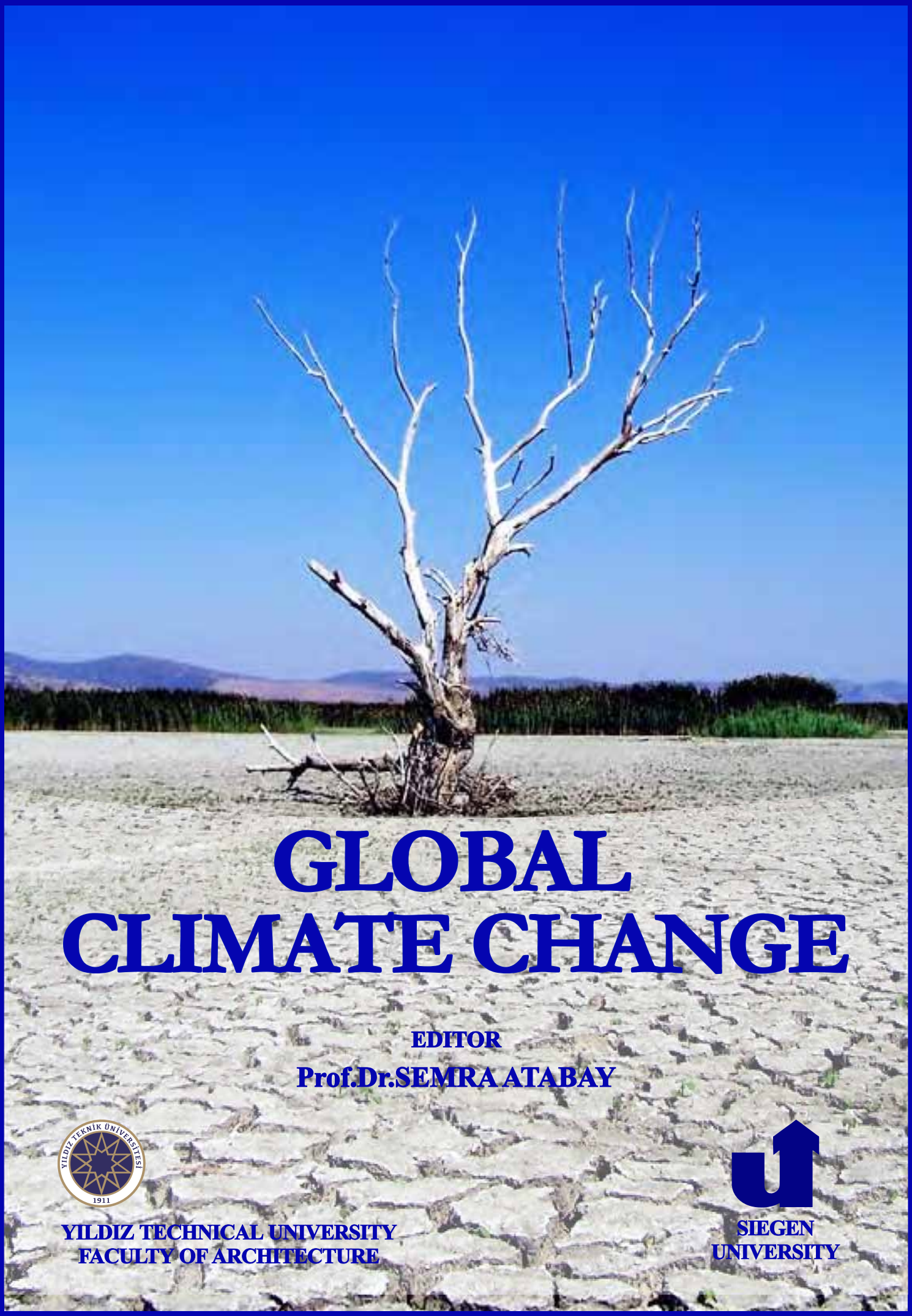

GLOBAL CLIMATE CHANGE

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FOREWORD

FOREWORD

We have observed that the economic development based production models, which rely on fossil fuels, have started to hinder the ecological carrying capacity of the atmosphere.

The discussion of eco-energy technologies and eco-economy policies are of the utmost importance to avert climate change in order to have a sustainable life in the world.

A conference on global climate change was organised to discuss the aforementioned issues on 6th and 7th of November 2013 at the Yildiz Technical University with the collaboration of Yildiz Technical University, Siegen University and Istanbul Branches of Turkish Chambers of Mechanical, Civil and Forest Engineers.

In this book we have published a selection of the papers presented during this conference.

On behalf of our university and the conference organisation committee, I would like to thank Prof. Dr. Ş¿smail Y¿ksek , the Rector of Yıldız Technical University, Prof. Dr. Nuran Plehvarian, the Dean of the Faculty of Architecture, the Goethe Institute in Istanbul, Friedrich Ebert and Heinrich Böll Foundations along with the Istanbul Branches of Turkish Chambers of Engineers, and companies from the industry for their support.

Additionally I would like to thank Dr. Zeynep Kaçmaz and Mr. Serkan Şaltan who assisted me in the production of this book.

Editor
Prof. Dr. Semra Atabay
Yildiz Technical University
2014

FOREWORD

It is obvious that in the last century 'Global Climate Change', which arose depending upon the factors such as population growth, industrialization and urbanization, has produced a series of problems which threaten environmental sustainability and have to be handled at international level. In this meaning, it can be emphasized that many international studies, which were started to be performed dating from the second half of the 20th century, have put forth environmental protection policies and development legislations in order to solve these problems. Every passing day, more researchers have started to deal with these vital problems; and, many congresses, conferences, workshops gathering around a common vision that aims to reach a sustainable future have been conducted following each other.

In this context, I should specify that this book, which has been compiled from a number of selected papers in the conference on 'Global Climate Change' carried out on 6th and 7th of November 2013 at our university, has a unique importance because of focusing on climatic problems of our century. Moreover, I believe that this book, which investigates the causes of 'Global Climate Change', discusses the current and probable results and seeks the solutions, has been completed with the support of many people and institutions deserving thanks. In this sense I would like to thank, first and foremost,Prof. Dr. İsmail Yüksek, the Rector of Yıldız Technical University, who hosts this conference at our university and Prof. Dr. Semra Atabay who has built this study on her experience and valuable ideas and compiled this book meticulously, then, Siegen University, Goethe-Institut Istanbul, The Friedrich Ebert Foundation, The Heinrich Böll Foundation, Istanbul Branches of Turkish Chambers of Mechanical, Civil and Forest Engineers and the organization committees of the conference, and finally, all the authors who have dealt with such an important issue and enriched this book with their studies.

Hoping that this study can pave the way for new ideas and lead to further studies in order to be able to live in sustainable and healthy environment…

Prof. Dr. Nuran Kara Plehvarian
Dean
Faculty of Architecture, Yıldız Technical University

GLOBAL CLIMATE CHANGE

Prof. Dr. Semra Atabay

Yıldız Technical University

1. INTRODUCTION

The rapid industrialisation of the 19th century was driven by the use of fossil fuels as energy source for industry as well as heating and transport purposes. The very large amounts of carbon dioxide generated by this process caused a greenhouse effect in the atmosphere. Meanwhile the impact of the industralisation on the global climate system is an established scientific fact as the added influence of greenhouse gases average global temperatures have increased by 1°C over the course of the past one hundred years.

Today we still generate most of our energy from fossil fuels and the level of carbon dioxide in the atmosphere is now 40% higher than the period before the industrialisation. As a result, the average global surface temperature has risen between 1900 and 2012 by approximately 0.9 °C. **(Atabay, 2012)**

One important indicator is the atmospheric carbon dioxide concentration. In the 1850s, at the beginning of the industrial revolution, it stood at 280 ppm; in the 1980s it had reached 350 ppm, and in May 2013 it was found to be at a level of 400 ppm. Many climate experts suggest that the CO2 concentration should be below 350 ppm in order to be on the safe side. **(Atabay, Karasu, 2013)**

Over the past years we have witnessed a series of unusual weather events caused by the rise in greenhouse gas concentrations in the atmosphere which may indicate that the climate is about to reach a tipping point. The International Panel on Climate Change (IPCC) points out in its reports that carbon dioxide levels rose by 1.19 ppm annually between 1900 and 1994, and almost twice as fast (2.31 ppm) between 2010 and 2012.

The NASA Goddard Institute for Space Studies has recommended an annual decrease in carbon emissions in the order of 6%. The IPCC warns of a carbon dioxide concentration in the atmosphere exceeding 450 ppm and global warming of over 2 °C in its last report. To stay below these threshold values, the report recommends the reduction of carbon dioxide emissions by 25-40% until 2020 and by 90% until 2050. **(Algedik, 2012)**

In the context of these "recommendations and commitments", a chronological review of these proposals and preventive measures adopted at international conferences will facilitate our understanding of the current status and future development of climate change and help to define the cause and effect of the current conditions.

Between 1973 and 2013, 18 high-level international conferences have been dedicated to the issue of climate change. They resulted in numerous declarations, conventions and agreements on the emission of carbon-based greenhouse gases. Among these agreements is the Copenhagen Accord that was signed by 140 countries and contains important pledges on emission reduction.

The commitments made by industrialised and developing countries are of vital global importance, but they have yet to reverse the trend in rising greenhouse gas emissions. The consequences of this are the rapid melting of glaciers and polar ice sheets and worldwide extreme weather phenomena such as heat waves, sustained heavy rainfall, flooding, landslides, hurricanes, tornados, typhoons and tsunamis. These atmospheric events are on the increase and cause widespread loss of tangible assets as well as countless lives.

Important ecological components of the global geographic space such as forests, agricultural land, surface and ground water systems, land and water-based biodiversity are also strongly affect by these events and pose a serious risk for life on earth. Rising ocean surface temperatures in the tropics release large amounts of energy into the atmosphere feeding destructive tropical storm systems which have severely affected a number of regions.

Since 1969 the following hurricanes and typhoons have been registered:

- In 1969, the hurricane Camille hit the US state of Mississippi with wind speeds of up to 300 km/h. Several people lost their lives in this event.
- In 1992, the hurricane Andrew destroyed 60,000 homes in Mexico and on the Bahamas.
- In the autumn of 1998, the Atlantic hurricane Mitch hit the east coast of Central America with wind speeds of up to 320 km/h, and caused the death of 11,000 people in Honduras and Nicaragua.
- In 2004, ten typhoons caused great material loss in Japan.
- In August 2005, the city of New Orleans was inundated by hurricane Katrina and destroyed entire settlements along the gulf coast with 8.5 m high giant waves.
- At the end of 2012, typhoon Bobha devastated the island of Mindanao, killing 2000 people and causing large-scale material damage.
- In August 2013, typhoon Trami caused widespread flooding on the island of Luzon, washing away large swathes of fertile agricultural land.
- The last great disaster was caused by typhoon Haiyan in November 2013 on the Philippines where 10,000 people lost their lives. With wind speeds of 310 km/h, Haiyan was one of the most destructive cyclones ever recorded. **(Atabay, Karasu, 2013)**

These powerful storms and the heavy rainfall they bring about have destroyed agricultural land, forests and the plant cover in many areas, reducing biodiversity and causing loss of lives and property.

The exceedance of 7 billion threshold by the global population has created higher and ever growing energy demand causing more greenhouse gas emissions due to using primarily fossil sources. If the population continues to grow at its current rate, and if the use of environmentally friendly energy remains negligible, carbon dioxide emissions will continue to grow exponentially.

Development and prosperity depends on economic growth; however if our production and consumption model does not change, we are heading for oblivion. The quality of life in industrialised countries is based on high-level consumption which means extensive use of natural resources and high CO2 emission rates. The same applies more and more to developing countries which emulate the production and consumption patterns in the rich

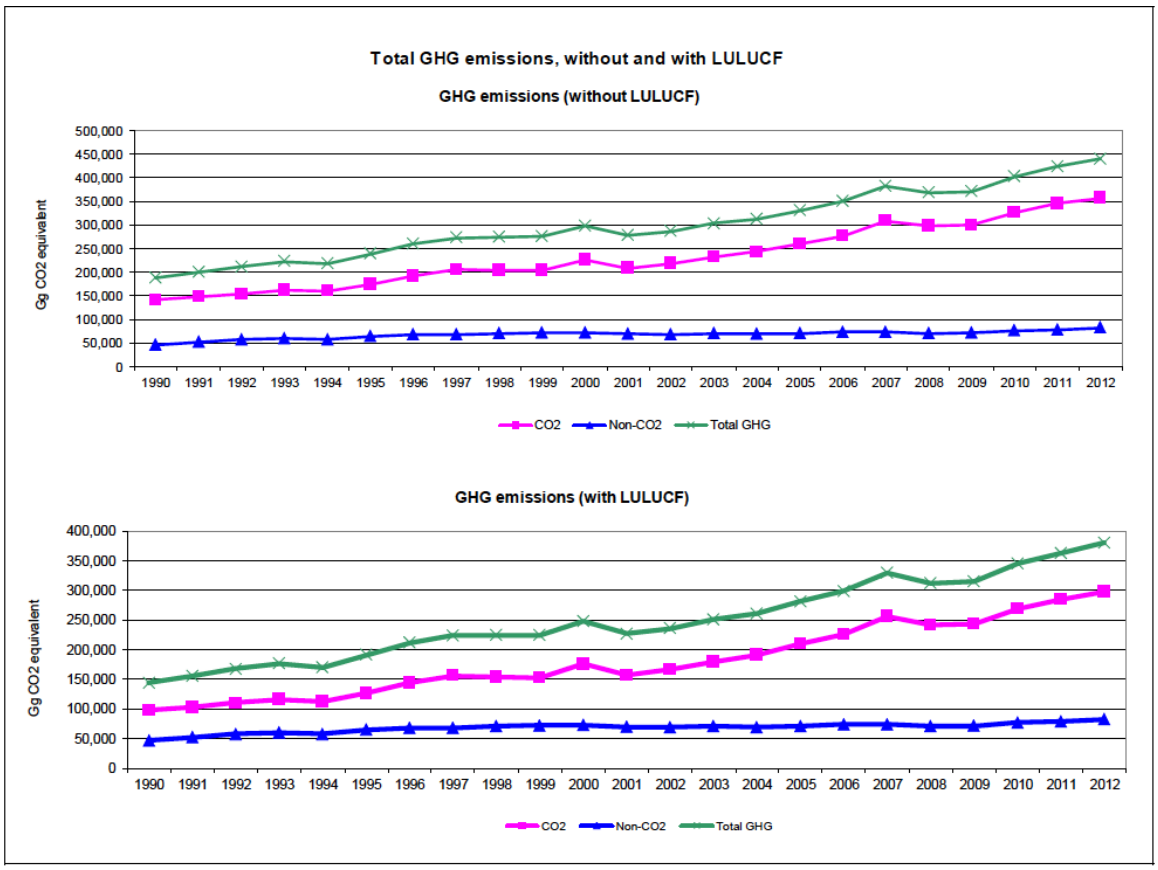
world. To break this cycle we need a new paradigm, a model of sustainability that balances the needs of the economy with those of the ecology. How this model should look like and how it should be implemented is the most crucial issue of our time. It is evident that our traditional way of production and consumption is not compatible with a sustainable way of life as far as the life on Earth concerned.

With regard to climate change, all developing countries are affected in the same way because in order to improve their living standard they produce and thus emit carbon dioxide. Their level of emissions per capita is still low at the moment. The world's three billion poorest generate only 7% of total carbon dioxide, while every single American out of a total population of 312.5 million leaves a daily CO2-footprint of 83 kg (food and other needs) which amounts to 17.6 metric tons per capita according to 2013 World Bank data (The World Bank, 2013)

2. GREENHOUSE GAS EMISSIONS in TURKEY

Turkey is rapidly developing and this is reflected in its generation of greenhouse gases. Between 1990 and 2011, emissions increased as follows: power generation: 283%, construction: 125%, industry: 264%, transport: 84%, agriculture: 5%, forestry: 184%, and waste management: 272%. The country's CO2 emission is mostly generated by the use of fossil fuels; they contribute 81.5% to Turkey's greenhouse gas emissions, followed by methane (CH4) 15.6%, nitroxide (N2O) 1.9%, and fluorine compounds (F) 1%. The UNFCCC data (The UNFCCC, 2014) below shows how Turkey's greenhouse gas emissions have risen rapidly since 1990s.

Exhibit 1. Turkey's total greenhouse gas emissions (Source: The UNFCCC)



According to data published by the International Monetary Fund (IMF) Turkey is the world's 17th largest economy and ranks 21st among 178 countries in terms of CO2 emissions. The 1st National Declaration on Climate Change states that CO2 emissions between 2007 and 2020 will rise on average 6.3% annually unless serious measures are taken, and will reach an output of 604 million metric tons a year in 2020.

3. TURKEY'S POSITION on GLOBAL CLIMATE CHANGE

Turkey has taken a number of political decisions in order to reach two important targets regarding sustainable development and measures against climate change. The government has prepared action plans for the periods 2007 - 2015 and 2015 - 2020. In this context, the country plans to implement short, medium and long-term procedures to ensure environmentally friendly growth and sustainable socio-economic development. The plans have been laid out with instruments to be used and holistic environmentally friendly policies to follow in preparation of implementation which has been determined through examining the risks and opportunities for all sectors that constitute economic and social life and the related function areas.

The "National Action Plan" prepared by the Expert Commission on Climate Change was approved and put into action in 2010. Among others, the National Strategy Paper on Climate Change sets the following strategic objectives: (2011-2023)

- To implement technological measures specifically for individual sectors as well as for all sector-related functions, and to develop know-how in these areas in cooperation with international parties in order to reduce the emission of greenhouse gases, using the measures based impartial and scientific findings and criteria,

- To discontinue policies that allow the use of old technologies which generate greenhouse gas emissions and cause climate change,

- To reduce greenhouse gas emissions in the energy sector; to carry out periodical measurements in order to ensure and regulate acceptable air quality.

Based on the objectives stated in the Strategy Paper, a National Action Plan was prepared. However, 541 individual targets defined in the Action Plan were not achieved between 2011 and 2014, among them the following are noticeable:

- Intensive energy use was reduced by only 10%, which is far less than other countries.
- Policies that allow the use of lignite coal without enrichment for power generating purposes are still in effect.
- Alternative energy sources such as wave, wind, solar, thermal and geothermal energy are not sufficiently exploited, and no R&D infrastructure to investigate this potential has been established.
- Structural and technological measures for temperature control in buildings are not yet sufficiently developed.
- Technical and environment-centred investment initiatives have yet to be initiated in both urban and rural areas.

The close interconnection between nature and the economy is an empirically supported phenomenon. The impact of commercial activities on the world's ecosystems has reached an extent that threatens the permanent destruction of important natural resources. Environmental pollution and the excessive exploitation of our natural resources have become a global problem which has been aggravated by global climate change due to the release of vast amounts of greenhouse gases. These developments have reached an extent that puts life on earth at risk.

4. CONCLUSION

Today, the world is faced with huge ecological crises, but with every further increase in carbon dioxide emissions the risk of even greater crises increases as well. Highly developed countries with their high-consumption-based life styles use an ever larger share of natural resources and energy which generate ever more carbon dioxide emissions.

When considered in conjunction with the world population growth, it is fair to say that climate change is one of the great challenges of our time. Global population is predicted to reach 9 billion by 2050, two billion more than today. That means more demand, more production, more consumption, more use of natural resources in agriculture, industry and the services sector, higher demand in energy, and thus more carbon dioxide emissions. Higher concentrations of greenhouse gases will most likely cause more severe atmospheric events affecting the entire planet.

The standard of life in industrialised countries is based on high-level consumption which means extensive use of natural resources and high CO2 emission rates. Governments continue to pursue fossil fuel based policies; many are also active in preparing reports and action plans aimed at cutting emissions. Compared to industrialised countries, developing countries generate less carbon dioxide emissions per capita than rich countries whose way of life is based on production and consumption. They lack direct access to high technology and financial base to make use of reusable energy resources like wind, geothermal and solar energy, and in most cases a low level of economic development to implement the preventive measures.

The current research focuses on the diverse and localised approaches to global climate change, however it is imperative to analyse the economic, political and social barriers faced by developing countries in order to adapt pertinent policies and measures which also contribute at a global level.

In this essay, Turkey's stance with regards to global climate change was concisely presented as an example of developing countries. But further studies are needed to identify differences and barriers through examining the economy and the climate change policies of other developing countries using a set of criteria which incorporate all aspects of economic and social context.

In this context, I believe that ~~a~~ swift progress towards definite and extensive measures at a global level would promote the survival of our civilization in order to achieve ~~a~~ sustainable economic development which incorporates global climate change.

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IS KYOTO PROTOCOL USELESS?

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Bahçeşehir University

Abstract

Kyoto Protocol is a serious attempt made by the international community to deal with one of the major environmental problems of our time that is global warming. No such endeavour has taken place before. But this agreement did not develop in a vacuum; there has been fore runners who inspired the international community to devise such a scheme. This paper considers a number of powerful ideas that are the building blocks of the Kyoto Protocol and then looks at it with a view to find out whether this agreement is useless. One of the most salient features of Kyoto Agreement is that it is based upon market environmentalism advocated by the Nobel Prize winning economist, Ronald Coase, who argued that in order to protect the environment we should rely more on the forces of the market rather than direct government intervention. Another powerful idea behind Kyoto is that we live in a closed environment which is like a spaceship and thus we can't go on polluting it nor can we deplete its limited resources in a reckless fashion, as advocated by Kenneth Boulding. If we do that we are doomed. Based upon the ideas of Spaceship Earth a number of model builders created various disturbing scenarios about the future of the mankind. The most powerful group was the Club of Rome who advocated a substantial change in our attitude towards the environment. The purpose of this paper is to look at these ideas which are the background of Kyoto Agreement and also make some remarks about its future.

Keywords: Market environmentalism, Spaceship Earth, World Models, Kyoto Protocol

Introduction

Kyoto Protocol is unique in human history. Never before such a large number of nations (192) got together to tackle a universal environmental problem; global warming. But this agreement did not occur in a vacuum for there are some major ideas/concepts behind it. After the Second World War major economies of the world were growing rapidly putting pressure on the environmental quality as well as on the stock of non-renewable resources. These issues attracted attention of a number of thinkers who began to puzzle about how to solve the global pollution problem which they realised that it would become a major international concern not in too distant future.

