a certain time from the atmosphere (TAS, 2006).

Konya province which ranks 7th in 81 provinces in terms of population density and Intensive result of rapidly development and industrialization, make Konya to pull immigration from other cities. According to the Turkish Statistical Institute the population of Konya which was 1 835 987 in 2000 reached to 2 205 609 in 2018 with 20.13% growth. Increasing population increases the volume of vehicles on existing roads, open new traffic networks and raises the number of vehicles. Therefore, it's so important to examine the air pollution results from motor vehicles which as one the mean sources of pollution and to take the necessary measures (Tuik, 2018).

Konya city is topographically surrounded by mountains (Taurus and Balkar mountains) which limited the wind formations and air pollution transportation to the other region thus specially in wither months which air pollution increases by domestics as well as other sources we can observe and increase in concentration and pollution of the atmosphere over the city (Fatma & Şükrü, 2018). The average annual temperature of Konya is 11.5C and the average temperature of the winter months (October and March) where the air pollution is high, is 3 C, the temperature in the coldest and the hottest month is -0.2 and 23.2 respectively (TSMS, 2018).

The presence of exogenous gasses in motor vehicles and there effective and direct toxic properties make vehicles more important than other pollutant sources. The amount of fresh air which is inhaling by as normal person daily is 15 m^3. This volume of the air simply can be polluted by a vehicle which does contain emission control system in 10 minutes (Atımtay, 2003)

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The first step of studying and preventing air pollution is to determine the amount of emissions released to atmosphere from different pollutant sources which is called inventory. The inventory of emissions can contribute to the future planning and will provide ideas for decision makers (Casanova, Ariztegui, & Valdes, 2004).

In this study, air pollutants (particular mater-PM, carbon monoxide-CO nitrous oxide-NO_X, and sulfur dioxide-SO_2) of vehicle in Konya province were investigated. The study contains only the main roads within provincial boundaries the sub-roads are not taken into consideration.

Properties and effects of vehicle emissions

Carbon Monoxide (CO)

As a result of burning fuel with lack of oxygen inside the motor cylinder the CO extracts. Due to its high affinity of hemoglobin it causes lack of oxygen when by binding to the hemoglobin. Staying in the environment containing 100 ppm for a long period of time will cause mild headache and environments with 500 ppm and 2000 ppm will cause fainting and loose of consciousness and even death respectively (Kaytakoğlu *et al*, 1995)

Nitrogen Oxides (NOX)

NO, NO_2 and N_2O_2 are all compounds of Nitrogen oxides. Nitrogen oxides are changing in relation with air access coefficient (the mass of air in which fuel burns to the amount of the air for complete combustion) and velocity in which vehicle travels. As the car travel by 90 km/h and air access coefficient is bigger than one the NOX emission increases (Alkaya & Yıldırım, 2000)

NOX combine with the hemoglobin in the blood and then with moisture of lungs product nitric acid, as the concentration of the acid increase in puts the human health in danger (SERT, 2008)

Particular Mater-PM

In the internal combustion engines the carbon molecule in the fuels drop which cannot find enough oxygen for burning results the emission of PM and mostly produced by diesel fuels motor vehicles (Dönmez *et al*., 2009). Although it changes according to the dimensions, concentrations and chemical structures of the particulars, it causes many diseases related to respiratory system and even deaths (Turalıoğlu & Bayraktar, 2003).

Material and Method

In this study three mean pollutant emissions, NOX, CO, and PM sourced from motor vehicles, were figured out by using emission factors.

Emission factors are defined by fuel volume or by mass of fuel called mass-based or task-based. The emission factor unit may determine the burning fuel such as Kg / ton or kg / m3. The unit of emission factors can be classified according to the types of activities. For example, if electricity is generated by a power plant, the emission factor unit is g / MJ. Or, if the distance is taken by a vehicle, the emission factor unit is g / km (Nurrohim & Sakugawa, 2004).

In this study, the factors given in Table 1, which shows the amount of emission in grams per kilogram of fuel depending on vehicle types, are used.

Table 1 Emission Factors (IKONAIR, 2012)

Vehicles	Fuel types	NOX (g/kg)	CO (g/kg)	PM (g/kg)
Car	Petrol	14.5	132	0.037
	LPG	15.5	68	0
	Diesel	11	4.7	1.7
Van/Minibus	Petrol	24	155	0.03
	Diesel	15	11	2.8
Autobus	Diesel	37	8	1.2
Trucks	Petrol	24	155	0.03
	Diesel	37	8	1.2
Others	Petrol	24	155	0.03
	Diesel	15	11	2.8

In the table 2 the amount of the fuel that vehicles burn per kilometer related to their types is given.

Table 2 Fuel Consumption According to Vehicle Types (IKONAIR, 2012)

Vehicles/ fuel type	Petrol(kg/km)	LPG (kg/km)	Diesel (kg/km)
Car	0.07	0.0575	0.06
Van/Minibus	0.1		0.08
Autobus			0.24
Trucks	0.1		0.24
Others	0.04	0.035	0.08

By calculating and multiplying the given values, we can find the emission rate according to the types that a vehicle has passed over a kilometer.
As stated in Table 3, the annual average daily traffic volume through State highways within the boundaries of Konya is obtained from the General Directorate of Highways. In this table, the average daily traffic and the length of travel times are given by type. Using the data, we provide daily and yearly total route lengths of the vehicles on the specified highways.

Table 3 Ankara St. 2017 Annual Average Daily Traffic (KGM, 2017)

Ankara Street Section no	Lenght (KM)	Total (aadt) Veh./day	Car Veh./day	Van/minibus Veh./day	Autobus Veh./day	Truck Veh./day	Others Veh./day
715-01	11	7782	6183	269	70	447	813
715-01	35	7157	5351	502	152	490	663
715-01	15	7649	6018	291	70	448	822
715-02	41	8086	5933	545	161	680	767
715-03	29	9652	7049	617	162	721	1103
715-03	19	11467	8054	440	93	970	1911
715-03	5	32449	26093	2637	256	2053	1411
715-04	31	15085	11633	960	268	1074	1151
715-05	25	6301	4641	476	128	530	526
715-05	6	4641	3227	326	98	462	528

The total annual pathways travel over the highways calculated and given in the table below with respect to the year and types of the vehicles.