Nobel Prize winning economist, Ronal Coase, reasoned that our environmental problems can be solved by a greater reliance on the forces of the free market rather than government regulation. In his opinion pollution problem could be resolved with the negotiation between the polluter and the polluted. For this, we need to institute property rights. His ideas were

thought to be odd at the time but in later years they became acceptable by a large number of policy makers.

Another influential thinker was Kenneth Boulding, an English economist working in the USA in the 1960s and 70s, who was impressed by the pictures of the earth taken from the space for the first time. These pictures made him obvious that our world was like a small self contained spaceship in which economic activities take place. The humanity would be doomed if we keep on contaminating our spaceship and deplete its limited resources in a reckless fashion.

Concerned by increasing global pollution and resource scarcity and the theories of doom a number of think-tanks began to work on the creation of world models in the 1960s and 1970s with a view to predict the state of the world in future. Amongst those was the Club of Rome who published its report, *Limits to Growth*, which made a front-page news headlines in many respectable newspapers of the world.

These arguments began to worry many world leaders who participated in a major environmental conference in Rio, 1992. At that meeting heads of states decided that there should be an international agreement to reduce the greenhouse gas emissions by relying on the forces of the market, which was advocated by Ronald Coase in 1960. This was the beginning of the Kyoto Deal. The purpose of this paper is to look at the ideas which are the pillars of the Kyoto Agreement and also make some comments about its future.

Ronald Coase and Market Environmentalism

According to Coase (I960), if a system of property rights is properly instituted and guaranteed by the force of law there would be no need for intervention on, say, pollution; the parties involved should be left to tackle the issue themselves. In a free market environment with well-defined property rights individuals would be able to achieve the desirable level of pollution. In Coase‘s theorem, it is not crucial which party, polluted or the polluter, holds the property rights.

Under certain assumptions, a desirable level of environmental degradation can be achieved by negotiations between the polluter and polluted. If the polluter has the property rights, he or she could be compensated by the polluted for costs incurred in pollution reduction. Similarly, if the rights are with the polluted, they could be compensated by the polluter for their tolerance of the nuisance. In fact, there is no requirement or restriction on the nature of the deal done; it could be a bribe as well as compensation. The assignment of property rights would solve the problem. See also Olson and Zeckhauser (1970) and Farrell (1987).

In the bargaining process, the polluted would be willing to pay any money less than the suffering he or she would otherwise have to bear. On the other hand, the polluted will accept any money higher than his or her benefit curve for a unit reduction in the level of activity. Coase‘s property rights approach becomes appealing when there are a small number of individuals involved. Interested parties could effectively negotiate a payment scheme to induce those who generate externalities to adjust their behaviour to acceptable levels.

There are a number of well-known cases of bargaining which have taken place between a small numbers of parties with satisfactory results. The 1939 Trial Smelter Arbitral Tribunal is a case in point. The tribunal dealt with smoke damage caused by a Canadian industrial plant in North America. An international arbitration body found that Canada was liable for the damage caused by the industrial unit located in her jurisdiction and recommended reduction of emission, Trial Smelter Arbitral Tribunal (1939).

Coase's theorem has been criticised from a number of viewpoints. When the number of parties involved is not small, the likelihood of negotiation becomes unworkable due to the administrative cost of co-ordination. Even when the number of polluters in a locality is small, those affected by the emission tend to become large enough to make direct negotiation unmanageable. When the numbers are huge, they will tend to treat the behaviour of all others as beyond their control. See Buchanan (1967), Kneese (1971) and Lerner (1971). With such numbers it will be extremely difficult for individuals to establish a definite and clear-cut bargaining strategy. It is inevitable that there will be different interest groups each trying to fight its own corner.

Demsetz (1969) contends that the idea of negotiation between interested parties would be relevant if negotiation costs are small. However, when an agreement is reached, we should not immediately assume that the cost of policing the agreement will be small. The problem will be even more acute in the case of regulation in which policy makers need to take the views of all those affected in the community before implementing and enforcing the policy. That is, cost of negotiation and enforcement for regulation is bound to be enormous and thus the best solutions to environmental problems are the development of property rights.

Coase's analysis that it makes no difference on efficiency grounds which party has the property right is debatable. When such rights are held by the rich and powerful, the outcome is likely to be different from the case in which the holders are average citizens. Furthermore, what if the victims of pollution are the poorest members of society, which may be so in many instances, would it then be morally right to expect the victims to pay the offenders for improvement in the quality of the environment?

There are also cases of external effects which are dispersed over a wide geographical area affecting a number of countries and millions of individuals. For instance, pesticide used by a farmer does not only affect a small group of individuals in the immediate area. It gets transported from its point of origin by winds, rivers and ocean currents and spread throughout the globe affecting countless numbers of individuals. Acid rain is another example of transfrontier pollution in which large numbers of industrial units affect millions throughout the globe. The nature of external effects in these cases makes it practically impossible to use Coase's property rights approach to strike a deal between the culprits and victims.

Furthermore, in the case of intergenerational environmental problems, it is not clear in Coase's theory who would be bargaining on behalf of future generations, especially the distant ones who may be the most vulnerable. In cases such as acute resource depletion, global warming and nuclear waste storage, can future individuals bribe present generations so that harmful activities are moderated or eliminated altogether?

It is also doubtful that individual bargaining power, even if it was practical, would result in a socially optimal outcome. Let us take a case in which a factory is emitting smoke which stays mostly in the surrounding district and individuals who live in that area are paid an amount sufficient to compensate them fully for the nuisance. In this case, since everyone is compensated, no one would have any motivation to live away from the factory. In effect, compensation would create an economic incentive to accept the bad effects of the externality with no offsetting benefits to anyone. In the words of Baumol and Oates: *An excessive amount of smoke emission and an excessive number of nearby residents should both be avoided. Excessive smoke emission can be curbed by a Pigovian tax on the producer. Now Coase's analysis has suggested that, to prevent too many nearby residents, it may be necessary to impose a tax on those who live nearby. Far from compensating the victim of the externality, Coase's view is that they should be charged for the smoke they inhale.*

Coase, in support of his position, argues further that the imposition of a pollution tax can itself introduce a set of externalities. In the previous example, let us say that more households move into the region which is affected by the smoke. In this way social damage caused by the external effects will be increased by the decisions of the households as the tax will affect the firm. Increased tax is an externality created by the decisions of the households which will reduce the value of the output produced by the firm. The failure to take account of this cost created by the households is comparable to the cost created by the firm on the households resulting from the emission. However, Baumol and Oates (1975) demonstrate that this type of reverse externality mentioned by Coase need not create resource misallocation because it is a pecuniary externality. Taxation would only change prices of some commodities and affects the financial circumstances of the parties involved. Increased smoke, on the other hand, will increase the cost on resource use as, for instance, households would require greater laundry service.

Recently, it has been argued that with imaginative methods the property rights approach can be extended to many cases. For example, exhaust fumes from cars are a major source of air pollution and a property rights-based approach can be used to moderate the problem. One proposed solution is to privatise major motorways which are the main source of traffic pollution. This would make the owner of the motorway, who was liable for damages; in turn seek measures to reduce this liability. Under this system, cars with better pollution control equipment would be subjected to lower tolls, while tolls at peak times would be made more expensive, thus reducing heavy concentrations of smoke by spreading the emissions more evenly during the day and night (Rothbard 1982).

Boulding's Spaceship Earth

In 1966, Kenneth E.Boulding (1966) published a short article _The economics of the coming Spaceship Earth' in a small book *entitled Environmental Quality in a Growing Economy*, edited by Henry Jarrett (1966). In his chapter, Boulding takes a long view of the state of the world with a critical look at the goals and values which had been accepted without much question for so long. Around that time, photographs of the globe taken for the first time from space showed that our world is a small, self-contained spaceship rather than an

endless plain with infinite room to manoeuvre. With growing population, exhaustion of natural resources and restricted space for disposal of all kinds of industrial and agricultural waste, Boulding expressed grave doubts about the desirability of economic growth, which had been one of the most important objectives of all governments.

In his view of an econosphere in which economic activities of mankind interact with local, national and world environments, growth—especially in the way that it has taken place in the industrialised world during the last century or so—is unsustainable. Most introductory textbooks in economics contain a diagram of an economic system showing the circular flow of economic activity in which natural resource scarcity, pollution and waste disposal are rarely mentioned. If they are mentioned—for example, with regard to waste problems—it is implicitly assumed that waste resulting from production and consumption will be recycled by nature to be returned to the land by the natural and indestructible powers of the soil. Furthermore, as firms bring factors of production together to produce goods and services demanded by other firms, as well as households, unlimited natural resource input is assumed to sustain the circular flow. According to Boulding, this is an open system in which a structure is maintained in the midst of a throughput from inputs to output.

The economic psychology which has been developed during the last couple of decades is that of the open system, which needs to be transformed into the closed system—the spaceship economy. Given the exhaustibility of fossil fuel and metal deposits, and the limitation of the world to absorb pollutants, such transformation is essential. If we do not make this move now, when we have relatively more room for manoeuvre, circumstances will force us to do it in the not so distant future under much tougher conditions. The large energy inputs that we have been obtaining from fossil fuel, and the raw materials from other exhaustible resources, are strictly temporary. We will run out of these items eventually. It is rather like the early settlers in America arriving from Europe on the eastern seaboard and moving to the west for further and further settlements in the belief that America is infinitely accommodating. Eventually, this belief was dented when settlers reached the shores of the Pacific Ocean.

In the transformation of a system from one form to another there are three essential items: matter, energy and knowledge—the last being the most important. Before anything else, man must have sufficient information about an issue or a problem; then he must visualise a solution. For example, a machine to speed up a production process originated first in the mind of man, and then material and energy resources were exploited for its construction. Knowledge and imagination is the key to all kinds of human development including economic transformation and progress. As an example, consider the destruction of capital in Germany during the last war. Because the knowledge of the Germans was not destroyed, the stock of capital was recreated within a couple of decades. In a country such as Ghana, there was no creation of substantial capital because the knowledge did not exist in sufficient amounts. Without credible information about the econosphere, the desire to modify the established patterns of economic behaviour will never take place. This is the first step. The second step is that mankind must then think of ways and means of constructing a new order within the context of a spaceship economy.

Boulding, in colourful language, tries to explain that established measurements of economic success do not make sense in a spaceship economy. For example, the growth rate of the gross national product is almost universally accepted as a measuring rod for the economic success of the nations. Likewise, at an individual level, income and wealth give a person great prestige in a modern consumer society. In conventional economics, consumption and production are regarded as good things and little consideration is given to resource depletion and deterioration of environmental quality which will eventually make both activities unsustainable.

The success of the economy is measured by the amount of the throughput from the ‗factors of production', a part of which, at any rate, is extracted from the reservoirs of raw materials and non-economic objects, and another part of which is output into the reservoirs of pollution. If there are infinite reservoirs from which material can be obtained and into which effluvia can be deposited, then the throughput is at least a plausible measure of the success of the economy. By contrast, in the spaceman economy, throughput is by no means a desideratum, and is indeed to be regarded as something to be minimised rather than maximised. The essential measure of the success of the economy is not production and consumption at all, but the nature, extent, quality and complexity of the total capital stock, including in that the state of the human bodies and minds included in the system. In the spaceman economy, what we are primarily concerned with is stock maintenance and technological change which results in the maintenance of a given total stock with a lessened throughput (that is, less production and consumption) is clearly a gain.

Figure 1 shows the economic activity inside the spaceship earth which contains, in its most simplified form, four sectors: households (or consumers), firms (or producers), exhaustible resources and waste disposal. Traditional economics focuses only on the first two whereas the econosphere considers all four simultaneously. Households provide factors of production (land, labour and capital) to firms, and firms supply goods and services in return. Both households and firms extract from the natural resource sector and both create waste in the course of production and consumption which is passed on to the disposal sector. The main problem here is that as the level of economic activity and population keep on growing, which was highly conspicuous at the time when Boulding formed his ideas, both scarcity and waste problems will get worse unless drastic measures are taken. The conventional system of growth cannot continue because of intensifying scarcity and worsening waste disposal problems. Boulding recommends that the natural resource base must be diligently protected and wastes must be properly managed; our long-term survival depends on our ability to manage these two sectors.

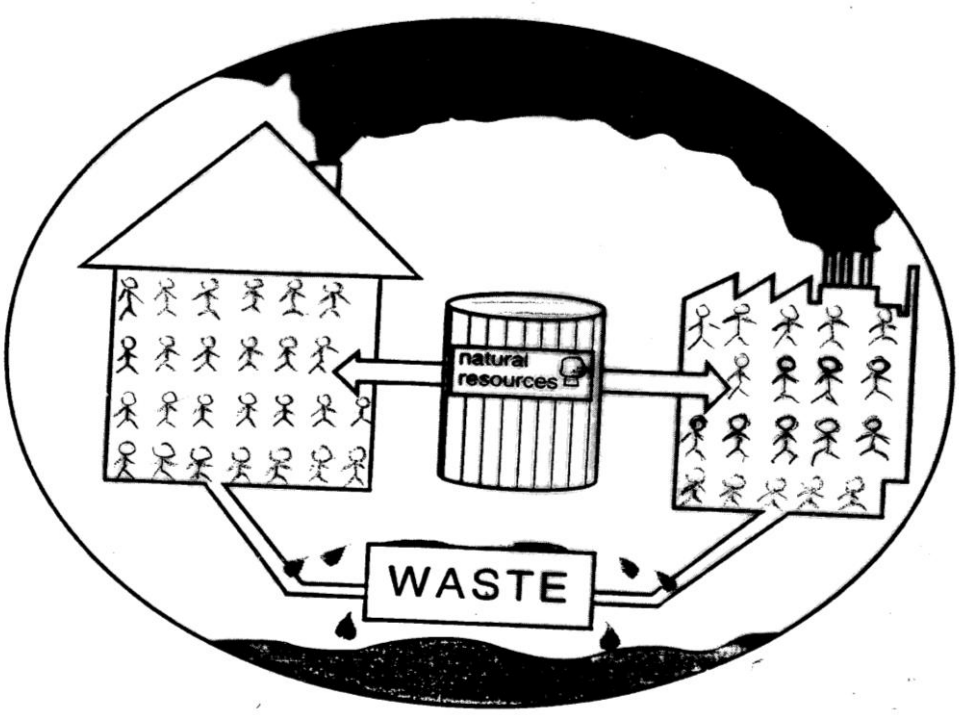

Figure 1. Spaceship Earth in Year 200

Let us say that Figure 1 illustrates state of the world at the turn of this century. What would the Spaceship look like in the middle of the century? Figure 2 indicates that in the absence of no change in human behaviour the world would be in a sorry state. Boulding warns against complacency in delaying the construction of a structure for the spaceship economy.

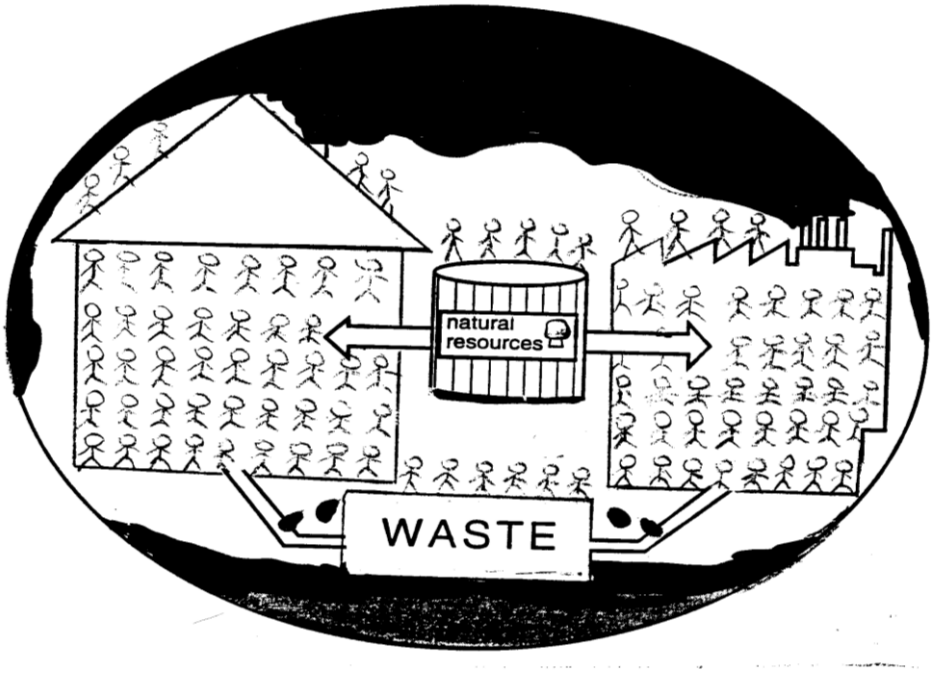

Figure 2. Spaceship Earth in, say, in Year 2050

An attitude such as let us multiply, eat, drink, spend, extract and pollute—i.e. let us grow in the usual way, as the Spaceship Earth is still a good way off—is harmful.

In many respects, spaceship economy has arrived, we have already run out of clean air in many industrial cities, many lakes have become cesspools, forests have disappeared from some regions, and once highly productive mines have been exhausted. But the greatest harm will be done to future generations as they are likely to inherit an even more contaminated spaceship, with less and less natural resource deposits in it. For this, there can be no moral legitimacy. A society which loses its responsibility to future generations soon falls apart, as history has demonstrated many times over.

In support of Boulding‘s Spaceship Earth concept, Barnett (1979) argues that the growth of economic activity over the last couple of hundred years has created many environmental problems and made the earth fragile. It is rather like an ant growing to the size of an elephant and becoming highly fragile and immobile in the process. If beings from outer space were to view the human ecology they would quickly observe the rapid damage to the environment which is resulting from unrestricted growth and in which market failure must bear some responsibility.

Club of Rome

It was only a matter of time before model builders would capitalise on Boulding‘s concept of Spaceship Earth and, by using computer simulation technology, would try to predict the future. One of the most notable works in this was by the Club of Rome. The world models contain three groups of items: absolute variables such as non-renewable resources, land availability, population, capital stock and population; changes in the levels of these variables, and auxiliary variables such as industrial output, food production, and effect of pollution of lifetime and pollution absorption time. In the first category, land is divided into agriculture, industry and service sectors. Population is divided into various age groups. All variables are measured by index numbers and in terms of growth rates.

The interaction between these three groups of variables is conducted by mathematical equations which include feedback loops. For example, growth in pollution impacts upon agricultural production and population growth rates. Accumulation of capital leads to an increase in living standards which in turn, by way of a different link, affects capital accumulation, a feedback process. For a further explanation of the working mechanism of the Club of Rome‘s world models, see Cole (1973), Hueting (1980) and Page (1973).

All computer models contain eight explicit variables: population, non-renewable resources, industrial output, pollution, food production, services, birth rate and death rate. Amongst these, non-renewable stocks always take a negative growth rate, i.e. they deplete. Other items can take positive or negative growth rates depending upon the events taking place in each model, or they can remain constant. All computer models have two distinct phases—past and future. The first one describes trends in all eight variables between 1900 and 1970. The Club of Rome contends that throughout recorded history human population, pollution, capital investment and food production have been growing exponentially. For

the future, the world is predicted to be entering into a number of possible shapes, depending upon the behaviour of the variables involved.

All in all, the Club runs fourteen models under various assumptions. In the first model, called the standard run, the proven stocks of destructible resources are taken to be the major constraint on economic growth. The collapse of the world system begins in the early part of the twenty first century when the food curve falls below the population variable. The system fails because of non-renewable resource exhaustion. The industrial capital stock grows to such heights that it requires enormous inputs of resources. As scarcity bites, marginal deposits become economical and then more and more capital is used for bringing inferior stocks out of the ground, leaving less to be invested for future growth. Capital investment cannot keep pace with depreciation, the industrial base falls apart taking with it agricultural and service sectors that have become highly dependent on modern inputs such as pesticides, inorganic fertilisers, computers, hospital laboratories, and so forth. Then the world system fails, the population rises for a short while due to the delays in the process and then begins to fall rapidly.

At a later stage, the Club obtains stable world models by implementing a number of operations. Population is stabilised by setting birth and death rates equal. Industrial capital, after a natural increase until 1990, is stabilised by setting investment rates equal to the rate of capital depreciation. In order to avoid non-renewable resource famine, their consumption is reduced to a quarter of 1970 levels. Economic preferences of society are assumed to be shifted towards the service sector such as health and education, and in this way levels of factory-produced material goods are reduced along with contamination. Pollution-generating industrial and agricultural output is curtailed to a quarter of its 1970 value. Capital is diverted to agriculture in order to produce food by way of environmentally- friendly methods. Under these assumptions, the Club becomes able to obtain a stable world model in which population, industrial output per head, and pollution are not growing. If the humanity achieves that the world is unlikely to become a hellish place.

Rio Conference of 1992

The Rio summit turned out to be one of the greatest gatherings of presidents and prime ministers (the most reliable tally reported to be 120) where rich and poor nations sat together to discuss the future of the planet. Leaders discussed many environmental problems but the main focus was on the global warming. One remedy for his problem was carbon tax to curb the greenhouse gas emissions. However, European leaders argued that it would be very difficult, if not impossible, to sell this to European taxpayers and shied away from it.

One alternative to carbon tax was thought to be carbon trading rights, which, essentially, is a market based instrument. In order to boost its credibility the father of market environmentalism Ronald Coase was given Nobel Prize in Economics in 1992. European leaders liked this method because it would not place an extra burden on the taxpayers. Almost immediately after the conference serious work started on the marketable pollution permits.

The Kyoto Deal

Kyoto Protocol was drafted in the Japanese city of Kyoto in 1997 with a view to reduce greenhouse emissions to combat global warming. According to this 38 industrial nations had to reduce their emissions by the year 2012 to levels, on average, that are %5 lower than 1990 levels. At least 55 nations had to ratify the Treaty before it became binding. Under the Treaty India, China and other developing countries had no obligation to control their emissions.

These 38 nations agreed not to exceed 16 billion tons of CO2 per annum in years 2008-12 which is less than 1990 levels. To this effect permits for 16 billion tons were to be awarded to them. If a nation emits more than her quota then she must purchase permits from other countries. Conversely, if a nation emits less than her share then she can sell her permits on the open market. In this way pollution emission permits would become valuable financial assets.

In January 2005 European Union allocated permits to 12 000 installations in five energy intensive sectors; cement, paper, glass, steel and power. The EU was well aware that the effectiveness of the system depends upon the price of the permits which is now determined by the law of supply and demand. If the supply is less than demand the permits would became costly. Since 2005 the price of permits fluctuates in line with changing economic conditions.

The latest economic crises which impacted upon adversely in all five sectors lowered the permit prices. The European Union is running an electronic registration system to track down ownership of the permits.

Is Kyoto Useless?

In 20011, one year before the expiry of the Kyoto‘s first phase Canada, Russia and Japan stated that they would not take on further targets. Canada was given %6 target to reduce her emissions. Canada was one of a few western countries who came out of the recession lightly and as a result in 2009 her emissions turned out to be %17 much higher than 1990 levels which meant enormous penalties. In the event Canada walked away from Kyoto as of December 2012.

As the first phase of Kyoto was coming to an end 200 nations meet at Doha and decided to extend Kyoto Protocol for another term until 2020. EU countries Australia and 8 other developed countries agreed to binding emission cuts in the extension plan. The USA had no intention of taking part in the second phase.

It is difficult to argue that the first phase of the deal is a success. Then the question is ―is Kyoto useless”? I do not think so. First and for most Kyoto signifies that nations have realised that there is a global problem which must be dealt with in a joint action. Collective deeds are extremely difficult to be realised but Kyoto has scaled this hurdle. Secondly, existing problems of Kyoto Protocol are likely to be ironed out over time. For example it took 50 years for the World Trade Organisation to evolve into its current form from a modest collection of bilateral agreements.

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EFFECTS OF URBANIZED AREAS ON URBAN CLIMATE

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Abstract

Today, future studies for Istanbul which is the most crowded 23th cities in the world and developing rapidly have great importance. Increasing disorganized and cursory structure of urbanization disrupts the urban environment. It is expected that the climatic nature of Istanbul will change much more dramatically because of the increase of artificial surfaces and destruction and decrease of forests in Istanbul. The aim of this paper is to obtain relations among the heat changes and residential tissue in rapidly changing and developing Istanbul metropolitan area.

In this study, urban structure and its morphological properties have been compared with urban temperatures by using remote sensing and GIS techniques. Increasing the densely built-up areas have been caused to an increase in temperatures due to enhanced heat absorption and wind obstruction. In urban areas temperature has changed up to 4,5˚C according to density of built-up ratio and urban vegetation.

Key Words: Heat island, urban morphology, remote sensing, GIS.

Introduction

Due to growing world population and changes in social or global economic relations, urban population began to increase rapidly especially in the last century. Since 2008, over 50% of the total global population already lives in urban areas. Future population growth is expected to reach 9.1 billion by 2050, with the numbers of urban dwellers to increase to approximately 6.3 billion. Most of the future population growth during this time period is expected to be absorbed by cities of the developing world[1].

In this context, uncontrolled urban development has important consequences such as increasing of greenhouse gas emissions, increment of urban density and destruction of the environment and this generates unhealthy living conditions. So, especially developing countries must change their urbanization politics radically and they have to be prepared for this rapid urban growth.

When the meso-scale and micro-scale climatic studies are investigated, it is seen from the results that the air temperature of dense urban districts is higher than the air temperature in urban fringe areas. This climatic effect also known as urban heat island is one of the most

[1] ECOSOC, 2011

obvious features of urbanization. The phenomenon is now becoming a major problem in Asia as well. Indeed, the urban heat island effect exists wherever there are large cities[2].

Air temperature values in densely built urban areas are higher than the temperature values of the surrounding areas. The phenomenon is known as the "heat island effect" and is the most obvious climatic manifestation of urbanization[3]. Especially, degradation of vegetation tissue, reduction of green area and increase of dark surfaces in urban centers soars the absorption of heat; hence this creates a warming effect[4]. Absorbed heat is scattered by buildings and surfaces; so, this causes a temperature increase in outdoor environment. At this point, relations with the topography of region and density-height-geometry of buildings have an important role in distribution of heat with air flows[5]. A cursory review of modern UHI literature from 1950 to 2006 exposes an alarming diversity of "urban" and "rural" measurement sites characterizing UHI[6].

There are lots of researches about urban climate, urban heat island and parameters that trigger this problem. According to this researches[7,8,9,10,11,12]

- population growth
- urban morphology
- urban density
- vegetation
- urban surface
- land cover
- wind direction and speed
- consumption behaviors and life styles

are the most important parameters of the formation of heat islands. The changing of urban climate is related with these factors.

Urban climate generates pressure to cities and their inhabitants that shouldn't be ignored; human is an outdoor creature and as long as the climatic conditions are favourable, it tends to be social in outdoor environment. But, gaps of this issue cause unsanitary conditions because of the unused urban climatic comfort parameters in urban planning stages. So, for the effective design of urban structures, heat and wind movements depending on urban morphological properties must be understood very well by urban planners.

[2] Yamamoto, 2006, p.2
[3] Santamouris, 2004, p.25
[4] Akbari et. al, 2001, p.295
[5] Santamouris, 2001
[6] Stewart, 2007, p.112
[7] Voogt et. al., 2003, p.374
[8] Oke, 2004, p.9-11
[9] Dodman, 2009, p.1-23
[10] Stone et. al., 2001, p.193
[11] Chow et. al, 2011, p.1874
[12] Kuşçu Şimşek, 2013, p.54

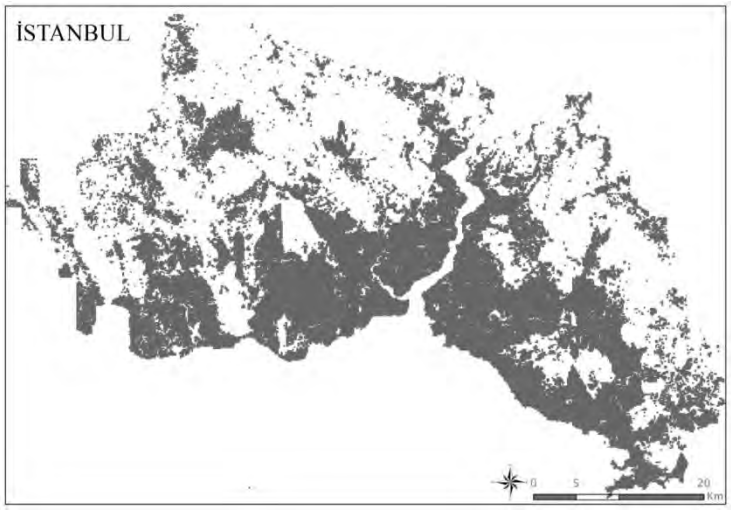
In this study, urban temperatures and urban morphological properties have been compared in meso-scale by using remote sensing and GIS techniques.

Methodology

Study Area:

Istanbul is a megacity, as well as being the cultural, economic, and financial centre of Turkey. The province covers 39 districts with an area of 5343 km^2. It's located at 41.01°N, 28.97°E in North-west of Turkey. The Bosporus is a 30 km straight which connects the Sea of Marmara to the Black Sea and divides the city into two sides; European and Asian (fig. 1).

Fig. 1. Study Area



Data:

Satellite Images : June 28, 2007 - summer period- Landsat-5 TM image was used parallel to the aim of this study. It has seven spectral bands; six of them acquire reflectance of the ground and one of them acquires surface temperature. In visible and infrared regions, spatial resolution of Landsat-TM images is 30 meters and in thermal region, it is 120 meters.

Istanbul Building Data : The building data which includes the basement areas and floor numbers for 2007.

Image Processing Studies:

Before starting the image processing studies, it was corrected by Landsat-5 TM radiometric calibration coefficients and correction formulas which were given by Chander et. al. [13,14].

[13] Chander et. al., (2007), p.490-494
[14] Chander et. al., (2009), p.893-903

After proper corrections for calculating LST, normalized difference vegetation index (NDVI) and emissivity (ε) values which highlight the reflection properties of surface elements were calculated. Then with the various formulas (as given by Gong[15] and Van de Griend[16]) applied on these values and thermal band, LST were calculated for each pixel. After, all pixels of this image were transformed to a point data to be used as a base data in GIS. Point datas that exist out of the settlement area, have been eliminated to analyze the impacts of urban structure more accurately. Settlement area has nearly 849250 points.

GIS Studies:

GIS studies provide an effective way to understand and solve the complexity of urban fabric. So, this method is used for preparation of substrates and their analysis. At this step, building data of Istanbul province area, including the basement area and floor numbers, have been used.

In the pre-GIS studies era, the study area was divided to 150x150m. grid polygons. And then, each grid cell was encoded by grid_id. Then each grid cell was intersected with building data.

Urban Texture Map : Urban texture was determined by classification. Urban structure has been classified to five classes with GIS techniques for each grid cell by used building data. Table 1 shows the properties of these urban texture classes.

Table 1. Urban texture classes and properties

Texture Class	Properties
Class 1	Represents to sparse texture that consists of detached, low rise garden houses
Class 2	Represents to mass housing areas which are integrated with green tissue
Class 3	Represents to combination of discrete, mainly 4-7 floors and high-rise buildings
Class 4	Represents to congested texture that consists of attached buildings with / without little garden and 4-7 floors in small parcels
Class 5	Represents to industrial areas with large buildings

Urban BAC and FAC Map : BAC and FAC values were obtained for each grid cell by given formula below. Then each of them was defined in a group that was given in table 2 and table 3:

Basement area coefficient : BAC

BAC = Σ basement area / grid area

[15] Gong et. al., (2005), p. 3260
[16] Van de Griend, 1993, p. 1119-1131

Table 2. Defining of BAC in a group

BAC	0.01 - 0.25	0.25 - 0.5	0.5 - 0.75	0.75 - 1
BAC GROUP	0.125	0.375	0.625	0.875

Floor area coefficient : FAC

FAC = Σ construction area / grid area

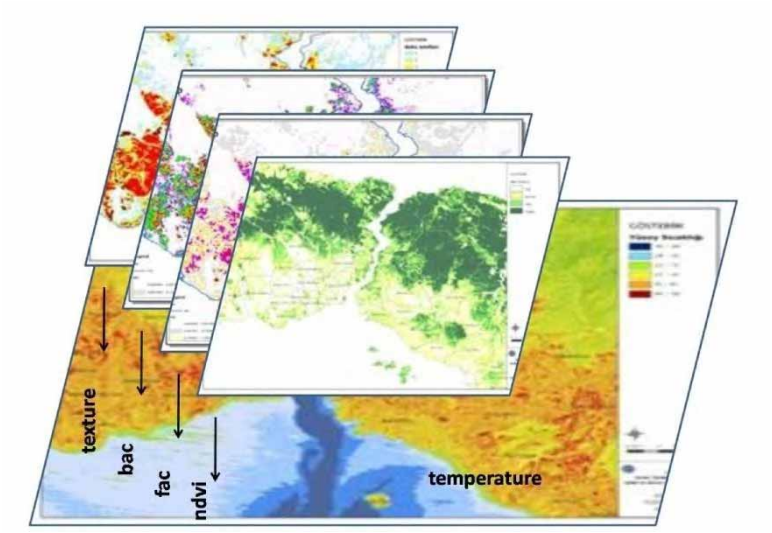
Table 3. Defining of FAC in a group

FAC	0.01 - 0.75	0.75 - 1.5	1.5 - 2.25	2.25 - …
FAC GROUP	0.375	1.125	1.875	2.625

Spatial Association of Data :

Urban texture, BAC and FAC map was calculated in 150*150 grid areas and then grid cells that exist out of settlement area have been eliminated. After all, temperature values were joined with NDVI values and each grid's texture code, BAC values and FAC values (fig.2). Thus, basic database is obtained for use in statistics.

Fig. 2. Spatial Association of Data



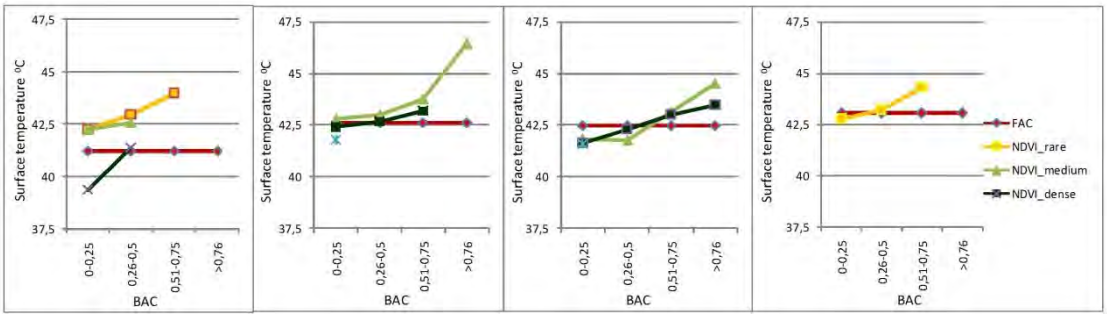
Results and Discussion

Urban heating is analyzed by computing descriptive statistics and classifying temperature values on urban texture, BAC, FAC and NDVI maps.

Before starting statistical analysis, normal distribution curves of the data had been checked and then variables have been used in regression analysis. As a result of regression analysis between urban structure variables and surface temperature; independent variables' definition rate of dependent variable (R^2) is found as 0.207 and variable interactions are found to be significant at the 0.001 level.

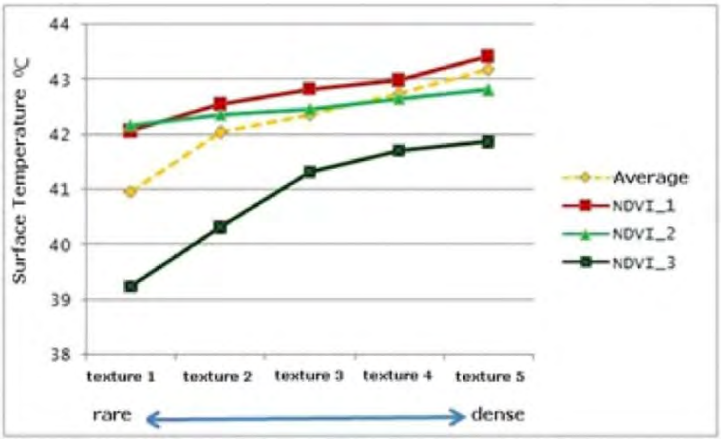
In this context, it is worth mentioning that, having been studied in the whole Istanbul area led to weakening of the results due to the increasing complexity of parameters. So, the regression analysis result can be remarkably improved by adding other parameters. But, in classifying of temperature values according to urban morphological properties give more specific results. In this context, graphics of clustering analysis of this study are given below in fig. 3 and fig.4.

Fig. 3. Evaluation the effects of BAC, FAC and NDVI on urban temperature



When NDVI, BAC and FAC values are evaluated together (each graphic represents another FAC value); according to the increase of the FAC values, were seen an increase in urban temperature values. Also, for each constant FAC value, increase of BAC values which are in different vegetative conditions cause to the increase of urban temperature values. On the other hand, results show that the increase of vegetation density is caused to reduction of the urban temperature values. Difference of minimum and maximum temperature value is nearly 4˚C.

Fig. 4. Evaluation the effects of urban texture and NDVI on urban temperature



When urban temperature values, NDVI values and density of urban tissue are evaluated together; first of all it is seen that the increase of urban vegetation in all texture groups is conduce to reduce the urban temperatures. Also in parallel to this, increase of the density of urban tissue is cause to increase of urban temperatures. The difference of temperature value between low and high densely urban texture is 4,17˚C. As evidenced by the results of analysis, density of urban tissue affect the urban climate adversely. On the other hand, in most densely urban texture (texture 5), the difference of temperature value according to presence of vegetation is nearly 1,3˚C. So, it is obvious that the presence of urban vegetation, especially in densely built-up areas, is an important parameter to reduce the urban temperatures.

Therefore, according to the results of analyzes, heat absorbed by building surfaces and this will cause to the increase of temperature. So, the clogged areas and their damaged vegetation are caused to generate urban heat islands. Especially, high rise buildings in densely built-up areas are trigger the effects of this problem.

Istanbul is a megacity which developed similar to the other world cities in the manner dictated by global dynamics. So, according to the findings from literature and studies about the city, Istanbul is vulnerable to the climatic threats as the other cities in the world which are exposed to climatic problems. Absolutely, in urban planning studies in Istanbul, these parameters have to be considered. Also, urban effects on climate must be analyzed with future scenarios and strategies must be established against these effects.

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INTEGRATION OF CLIMATE CHANGE ADAPTATION AND MITIGATION POLICIES IN LAND-USE PLANNING AND ENVIRONMENTAL IMPACT ASSESSMENT

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TEMA Foundation

Abstract

Climate change has emerged as the greatest long-term environmental challenge of our history. The Intergovernmental Panel on Climate Change (IPCC) concluded in the 5th AR (Assesment Report) that between 1901-2012, global average surface temperature has increased 0,9 ^{0}C due to antrophogenic climate change and the CO_2 levels in the atmosphere has reached to 400 ppm which is a record level for our history. The increasing CO_2 levels accelerate antrophogenic climate change and its impacts. Today, due to direct impacts of climate change, the world faces record-breaking temperatures, extreme rainfalls, floods and other climate related disasters.

The impacts of climate change affect all the sectors and therefore, climate change must be better integrated into both general and sector-specific policies such as urbanisation, agriculture, transportation, and land use planning.

This article aims to make an argument for the need of better integration of climate change adaptation and mitigation policies in land-use planning and environmental impact assessment processes.

It discusses the importance of integrating potential climate change impacts to Environmental Impact Assessments (EIA) to develop better climate adaptation and mitigation policies. The article, also proposes that climate projections should be included into the land use planning process. The discussion is based upon a comparison between international practices and Turkish applications.

1. CLIMATE CHANGE and IMPACTS IN TURKEY

IPCC 5th Assessment Report identifies that warming in the climate system is unequivocal and the human impact on climate change is clear. Besides, IPCC declares that the atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased[1].

According to IPCC 5th Assessment Report, each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. In the

[1] IPCC, 5th AR Press Release, 2013

Northern Hemisphere, 1983–2012 was likely the warmest 30-year period of the last 1400 years (medium confidence). The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800.000 years. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions[2].

Besides, IPCC also analyzes the regional impacts in the Annex I of the 5th Assessment Report. According to this analysis, most of the regions in Turkey which belong to Mediterranean and Sahara Region are some of the most vulnerable regions to climate change that expects increasing temperatures, decreasing precipitation and other impacts. Besides, according to the regional projections; increased temperature will likely reduce the productivity of major crops and increase their water requirements, thereby directly decreasing crop water-use efficiency[3].

A regional climate model projection (ICTP-RegCM3 simulations realized by Sen et al.) shows that an increase in air temperature of 5 to 7°C during the summer season over the west and an increase of 3.5°C for the winter season for the eastern part of Turkey is expected in the 21st century. Their research also projects the following:

> "Precipitation is predicted to be 40% less in the southwest, although it may increase by 25% in the eastern part of the Black Sea region and north - eastern Turkey. The results suggest more frequent, intense and long-lasting droughts in the country particularly along the western and southern coasts under future climate conditions. A shift of climate classes towards drier conditions is also projected for the western, southern and central regions during the 21st century. Evaluating the role of the climate change trends in crop production reveals significant decreases in yield and shortened growth seasons for first- and second-crop corn, a likely result of high temperatures and water stresses. In addition to rising temperatures and declining precipitation, increasing frequency, severity and duration of drought events may significantly affect food production and socio-economic conditions in Turkey."[4]

The projections realized by IPCC and other detailed regional projections present that climate change will be one of the critical issues that might affect different sectors such as urbanization, agriculture, construction and likely to cause socio-economic changes in the country. In the case that necessary policies and decisions which would allow country to be climate resilient are not applied; Turkey would become much more vulnerable to impacts of climate change. For instance, the lack of integration of climate change adaptation and mitigation policies to sectoral policies brings an unexpected load to country's budget. In case of continuous lack of integration of climate change to existing sectoral policies, the load to budget will increase significantly.

In an economic point of view, Kadioglu M., analyses the actual impacts of climate change in Turkey:

> "In Turkey, economic damages due to climate change increase in last years. In Turkey, due to the human induced climate change flood disaster financial damages approximate earthquake damages in the metropolitans. Hail damage took the first place in insurance payments.

[2] IPCC, 5th AR Press Release, 2013
[3] IPCC, 5th AR Annex 1, 2013
[4] Sen et al,2012,s: 175

> There were about 140 flood incidences in Turkey in 1963, while in 2010 over 160 floods occurred. As a result of an average of 200 flood disasters occurring annually, a financial loss of approximately 100 million dollars arises every year.
>
> A considerable increase in storms due to high winds has also been observed.In Turkey, the storms formed in this way were below 50 per year for many years, however, this rate increased to 250 in 2010. Recently, tornadoes and lightings are added to the disasters that have become destructive. Loss of lives due to lightings occurring during storms only in recent years reached to approximately 400."[5]

The actual and the projected impacts of anthropogenic climate change in Turkey, shows that mitigation and adaptation to climate change should become one of the country's priorities. However, the impacts of climate change are not yet included in the land use planning and environment impact assessment processes.

2- ACTUAL LAND USE PLANNING PROCESS IN TURKEY

It is not possible to increase existing amount of soil in the nature. For this reason, natural assets such as soil should be planned with the mentality of protecting and developing natural assets.

Turkey has been evaluating its lands with Land Capability Classification method, whereas according to more recent research studies, more complex models exist for land use evaluation. For instance, A Framework for Land Evaluation developed by FAO (Food and Agriculture Organization of the UN) is used in recent academic studies.

According to the results of Land Capability Classification research, Turkey has 26.546.585 hectare 1st, 2nd, 3rd and 4th class of agricultural lands which make 34,6% of all lands in Turkey. In another words, 1/3 of Turkey's lands are appropriate for agricultural activities. A total of 46.692.633 hectare of Turkey's lands are grazing lands, forests and maquis shrublands which make 60,9% of country's land. Only 3.455.513 hectare which makes 4,6% of country's lands are suitable for other land use activities. These numbers identify "ideal land use activities" of country and theoretically, Turkey should realize its land use planning according to this research results. However, the existing environmental problems show us that Turkey is not applying scientific results into practice[6].