Table 4 Total Taken Pathways with Respect to Vehicles Types (Km) (KGM, 2017)

Year/Vehicles	CAR	Van/minibus	Autobus	Truck	Others	Total (Km)
2010	4218174	399875	207953	1105093	641006	6572101
2011	4502718	406670	208243	1019705	836572	6973908
2012	4600635	401117	188827	956673	879743	7026995
2013	4823808	396088	202789	936349	1031343	7390377
2014	5761842	419960	316977	958752	1227574	8685105
2015	6136374	440122	281186	976448	1358739	9192869
2016	6641931	492737	277136	970672	1442029	9824505
2017	7167254	679616	252603	848524	1568976	10516973

By computing the data according to following relation, the quantity of the pollutants released by vehicles annually were figured out.
Emission (g) = highways length (km)* annual average daily traffic*emission factor (g/kg) *fuel burn factor (kg/km)

$$Ei = \sum (\mathrm{L} * \mathrm{V}) * \mathrm{EF} * \mathrm{F} *$$

Where;
E_i: is shows amount of Emission (g),
V: annual average daily traffic,
L: length of the traveled pathway,

EF: emission facto (g/kg),
F: fuel burn factor (kg/km)

Results

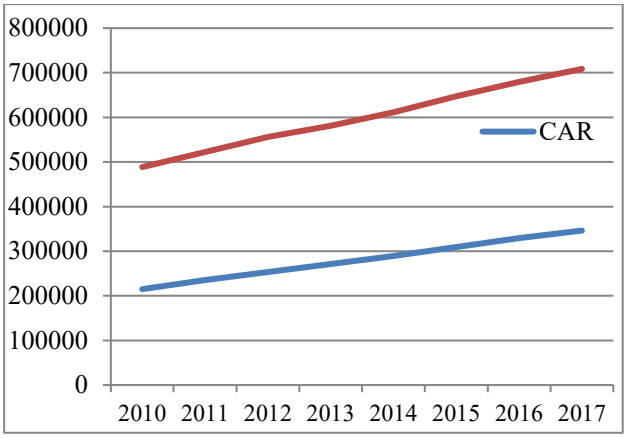

Figure 1. Number of vehicles and personal cars passing through main roads in Konya Province where x axis shows the years and y axis the amount of emissions

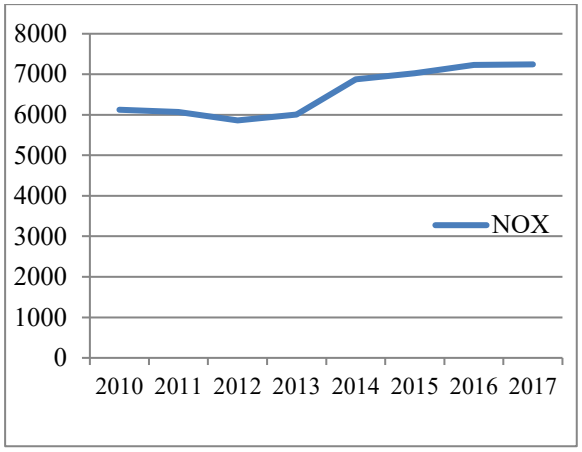

Figure 2. Changes in the amount of NOX pollutant calculated by years where x axis shows the years and y axis the amount of emissions

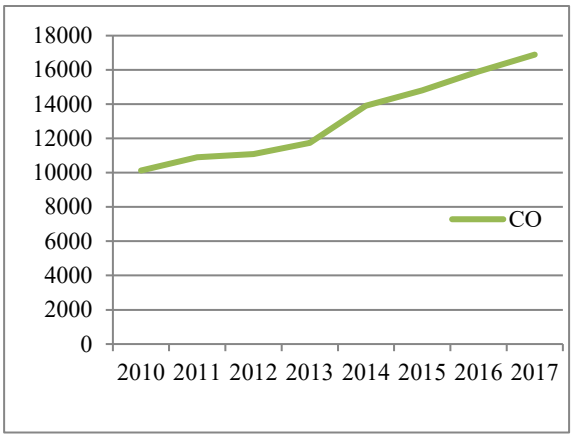

Figure 3 Changes in the amount of CO pollutant calculated by years where x axis shows the years and y axis the amount of emissions

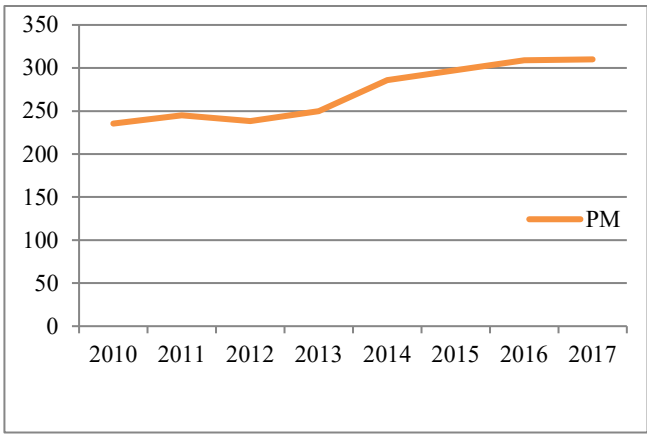

Figure 4 Changes in the amount of PM pollutant calculated by years where x axis shows the years and y axis the amount of emissions

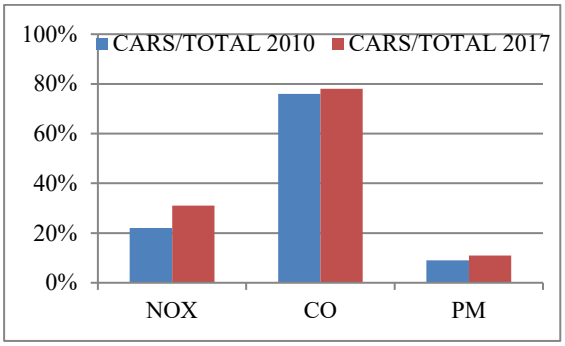

Figure 5 Contribution of the personal car to the total traffic pollutants on main road ways calculated by years where x axis shows the particles and y axis the percentages

Year/ parameters	2010	2017	Changing rates (%)
Vehicles	488,626	708,617	45
Cars	214,970	346,270	61
NOX	6127	7244	18.23
CO	10128	16892	66.7
PM	235	310	32

Table 5 Number of vehicles, amount of emissions in ton and changing rate with respect the years

Conclusions and Discussion

As shown in Figure 1, the total number of motor vehicles was 488,626 in 2010 and 708,617 in 2017 with an increase of 45%. While the total number of personal cars was 214,970 in 2010, it was calculated as 346,270 with an increase of 61 percent in 2017, which is a disproportionate increase.

Figure 2 shows the status and route of NOX from 2010 to 2017. In 2012, the amount of emission was 6127 tons and it decreased by 4.3% to 5861 tons in 2012. In 2014, there was a sharp increase of 14.45% compared to 2013. Confronting to 2010, an increase of 18.23% was observed in 2017 with a rising 1117 tons in the amount of emission.

As shown in Figure 3, the CO showed a sharp change in 2014. It increased from 10128 tons in 2010 to 16892 tons in 2017 with an increase of 66.7%.

The particular matter (PM) showed a sharp increase in 2014 and the total PM change in 2017 was around 32% compared to 2010, which means a total increase of 85 tons.

We figured out that CO is the emission which changes with high rates and NOX is with lowest rates.

The economic growth parallel with increasing of population causes significant raise in the number of personal vehicles which effects air pollution adversely. As shown in the figure 5 the contribution of cars to total amount of emission were 22%, 76% and 9% to NOX, CO and PM respectively in 2010. These percentages increased to 31%, 78% and 11% with respects to the total vehicle's pollutants respectively by 2017.

By changing socio-economic conditions of the urban populations, industrializations and demand for energy consumption as well as tendencies for comfort life will push the pollutant emission releasing rates upper. On account of this it is vital to take some serious decision and put them in action for preventing air pollution and owning a healthy life and sustainable environment. For maintaining this, the following recommendation done for studied area.

- Ensuring that the buses of Konya Metropolitan Municipality pass from diesel to CNG,
- The 11 streets located in the city center should gradually close to the traffic in order to reduce the amount of the measures by decreasing annual daily average traffic volume.
- Refurbishing the existing trams and improving comfort, with the increasing interests to public transports reductions in the number vehicles join to the traffic will be observed,
- Replacement of fuel systems for all minibuses and service vehicles carrying passengers in the city,
- Green wave regulation in order to prevent excessive speed in city center and to provide flow in traffic
- Synchronizing traffic lights to reduce exhaust pollution caused by unnecessary waiting
- The creation of urban traffic control centers for intelligent access systems
- Keeping the prices of all the auto parks in the city centers quite high
- Infrastructure studies for the construction of bicycle paths should be done and bicycle paths have to increase in the city plan depending on urban development.

A good strategy, a good planning and the ability to see the future and to take the necessary measures, therefore, is important for a healthy life, quality and sustainable environment.

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Research Paper

Antibacterial, Antioxidant and DNA Interaction Properties of *Cistus creticus* L. Extracts

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Abstract: Medicinal plants are a natural source that possesses significant biological functions. *Cistus* (*C.*) *creticus* which are medical plant are of antibacterial, antioxidant and cytotoxic activities. This study was performed to investigate the antibacterial, antioxidant and DNA interaction properties of *C. creticus* extracts. Samples of *C. creticus* L. were obtained in May 2018 in the region of Amasya. The different extracts of *C. creticus* leaves were obtained by using soxhlet apparatus for 4 hours. Antibacterial activity of extracts was tested against four Gram positive and four Gram negative by the disc diffusion method. Antioxidant activities of extracts were determined with DPPH radical scavenging, ferric reducing and metal chelating methods. The ability to repair the plasmid DNA breaks created by hydroxyl radicals was also determine using pUC18 plasmid DNA. As a result, *C. creticus*. extracts have strong inhibitory activity against all tested bacteria. The chloroform extract was also very effective against Gram positive bacteria especially *Bacillus cereus*. Among the Gram-negative bacteria, the most susceptible bacterium was identified as *Pseudomonas aeruginosa*. Moreover, ethanol extract had repair effects on plasmid DNA in H_2O_2 condition. Among the different extracts of *C. creticus* chloroform extract showed the highest in vitro antioxidant activity. In this study, *C. creticus* collected from Amasya has shown significant antibacterial, antioxidant and DNA interaction activity and could be therefore a useful source in the discovery of new antibacterial and antioxidant compounds. However, the use of extracts as a complement to the treatment requires further research to thoroughly understand the activities and interactions with recommended medicines.

Keywords: *Cistus creticus L. Antioxidant, Antimicrobial, DNA interaction.*

Introduction

Cistus species are found in the Cistaceae family, which is a large family. They are in the form of perrenial shrubs with pink or white flowers (Stępień et al., 2018; Menor et al., 2013). *Cistus* species are colloquially known as "rock roses" (Hocking, 1997; Bouamamaa *et al*., 2006). There are 20 *Cistus* species in the world, and they are mostly distributed in the Mediterranean region, Middle East Europe, West Africa and Asian countries. There are five different types of *Cistus* in Turkey, which are *C. creticus* L., *C. laurifolius* L., *C. monspeliensis* L., *C. parviflorus* Lam, *C. salviifolius* L. (Szeremeta et al., 2018; Catoni et al., 2012; Comandini et al., 2006; Güvenç et al., 2005).

Some plants are used in the parfum industry, while others have been used in traditional folk medicine since ancient times. Chemical studies on different genera have basically shown that their antioxidant properties, which are considered to have therapeutic potential, originate from profenolic compounds and terpenoids (Kupeli & Yesilada, 2007; Menor *et al*., 2013; Stępień, 2017). Oxygen reactive forms such as peroxide, superoxide and hydroxyl radicals cause many oxidative stress-related diseases, including diabetes and Alzheimer's disease. The ability of antioxidants to sweep toxic oxygen radicals is very important in this sense.