In 1966, Turkey, in order to create a database on land resources and to bring service to agricultural planning, started preparing 1/25.000 scaled topographic maps which are named "Turkey Improved Soil Maps" and finalized them in 1971. These are based on 1/100.000 scaled "Provincial Soil Resource Inventory Reports" and 1/200.000 scaled 26 Big Water Catchment Basin. Today, Turkey still does not have 1/25.000 or larger scaled detailed soil maps that "rural land planning", "land planning" and "soil management planning" reports could be produced. For this reason, Turkey's land planning process is continuing through 1/100.000 scaled and downscaled "City or Provincial Environment Plans"[7].

[5] Kadıoğlu, M. 2012.;s: XIII
[6] Sarı,2006, s:75 - 89
[7] Erol,2007, s:21 - 25

However, there are many discussions about the sufficiency of 1/100.000 scaled city or provincial environmental plans to answer the purpose of appropriate land use planning. In practice a lot of exceptions are applied to city or provincial plans that permit the inappropriate land use. In order to clarify this issue, the project of the 3rd Bridge in Istanbul would be a good example.

The bridge which will be situated between Garipçe in Sarıyer on the European side and Poyrazköy in Beykoz on the Asian side; does not exist in the Master Plan of Istanbul. The 1/100.000 scaled Master Plan of Istanbul, which came into force in 2009, serves as the essential guide to sustain an organized development of Istanbul. In this plan, the development of Istanbul is defined as "expanding Istanbul on the east-west axis and along the Marmara Sea linearly with a multi-centric design (establishing central business districts at intervals) while sticking to environmental sustainability principles"[8] Furthermore, the 1/100.000 scaled Master Plan of İstanbul envisioned stopping the city's development towards the north, where there are water basins and ecological corridors. However, the project of 3rd Bridge is contradicting with the existing Master Plan of Istanbul. In the absence of sound scientific analyses and evaluations, the 3rd Bridge Project was included into the 1/25.000 scaled land-use plan only by referring to an approval decision by the relevant municipality council.

This exception is not only a problem but it is also against the Zoning Law. According to the 3rd Bridge Evaluation Report of Chamber of Urban Planners:

> "Zoning Law (Code No. 3194) stating that "each plan must comply to the principles and decisions specified in the upper scaled plans". The main reason behind this contradiction is the addition of the 3rd Bridge Project to the (lower-scaled) 1/25.000 and 1/5.000 scaled land use plans without including it in the (upper-scaled) 1/100.000 scaled Master Plan by the approval decision of the İBB Council on June 17, 2010. In this case, by preferring a totally mistaken approach, rather than adapting to the decisions of Master Plan that suggests alternative solutions against a 3rd bridge, this upper-scaled plan is tried to be adjusted to the lower-scaled plans that contain the route of the bridge. For this reason, the practice of adding the bridge crossing to lower-scaled plans and the attempts to maintain a fictitious compliance to upper-scaled plans is clearly violating the Zoning Law.
>
> On the other hand, 3rd article of the Zoning Law states that "No area can be used for purposes other than the ones presented in different scaled plans, the conditions of the area and the provisions of the regulation". This provision of the law that regulates the relationship between plans and implementation areas and the relationship between the 3rd bridge and its approach roads show that the the 3rd Bridge Project cannot be realized before being approved and presented in the 1/100.000, 1/25.000, 1/5.000 and 1/1.000 scaled plans."[9]

In this case, not only the lack of land management plans, but also the exceptions done for certain projects during planning process cause a lot of environmental problems in Turkey. During the construction of the 3rd Bridge, around 2,5 million trees are expected to be cut down, which means an important destruction for natural carbon sinks for Istanbul and for Turkey from the climate change point of view[10].

[8] UCTEA Chamber of Urban Planners Istanbul Branch, 2010
[9] UCTEA Chamber of Urban Planners Istanbul Branch, 2010
[10] UCTEA Chamber of Urban Planners Istanbul Branch, 2010

3 – ACTUAL ENVIRONMENTAL IMPACT ASSESSMENT PROCESS IN TURKEY

Environmental Impact Assessment procedures have been regulated under a law in Turkey since 1993. According to the Turkish EIA Regulation ("EIA Regulation"), EIA refers to the studies of determination of the likely positive or negative impact that the projects will have on the environment. EIA should also be studying possible environmental protection measures relating to these projects in order to minimize negative effects; determining and assessing selected technological alternatives and locations; and monitoring and controlling the implementation of such projects.

Projects in the Appendix 1 list, Projects with "EIA Required" decision and Projects in Appendix I with capacity increase should apply to Ministry and if necessary take EIA positive report to be established. Projects in the Appendix II list and projects in Appendix II with capacity increase should apply to Governor and take EIA positive report if necessary. Generally Governors consider that EIA is not required for the projects in the Annex II.

Turkmen, has summarized EIA process in 6 steps:

"Initiating EIA Process and Establishing the Commission: The project owner shall apply to the Ministry by submitting the relevant documents and the Ministry shall examine the information and documents in such application file in terms of convenience. In case that the application file was duly prepared and submitted, the Ministry shall, by taking into account the information provided in the application file, establish a Commission ("Commission") consisting of representatives of relevant institutions and organizations, officials of the Ministry, and project owner and/or representatives. The members who represent the institutions and organizations in the Commission shall have sufficient professional knowledge and experience and are authorized to provide opinions on the subjects limited with the task field of the institutions and bodies which they represent.

Public Participation Meeting: Public participation may be defined as the involvement of individuals and groups that are considered to be positively or negatively affected by a proposed intervention subject to decision-making process or are interested in it. Prior to the date of the Scope and Special Format Determination Meeting of the Commission, a Public Participation Meeting on a date which shall be determined in agreement with the Ministry shall be organized by the owner of the project in order to inform the public and receive their opinions and recommendations concerning the project.

Scope and Special Format Determination: The special format specified by the Commission shall be given by the Ministry to the project owner and/or its representative within a certain period. The project owner is obliged to submit the EIA Report to the Ministry within a determined period. In case the EIA Report has not been submitted or a justified additional time extension has not been requested within the determined period, the applications shall be considered void.

Submission of the EIA Report: Pursuant to the EIA Regulation, the project owner shall submit the EIA Report to the Ministry. The EIA Report shall be inspected by the Ministry in terms of compliance with the general format and whether it has been prepared by the professional specialists who should have participated in the working group or not. Sufficient copies of the EIA Report which is concluded to comply with the special format shall be

provided by the project owner and submitted to the Ministry. Initiation of examination and assessment process of project and submission of the EIA Report to public opinion shall be announced by the Ministry and relevant governorship by appropriate means of communication such as billboards, announcement, internet, etc.

Examination of the EIA Report: During examination and assessment meetings, the Commission shall examine and assess whether; the EIA Report and its appendices are sufficient and appropriate, the examinations, calculations, and evaluations are based on a sufficient level of data, information, and documentation, the likely environmental impacts of the project have been sufficiently and comprehensively examined, the necessary measures to dissipate likely negative effects have been determined, the Public Participation Meeting has been duly concluded, and the issues highlighted in the Public Participation Meeting have been sufficiently resolved.

Submission of Final EIA Report and the Decision of "EIA Positive" or "EIA Negative": The project owner shall submit the EIA Report finalized by the Commission and other determined documents to the Ministry. The Ministry shall give an "EIA Positive" or "EIA Negative" decision within a certain period by taking into account the studies of the Commission on the EIA Report and submit such decision to the project owner and relevant institutions and organizations in writing. The Governorship shall, by appropriate communication means, announce the content of the decision, reasons constituting the basis for the decision, and that the opinions and recommendations of the public have been reflected in the Final EIA Report. In case that the required investments are not initiated within seven (7) years as of the date of "EIA Positive" decision and such decision shall be deemed invalid." [11]

Recently, European Union has published "Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment". Through this document European Commission aims to work closely with Member States and stakeholders to set guidelines and to ensure that account is taken of climate change impacts when implementing the Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) Directives[12].

Even though Turkey is an accession country to European Union, the positive and negative impacts of projects to climate change, are generally not taken into account during the EIA application process. The projects that take "EIA is not required" approval can sometimes cause high level of destruction of carbon sinks or increase of green house gas emissions. Without necessary evaluation of the project's effect to increase or decrease green house gas emissions, to the capacity of carbon sinks, to adaptation and mitigation; these projects are likely to cause more severe climate change impacts.

Scientific researches clearly present that climate change would mean less precipitation, more droughts, increasing desertification in arid and semi arid lands and wider and more affective forest fires for Turkey. Due to this, decreasing crop production and increasing water stresses should be also considered. In order to address climate change with appropriate policies and applications, forest fires, drought, land degradation and desertification projections should be included into EIA processes and land use plans with a multi- disciplinary and multi- sectoral approach.

[11] http://www.mondaq.com/x/103760/Environmental+Law/An+Overview+on+Environmental+Impact+Assessment+Procedures+in+Turkey
[12] European Union, 2013

4 – CONCLUSION

UN General Secretary Ban Ki-moon defines climate change as "the greatest collective challenge we face as a human family" and we have already started to see impacts of climate change on people and places all over the world. Melting glaciers, increasing droughts, rising sea levels, acidification of oceans are the existing impacts of climate change and scientists project that impacts will worsen and we have to act immediately on adaptation and mitigation.

In order to minimize the impacts of climate change in different sectors such as urbanization, agriculture and industry and to make progress towards combating and adapting to climate change, and halting the loss of biodiversity and the degradation of ecosystems, it is vital to fully integrate climate change in the plans, programs and projects with a multi- disciplinary and multi- sectoral approach.

Environmental Impact Assessments and Land Management Plans are legally-required and systematic tools, and as such are well suited to tackling climate change. For this reason, climate change should be integrated to these tools in order to develop general and sector based climate change adaptation and mitigation policies.

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THE ECOLOGY OF URBAN TRANSFORMATION

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Abstract

The threshold marking the half of the world's population living or having to live in urban ecosystems has already been exceeded and cities or urban ecosystems turned to be the natural habitats of modern man. Practically, all rural areas outside city limits face the tough issues such as either meeting the ever growing and diversifying needs of city life or coping with the ever worsening impacts of urbanization.

In Turkey, the shift from quantitative to qualitative urbanization phases and the period in which the discussions and practices related to urban transition started came out almost simultaneously. Ecologic or environmental paradigms and politics are predominantly urban origin. That is the reason why, the city has to be the inevitable starting point in understanding and managing local or global ecological issues experienced or likely to be experienced, including global climate change. This obliges the whole urban transformation activities to be based on ecology at large.

Despite its urgent importance, the number of experienced urban ecologists and the research work carried out in this field are astonishingly low.

By taking off from a research study carried out in Antalya, the urban transformation practices performed particularly in Istanbul will be studied and questioned in the context of city including its close periphery. Considering the pre-transformation structures as reference points, to develop proposals and strategies based on the ecological dimensions and contents of urban transition will be the major goal of the paper.

Key Words: Urban transition, eco-architecture, quantitative-qualitative urbanization, urban ecology

Introduction

Data reveals that the dependence on urban lifestyle which offers better social as well as economic conditions than rural areas will gradually deepen and sprawl. Urbanization, the demographic transition from rural to urban, is associated with shifts from an agriculture-based economy to mass industry, technology, and service. It is widely recognized that the cities or built ecosystems are, directly or indirectly, one of the leading causes of environmental issues we face globally. The sheer magnitude of population growth is an important variable affecting urban environmental issues because it directly affects the spatial concentration of people, industry, commerce, vehicles, energy consumption, water use, waste generation and other environmental stresses (1).

For the first time ever, the majority of the world's population (54%) lives in a city, and this proportion continues to grow. One hundred years ago, 2 out of every 10 people lived in an urban area. By 1990, less than 40% of the global population lived in a city, but as of 2010, more than half of all people live in an urban area. By 2030, 6 out of every 10 people will live in a city, and by 2050, this proportion will increase to 7 out of 10 people. Currently, around half of all urban dwellers live in cities with between 100 000 - 500 000 people, and fewer than 10% of urban dwellers live in megacities. There is doubt that 20th century was the century of urbanization but it seems that the 21st century will be the century of cities.

These urban areas make up only 2 percent of the world's land and spend almost three-quarters of the world's resources. That is a lot of people in a very small space consuming a great deal. And in conjunction with that density, total pollution of which global warming is an integral part is soaring. Istanbul, a Turkish megacity hosting more than 15 million dwellers, for instance, released more than 60 million(4t per capita x15 million) tons of carbon dioxide, into the atmosphere in 2010 while London released 45 million (5,7t per capita x 8 million) tons.

Since Neolithic revolution, happened nearly ten thousand years ago, the dependence of man to nature is gradually and consistently decreasing. Evolutionally, nature adapted man of yesterday turned to be a city dependent species of today. This modern, city adapted man cannot survive exclusively outside the city limits in wild anymore.

Shortly, we may conclude that ever growing man-made urban areas causing pollutions of all origins turned to be the natural habitats of modern man.

Turkey where urbanization has started at around 1950's and skyrocketed around 1980's, is now experiencing a shift from quantitative urbanization stage to qualitative urbanization stage. Quantitative urbanization stage is defined as a stage in which dwellers are basically in need of any shelter to hide themselves at any price. The Quantitative urbanization stage, on the other hand, stands for a stage in which dwellers demand livable and secure habitats in addition to housing. This shift has also been coincided with or encouraged by a 7.4 magnitude earthquake that struck northwestern Turkey on August 17, 1999, leaving approximately half a million people homeless. A reconnaissance study carried out by the Chamber of Civil Engineers in Antalya a very popular touristic destination, has shown that 55% of private and 75% of state structures are not strong enough to withstand to moderate scale earthquakes.

August 17 earthquake phenomenon played a crucial role on the concept of urban transformation by focusing it almost solely on earthquake resistance and almost ignoring the initiatives such as "UN-Habitat's Cities and Climate Change", "Energy Efficient Cities", "Smart Green Cities", "Eco-cities" which are focused on innovation at the intersection of technologies, business, economics, environment and policy on the urban scale.

Although there are too few cities for which there are detailed greenhouse gas emission inventories, it has become quite common for cities to be blamed for generating most of the world's (75-80%) anthropogenic greenhouse gas emissions(2,3). If greenhouse gas emissions from agriculture, heavy industries, power stations, etc. are assigned to the location of the person or institution who consumes them, rather than where they are produced, cities would account for a higher proportion of total emissions.

Due mainly to the modification of land surface for urban development by human activities, some cities or metropolitan areas are significantly (3-5^{0}C) warmer than their surrounding rural areas. This phenomenon is called as Urban Heat Island (UHI).

An holistic urban transformation design, therefore, should not focus only on one dimension (earthquake resistance) of the process but has to embrace all dimensions if livable, sustainable, green and secure cities are to be created.

Innovation means to commence, therefore it is needed to start the process. Dreaming the ideal we have to do the possible. The solutions suggested for the coming 20-30 years are meaningless, because then the problems would likely be different. We therefore need urban policies which will start changes from now on. To see the outcomes we do not need to wait for decades**.** Present-day belongs to us and is under our responsibility. There is always a small transformation at the heart of a larger transformation so we have to start creating small elements which could easily be applied and practiced.

An Urban Ecology Study in Antalya

In order to find out the variations of some climatic parameters such as temperature (^{0}C), relative humidity (%) and wind velocity (m/sn) in and outside the city limits of Antlya / Turkey 1488 measurements at 144 locations for a period of 10 months (between March-December 2000) were made (4) .

The measurements within the city limits were taken along the streets situated K-G (perpendicular to coastline) and D-B (parallel to coast line) directions, across the streets On the sides and in the middle) and in green parks (Karaalioğlu). For comparison the measurements (0700, 1400 and 2100 hours) of State Meteorology Station located near the airport of Antalya were used.

Average daily temperature within the city (24.21) was found to be 2.89^{0}C warmer than the average daily temperature of open space (21.32). on the other hand, the average daily relative humidity (%49.78) and wind velocity values (0.96m/sn) were found to be lower than the open space values (%56.68, 2.45m/sn respectively).

One of the major outcome of this urban ecology study is that the alleviating effect of the sea is almost entirely removed because of urban sprawl which ignores ecological principles in city planning and management. Even some of the main streets located perpendicular to coast line to carry the cooling sea winds deeply into the city are suffocated within 250-300m away from the coastline that converts a larger part of a coastal city into a terrestrial one.

The results of this study support the fact that the cities create heat islands. Since the urban areas generate and trap heat, cities are often several degrees warmer than the suburbs. This, in turn, increases the number of local storms. The main cause of the urban heat island is modification of land surface by urban development which uses materials such as asphalt, concrete, tile, etc which effectively retain heat. Waste generated by energy usage (cars, air conditioners, etc) is a secondary usage. As a population centre (city) grows, it tends to expand its area and increase its average temperature.

The temperature difference between urban areas and the rural areas can be as much as 5^0C. Nearly half of this increase is due to the prevalence of dark roofs, with the remainder coming from dark-colored pavement and the declining presence of vegetation. The heat island effect can be counteracted slightly by by using white or reflective materials to build houses, roofs, pavements and roads, thus increasing the overall albedo of the city.

Climate Change in Cities

The latest report from the Intergovernmental Panel on Climate Change recognizes that urbanization is missing from climate model projections and the potential for differential rate of radiatively-forced climate change in urban compared to rural areas has received little attention. The magnitude of urban heat island is a function of urban morphology and physical characteristics, urban extent, waste heat release, and regional climate factors.

To cope with the problems created in urban areas new strategies such as Cool Communities, UN-Habitat's Cities and Climate Change Initiative, Resilient Cities, Green or Eco-Cities, US Green Building Council, Leadership in Energy and Environmental Design (LEED), Green Building Initiative have been suggested. All of these suggestions share similar characteristics: They aim to reduce or eliminate fossil fuel use, adopt sustainable building practices, promote green space and clean air quality, implement energy-efficient and widely available transportation, create walkable city designs, and develop well-organized mixed-use neighborhoods that combine living, working and shopping. These qualities add up to sustainable urbanism. For example, one of the ways for a city to be green under Green Building Rating System is to take action that reduces heat islands, minimizing impacts on microclimates and human and wildlife habitats. Reflective roofing or planted roof can help a building to be awarded by a LEED certificate.

Because some parts of some cities may be hotter than their surroundings, concerns have been raised that the effects of urban sprawl might be misinterpreted as an increase in global temperature. Such effects are removed by homogenization from the raw climate data by comparing urban stations with surrounding stations. While the heat island warming is an important local effect, there is no evidence that it biases trends in the homogenized historical temperature data.

Trees and Climate

Trees affect our climate, and therefore our weather, in three primary ways: they lower temperatures, reduce energy usage and reduce or remove air pollutants. Each part of the tree contributes to climate control, from leaves to roots. Leaves cool the air through a process called evapotranspiration which is the combination of evaporation and transpiration. Both release moisture into the air thus increasing the relative humidity. For example, a large oak tree is capable of transpiring roughly 10 000 liters of water into the atmosphere during one year.
When cities are furnished by planting adequate trees the urban energy consumption can significantly be reduced by 8-18% in cooling expenses and 2-8% in heating expenses.

Conclusions

Turkey is still a very fast growing and urbanizing country. Turkey is now also experiencing a shift from quantitative urbanization stage to qualitative urbanization stage which has coincided with a 7.4 magnitude earthquake that struck northwestern Turkey on August 17, 1999. Nowadays, Urban transformation has become one of the main topics of the country as well as the present government.

Starting from Istanbul, millions of houses and apartment buildings will be replaced by earthquake proof ones in almost a decade. Green building strategies should be added to the urban transformation plans.

The vision of an administrator who intend to rule a city should be focused on future while his/she should tightly step on the present. Administrators focusing merely on the daily needs of the people put the future of their cities in jeopardy. On the other hand, the ones focusing merely on the future and ignoring the daily needs of people lose the support of their voters and consequently can't be successful. Namely, they have to pick out which of the presently existing unbelievably divers information is essential, which is strategic and which is a daily demand. The best idea is to combine present with future.

What we are to run after should be the development of well designed cities which are socially equitable and environmentally sound. The major point which makes a well designed city different than the others is its capacity in setting up the nature in to the city limits.

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GEOENVIRONMENTAL VARIABILITIES WITH EFFECTS ON THE SAFETY OF INFRASTRUCTURE

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Abstract

Groundwater composition and quality change due to mankind's activities, and fluctuating climatic factors impact on the Geoenvironment. This creates a network of parameters that strongly influence the durability and long-term performance of Geomaterials and, subsequently, on the various components of infrastructure.

Climatic factors have been changing, with extreme intensities rather than the average occurrences. Temperatures and rainfalls have risen in excess of those generally considered in design. Consequently, the design factors-of-safety may be in question as well as the design life of an engineered structure. These variables may have undesirable influence on the overall safety and stability of executed engineered works, which could endanger the safety of the public user.

Globally, the emphasis on Geoenvironment has increased during recent years. This paper discusses the various aspects of Geoenvironment and how it relates to Geomaterials and, ultimately, Infrastructure. Literature is presented showing the world-wide concern and interest in this developing interdisciplinary science.

Key Words: Climate Change, Geoenvironment, Geotechnic, Infrastructure, Public Safety

Introduction

Scientists and policymakers throughout the world are very concerned about the apparent changing climate of the earth, and are endeavoring to clarify the situation for appropriate governmental organizations and responsible bodies. The extensive diversity of weather and climates must be ordered and classified in a comprehensive and logical manner that can be understood and managed in a positive direction.

There are numerous scientific and semi-governmental organizations engaged in climate research. Probably the best well-known is the Intergovernmental Panel on Climate Change (IPCC). This group is a scientific intergovernmental body that was established by two United Nations (UN) organizations in 1988. These were the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The IPCC was endorsed by the United Nations General Assembly through Resolution 43/53 (1).

The IPCC has as a part of it's mission to provide comprehensive assessments about the risk of climate change caused by human activity. Assessment reports have been published

periodically since 1990, and the Fifth Assessment Report is expected to be published next year (2014). In addition, the IPCC produces a Summary for Policymakers (SPM), which is intended to present in an understandable less scientific language the highlights, conclusions and recommendations of the assessment reports.

Concurrently with the work of the IPCC, independent research projects worldwide investigate and report on various aspects of climate change. A large proportion of this research concerns nonanthropogenic aspects of our changing climate. Numerous organizations investigate and report on the findings of these projects, the information being distributed and verified by scientists around the world. A great amount of original research data is available through the Internet, making it possible for investigators to quickly compare and analyze factors affecting climate change.