Thanks to its rich chemical compounds, it has anti-inflammatory, antibacterial, antifungal, antiviral, anti-allergic effects and is used as a therapeutic agent against various diseases, strengthening the body resistance. In addition, various ethnobotanical studies have shown that *Cistus* species are a good remedy for infections (Bassole & Juliani, 2012; Salin *et al*., 2011). Furthermore, the studies have shown that

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extracts obtained from *Cistus* species have antiulcer, wound healing, vasodilator and cytotoxic effects (Güvenç *et al*., 2005; Stępień, 2017). However, no study has been conducted on DNA interaction of creticus.

The aim of this work is to determine the antibacterial activity of extracts obtained from the leaves of *C. creticus* L. plant found in Amasya province by using disk diffusion test, and to determine the antioxidant activities with the methods of radical scavenging activity (DPPH), metal chelating activity and ferric reducing antioxidant power assays. Additionally, the protective role of *C. creticus* L. extracts on hydroxyl radical-induced DNA damage has been investigated through plasmid DNA.

Materials And Methods

Sample extraction

C. creticus L. was collected from natural population which are located in Amasya in May 2018 (Baytop, 1999). The leaves of *C. creticus* L. were then dried at room temperature. The plants (25 g) were extracted with the soxhlet tool (Isolab, Turkey) for 4 hours in ethanol, dichloromethane (DCM) and n-hexane (HXN) (prepared by using solvents of different polarity). The extracts were filterd by Whatman No. 1 paper. The solvents were removed under a rotary vacuum until dry (Heidolph Collegiate, LV28798826, New Jersey, USA). Then the residue dissolved in Tetrahydrofuran (THF, Sigma) for antimicrobial activity (20 mg/mL). The extracts samples were stored at 4 °C in dark bottle for investigation (Bouyahya et al., 2016).

Test organisms and culture condition for antibacterial analysis

Extracts of *C. creticus* L. were tested against Gram positive (*Staphylococcus aureus* ATCC 25923, *Staphylococcus aureus* ATCC 25953, *Bacillus cereus* ATCC 7064 and *Bacillus subtilis* ATCC 6633) and Gram-negative bacteria (*Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Pseudomonas aeruginosa* ATCC 9027 and *Salmonella enteritidis* ATCC 13076). Before use, Bacterial strains were subcultured overnight at 37°C for 18 to 24 h in Tryptic Soy Broth (TSB, Oxoid, Hampshire, UK).

Antibacterial activity

Antibacterial activity of the *C. creticus* L. extracts were investigated by the disc diffusion method (CLSI 2010). *S. aureus* ATCC 25923, *S. aureus* ATCC 25953, *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853, *P. aeruginosa* ATCC 9027, *B. cereus* ATCC 7064, *B. subtilus* ATCC 6633, and *S. enteritidis* ATCC 13076 were used in bacterial strains. The concentrations of the microorganisms were adjusted using turbidity measurements (0.5 McFarland) using serum physiologic solution. The concentration of bacterial suspensions was adjusted to 10^8 cells/mL. Then, extracts (20 mg/mL) prepared in THF loaded 6 mm diameter sterile blank discs (Oxoid). Inhibition zones were determined after incubation at 37 °C for 24 h. As a positive control for bacteria, gentamicin (10 µg) and ceftriaxone (30 µg) were placed in Petri dishes. All tests were carried out in three times.

Antioxidant activity

Free radical scavenging activity

The free radical scavenging activity was determined with 1,1-diphenyl-2-picryl-hydrazyl (DPPH•) using methods of Brand-Williams (Brand-Williams et al., 1995). Different concentrations of plant material were prepared, and 0.75 mL of this extract was added the 1.5 mL of 20 mg/L DPPH• solution in methanol. This solution was added to, butylated hydroxytoluene (BHT), and trolox (25-400 µg/mL). The mixture was shaken vigorously, and the decrease in absorbance at 517 nm was measured for 30 min at room temperature. Water (0.75 mL) in place of the sample was used as control. IC50 value was calculated to use the linear regression as the concentration required for 50% reduction of the DPPH radical. The percent inhibition activity was calculated using the following equation: free radical scavenging effect % = $[(A0 - A1)/A0]\cdot 100$. ($A0$ = the control absorbance and $A1$ = the sample solution absorbance).

Metal chelating activity

The chelating activity of extract on ferrous ions (Fe^{2+}) was measured according to the method of Decker and Welch (Decker and Welch, 1990). Aliquots of 1 mL of different concentrations (100–500 µg/mL)

of extracts were mixed with 3.7 mL of deionized water. The mixture was incubated with $FeCl_2$ (2 mM, 0.1 mL) for 30 min. After incubation, the reaction was initiated by addition of ferrozine (5 mM and 0.2 mL) for 10 min at room temperature, and then the absorbance was measured at 562 nm. A lower absorbance indicates a higher chelating power. The chelating activity of the extract on Fe^{2+} was compared with that of EDTA at the same concentrations. Metal chelating activity (%) = $[(A0 - A1)/A0]\cdot 100$.

Estimation of total phenolic content

According to the methods of Slinkard and Singleton (Slinkard and Singleton, 1977), using Folin–Ciocalteu reagent were determined depending on phenolic standard gallic acid. 1 mL of the plant extract was introduced into test tubes followed by 1 mL Folin–Ciocalteu's reagent. The solution was kept in the dark for 5 min and then 3 mL of sodium carbonate (2%) was added. The tubes were covered with parafilm and kept again in the dark for 1 h and were measured absorption at 765 nm with a spectrophotometer and compared to a gallic acid calibration (GAE) curve. The results were expressed as mg gallic acid/g dried sample. Each assay was carried out in triplicate.

Estimation of total flavonoid content

Total flavonoid content was determined with quercetin standard solution using Park method (Park et al., 2008). The plant extract in 0.3 mL of was introduced into test tubes followed by 3,4 mL 30% methanol, 0.15 mL of 0,5 M $NaNO_2$ and 0,3 M $AlCl_3$ reagent. After 5 min 1 mL of 1 M NaOH was added and measured absorption at 506 nm with a spectrophotometer and compared to a quercetin calibration curve. Each assay was analyzed in three times. The total flavonoids were described as mg of quercetin equivalents (QTE) per g of dried fraction.

DNA interaction assay

To explore the beneficial effect of the *C. creticus* L. extracts on hydroxyl radical-mediated DNA damage plasmid DNA pUC18 (Thermo Scientific) was used. Firstly, the *C. creticus* L. extracts were dissolved Dimethyl sulfoxide (DMSO, concentration range from 12.5 to 100 mg/ml). A reaction mixture (20 µl final volume) containing 0.25 µg/µl plasmid DNA pUC18, 1 µl of 3% H_2O_2, 0.1 g/ml *C. creticus* L. extracts in Tris-EDTA (TE) buffer was prepared. H_2O_2 and 0.1% tetrahydrofuran treated plasmid DNAs were used as control groups. Secondly, the prepared mixture for each *C. creticus* L. extracts was incubated for 24 h at 37°C. 2 µl loading dye (bromophenol blue [0.025%] and sucrose [4%] in dH_2O) was added into the mixture (10 µl total volume) and loaded on to the 1% agarose gel. Electrophoresis process was for 90 minutes at 80 V in TBE running buffer (pH 8). The Gel was imaged under UV light (Attaguile et al., 2000; Ayvaz et al., 2018).

Results and Discussion

In this work, results indicate that ethanol, DCM and HXN extracts showed antibacterial activity with specific differences according to the test microbial strain. Gram negative bacteria are more sensitive than Gram positive bacteria. Infact, the disc diffusion tests ranged from 9-18 mm for the *C. creticus* L. ethanol extract, 8-11 mm for the *C. creticus* L. DCM extract and 8-14 mm for the *C. creticus* L. HXN extract. Extracts revealed an improved antibacterial activity against *Staphylococcus aureus* compared with that of antibiotics ceftriaxone and gentamicin. The highest diameter of inhibition is found with ethanolic extract against *Pseudomonas aeruginosa* ATCC 27853 and *P. aeruginosa* ATCC 9027 strains. Thus, *P. aeruginosa* shows extreme sensitivity, and the six other bacteria espond very positively to its antibacterial activity. Furthermore, the extracts of *C. creticus* L. were effective against *E. coli* except for the DCM extracts. Especially ethanol of *C. creticus* L. were found to be active against all bacteria. The results are showed in Table 1.

Table 1. Antibacterial effect of the extract against wild type microorganisms (mm)

	Microorgansims							
	B.s	**B.c**	**P.a 9027**	**P.a 27853**	**S.a 25953**	**S.a 25923**	**S.e**	**E.c**
Ethanol	11	10	14	18	10	10	9	10
Dichloromethane	9	14	10	9	8	8	8	-
n-Hexane	10	11	14	9	9	8	10	8
CRO 30 µg	27	13	14	30	24	32	14	30
CN 10 µg	20	21	21	21	21	20	23	21

Microorganisms: B.s: *Bacillus subtilis* ATCC 6633; B.c: *Bacillus cereus* ATCC 7064; P.a. *Pseudomonas aeruginosa* ATCC 27853 and *Pseudomonas aeruginosa* ATCC 9027; S.a: *Staphylococcus aureus* ATCC 25953 and *Staphylococcus aureus* ATCC 25923; S.e: *Salmonella enteritidis* ATCC 13076; E.c: *Escherichia coli* ATCC 25922. CRO: Ceftriaxone, CN: Gentamicin.

Overall, Gram-negative bacteria exhibited higher sensitivty to the extract antimicrobial properties than the Gram-positive ones. These results are consistent with those found in literature. These results could be partially related to the phenolic composition of the extract, Additionally, the antioxidant capacities of those extracts showing high polyphenolic content were determined via a panel of antioxidant measurements. The DPPH assay of the extracts showed potent antioxidant activity, which was comparable to that of the synthetic antioxidant BHT and Trolox. High DPPH activity was found at the ethanol extracts. Also, calculated IC50 value of the ethanol, DCM, HXN; 165.10, 189.71, 397.29 respectively. One recent study reported that *C. creticus* L. subsp. eriocephalus plant possess highest activity (Bullitta et al., 2013). Antioxidant properties of *C. creticus* using metal chelating assay are shown in Figure 1.

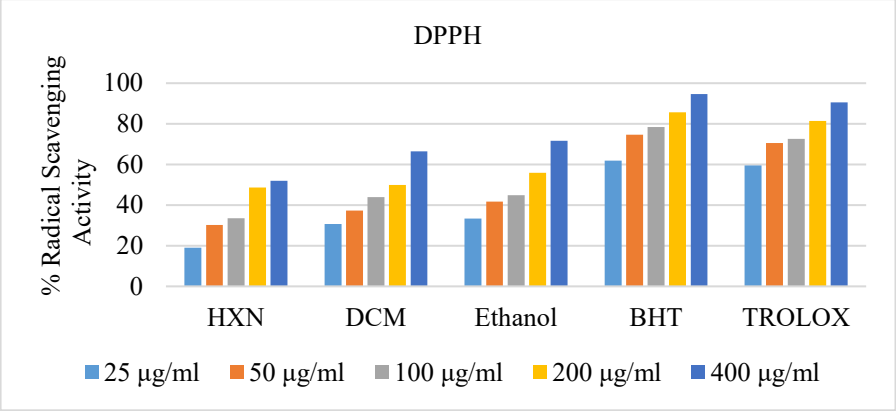

Figure 1. DPPH radical scavenging of extracts

Among extracts, antioxidant activity in terms of metal chelating activity, ranged between 43 and 32%, whereas it ranged between 95 and 75 % in the EDTA standard.