This paper will look into the various aspects of the environment of the geological conditions affecting the safety and stability of our infrastructure. In particular it will concentrate on the limits of the conditions that are exceeded as a result of changing climate and extreme events, which may exceed the original design parameters. It is intended that the identification of these unforeseen situations would enable a timely reevaluation and analysis in order to enable upgrades prior to catastrophic consequences. Furthermore, it could provide valuable new design parameters for policymakers and building codes that would provide for the security of the general public in utilizing the infrastructure. (Page End Note: (1) IPCC Website: http://www.ipcc.ch/organization/organization.shtml

Background

The world population has now reached 7 billion. Some reports calculate that the world population could exceed 9 billion by 2075 (1). There is substantiated speculation that it could in fact exceed 10 billion by 2050. (Page End Note: United Nations Department of Economic and Social Affairs/Population Division 1 – Report: *World Population to 2300*)

Whatever the actual value, there will be an ever increasing demand on aging infrastructure, especially that designed without consideration of the extreme weathering event consequences on the geological environment. (See Figure 1).

Figure 1 - Urban Flood

Designing for Weather

The result of such a catastrophic event as seen in Figure 2 on the continued stability of the infrastructure is quite problematic. Unfortunately, recurrences of such extreme events are increasing in frequency. Basic to an analysis is the evaluation of a design event, or the frequency of occurrence of particular weather aspects such as rainfall intensity.

A design event could be a design storm, for example, which is precipitation of a certain magnitude an duration. The design principal is that such an event would occur with a given frequency (return period) with the resulting impact, i.e. flooding, to occur with a similar frequency. Remediation activities should include measures to prevent comparable damage from a similar event, and realization that such events will probably occur with increasing frequency. Policies and building codes should be revised in accordance with this updated data.

Following the devastation from hurricane Sandy, Mayor Michael R. Bloomberg is the mayor New York City and is also the Chair of the C40 Cities Climate Leadership Group. He stated that policymakers needed to look closely at infrastructure regulations. It was obvious that zoning and construction practices had not foreseen the intense circumstances imposed by this extreme storm. Cities had been put on the frontlines of the battle against climate change events since for the first time in human history, more than half of the world's population was living in cities, and also producing about 70 percent of the global greenhouse gas emissions.

For coastal cities the risks are especially serious. Storm surges may become even more powerful, and dangerous intense storms are likely to increase. In addition heat waves may be longer and more intense for urban populations in the years to come. There is no time to wait and debate the science of climate change. There is too much at stake, and action needs to be taken. In order to prepare for future events, changes would be necessary. (Page End Note: http://www.cnn.com/2013/08/21/world/europe/bloomberg-why-sandy-force-cities/index.html, "Why Sandy forced cities to take lead on climate change" August 21, 2013"

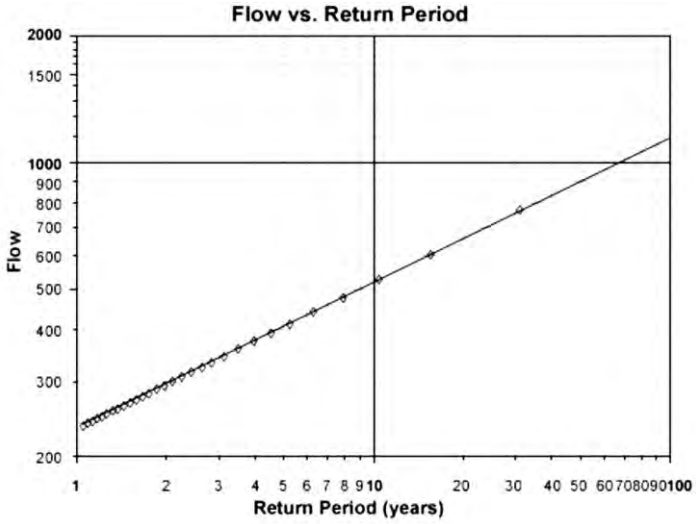

Figure 2 - Flow / Return Period Diagram

Flow frequencies of waterways used for design are based on historical measurement records, and presented in tables and graphs for reference (See Figure 2) (Page End Note: http://stream2.cma.gov.cn/pub/comet/HydrologyFlooding/FloodFrequencyAnalysisInternationalEdition/comet/hydro/basic_int/flood_frequency/print.htm#page_4.1.0)

Current infrastructure has probably been designed using such information. However, following a design event and damage, reconstruction using the same diagram could lead to further damage in the future. It must be realized that return periods are decreasing and that similar or extreme events could occur more frequently with costly consequences.

The Rocky Mountain Climate Organization and Natural Resources Defense Council released a report entitled "Doubled Trouble: More Midwestern Extreme Storms". Analysis of a half century of precipitation data across the Midwest United States indicates that the region has had an increasing number of large storms since 1961. The largest of storms, those of three inches or more of precipitation in a single day, have increased the most, with their annual frequency more than doubling over the past 51 years.

The report also presents new evidence linking extreme storms in the Midwest to major floods, the region's most costly regularly occurring natural disasters. The new analysis shows that the two worst years in the Midwest for storms of three inches or more per day were 2008 and 1993, the years with the Midwest's worst floods in some 80 years, which caused $16 billion and $33 billion in damages and rank among the nation's worst natural disasters.

The frequency of extreme storms has increased so much in recent years that the first 12 years of this century (2000) included seven of the nine top years (since 1961) for the most extreme storms in the Midwest. The average return period between two extreme storms at a single location in the Midwest has shrunk from once every 3.8 years in 1961-1970, to once every 2.2 years in the last decade. (Page End Note: http://www.rockymountainclimate.org/reports_3.htm, The Rocky Mountain Climate Organization and Natural Resources Defense Council)

The US National Center for Atmospheric Research has stated that storm frequencies are exceeding those in historical records dating back more than 150 years. It can be expected that a 100-year event may occur in 20 year cycles. The resistance of infrastructure, e.g., dikes, dams, and levees, was not designed for this intensity. Rehabilitation and new construction must take these significant and impacting emerging factors in account. Page End Note: http://www.newscientist.com/article/dn12377-tropical-storms-stepping-up-with-climate-change.html, Reed Business Information, New Scientist Weekly, "Tropical storms stepping up with climate change", 04 September 2007 by Jeff Hecht

Evaluating the Environment

–Geo" has become an increasingly applied prefix to a large number of disciplines, Geology probably being the first and foremost. –Environmental Geology" is a relatively young interdisciplinary science, most significantly interweaving the geological factors of the environment and environmental geologic conditions. Subsequently, –Geoenvironment" has become a popular nomenclature.

The actual term –environment" has been in common use since the 1960's. The Norwegian Professor Wik presented the first internationally-accepted definition as –...that part of the universe which is in interaction with the man which the man exploits and affects and to which he adapts...". which was later expanded and modified. Newer refinements include that part of the lithosphere that directly influences the conditions of the existence and development of the society, which man exploits and converts. Page End Note: http://www.geologicacarpathica.sk/special/H/Hrasna.pdf

Essentially, the geocomponents of the geoenvironment are rocks relief, groundwater and geodynamic phenomena. It follows that the environmental geological factors (geofactors) are the properties that affect the quality of the geoenvironment. –Environmental Engineering" is another approach to this topic considering the engineering aspects of humankind's relationship with the environment. Engineering Geoscience is another aspect of geotechnical factors.

Geoenvironmental Engineering is a relatively new discipline, based on traditional subjects such as Soil Mechanics, Geotechnical Engineering, Environmental Engineering, Earth Science and Soil Chemistry. The Geoenvironmental Engineering Infrastructure Cooperation Network, GeoEnvNet, was established at the beginning of 2001, under the European Commission's Fifth Fra-Framework Programme of Research. The major objective of the network is the linkage of various European infrastructures, in the area of Geoenvironmental Engineering, with the overriding ambition being the establishment of –European Excellence" in this area. (Page End Note: Thomas, H.R., AND Baxter, G.M.L., "GeoEnvNet – A European Geoenvironmental Engineering Network", Geoenvironmental Research Centre, Cardiff School of Engineering, Cardiff, UK.; http://kg.sggw.pl/konf/art_en/1.pdf)

The American Society for Civil Engineers (ASCE) has a dedicated section and regularly publishes the –Journal of Geotechnical and Geoenvironmental Engineering" This paper will look more closely at the environment and groundwater and interactions with infrastructure.

However, for clarification it necessary to briefly mention the field of "Climate Engineering", which is an application of –Geoengineering" This is the deliberate attempt through scientific and engineering technology to alter the earth's climate. Although discussed and researched, actual trials have not been implemented. The consequences of such efforts are unpredictable and could possibly worsen the climatic situation and be detrimental to the environment.

Discussion

Groundwater is in part composed of rainwater that has infiltrated through soils and surface materials. In passing through these materials, physical and chemical reactions occur, changing both the medium and the water chemistry. The influence of groundwater on the stability and behavior of infrastructure components may be visible or unseen, but impacts greatly on the performance of engineered structures. These factors should be evaluated with relation to changing weather events in order that necessary and proper modifications can be made to construction policies and building codes.

Chemical Reactions

The rusting of iron structures exposed to the environmental elements is an obvious common and well-recognized affliction. There are many remedial methods available to alleviate this situation. Conversely, wood when submerged and protected from changing elements (i.e., wetting and drying) is very resistant to deterioration. Therefore, wood pile foundations perform well for many years. However, due to climate change, high temperatures of extreme duration may lower groundwater tables and instigate the rotting of wood foundations that had been submerged and stable for many years.

Another all-too-common defect is the carbonization of concrete See Figure 3). Calcium carbonate forms when carbon dioxide in the air reacts with the calcium hydroxide in concrete. This is essentially the reverse of the chemical process that takes place in a kiln for the production of cement. The result is a reduction of the alkalinity of the concrete, which threatens the corrosion protection of the reinforcing steel. This is a slow process, averaging about 1 mm per year. The rate is mainly influenced by the permeability and calcium content of the concrete as well as the ambient atmospheric conditions. This takes place more rapidly in hot climates, and is very slow in the presence of high relative humidity. (Page End Note: Vaysburd, A. M.; Sabnis, G. M.; and Emmons, P. H., ―Concrete Carbonation—A Fresh Look,” Indian Concrete Journal, V. 67, No. 5, May 1997, pp. 215-220.)

Figure 3 – Carbonation of Concrete

Physical Properties

Soils are probably the most frequently utilized material for the foundations of buildings, highways, railways, airports and a multitude of other civil engineering infrastructure works. The physical and chemical properties of soils are thoroughly investigated for the determination of the design parameters necessary for successful performance of a structure. Standards for testing have been established by national organizations in order that the safety and security of the general public can be assured. Building codes and zoning regulations have been created for guidance. Because much of this was based on historical data, it is in need of review and modification (See Section ―Designing for Weather" above).

It has been said that ―Water is the Public Enemy Number-One for Foundation Engineers". This can be justified by the occasions of engineered works being disturbed by water during construction as well as changing water conditions subsequently. Proper design requires not only the physical interaction of a soil material with water for stability, but must also predict the presence of water and it's chemical properties during the life of a structure. (Page End Note: Handy, R.L. and Spangler, M.G., (2007), ―Geotechnical Engineering: Soil and Foundation Principles and Practice, Fifth Edition", The McGraw-Hill Companies, pp 194-245)

Due to climate changes, groundwater may vary in unforeseen ways in composition and presence. Water tables may rise and fall extremely. Due to flooding and infiltration, the water chemistry may become highly altered. It has been observed that large concentrations of toxic elements accumulate in the built environment. Corrosion products from vehicles and wear products from roadway surfaces collect in roadside soils. Dissolved de-icing salts (ions) flow into the surrounding areas along with the melt water. (Page End Note: http://www.kth.se/en/abe/forskning/markovatten/egc/forskning/soil-and-groundwater-chemistry-in-the-built-environment-1.283219 [Date of accessibility: August 2013])

Groundwater, consequently, takes up masses of these waste products and carries them through the soils, in a somewhat unpredictable manner. Flooding further distributes these materials in a random way, transporting them to other locations where they may infiltrate and react with the local geoenvironment. With increasing populations, construction is taking place, with or without proper design and authorization, in areas previously designated as undesirable or forbidden for habitation. Under extreme weather events, these are usually the first to be stricken, and typically undergo the heaviest devastation. Better attention should be paid to the enforcement of regulations and construction practices. Heavy rains wash over the surface and groundwater destroys the underlying support.

Pure water is composed of hydrogen and oxygen and is colorless, tasteless, and odorless. Groundwater becomes contaminated by the substances with which it comes into contact, and is not available in a pure state. Water can dissolve every naturally occurring substance on the earth to some degree.. Because of this property, water has been termed a "universal solvent", which can be beneficial to mankind. However, the solvency power of water can create corrosion reactions by the slow dissolution of metals by water. Deposition reactions represent a change in the solvency power of water as its temperature is varied. Extreme climatic

temperature variations will have an effect on groundwater chemistry, and on the interaction with soils. (Page End Note:
http://www.gewater.com/handbook/Introduction/ch_1_sourcesimpurities.jsp
Chapter 01 - Water Sources, Impurities and Chemistry)

Summary and Conclusions

Scientific studies and research has established that the climate of the earth has been changing since the beginning of the past century and even before that. Most dramatic has been the occurrence of extreme weather events with increasing frequencies and intensities. The concept of the –environment" has been defined and modified in keeping with the progress and influence of the human population.

The various aspects of the effects of climate change are being investigated from many angles. Engineers are approaching this from an Environmental Engineering standpoint. Geologists are working on the Environmental Geology aspect. Scientific professionals are defining in better detail the consequences of climate change on our environment and how the global population is affected.,

Geoscientific professionals are well-qualified to determine the characteristics and parameters required to assure a safe and secure engineered work. It is necessary to define precisely and extensively the impacting factors of the weather and climate in order to make suitable and satisfactory designs. The variability of geofactors can be evaluated and considered in planning and analysis.

The destruction and deterioration of infrastructure systems and networks has been documented, analyzed and evaluated. The monetary costs and great loss of life and livelihood are extensive. It is time to take measures to prevent such consequences through updated regulations and construction practices. The expense of building to higher standards will be enormous, and must be well-planned. Decision makers and policymakers need to work to define and achieve these goals.

As the climate is changing, so is the world changing, and with it the billions of inhabitants of the earth. For our future, and that of the coming generations, we can and should work to assure a hospitable environment on the continents and oceans and in the atmosphere.

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http://www.gewater.com/handbook/Introduction/ch_1_sourcesimpurities.jsp Chapter 01 - Water Sources, Impurities and Chemistry [Date of accessibility: August 2013]

COMPARING COASTAL RISKS OF MEGA CITIES - EXAMPLES OF HAMBURG AND ISTANBUL

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Abstract

Istanbul should be at the center of global warming related research with its high population and critical infrastructures for Turkish Gross National Product (GNP). Data observed from the tide gauges at Turkish coasts shows significant trends, while the driving impact seems to be the vertical crustal movement. Since the design of coastal defense structures mainly depends on the relative SLR, more attention should be given to this topic.

Apart from the fact that megacities are highly populated, they are also a center of economical activities; which increases the concern. The similarity of megacities, specifically concerning the terms of vulnerability and exposure, suggests a comparison between different cities also on the basis of storm surge risk assessment. While the consequences of storm surges are mostly neglected in coastal management at Istanbul, analysis with highly developed models and long-term measurements generates a comprehensive archive of information for Hamburg. Given the high vulnerability against coastal hazards, the present study aims at comparing both cities in terms of risk assessment.

Key Words: sea level rise (SLR) · storm surges

Introduction

Storm surges are a major threat for coastlines worldwide and there is a rising global concern which is connected with the fact of global warming triggering sea level rise (SLR). With rising mean sea levels also the magnitude of extreme events will be shifted on a higher base level. This shift is expected to be approximately linear along most coastlines of the global ocean (Woodworth & Blackman, 2004; Menéndez & Woodworth, 2010). However, in some regions a number of authors pointed to a non-linear relationship for the recent past (Jensen et al. 1992; Bromirski et al., 2003; Dangendorf et al., 2013; Mudersbach et al. 2013), suggesting that storm surges may occur even higher than just due to mean sea level rise (MSLR) would be expected (Arns et al., under review).

Global average sea level at the last glacial maximum, which happened about 20,000 years ago, was over 120 m below present day (Church et al., 2001). Church et al. (2001) also emphasize that it rose at average rates of about 10 mm/yr between B.C. 13,000 to B.C. 4,000, 0.50 mm/yr over the last 6,000 years, 0.10-0.20 mm/yr over the last 3,000 years, and 1-2

mm/yr during the twentieth century. A cumulative rise of 26-82 cm by 2100 is further predicted under different climate change predictions (IPCC, 2013).

There are several reasons which influence the long-term behavior of sea level. The first is the addition or withdrawal of ocean mass, which can either be caused by land ice mass changes or by terrestrial exchange processes such as groundwater pumping (Slangen, 2012). The second reason can be related to the expansion or contraction of ocean water due to density variations induced by changes in temperature or salinity. Additionally, the vertical displacement of the Earth's crust due to Glacial Isostatic Adjustment (GIA) may influence sea level relative to the land (e.g. Peltier 2004). Over the past ~50 years global SLR has been dominated by the second component, i.e. changes in ocean temperature, whereby in the last two decades the contribution of ice mass has been accelerated considerably (Church et al., 2001).

In contrast to the global attention of climate change related issues, in Turkey there was only a little interest to the topic since the 1990s. There are just a few coastal defense measurements dealing with such problems. According to the Turkish Regulation for shore management, sea level is accepted as an unchanging boundary between land and sea (Karaca & Nicholls, 2008). Even without the greenhouse effect, such a definition is technically inaccurate, since sea level is characterized by considerable variations of different temporal and spatial scales (Milne et al., 2009). In the past it has not mattered, because other processes were offsetting sea level changes (Erol, 1990; Douglas, 2001; Karaca & Nicholls, 2008). However, in the present time, following this definition will yield irrational results, as the United States of America and other countries with higher current rates of relative SLR have already experienced (Titus et al., 1985). Hence, SLR and climate change should be considered as an important long term issue.

Since the climate is a strongly changing phenomenon with considerable impacts on human society, protection measurements shall be taken to mitigate the impacts also in Turkey, specifically in Istanbul. Considering the similarities among megacities, Hamburg for example creates a base to activate the public interest to the danger with potential preliminary prospects of mitigation. Despite the fact that the sources of storm surges are distinctive in both cities, due to surrounding sea types and atmospheric circulation patterns, their impacts are expected to be quite similar. Hence, in the present paper we aim to compare both cities in terms of potential risk sources to create a foundation for further research in that area. The focus is given on long term sea level variations as SLR and short term fluctuations as temporarily rapid sea level changes. We will start in section 2 and in section 3 with describing recent research results of the sea state in both areas. In section 4 infrastructural conditions are compared and discussed while final conclusions are given in section 5.

1. Conditions along Turkish Coastline and in Istanbul

Sea level related studies are started with works of Oguz Erol (1990) in Turkey and increased within time since then. In the present section mainly three most recent studies are reviewed. Majority of the citations are given to the works of Coskun Demir and Hasan Yildiz for SLR related issues; while the chapter 1.2 is mainly based on the project named "TRANSFER". In the mean time the study of Karaca and Nicholls (2008) is referred many times in all the paper long as the base of the comparison.

Figure 1 shows the location of Turkey and the main continental tectonic plates consisting primarily of the country. It is located between Middle East and Europe. Its coastline is

approximately 8.333 km surrounded with 4 different marginal seas (Marmara, Black, Aegean, and Mediterranean) while the total land area is 779.452 km2. The Black Sea is connected to Marmara Sea with the Bosporus along Istanbul, while Marmara Sea is to Aegean Sea with the Dardanelles Strait. The country is mainly placed on the Anatolian Plate, which is pushed towards north from its eastern tale by the Arabian Plate. This formation causes continuous tectonic activates along the borders of the Anatolian Plate, i.e. Gölcük (Magnitude of 7.4) and Düzce (Magnitude of 7.2) Earthquakes in 1999. Both of their epicenters are around 150 km distance eastwards from Istanbul. Therefore, it is essential to take also tectonic activities into account, while assessing sea level changes along the Turkish coastlines.

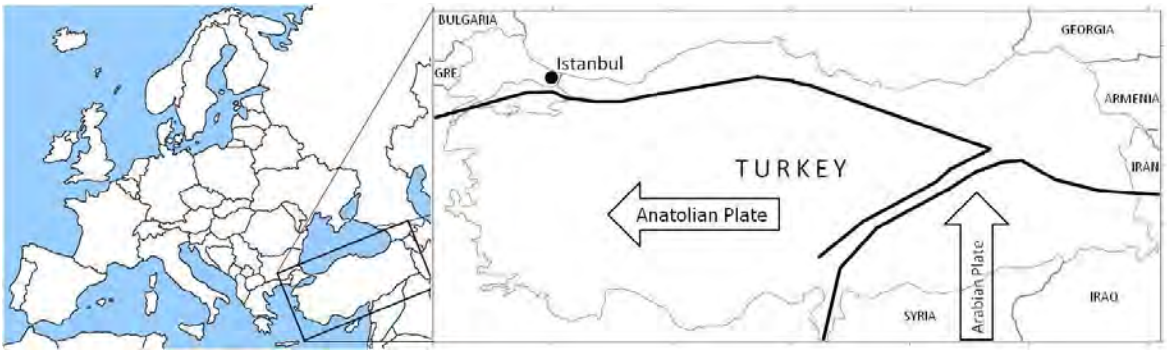

Figure 1: Location of Turkey and Istanbul with a general view of continental tectonic plates

1.1. Sea level rise (SLR)

One of the most recent studies was done by Yidiz and Demir (2002). The authors aimed at giving relative as well as absolute values of SLR by analyzing monthly mean sea level (MSL) records in combination with episodic GPS measurements. Their studied records together with their estimates of long-term trends are summarized in Figure 2 and Table 1. All together, 17 years of monthly MSL were analyzed, in order to determine relative and absolute sea level changes as well as the vertical crustal movements from the Turkish Coastline. Relative SLR from ~4 to ~9 mm/yr were detected at four of the tide gauges (Figure 2 and Table 1) and absolute SLR from 2.00 to 2.60 mm/yr at Antalya-II and Menteş, which was further found to be consistent with the global SLR rates for this period (Douglas, 1997). In general it is seen that vertical crustal movements have a strong impact on relative SLR rates. They further confirmed the high rates of relative SLR one year later with an additional year of data. In further detail, local tide gauge records of 19 years (1984–2002) indicated relative mean SLR of 8.70 ± 0.80 mm/yr for Antalya-II, 3.30 ± 1.10 mm/yr for Bodrum-II (Mugla), 9.60 ± 0.90 for Erdek (Balikesir), and 6.80 ± 0.90 mm/yr for Mentes (Izmir) (Yildiz et al., 2003; Demirkesen et al., 2008). These results are emphasized with their consistency to previous works; the study of Demir and Yildiz (2002) together with vertical crustal movement information is presented at the Table 1.