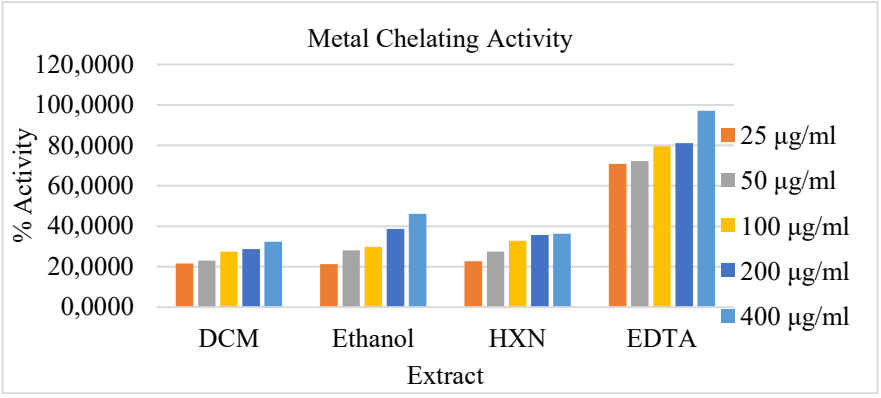

Figure 2. The results for metal chelating activities of extracts

Table 2 shows the total phenolic and total flavonoids content in the different solvent extracts of *C. creticus* in Amasya. Among the extracts, the highest phenolic content was found in ethanol (130.32 mg GAE/g dry wt.) followed by DCM and HXN. The flavonoid content was the highest in ethanol extracts. The differences in flavonoid content in extracts DCM and HXN were observed to be the insignificant however total phenolic content amount were very different in extracts.

Table 2. Total phenolic and flavonoid content

	Total Phenolic Content (mg GAE/g)	**Total Flavonoid Content (mgQTE/g)**
n-Hexane	68.3163	60.71
Dicholoromethane	112.1473	63.98
Ethanol	130.3205	83.94

Reactive oxygen species, from both endogenous and exogenous sources, may be involved in the etiology of diverse human diseases, such as coronary heart disease, infammation, neuro-degenerative diseases. According to gel electrophoresis, extracts were dissolved in DMSO and 0.25 µg/µl pUC18 plasmid DNA was treated with 12.5, 25, 50 and 100 mg/mL extracts respectively (Figure 1).

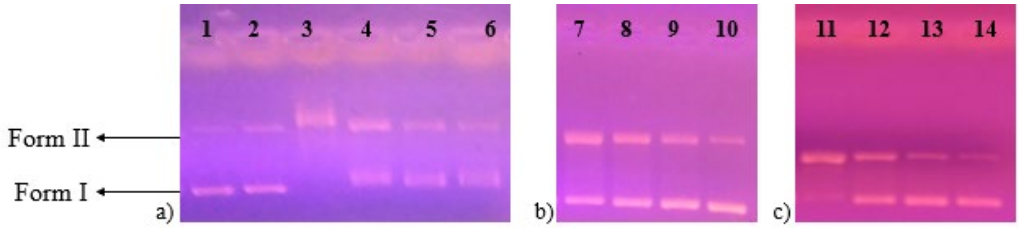

Figure 3. Gel image of extracts of *C. creticus* L. a) Lane 1: pUC18 plasmid DNA control (blank); Lane 2: DMSO control; Lane 3-6: H_2O_2, pUC18 plasmid DNA and different concentration of ethanolic extracts (12,5-100 mg/mL). b) Lane 7-10: H2O2, pUC18 plasmid DNA and different concentration of dichloromethan extracts (12,5-100 mg/mL). c) Lane 11-14: H_2O_2, pUC18 plasmid DNA and different concentration of n-Hexanolic extracts (12,5-100 mg/mL)

Figure 3 shows the gel imagene of DNA after UV-photolysis of H_2O_2 in the absence and presence of different extracts of leaves of *C. creticus*. DNA derived from pUC18 plasmid showed two bands on agarose gel electrophoresis (lane 1), the faster-moving band corresponding to the native form of supercoiled circular DNA and the slower-moving band being the open circular form (Attaguile et al., 2000). Increasing doses of *C. creticus* extracts had a protective effect on hydroxyl radical-mediated plasmid DNA damage, but a low concentration of these extracts had no protective effect on plasmid DNA in H_2O_2 conditions. It appears that extracts, ethanol, DCM and HXN, exhibit relatively similar effects against plasmid DNA.

Conclusion

The findings highlighted that *C. creticus* extracts were able to inhibit the growth of a wide spectrum of bacterial strains, known for their implications in infections. Moreover, the results of this study suggest that their antioxidant and DNA interaction activities. Hence, this extracts of *C. creticus* can be a promising agent to control microbial growth, even if more detailed reports on its toxicity and mechanisms of action are requested to overcome the impediment of its application in several industries.

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Battery Collection in Turkey, Case Study of Küçükçekmece Municipality

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Abstract: Batteries are classified as hazardous waste according to European Union and Turkish laws and regulations. Battery waste contains electrolyte solutions as basic or acidic forms that could get involved with underground water or soil. Metallic ingredients on the other hand, are valuable source for metal recovery. This paper evaluates status quo in battery collection schemes in Turkey and Küçükçekmece Municipality as a case study. Population over 80 million people with use of over 10.000 kilograms of battery every year makes Turkey an interesting example in developing countries in case of battery collection. Küçükçekmece Municipality waste battery collection scheme is explained and collected amounts are given in this paper. Küçükçekmece has a population of 750,000 people approximately with being one of the most crowded cities in Turkey. High population density and being a recently urbanized region makes Küçükçekmece an interesting example of Turkish battery collection scheme.

Keywords: Waste Battery, Waste Battery Collection, Waste Management

Introduction

European Union has the legislation especially for batteries, battery waste and battery collection. Legislation 2006/66/EC is a document of 28 pages defines battery, accumulator, battery pack, portable battery, button cell etc. (EU Directive, 2006). The Directive defines collection scheme and gives collection targets for the member states which is at least 45% after September of 2016. According to EU Stat database this target was fulfilled in 2017 by Austria, Belgium, Denmark, Finland, Germany, Lithuania, Luxembourg, Netherlands, Sweden, Switzerland (Eurostat, 2018).

In Turkey battery use per capita is 110 grams yearly which is quarter of the European mean (Eurostat 2018, Directive, 2019) Legislation on battery use and collection is regulated by Directive on Control of Waste Battery and Accumulators (Directive, 2019). This regulation is on the same basis as 2006/66/EC with deviations in details. Turkish regulation divides batteries in two groups; non - Ni-Cd and Hg-O batteries, Ni-Cd and Hg-O batteries. These two groups have different collection targets. Although collection targets are set there is not any legal burden in case of collection targets are not fulfilled. Waste battery collection in Turkey is done by Turkish Battery Importers Association (TAP) by law. TAP has 562 registered members by the time 2019 January (TAP, 2019) TAP states that agreement of waste battery transportation with two national cargo company, organized industrial zones, public establishments and military organizations. Municipalities have two sided agreements with TAP. TAP provides collection materials to municipalities.

This study aims to increase awareness of battery collection, battery use and waste battery for Turkey and other developing countries. Küçükçekmece Municipality is a good example of micro battery collection scheme of Turkey. Küçükçekmece Municipality is collecting waste batteries in 81 collection points in contact with TAP. Educational operations in schools for both waste batteries and recycling is in contact with schools are conducted.

Materials and Method

This study is conducted with data from Eurostat for European Union battery use and collection numbers, TAP for Turkey battery use and collection numbers and Küçükçekmece Municipality Annual Report for Küçükçekmece battery collection numbers. Simple methodology is used for evaluating numbers. All data is collected and compared with each other. Life cycle assessment of Turkish battery

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market could not be performed due to lack of data. Collection data and status quo is collected via personal interviews and reports.

World Battery Market

Worldwide battery market has gigantic economic value. In 2016, solely alkaline battery market value was 7.25 billion U.S. Dollars and further expansion is forecasted for the next years (Statista, 2018). Lithium based battery market had value of 9.80 billion U.S. Dollars in 2015 (Roland Berger, 2011). Electric vehicles are expected to have revenue of 271.67 billion U.S. Dollars in 2019 (Roland Berger, 2011) Battery industry worldwide has great economic value and raw material demand. Increase in electric vehicles, electrified transportation and global climate change pushes countries and companies to produce more efficient batteries and increases battery market interest.

Battery Collection Around The World

World battery collection for sustainable environment and sustainable economy is a crucial area of interest. Depletion in battery raw materials makes it mandatory to recycle waste batteries. Battery collection is becoming a point of interest within the past years. The European Union has legislation on battery collection which is called 2006/66/EC. According to this legislation every member of union have to achieve at least %45 level of battery collection (EU Directive, 2006) This collection rate was fulfilled by 10 member state yet for collection target remains to be reached for other 18 member state.

In Japan battery collection has been done by municipalities and Japan Portable Battery Recycling Center oversees collection and recycling of batteries. Japan battery collection scheme consists of separate battery collection which different type of batteries collected separately. This system is found to be inefficient against all type battery collection rule in European Batteries Directive (Terazeno et.al., 2015)

Waste battery management in Mexico is only consists of limitations to maximum levels of Hg, Pb and Cd of batteries. Batteries in Mexico are landfilled. Legislation situations in other Latin American countries are similar and mainly prohibit maximum levels of heavy metals therefore permits landfill of waste batteries in acceptable level of heavy metal ingredients (Guevara-Garcia, and Montiel-Corona, 2012). Zand and Abduli (2008) stated that in Iran spent batteries are landfilled with municipal solid waste without any treatment.

General opinion and start point of collection schemes in countries and studies make EU Directive 2006/66/EC basis of battery collection operations. Realistic collection targets and collection scheme that considers environmental impacts of waste batteries make the directive basis of battery collection idea.

Battery Collection in Turkey

Turkish battery market has a steady condition since 2007 with exception 2010. Annual battery import reports are given in Table 1. There is no battery manufacturing operation in process for now with exception of automotive batteries. Thus imported battery numbers indicates Turkish annual battery use.

Table 1. Turkish Battery Import Numbers. (TAP-1, 2018)

Year	Primary Batteries, mt	Secondary Batteries, mt
2005	6745	49
2006	5816	926
2007	10862	235
2008	10222	241
2009	9096	366
2010	6756	133
2011	8870	279
2012	10262	284
2013	8896	276
2014	9215	314
2015	9569	302
2016	10612	292
2017	10083	260

Table 1 shows battery imports in Turkey, these numbers exclude automotive accumulators and built-in batteries on imported electronics. Primary batteries have dominance over secondary batteries in Turkish battery market. Primary batteries can only be used for once therefore they are consumed in higher numbers. There is not any official explanation of decreasing battery imports in 2010. Battery imports of Turkey for specified battery types are given in Table 2. Table 2 shows battery import number of 2016 and 2017 according to imported battery type (TAP-1, 2018). Zn-C and alkaline batteries are the highest imported battery type. This can be explained by their large area of application with different electronic devices. Other battery types are generally considered for specialized applications.

Table 2. Battery imports of Turkey according to types in 2016 and 2017 (TAP-1, 2018)

Battery Type	2016, mt	2017, mt
ZnC & Alkaline	7730	6521
Lithium Batteries	184	165
Silver – Oxide	12.1	11.6
Zinc – Air	33.7	41.1
Lithium Button Cell	63.6	62.7

Imported batteries are also source of raw materials after use. The possible created source of batteries are calculated and given in Table 3. Table 3 shows imported battery chemistries per year, metallic values possible to recover and replacement of yearly use for Turkey. Manganese is the highest rate of metal in batteries for Turkey metal use. Manganese need of Turkey can be fulfilled by waste batteries by 5.64% and can create an economic value of 195.000 US $. Total economic value of metals in batteries are over 1 million US $ for Turkish economy.

Table 3. Battery imports of Turkey, metallic material value and replacement of yearly need.