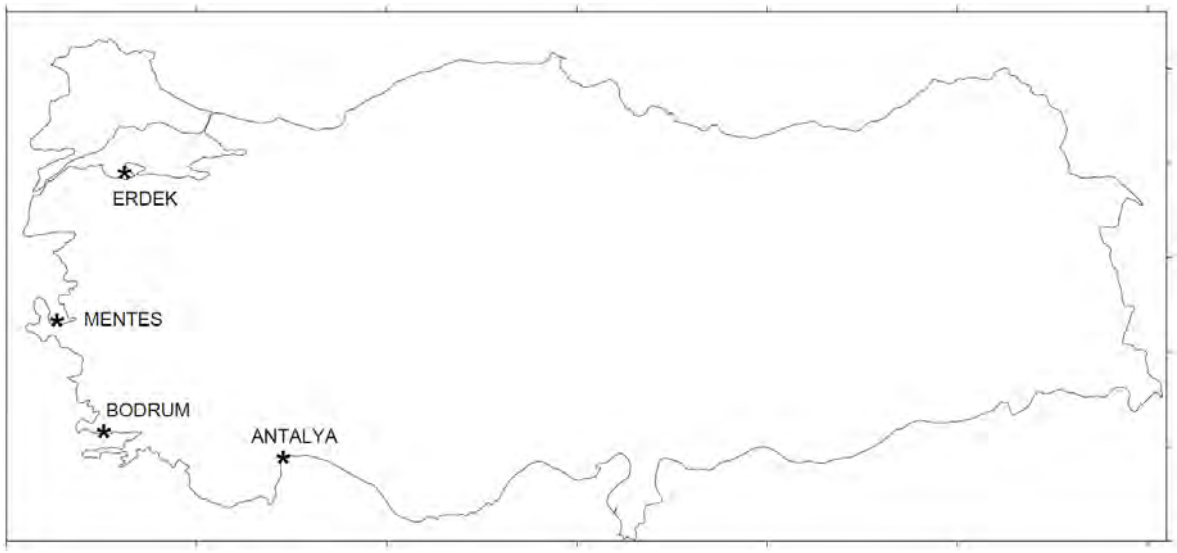

Figure 2: Tide gauge stations, started operating since 1984 and 1985 (Gürdal, 1998).

Table 1: Relative sea level change around Turkish coasts (Yildiz & Demir, 2002).

Tide gauges (Monthly sea level period)	Vertical crustal movements [mm/yr] L: Periodical leveling GPS: Periodical GPS	Relative sea level changes [mm/yr]
Antalya-II (1985-2001)	-5.35 ± 0.60 (L) (with respect to DN-21)	7.93 ± 0.98
Bodrum-II (1985-2001)	4.30 ± 0.90 (GPS)	4.59 ± 1.59
Erdek (1984-2001)	-16.12 ± 6.11 (GPS+L)	9.09 ± 1.00
Mentes (1985-2001)	-4.20 ± 1.90 (GPS)	6.19 ± 1.01

Getting a general overview about the sea level changes at the Turkish Coast Line with a special focus on Istanbul has some difficulties; as the available data is short and noisy, while vertical land movement contaminate the absolute sea level signal. Relative sea level observations at various Turkish tide gauges indicate that they are exposed to huge amount of tectonic activities (vertical crustal movements). Additionally the time scale, which the data is covering, creates a gap in the relevancy of the data. This complication is repeated in the neighboring stations in the Eastern Mediterranean Basin. Records from the Greek tide gauges are generally starting from 1969, while Alexandria tide gauge covers the time interval from 1944 to 1989. Estimating long term trends are unfortunately not easy due to these facts, especially given the high amount of decadal variability (Calafat & Chambers, 2013). Observations of Marcos et al. (2008) also points out the similar facts for this area.

Contrary to the situation of the Eastern Mediterranean Basin, time intervals recorded from the Black Sea are longer. They reach up to 120 years. Varna (Bulgaria), Constanza (Romania), Sevestapol (Ukraine), and Tuapse (Russia) tide gauges show a relative SLR of 1 to 2 mm/yr, agreeing with reported global mean trends (Karaca & Nicholls, 2008). Poti and Batumi gauges show a significant relative SLR of 3.70 mm/yr and 6.80 mm/yr, respectively, implying significant subsidence is occurring in Georgia (Karaca & Nicholls, 2008). Also the recorded data points out that continuously more than 72 hours northeast wind action, with speed 24-34 m/s can cause extreme sudden fluctuations up to 1.50 m at Varna (Palazov et al., 2007), which gives a clue about a potential risk at Istanbul due to sudden impacts. As mean sea level (MSL) rises, it directly affects extreme sea level events by shifting the frequency distributions of storm surges to higher base levels (i.e. events of a given height occur more frequently) (Hunter, 2010). Therefore the study objective requires further investigation about storm surge.

1.2. Storm surges and rapid sea level changes

According to historical records in Turkey and in surrounding countries, tsunamis and other rapid sea level changes were frequently observed (Soysal, 1984). In close seas the waves may not be very high, nevertheless they are dangerous. Therefore further consideration is needed to improve current knowledge. Understanding the formation will be useful to estimate potential hazard as well as its impacts. In Marmara Sea a tsunami can be triggered by either seismic activities or submarine landslides (Hancilar, 2012), while storm surges might be directed by climate change (Karaca & Nicholls, 2008) or tectonic activities (Demirbag et al., 1998).

Tsunami waves have hit the Turkish coasts destructively in past. They were recorded at the Izmit Gulf and at the estuary of Istanbul-Golden Horn Harbor in the Marmara Sea, at the Izmir Gulf and Islands in the Aegean Sea, and at the Fethiye Gulf in the Eastern Mediterranean Sea (Erol, 1990). Hancilar (2012) emphasizes the possibility of tsunami waves due to submarine landslide, which might hit the western shores of Istanbul. A potential wave height might reach to 1 m up to 2.5 m, while the inundation reaches to 3 m around Tuzla Harbor. The impact of such a tsunami wave or any other source which causes around 1 m to 2.5 m of sea level change is a severe impact anywhere; especially for a country like Turkey, where the majority of the total revenue is depended on the marine based business sectors. Only in Istanbul, where the 60% of the Turkish Gross National Production (GNP) (Karaca & Nicholls, 2008) is produced, the total monetary value based on the construction costs of the physical elements hit by tsunami is counted as 365 million Euros (Tinti, 2009; details are presented at Figure 3). The main sectors exposed are fishing, trade (harbors), tourism, agriculture.

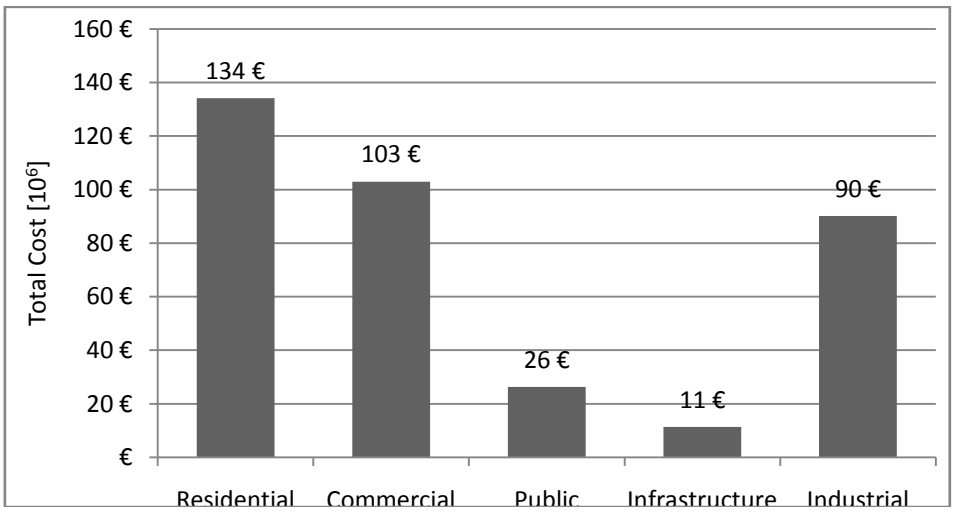

Figure 3: Total monetary value based on the construction costs of the physical elements at risk along the western shores of Istanbul (Tinti, 2009)

Beside the economical losses, the cultural and historical destruction would be irreversible as well as loss of life. The historical heritage of Istanbul reaches up to thousands of years; even if they are safe from the structural point of view (UNESCO, 2010) they are believed to be vulnerable to storm surges. Another intangible risk is the vulnerable population. Karaca & Nicholls (2008) emphasizes that the exposed population to 1 m sea level change is about 10% to 30% of each city at the coasts of Turkey. It means about 1.5 to 4 million people officially

for Istanbul, considering the population of 13,854,740 (Türkiye Istatistik Kurumu, 2012). Nonetheless, Tinti (2009) mentions that the number of directly exposed inhabitants is about 32,000 located in the pilot area due to tsunami hazard.

2. Conditions along North Sea Coastline and in Hamburg

Germany as well as Hamburg has a long lasting relation with sea related problems. There are numerous studies considering the state of the future along its coastlines as well as considerable efforts to mitigate the impact of related problems. One of the most recent projects is called XtremRisK, which was seeking to investigate extreme storm surges at open coasts and estuarine areas for an integrated risk assessment under extreme conditions. Within the project potential risk was tried to be estimated for a pilot area, Wilhelmsburg, in Hamburg (Oumeraci, 2012).

Germany has coastlines along the North Sea, the so called German Bight, and with the Baltic Sea. The territory of Germany covers 357,021 km2. Hamburg is the second largest city in the country, which is located at the Elbe estuary directly connected to the North Sea. It has the highest nominal Gross Domestic Product (GDP), while the most significant economic unit for the city is the port of Hamburg. The port is the biggest after Rotterdam in Europe. Figure 4 shows the location of Germany and Hamburg within Europe. Although, the country is not exposed to crustal movements in general, so as the entire west and central Europe, the storm surge impact is considerably higher compared to the countries located around Mediterranean Sea.

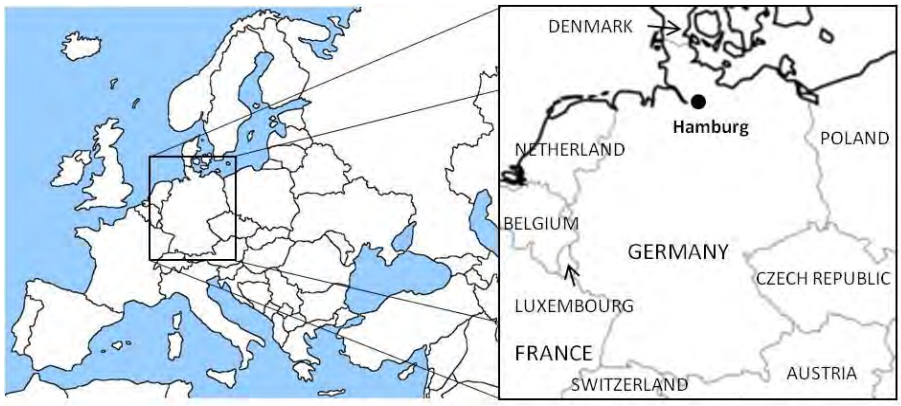

Figure 4: Location of Germany and Hamburg

2.1. Sea level rise (SLR)

Sea level related issues are well studied around North Sea. As long as the sea level variability is very important in the region for coastal planning, not only long-term changes in MSL but also short-term variability are given attention. This fact is seen in the number of tide gauges along the German Coastline which is about 90 (LLUR, 1998). The shortest tide gauge records are from 1950s while the longest records are before 1850.

Jensen et al. (2011) show the SLR of 2.20 ± 0.60 mm/yr between 1937 and 2008, with periods of accelerated rates at the end of the 19th and 20th century. However, these recent high rates

are still not unusual compared to earlier periods. Dangendorf et al. (2012) emphasized the impact of North Atlantic Oscillation (NAO), which has a considerable effect especially during winter months, producing non-neglectable multi-decadal trends. In the mean time Wahl et al. (2013) suggests to consider approximately 0.80 m height as future projections. Due to the awareness to risk in Hamburg, the SLR in the limits of 0.40 to 0.80 m is not considered as a serious threat. Already built infrastructures protecting the city are capable of handling the SLR which is higher than the value range suggested by IPCC. The main problem, more than SLR itself, is the influence of it to storm surges and other related hazards.

2.2. Storm surges and rapid sea level changes

The North Sea Basin is directly open to the Atlantic Ocean. The potential sea level fluctuations are respectively higher than both the Marmara and the Black Sea. For instance, the water surface elevation of the Probable Maximum Tsunami is 8.80 m National Amsterdam Peil resulting from the assumed landslide event, and is significantly higher than the Maximum Credible Earthquake generated tsunami water surface elevation (4.52 m) (Dababneh et al., 2012). Although the wave height seems significantly high at Amsterdam, it is estimated less than 1 m at the German Bight. It appears that the German Bight will be protected from the catastrophic impacts of a hypothetical tsunami by its location in the wave shadow of Norway and at the end of a wide, shallow shelf and by the narrow British Channel (Bork et al., 2007). Considering also Hamburg is located at the end of the Elbe estuary together with the dikes due to tide range, the impact is significantly minimized.

There is a strong influence of the tidal dynamics of the North Sea with a mean high tide in Hamburg of 2.10 m above sea level (a.s.l.), (Naulin et al., 2010). In the past, the city was affected by a number of extreme storm surges. In 1962, a storm surge with a peak water level of 5.70 m caused 315 fatalities with considerable damages on infrastructures. Though a more extreme storm surge with the highest observed water level in Hamburg of 6.45 m occurred in 1976, the storm surge caused no fatalities owing to the improved flood defense system.

The trivariate exceedance probabilities for 10 million storm surge scenarios and related runoff scenarios for Hamburg are computed and investigated by Wahl et al. (2013). Analyses mainly show that (trivariate) exceedance probabilities for Hamburg are very small (Pe < 10-6 [1/a]) for extreme events. Nevertheless they were decided to be used creating some conceptual scenarios. Within the scope of XtremRisk project developed scenarios are presented at Table 2, which is used to estimate the danger in the pilot district (Wilhelmsburg) in Hamburg.

Table 2: Storm surge scenarios developed by SP1 for Hamburg (Ujeyl et al., 2012)

Storm surge scenario	Peak water level [m]	Exceedance probabilities [1/year]
HH-XR2010A	8.00	$7.72 \cdot 10^{-6}$
HH-XR2010B	7.25	$8.09 \cdot 10^{-8}$
HH-XR2010C	8.64	$5.30 \cdot 10^{-8}$

With scenario ~~"~~HH-XR2010A", Wilhelmsburg district of Hamburg is investigated in detail by Burzel et al. (2013). The investigation site is located on an Elbe River Island surrounded by the Northern and Southern Elbe River branches. The overall area of the island is 50 km2.

With an area of 35 km2, Hamburg-Wilhelmsburg is the largest quarter of Hamburg. There are approximately 50,000 inhabitants, i.e. 1,400 inhabitants per km2 on average.

Most of the residential areas of Hamburg-Wilhelmsburg (about 15 km2 in total) are located in flood prone areas (Burzel et al., 2010). They mainly have an elevation between 0 m and 3 m. Therefore, the area is protected by a flood defense ring composed of dikes and two flood walls. The dike ring has an overall length of 24 km and a height varying from 7.80 m to 8.35 m (Naulin et al., 2010).

The overall inflow volume is in the order of 7.2 million m3, which results in a flooding of 75% of the area of Hamburg-Wilhelmsburg in Scenario HH-XR2010A. Ujeyl et al. (2012) mentioned that if the consideration is taken on to Scenario C, 98% of the entire site would be flooded. 530 million Euros damages on residential buildings are calculated (Ujeyl & Kowalewski, 2012). In addition, losses in the order of 70 million Euros are estimated for the interior of private households overall damages with 62% and 7,135 of 9,462 buildings are affected. 916 injuries and 2 fatalities are estimated. Within the work overall 25 cultural goods are highly damaged while 76 of them moderately and 35 is in small aspects among 283 heritages and 11 non-heritage sites (Burzel et al., 2013).

3. Comparison and Discussion

The potential risk to human life, economic assets and the environment is significant in coastal regions. According to the United Nations Environment Program (UNEP), more than 1/3 of today's earth population is living near the coast or at least up to 100 km far from the coastline, and this percentage is expected to increase (DKKV, 2002). For Europe, the population living in coastal municipalities has reached 70 million, and the total value of economic assets located within 500 meters of the European coastline including beaches, agricultural land and industrial facilities was estimated at 500 to 1.000 billion Euros in 2000 (Wood & Gendebien, 2005).

Value of the exposed items along western shores of Istanbul is given as 365 million Euros with 32,000 exposed populations. It does not match with the number given for storm surge impact in Hamburg as 70 million Euros for 50,000 people, even if the impact was about 3 times higher. If the projection covers the entire city, in Istanbul, exposed population might reach to 1.5 million people as it is also suggested by Karaca & Nicholls (2008). These numbers are paralel to the ones given by UNEP, a little higher in Istanbul. In the case of an event with the same impact as Hamburg exposed number of elements will also be higher in Istanbul.

The biggest impact will be on cultural heritages in case of Istanbul. Already in Hamburg the effected items are 38% of all, which is about 111 cultural and historical heritages. Projecting the same number to Istanbul means thousands of heritages exposed to storm surges.

Conceptual wave heights are quite seperated between the two cities as 3 meters in Istanbul and as 8 meters in Hamburg, which are used in the risk assessment studies. Contrary to the SLR values as 6.95 ± 1.15 mm/yr (1984-2001) averagely around Turkey, 2.20 ± 0.60 mm/yr (1937-2008) in the last decades around Germany. Even the data exist for the period covering 1937-1983 in Turkey; these values are not yet qualified as relevant. Therefore a long term comparison is not likely to be assessed for the present time.

Table 3: Summary of the comparison among the pilot research areas

	Potential maximum wave height [m]	Total population	Exposed population	Approximated economical losses [million €]	Damage heritages
Wilhelmsburg	8.00 (Peak water level)	50,000	37,500	70	111
Tuzla	3.00 (Tsunami)	197,657	32,000	365	-

The German Coastline is about 2,400 km, and it is tracked continuously by more than 90 tide gauges (LLUR, 1998). This number in Turkey is 20 presently functioning and 7 of them are functioning since 1980s (HGK, 2013), while the Turkish Coastline is about 8,000 km. Approximately the number of station is 4 times lesser while the coastline is 3 times longer.

Table 4: Summary of the comparison among the countries

	SLR [mm/yr]	First record date [year]	Length of the coastline [km]	Number of tide gauges
Turkey	6.95 ± 1.15 (1984-2002)	1985 (1937 not qualified data)	8,000	20
Germany	2.20 ± 0.60 (1937-2008)	1843	2,400	90

4. Conclusion

A comparison between Istanbul (Turkey) and Hamburg (Germany) in sea related hazards has revealed differences in both potential hazard estimations and the observed data. As long as the contributing members to those hazards are quite diverging from each other, a precise comparison is unfortunately not likely to be done. Therefore only some facts related to the topic from both the countries are given related with the topic.

The information obtained demonstrates that a hazardous event will have a very strong negative impact on the built environment. Without resilience strategy the recovery will be a challenge for the whole society and difficult to accomplish. Despite the high level of vulnerability, the research on the topic of global warming related issues is very limited in Turkey. Turkey would appear to be one of the countries least vulnerable; yet even here, the consequences could be severe (Erol, 1990; Karaca & Nicholls, 2008). Clearly, policy makers need to take continuous sea level changes into account. Average SLR of 6.95 ± 1.15 mm/yr (1984-2001) is a serious threat for the coasts of Turkey. Doing so would help to ensure that new development is consistent with current environmental changes.

Thus there is a need for integrative resilience strategies in flood prone areas of Istanbul just as it is obtained for Hamburg. Even if such an impact has a return period of thousands of years, it should be considered as a threat to the city. Additionally, reconstruction of the old data (1937-1983) will support to estimate significant long term SLR trends respectively.

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HOW TO MAKE WATER MANAGEMENT CLIMATE PROOF: FROM HYDROLOGICAL IMPACT ANALYSIS TO THE DEVELOPMENT OF ADAPTATION OPTIONS

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Abstract

Recently available river gauge data in Germany indicate that the behavior of catchment hydrological systems is changing. Annual average, flow regime as well as extreme events exhibit changes for numerous river catchments. While different driving forces may contribute to these changes (e.g., climate change, land use and land cover change, river training), a high correlation between changes in annual rainfall and runoff rates suggests that climate change is responsible for the change in the general discharge pattern.

In order to be able to assess the expected impact of hydrological change on regional water management, a physically based water balance model is applied to a pilot region in Northwest Germany, resulting in a scenario based assessment of likely changes on average flow conditions, seasonal water flows and extreme events (floods, droughts). The results show that the observed trends probably will persist until the end of the 21st century according to the IPCC scenarios.

In Northwest Germany, the available water drainage infrastructure is already working close to its capacity in many areas. This implies that further demand for water regulation will arise in future. Decisions have to be made how to adapt water management to climate change. While traditionally many regions aim at strengthening the water management infrastructure, alternatively land use could be adjusted to changing boundary conditions, as well. In a participatory process, climate adaptation options were developed for the Wesermarsch County in Northwest Germany. To raise acceptance, possible adaptation measures were developed within a regional forum consisting of stakeholders representing the most important water influencing and water dependent actors of the county. While the process itself was affected by controversial discussions, in the end all stakeholders agreed on a common vision on how to develop the county and its water management. The participatory process in this context was the necessary requirement for such an agreement.