Battery Type	Zn, mt	Mn, mt	Fe, mt	Li, mt	Ag, mt	Hg, mt
Zn-C, Alkaline (Yeşiltepe and Şeşen, 2016)	1777	2040	2300	-	-	
Lithium Batteries (Yun et.al., 2018)	-	10.8	16.2	2.35	-	-
Silver – Oxide (Jadhar et. al., 2018; Aktaş, 2010)	0.61	-	6.68	-	2.78	0.24
Lithium Button Cell	-	10.4	26.3	1.15	-	-
2016 Use in Turkey (MTA, 2016)	423.057	36.557	10.420.000	4569	620	0
Replacement of Batteries, %	0.4	5.64	0.02	0.07	0.4	N/A
Possible Economic Value, US $(MTA, 2016)	754.000	195.000	143.000	4100	1600	-

TAP (Turkish Battery Manufacturers Association) is the only legal institution on battery collection in Turkey. Savaş Arna, manager of TAP battery collection operation, stated that “Turkish battery market consists of imported batteries. Turkey produces only automotive accumulators and collection and recycling of lead acid accumulators are under control of their manufacturers by law. Our operation is to collect waste batteries from public areas like mosque, museum, school, hospital etc. Also we arrange campaigns in schools to educate young citizens to recycle and dispose batteries at battery collection points”. TAP has 561 members around Turkey. Collection is done in public areas by application of municipalities. Collected batteries are send to TAP collection points or in possible occasions TAP collects them by their own collection vehicles. Logistics are done and covered by TAP (Arna, 2018).
Waste battery collection numbers and collection rate of Turkey is given in Table 4. Collection amounts are available up to 2016. Collection rate which is given in Table 4 is collected amount in respect to previous years sold amount. Collected waste batteries are not classified consequently collected battery chemistries are not available in statistics. Collected waste batteries are placed in underground collection depots which is isolated and fortified with concrete (Arna, 2018). Underground waste battery collection point can be seen in Figure 1.

Figure 1. Waste Battery Depots (TAP-2, 2018)

Table 4. Battery collection amounts of Turkey in metric tons (TAP-1, 2018)

Year	Collected Amount, mt	Collection Rate, %
2005	152	2.23
2006	226	3.35
2007	252	2.27
2008	325	3.10
2009	414	4.38
2010	451	6.54
2011	497	5.43
2012	526	4.99
2013	555	6.05
2014	628	6.60
2015	719	7.29
2016	730	6.70

Collection amounts in Turkey are not at satisfying level yet. Collected waste batteries are not even 10% of previous years sold amount. In 2004 in a short communication article Turkish battery collection is investigated and result was 1.2% of used batteries were collected by Istanbul Municipality (Aktaş et.al, 2004). Today collection rate of waste batteries is increased yet not to a satisfying level.

Küçükçekmece Municipality Case Study

Küçükçekmece Municipality is in Western or European side of Istanbul with the population over 700.000 residents. Urbanization in Küçükçekmece is accelerated in last decade. Increasing urbanization and industrialization increased waste amounts. Battery collection operation in Küçükçekmece Municipality is under administration of Environment and Waste Management Department. Municipality shares collected waste amounts via annual reports that can be accessed on the municipality website. Recyclable waste amounts of Küçükçekmece Municipality for 2016 and 2017 are given in Table 5.

Table 5. Collected Recyclable Waste in Küçükçekmece Municipality (Küçükçekmece Municipality Report, 2017)

Year	2016 (mt)	2017 (mt)
Packaging Waste	69860	43327
Waste Battery	10.6	6.9
Used Oil	92.8	99.6
Waste Electronics	0.7	1.8

Waste batteries are collected in 82 schools and public areas. Main collection target for municipality is schools and in 2017, 17.000 students are informed about waste management and recycling. Collection is being done by battery collection boxes and machines. Students are motivated through battery collection competitions between classes and schools. Ordinary citizen behavior is based on voluntary action. Municipality employee Ms. Merve stated that "Collection campaigns are based on voluntarily action and schools. Municipality is in charge of collection and storage of waste before shipped to TAP. TAP is informed when capacity is get full then licensed cargo trucks take waste battery for TAP's action." Battery collection machines and boxes are given in Figure 2. Battery collection machines give promotion tickets to students that can be turned into gifts. Küçükçekmece has the 1% of population in Turkey and collects 1% of collected waste batteries in Turkey. Collected batteries are given to TAP for further processing (TAP-1, 2018; TAP-2, 2018; Temel, 2018).

Figure 2. Battery Collection Machine and Box (Küçükçekmece Municipality Report, 2017)

Conclusion

By means of battery materials over 6000 mt material is untreated and out of use for Turkey yearly. Total economic value is over 1 million US $. This economic value is based on material price and can be improved by producing higher technology material. Küçükçekmece case is a minor example in Turkey waste battery management. Waste battery management is only collection and storage. Battery collection amounts are low for municipalities to be evaluated for recycle and legally municipalities are obligated to transfer collected waste batteries to TAP. This perspective shows municipalities are only in charge of collection and there is no motivation or challenge for them to increase collection rates indeed.

Battery collection situation in Turkey is evaluated in this paper with Küçükçekmece collection operation. Another study of battery collection in Turkey is done for Kahramanmaraş and results showed that total collected waste battery amount in 2016 is 1.957 kg (Karadeniz and Morcalı, 2018). Kahramanmaraş has higher population than Küçükçekmece yet collection amount in Küçükçekmece is higher. This result shows importance of Küçükçekmece within the waste battery collection scheme in Turkey. Turkish laws and regulations on battery use, disposal and recycling are evaluated. Battery collection is considered as an important issue for environmental care and mandatory laws are specified but battery collection scheme in Turkey yet to be improved. Statistical data is hard and complex to obtain. There is not licensed battery recycling facility on operation right now only physical separation of batteries conducted in a private sector company. Akın and Kuru (2011) suggested that electronic waste recycling should be evolved into industrial practice for both economic and environmental perspective. Low collection rates and battery usage in Turkey restrain economical recycling operation hence; battery collection rates should be increased in order to increase interest on this topic.

Low collection rates are result of authority gap in waste management laws. Laws are completely defined and in harmony with European Union laws though exercise of laws are not fulfilled. Low collection rates make recycling operation uneconomic and uneconomic recycling operation decreases collection motivation. Krekeler et al. (2011) stated that waste battery collection with low collection rate or low consumed battery amount increases per capita collection expenses. Situation in battery collection in Turkey is a complete dilemma right now. As a solution legal burdens, recycling or battery use tax should be considered. Otherwise uneconomic recycling without legal burdens is not a sustainable way through, this problem would not be solved in near future.

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