Key Words: Climate impact, water management, climate adaptation, participation

Introduction

Climate change is one of the key issues in recent environmental research and studies on sustainable development (IPCC, 2007). Science and society are debating on how to react to climate change. Two main complementary strategies are recently suggested: (1) to mitigate a

future climate change (e.g., by reducing the emission of greenhouse gases) and (2) to adapt to those changes which cannot be mitigated. While mitigation needs to be evaluated on a global scale, adaptation to climate change is a local to regional scale issue (Füssel, 2007). According to van den Hurk and Jacob (2009), „global mean temperature will continue to rise by approximately 0.1 °C per decade during the 21st century due to the delayed response of the slow components in the climate system even when greenhouse gas concentrations will not increase from the level reached in 2000". Therefore, independent of the efficiency of future mitigation, an adaptation to continuing climate change is necessary if such climate change exceeds current climate variability.

Due to the increasing relevance of adaptation to climate change, the scientific community has paid more attention to this topic in recent years. Publications introduced general concepts and approaches for adaptive planning (e.g., Füssel, 2007) and analyzed regional possibilities for and limitations of climate change adaptation (e.g., Kabat et al., 2005; de Bruin et al., 2009). Most authors agreed that adaptation needs to be on regional scale (e.g., Wesselink et al., 2009) and consider different issues (de Bruin et al., 2009; Veraart et al., 2010) such as natural systems, agriculture, economy and water management. Planning adaptation to climate change also requires the use of information on present and future climate conditions. Therefore, most developments of adaptation strategies or concepts are based on future climate projections in comparison to past trends and the analysis of current climate variability.

One sector which is mostly considered within climate adaptation studies is the water sector (Bormann et al., 2012). Some authors argue that climate change will only transform boundary conditions for water managers (e.g., van Beek, 2009). Many stakeholders as well as experts perceive water related risks (e.g., floods, droughts) as most serious impact of climate change (Veraart et al., 2010). Correspondingly, many studies conclude that a closer cooperation between water management and spatial planning is required. Fresh water plays a particular role in coastal regions (Bormann et al., 2009; Veraart et al., 2010). In low lying coastal areas such as The Netherlands and Northwest Germany, water management is crucial due to the interactions between fresh water and salt water, storm tides and river floods as well as seasonal variations in fresh water availability. In terms of climate change, these regions will further be faced with rising sea levels and a likely hydrological change characterized by increasing frequencies and intensities of floods and droughts.

In this study, the importance of hydrological data analyses and model based projections as well as their conceptualization was analyzed with respect to their impact on the participation based process of the development of adaptation options, carried out by a community of stakeholders from water related sectors in the Wesermarsch County, Northwest Germany. Projections of a regional climate model were compared to observed changes from the past and used to quantify possible future hydrological change in a region which might necessitate an adaptation of the regional water management. Previous research showed that stakeholders are an indispensable part for the process of developing regional adaptation strategies (e.g., Füssel, 2007; de Bruin et al., 2009; Huntjes et al., 2010). Within such a participation process, an adaptation strategy for regional scale water management has been developed by a group of stakeholders, experts and scientists in the framework of the Climate Proof Areas (CPA) project (EU Interreg IVB North Sea Region).

Methodology

Data analysis: Based on daily time series of 78 river discharge gauges across Germany (Figure 1) trends in average annual flow, maximum annual flow and in the flow regime were identified. Trends in average flows (min. 50 years data) were determined by ordinary least-square linear regression (Bormann, 2010). They were correlated with linear trends in catchment precipitation over the same period derived from GPCC data set of the German Weather Service (Schneider et al., 2008). Trends in maximum annual flows (min. 50 years data) were determined by ordinary least-square linear regression (OLS). At each river gauge, a linear regression was fit to the available time-series data. For each time series, a null hypothesis was tested that the linear fit had a slope that was indistinguishable from zero (i.e., no change over time). These null hypotheses were assessed using rejection thresholds of both $\alpha \leq 0.10$ and $\alpha \leq 0.05$. For comparison the non-parametric Mann-Kendall test (Kendall, 1979) was performed to quantify trend significance (Bormann et al., 2011). Changes in the flow regime (min. 60 years data) were analyzed by calculating changes in monthly Pardé coefficients (Pardé, 1933) for moving 30 year time periods (Bormann, 2010). The Pardé coefficient is defined by the ratio of mean monthly and mean annual flow.

Climate change projections: In order to assess the possible future climate change, regional climate projections of the WETTREG model (Weather Type Based Regional Climate Model; scenarios A1B, B1, A2) were used. The model generates station based time series. WETTREG is a stochastic downscaling approach determining the frequency of specific weather types from global climate models (e.g., ECHAM) to simulate station specific weather time series. WETTREG was applied across Germany (Spekat et al., 2007). For the Wesermarsch County, the variations among the scenarios were relatively small compared to the differences between current conditions (=base line; 1961-2000) and the three available scenarios. Accordingly, the results of the A1B scenario were selected as input for the hydrological model. The A1B scenario is a rather pessimistic one and describes relatively well the development of the change in global temperature since the year 2000. The investigation of time series for four climate stations around the Wesermarsch and the nine rain gauges located in the Wesermarsch revealed consistent climate trends. For the year 2050, WETTREG projected an increase in temperature of ~1 °C and an increase in winter precipitation (+25% from December to February) while summer precipitation was expected to decrease by 15% (from June to August). Similarly, average wind speed was expected to increase in winter and decrease in summer while sunshine duration was projected to increase in summer (Spekat et al., 2007).

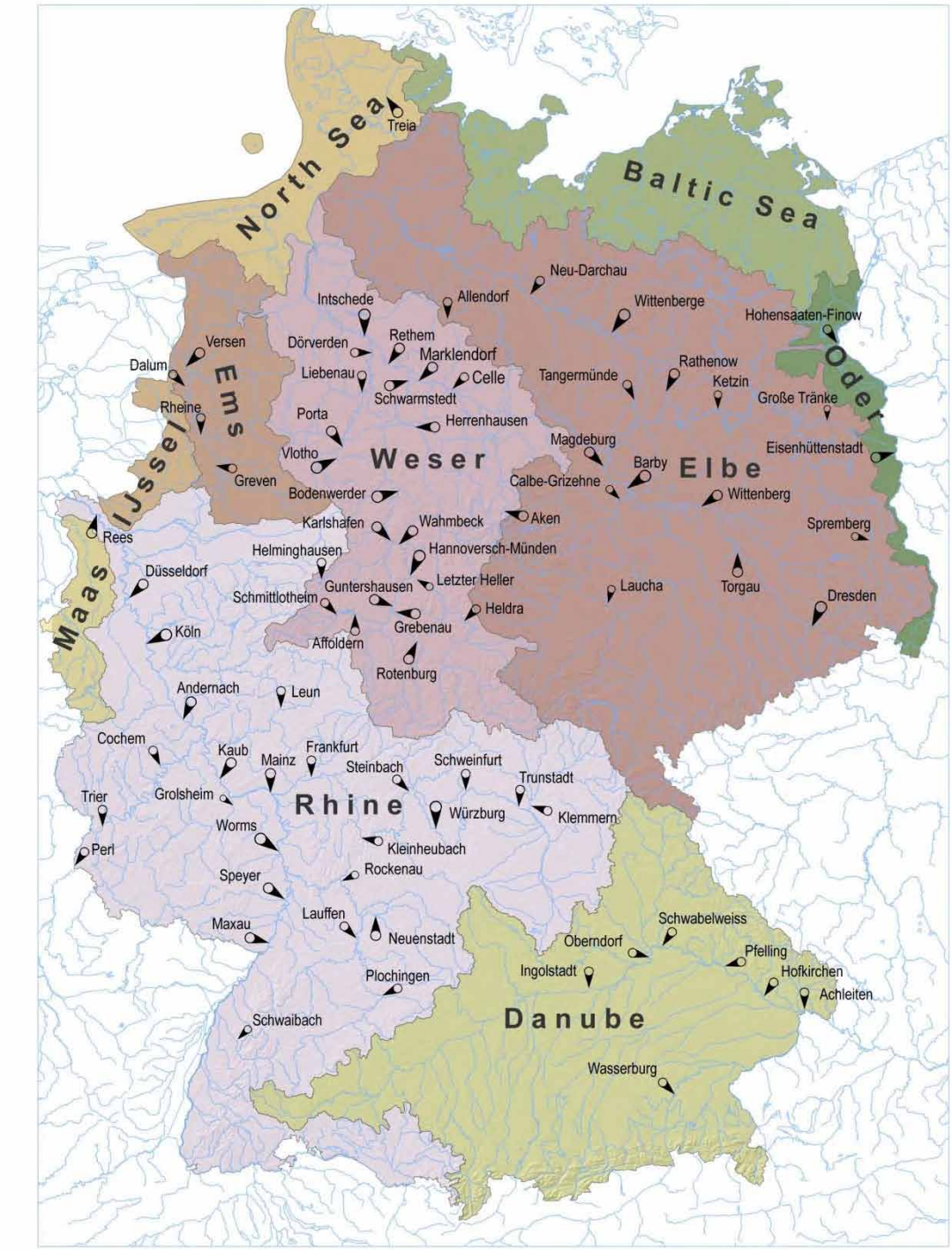

Figure 1: Location of the investigated river gauges and river catchments within Germany.

Hydrological model: Based on the climate projections, hydrological change can be estimated by applying a hydrological model. Physically based models are expected to be suited best to reproduce future hydrological behavior und changing boundary conditions (Elfert and Bormann, 2010). The 1-D physically based model SIMULAT (Diekkrüger and Arning, 1995; Bormann, 2008) was applied to the available climate scenarios from the WETTREG model. SIMULAT is based on the Richards‟ equation representing the unsaturated soil water flow and the Penman-Monteith equation for potential evapotranspiration. The model requires information on weather (temperature, air humidity, radiation, and wind speed), soil conditions

(soil texture and bulk density), vegetation type / land use and topography. SIMULAT has already been used in several climate change impact studies (e.g., Bormann, 2009; Bormann, 2011) and could be validated at different spatial scales and for different physiographic regions without any model calibration (Diekkrüger et al., 1995; Aden and Diekkrüger, 2000; Giertz et al., 2006; Bormann, 2008). Model parameterization was based on typical regional soil properties (marsh soils) and land use characteristics (grassland).

Participation: Since adaptation planning on regional scale must integrate local people, an integrative and participatory bottom-up process was organized to develop and agree upon regional adaptation options for the Wesermarsch. Stakeholders from regional and local organizations were invited to take part in this process. A regional stakeholder forum was established consisting of water managers, farmers, urban and regional planners, civil servants from different administrative levels, nature conservationists and scientists, meeting twice a year over a period of 3.5 years. They identified water management being the common focus issue. The regional forum aimed at the development of an inventory of recent water related problems, possible solutions and the identification of actors to be further integrated in this process. The stakeholders agreed upon a time horizon of adaptation planning for the year 2050. Expert interviews were carried out individually with all stakeholders in order to ensure the consideration of their institutional and personal point of views on recent and future problems, solutions and visions without being confronted to other stakeholders with different interests. The current knowledge on regional climate change and its implications on regional hydrological processes were presented to the regional forum to provide basic information for this collaborative planning process. All members of the regional forum were invited to contribute to a joint „„Wesermarsch vision 2050"".

Regional characteristics of the Wesermarsch: The Wesermarsch County (822 km²) serves as an example for many regions along the North Sea coast lying below sea level. The rural county has a population of about 92,000 people (year 2009). 95% of the area is used for agriculture (from which 90% is grassland, mainly for dairy cattle). The topography is predominantly flat (elevations between -2 m and 5 m above sea level), soils are either fine textured (marsh soils) or organic (peat). In order to safeguard the region against storm tides, dikes have been constructed for centuries and continuously heightened to reduce the risk of flooding. The Wesermarsch County is faced with several hydrological challenges. In winter time, water has to be drained from the area to avoid flooding. In order to minimize the energy amount required for pumping, the region is drained during low tide as far as possible. Contrarily, in summer time, the region suffers from a water deficit which needs to be compensated to avoid drying out of marsh water bodies. For this purpose, fresh water from the Weser River is conveyed into the canal system of the Wesermarsch during high tide. Due to the deepening of the Weser River for shipping and the intense drainage of low-lying areas, salinization of surface and groundwater bodies is an increasing problem. In order to regulate water surplus and deficits, a traditional water management system has been developed in the last centuries. A dense network of ditches, channels, barriers, sluices and pumping stations has been established to regulate ground- and surface water levels in the region. The functionality of this network depends on the flow conditions and water levels of the Weser River.

Results: Observed hydrological trends

Analyzing average annual flows revealed increasing flow trends for most of the gauges while flow increase for the Rhine and Danube River was largest followed by Ems River (Figure 2). Elbe and Weser Rivers also showed predominantly slightly increasing flows while a few individual gauges were identified which showed even slightly decreasing flow trends. Comparing linear trends in rainfall and flow revealed that 66% of the variance in the flow trends can be explained by changes in catchment precipitation. Therefore climate change plays the dominant role in studying the causes of hydrological change.

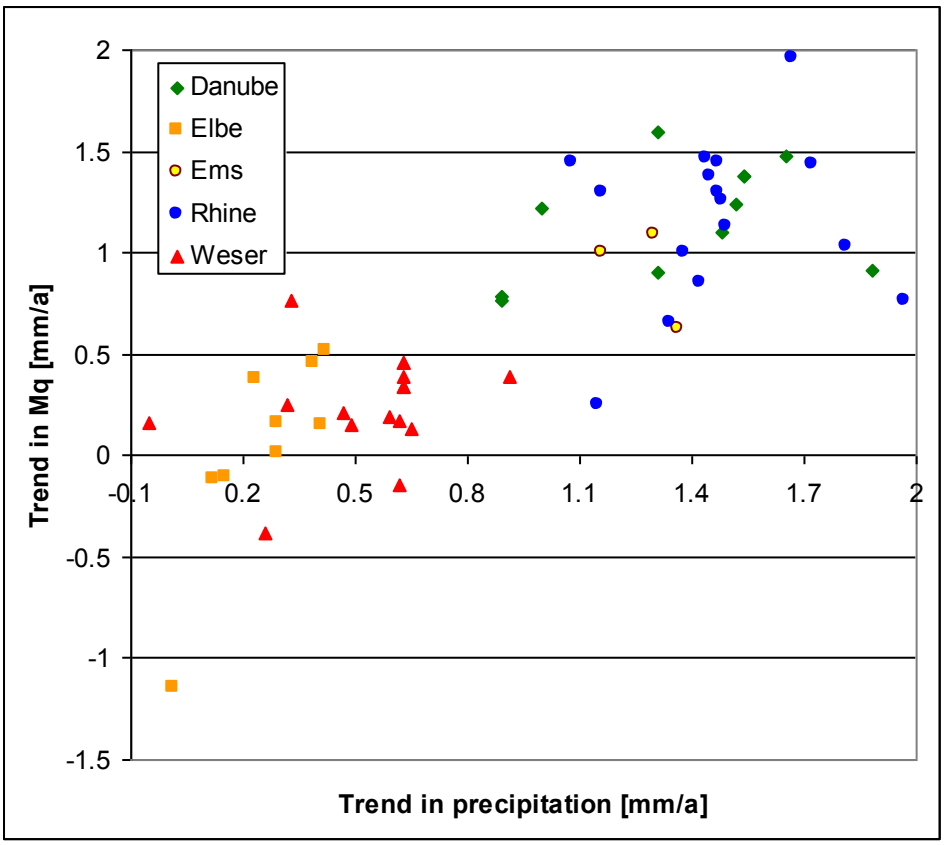

Figure 2: Correlation between linear trends in annual catchment precipitation and annual specific discharges (Mq). Regression equation: $\Delta Mq = 0.89\ \Delta Precip - 0.16$; $R^2 = 0.66$ (determined for all river catchments).

Analyzing trends in maximum annual discharges across Germany resulted in significant trends at 19 of 79 gauges at $\alpha \leq 0.05$, and another 8 (27 of 79 total) at the more liberal confidence level of $\alpha \leq 0.10$. Of those 27 gauges with significant trends, 21 of those trends were positive (increasing discharge), while 6 were negative (decreasing flood discharges). The Mann-Kendall test identified 14 gauges showing trends in annual maximum discharge at $\alpha \leq 0.05$ and another 10 gauges at $\alpha \leq 0.10$ (Table 4). 17 of those 24 gauges showed increasing trends while seven were negative. Mann Kendall test and OLS method thus gave comparable results.

At most Weser River gauges analyzed here, negative trends in flood discharge were found, among them statistically significant decreasing trends for four of those gauges (e.g., Intschede, Figure 3). The reason for these decreasing trends is that several large floods occurred on the Weser prior to 1950 (mainly even prior to 1900). At two gauges (Dörverden (Figure 3) and Liebenau), collection of discharge data started in the 1970s, and increasing trends in annual maximum flows were detected at these sites. At the other Weser gauges, data collection started between 1840 and 1940. The Weser tributaries show non-uniform trends which are predominantly non-significant (except the increasing annual maximum discharge trend on the Eder River at Schmittlotheim). Details can be found in Bormann et al. (2011).

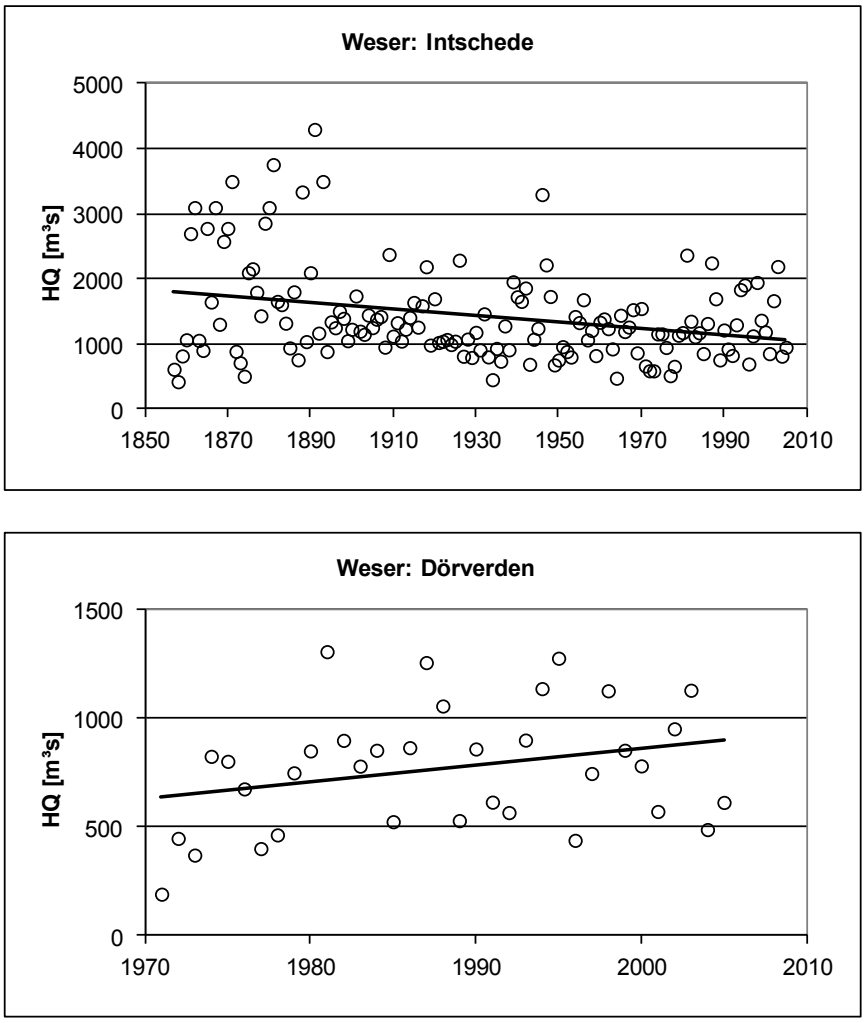

Figure 3: Sample trends (Weser River) in annual maximum discharge for Intschede (decrease significant at $\alpha \leq 0.05$) and Dörverden (increase significant at $\alpha \leq 0.10$).

The analysis on the flow regimes show that, despite environmental and anthropogenic changes, the general runoff regime types of German rivers have not changed in terms of the dominating feeding mechanism since observations started. Nevertheless, the characteristics of the regime types have changed. Maximum monthly Pardé-coefficients have consistently increased for pluvial flow regimes and decreased for nival flow regimes. In addition, the timing of the extremes in monthly Pardé-coefficients as well as the amplitude changed at many gauge stations. The amplitude decreased for nival and increased for pluvial flow regimes. Therefore, the changing environment, dominantly climate change, affected the

runoff regimes. Table 1 provides an overview over the changes identified for the investigated German rivers (figure 1). Similar trends were identified for the different river catchments.

Table 1: Specific, climate induced changes in the runoff regimes of the investigated German rivers (PC: Pardé-coefficient; + : increase; – : decrease; 0 : no trend).

River	Regime type	PC maxima	PC minima	PC variability	PC summer	PC winter
Rhine	nival	–	+	–	–	+
	nivo-pluvial	–	**0**	–	–	+
	pluvio-nival	+	–	+	–	+
Rhein tributaries	pluvial	+	–	+	–	+
Danube	nival	–	+	–	–	+
	nivo-pluvial	**0**	+	–	–	+
	pluvio-nival	**0**	+	–	–	–
Danube tributaries	pluvial	–	**0**	–	**0**	–
	nival	–	+	–	–	+
Elbe	pluvio-nival	**(+)**	**0**	**(+)**	**0**	+
Elbe tributaries	pluvial	+	–	+	–	+
Weser	pluvio-nival	+	–	+	–	+
Weser tributaries	pluvio-nival	+	–	+	–	+
Ems	pluvial	+	–	+	–	+

The springs of both headwaters of the Weser River, the Fulda and the Werra, are located in the lower mountain range. Therefore, both rivers as well as the Weser River show unimodal, pluvio-nival runoff regimes. Discharge maximum is in late winter (March), discharge minimum in late summer. The lower part of the Weser is tidally influenced by the North Sea. All gauges in the upper and middle Weser showed increasing Pardé-coefficients in winter (December to March) and decreasing Pardé-coefficients in summer (June to September) since the middle of the 20th century, inducing an increase in seasonal variability of discharge. As snow plays only a minor role in the Weser catchment, this is mainly due to the change in precipitation (increase in winter, decrease in summer). All investigated tributaries showed identical trends from analysis of monthly Pardé-coefficients. For all gauges, seasonal variability in discharge increased, despite the increasing storage volume of reservoirs and discharge control for shipping industry. Climate change can be assumed to be the dominant change in the catchment affecting the runoff regime (Bormann, 2010).

As a general conclusion from data analysis it can be stated that hydrological conditions did already change significantly with respect to average flow conditions, seasonality and extremes. Despite river training activities and land use change, climate change can be assumed to be the dominant driver of the observed hydrological changes (Bormann 2010; Bormann et al., 2011). Such changes led already to necessary adjustments of flood protection measures, drainage infrastructure and river regulation for inland navigation.

Results: Scenario analysis

Model simulations for the Wesermarsch were carried out for 14 decades including 40 years baseline data (1961-2000) and 100 years scenario runs (2001-2100). Each decade was represented by 200 years climate scenario runs to represent climate variability. The application of the hydrological model resulted in increasing runoff rates in winter and an increasing water deficit during summer months (Figure 4; see also Bormann et al., 2012; Bormann et al., 2009). Changes in the simulated water balance can be interpreted as changes in water volumes to be additionally drained (winter) or watered (summer), respectively. While in winter runoff generation could be expected to increase by 10 mm per month until year 2050 (scenario A1B), water deficit during summer months might increase by approximately 10 mm per month (scenario A1B). Until year 2100 climate change can be expected to have the double impact. The differences among the three investigated climate scenarios were smaller than the differences between baseline and scenarios.

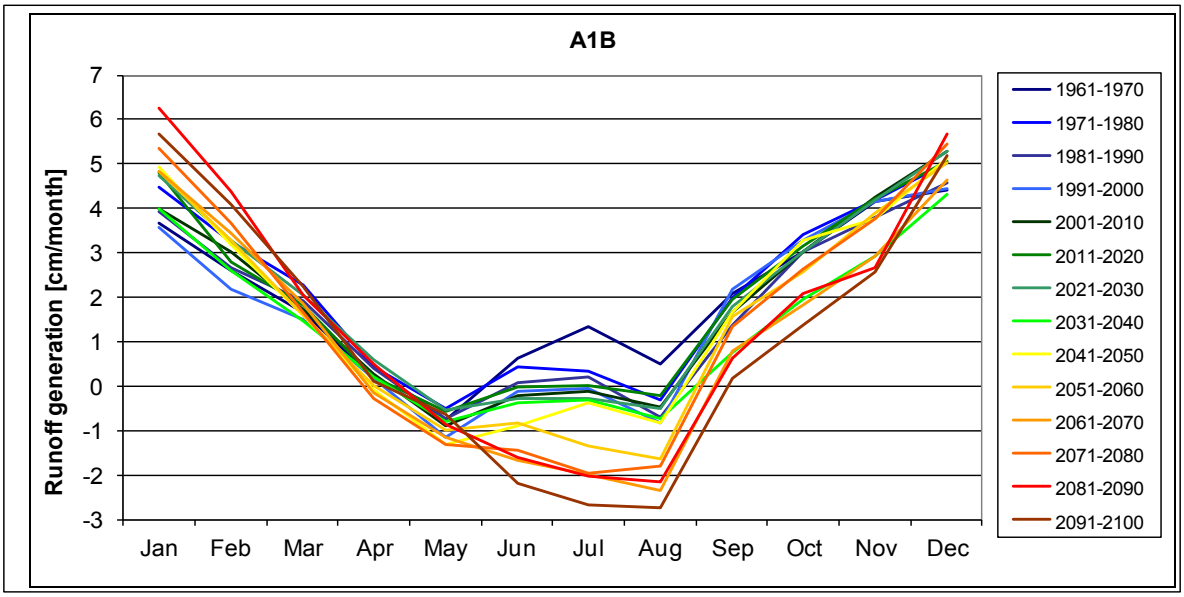

Figure 4: Changes in scenario based runoff generation simulated for the Wesermarsch (scenario A1).

Participatory planning process

The inventory of recent water management related problems revealed that already today the regional water management system works at its limit (Bormann et al., 2009). The above described information on past and (possible) future hydrological change was presented to the stakeholder forum. It was used to (1) raise awareness that the amounts of water to be drained and watered might probably change in the coming decades and to (2) be able to estimate additional volumes of water to be managed by an adjusted water management system. Stakeholders were aware that observed trends from the past might persist in future and that water management challenges due to current climate variability probably would be exceeded in the future.

The development of multifunctional land use options for the Wesermarsch was taken into account due to the cross-sectoral composition of the regional forum. Although agriculture uses dominates the county, several other sectors such as nature protection, industry and tourism have specific interests in the future development of the region and its landscape. In order to consider the different sector specific views on the future, all members of the regional forum were invited to contribute to the joint „„Wesermarsch vision 2050"" (Ahlhorn et al., 2011). During one workshop all participants were asked to describe their personal ideas on a future development of the Wesermarsch until year 2050. They expressed their interest to achieve continuity with respect to landscape, land use (agriculture), coastal protection and working conditions (Table 2). Together with the information on the expected regional climate change as well as its likely effect on the hydrological cycle, the landscape vision represented the main boundary condition for the adaptation planning process.

Table 2: Crucial sectors of the stakeholders" vision of how the Wesermarsch County should look like in year 2050.

Sector	Vision
Landscape	Preservation of the current state of the landscape (open, grassland dominated, dairy cattle).
Agriculture	Competitive agriculture should be possible as it is now.
Job market	Jobs should be safe in future; focus is set on agriculture, tourism and harbour related economy.
Coastal protection	Future life behind the dikes should be at least as safe as it is now. Reduction of compensation requirements of coastal protection measures.

Based on this "Wesermarsch vision 2050", the climate scenarios and the likely impacts on the hydrological conditions, two focus groups developed and discussed different adaptation options for a future water management, focusing on the needs of rural and urban areas. In both cases, the focus groups favored to compose an adaptation portfolio, consisting of a set of parallel, possible adaptation measures, instead of developing a comprehensive adaptation strategy. Most of the recommended adaptation measures were based on technical solutions (e.g., dike enforcement, extension of the canal system, modernizing pumps, building barriers; Table 3). The proposed adaptation options, however, complied with the currently applied water management statutes of the water boards. Most of the stakeholders denied planning the development of stagnant water bodies in the landscape in order to provide additional water storage due to expected problems in water quality and waterborne diseases. Instead, they suggested to enhance the performance of existing pumping stations despite an expected increase in energy costs. In general, the problem of future drainage of rural area was rated to be less important than the watering issue. The water board representatives agreed that present water management is organized too much focusing on the individual water board areas. They assumed that a better cooperation among neighbored water boards would increase the flexibility and efficiency of future water management and would reduce the system vulnerability.

Table 3: Portfolio of possible water management adaptation measures

	Rural pilot area	Urban pilot area
Increase in water storage capacity	Heightening of inland dikes Deepening inland channels Sediment removal	„city as a sponge" schemes (green roofs, multifunction use of parking areas, lakes) Retention in the Hinterland: additional polders
Improved drainage capacity	Heightening of inland dikes	Establishment of flood ways Additional sluice
Storm flood protection	Heightening of dikes Storm barriers (Weser, Jade)	Storm barriers (Weser, Jade)
Maintaining watering	Installation of a freshwater polder Installation of an additional drinking water system for agricultural water demand Freshwater system Jade Bay Extension of the historic watering channel	*Not necessary*
General	Improved cooperation among water boards Drainage and watering considering topography	

For comparison, an international expert group from the EU funded "Climate Proof Areas" project (www.climateproofareas.com) was invited to develop independent adaptation options. During a project workshop they were asked to suggest their own adaptation portfolio on water management in the Wesermarsch County.

In addition to similar technical improvements of the drainage and watering system, the international experts recommended to promote "living with water" as part of the development concept. Seasonal storage of water and wetland development could – as shown in large part of the Netherlands over the past decade – substantially contribute to positive effects on nature protection, tourism and aquaculture. Beyond the vision of the regional forum, they suggested to merge all water boards within the county in order to increase flexibility and efficiency of the county wide water management.

Conclusions

This study shows that climate change already has a significant impact on catchment hydrology in Germany. Average behavior, seasonality as well as extremes are affected. Scenario based projections on future climate change show that trends observed in the past can be expected to persist in future across large parts of Germany. Design and operation of water management systems must take care of these changing hydrological boundary conditions.

Based on the results of the regional scale Wesermarsch study it can be concluded that – in agreement with recent EU directives – beyond a sound hydrological system understanding and reliable projections, a successful climate change adaptation requires an integrative and participatory bottom-up process in order to raise awareness and acceptance of the regional population. The essential knowledge on past and possible future regional climate change must be linked to specific knowledge on resp. of the region and its actors. It is further appropriate to initiate both a collaborative planning and a social learning process. Knowledge on predictive uncertainty should be processed according to stakeholders‟ way of thinking. The choice of an (adequate) time horizon thereby affects the degree of flexibility in the proposed solutions.

During the adaptation process, available information was used selectively according to the stakeholders‟ attitude. Therefore, stakeholders have to share their knowledge and to come to a mutual understanding which can be realized by social learning in a regional forum, as part of collaborative planning process. They were aware that water management can be a suitable driver for integrating future economic and environmental development. In the end, the stakeholders agreed on a common vision on a future water management in the Wesermarsch County serving different economic and ecological sectors. Therefore, similar processes performed in other regions can stimulate a pro-active adaptation to change, based on a common vision of future (landscape) development. It became obvious that successful participation requires confidence among all participants. Hence time matters, participation should be part of the adaptation from an early stage in the adaptation process onwards.

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A STUDY REGARDING THE EFFECT OF CLIMATE CHANGE ON WATER RESOURCES POTENTIAL IN TURKEY

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Abstract

Climatic change is expected due to the increasing atmospheric concentrations of carbon dioxide and other anthropogenic or natural greenhouse gases. Such change should be evaluated in the planning and management of water sources. Generally, the hydrological impacts of climatic change have been studied either with deterministic or conceptual models. In this study, the effects of the changes obtained from General Circulation Models that may arise in temperature and precipitation on runoff have been investigated. Thornthwaite water budget model is used for the modeling of basin stream.

The study is performed on Bartin Basin, in West Black Sea Region in Turkey, which has a high flood risk. Most distinct impact of the climate change may be desertification and increase in the possibility to lead to drought. However, the assessment of hydrological impacts of climate change on the basins having high flood risks will be helpful in planning a suitable watershed management and selecting necessary water structures.

Key Words: Climate Change, General Circulation Models, Thornthwaite Water Budget Model.

1. Introduction

The Earth is facing a global warming as a result of consuming fossil fuels, destroying forests, and excessively using the soil. Presumably the distributions of continental and aquatic sources in time and place may change owing to such warming in the atmosphere. Therefore, quantitative estimates should be done in topographic scales for the hydrological and meteorological impacts of climate change. Thus, water sources may be planned and managed more realistically in the future.

Air temperature increased between 0.3 and 0.6°C in the last 100 years globally (Jones, et al., 1990). Unless the greenhouse gases arising due to human activities are not reduced in the next 10 years, it is estimated that global temperatures would increase between 0.2 and 0.5°C (IPCC, 1990).

The effects of power plants on the environment divided into two categories including local effects and global effects. Local effects are the effects on air and water quality, waste management problems, and acid rains. Global effect is the greenhouse gas effect. Another

important effect is that the emissions have an impact on the human health and ozone layer, and that the gases such as mercury and arsenic create toxic effects.

CO_2 forms only one of the anthropogenic emissions. Methane (CH_4), nitrogen oxides (NOx) and Ozone (O_3), and the chlorofluorocarbons (CFCs) are other greenhouse gases. Such gases result in global warming more than CO_2 on molecular basis. However, in consideration of the concentrations and exposure period, it has been calculated that the contribution of CO_2 in global warming was 55% between 1980 and 1990 for the USA.

In 1992, the United Nations established a framework agreement on the climate change (United Nations Framework Convention on Climate Change, FCCC). The convention was signed and agreed on by 165 countries. The theme of the convention was to monitor global warming and reveal the potential impact of global warming on agriculture, coastal areas, environment in general, and national economy. The convention entered into force as of March 21st, 1994.

Largest contribution in CO_2 emission in our country by years is from oil consumption. Lignite and hard coal follow oil respectively. CO_2 emission due to natural gas reached 9.4 million tons in 1993 and had a share of 6.2% within total emissions. CO_2 amount per person in Turkey was 1200 kg in 1970; whereas, it increased 2.1 time and reached 2555 kg in 1993. It is estimated that the CO_2 amount per person was approximately 3550 kg in 2000 (Pala, 1995; Pala, 1997).

Examinations on the emission amounts per m^2 between 1970 and 1993 show that, while the CO_2 emissions per m^2 in 1970 was 52g, it has been 102g in 1982, and 188g in 1993. It is estimated that CO_2 emissions would be 388g in 2005 and 536g in 2010 (Pala, 1997).

It is possible that climate changes in the past give some ideas about climate changes in the future. For instance, it has been reported that highest average temperatures globally was observed in 1980s (Jones et al., 1990). There are four groups used in creating regional climate scenarios of the results obtained from General Circulation Models (GCM). Changes in temperature and rainfall were obtained from GCM cells through statistical interpolation for the meteorological stations in the basin in this study.

There are many studies in literature which examine the effect of climate change scenarios on hydrological parameters. The effect of climate change scenarios on open water vaporization was examined through the mass transfer method (Quinn and den Harlog, 1981). In another study, the effect of scenarios generated from GCM on irrigation areas and soil humidity were examined for Saskatehewan basin (Cohen, 1991). In another study where stochastic models were considered, the impact of GCM scenarios on the streams was examined (Revelle and Waggoner, 1983).

The objective of this study is to investigate the effects of changes in precipitation and temperature on runoff from Bartin Basin, in West Blacksea Region, in Turkey which has a high flood risk. Main impact of the climate change may be the increase in temperature leading dry climates. However assessments of hydrological impacts of climate change on the basins having high flood risks will be helpful in planning a suitable watershed management and selecting necessary water structures. Thornthwaite water balance model is used in the study. The investigation is conducted using data from the Bartin basin in Turkey. Four types of General Circulation Models (GCMs) were run to generate climate scenarios of temperature

and precipitation. Then the water balance model was used to assess the impacts of climatic change on hydrologic characteristics of the Bartin basin.

2. Climate Change Models

The climate models employed in this study are four separate models known as GFDL (Geophysical Fluid Dynamics Lab), GISS (Goddard Institute for Space Studies), UKMO (United Kingdom Meteorological Office) and 11-layer AGCM (Atmospheric General Circulation Model). Those models give monthly global changes for three variable outputs such as surface temperature (°C), precipitation (mm/day) and surface solar radiation (W/m^2). The programs were prepared in FORTRAN language. A program known as GRDPT reads the data available in the models running for three variables based on the coordinates entered by the user and selects the point of input closest to the coordinates specified. If the carbon dioxide concentration in atmosphere for each model based on the point selected is 1 x CO_2 and 2 x CO_2, monthly average temperature, precipitation and solar radiation values as well as the differences and rates for each of the variables are calculated.

The study is performed on Bartin basin located in West Black Sea Region where the flood risk is high. Most distinct impact of the climate change may be desertification and increase in the possibility to lead to drought. However, the assessment of hydrological impacts of climate change on the basins having high flood risks will be helpful in planning a suitable watershed management and selecting necessary water structures.

Bartin basin, having an area of 2070 km^2, is located in West Black Sea Region; and the hydrometeorological stations existing both in the basin and around of the basin with a runoff gauge station are shown in Figure 1. Trend analysis was performed by using the average precipitation and temperature values observed in Bartin and Ulus meteorological stations between 1950 and 1994. It was determined that there were not any significant trend in the values measured in the results obtained at a significance degree of 5% and 10% through student-t test.

Monthly average temperature and precipitation values in case the carbon dioxide concentration obtained from the models and available in atmosphere was 1xCO_2 were compared with the values observed on the basis of basin (Figure 2) and most suitable model was determined. As shown in Table 1, best result for rainfall was obtained from UKMO and for temperature from GISS models through the least squares method among four models compared on monthly basis. The fact that similar results were obtained from a study performed for Gediz basin show that such model provide suitable results on the basis of basins and countries (Seker, 1998).

It was concluded from the results obtained for Bartin and Ulus stations in Bartin Basin that temperature increased in each month and highest increase was in February, April and November as 5^0C. The change in precipitation was both towards an increase and decrease. It was deduced that there may be increase in precipitation in winter and spring months except for March, however considerable decrease in summer months (Table 2).

Using such information obtained in terms of basin, the results of model in case of precipitation being 2xCO_2 throughout Turkey were compared with average results of many

years. Figure 3 shows monthly precipitation averages of many years obtained from meteorological bulletins for the purpose of comparing the results of climate models performed in global scale on the basis of country and basin (TAGEM, 2000). Furthermore, monthly average precipitation distributions in Turkey as obtained from UKMO model in case of $2xCO_2$ are provided in Figure 4.

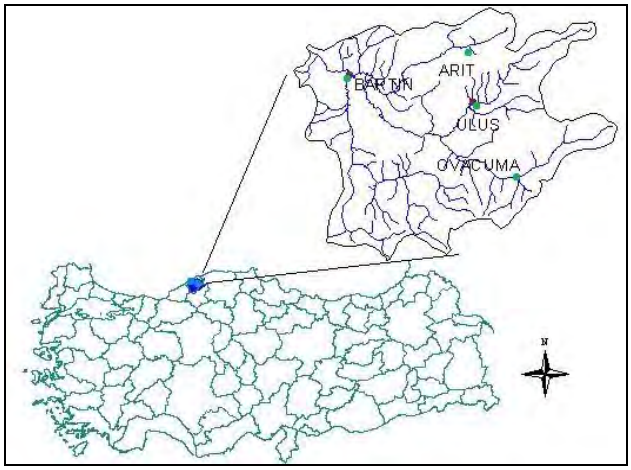

Figure 1. Location of Bartin Basin in Turkey and hydrometeorological stations

Table 1. Comparison of GCM models and values obtained in Bartin meteorological station through the least squares method.

Rainfall (mm/month)					Temperature (^oC)			
Months	GFDL	GISS	UKMO	11Layer	GFDL	GISS	UKMO	11Layer
January	2109,31	1834,18	586,96	1103,39	15,21	1,21	13,7	190,4
February	228,28	144,22	79,37	110,02	8,14	0,31	5,51	208,7
March	318,14	48,49	29,55	753,3	7,72	0,01	0,85	119,3
April	28,72	826,04	214,89	627,95	9,16	0,86	0,22	24,6
May	367,24	45,75	747,27	1319,61	2,58	13	2,23	0,09
June	2101,39	742,07	137,84	1557,02	0,67	0,01	2,94	28,56
July	3695,53	419,88	1081,81	3502,16	11,45	0,17	2,20	67,5
August	5394,23	1801,62	2366,38	779,78	24,89	0,04	4,8	71,44
September	3766,61	1829,51	75,21	883,71	2,49	0,67	22,8	18,9
October	5648,89	6124,49	374,77	1371,15	0,88	6,44	32,1	0,17
November	2864,2	1955,25	5,21	3590,19	0,81	4,41	46,2	43,4
December	8460,65	4106,48	722,63	9158,84	4,98	18,76	27,8	114,8
Total	34983,21	19877,95	6421,92	24757,13	88,98	45,88	161,35	888,05

Table 2. Scenarios developed for Bartin meteorology station

UKMO							GISS					
	Temperature (^0C)			Rainfall (mm/month)			Temperature (^0C)			Rainfall (mm/month)		
Month	$1XCO_2$	$2XCO_2$	Diff.	$1XCO_2$	$2XCO_2$	Diff. (%)	$1XCO_2$	$2XCO_2$	Diff.	$1XCO_2$	$2XCO_2$	Diff. (%)
1	7.8	13.1	5.24	83.7	105.4	25.9	3.0	7.7	4.7	65.1	71.3	9.5
2	6.3	11.6	5.28	64.4	67.2	4.3	3.4	8.5	5.11	61.6	58.8	-4.5
3	7.4	13	5.64	68.2	62	-9.1	6.4	10.7	4.34	55.8	83.7	50
4	11.5	17.6	6.05	75	90	20	10.1	15.3	5.17	33	27	-18.2
5	16.9	23	6.08	83.7	120.9	44.4	11.8	16.6	4.76	49.6	58.9	18.8
6	21.2	26.8	5.62	48	84	75	19.6	22.8	3.15	33	39	18.2

7	23.1	28.7	5.33	27.9	24.8	-11.1	24.2	27.3	3.19	40.3	37.2	-7.7
8	23.5	29.3	5.79	27.9	12.4	-55.6	21.5	25.5	4.03	34.1	21.7	-36.4
9	22.1	28.3	6.21	54	60	11.1	16.5	21.2	4.75	21	9	-57.1
10	19.1	25.1	5.97	83.7	108.5	29.6	10.9	14.6	3.69	24.8	43.4	75
11	15.2	21	5.71	111	144	29.7	6.3	11.9	5.52	66	54	-18.2
12	11.1	16.5	5.41	114.7	127.1	10.8	4.5	8.9	4.32	77.5	86.8	12

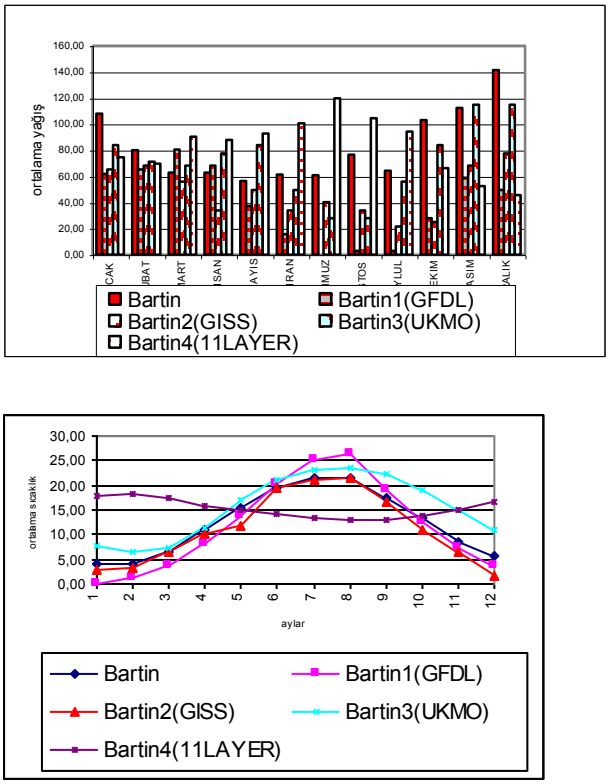

Figure 2. Comparison of average rainfall and temperature values for Bartin meteorological station through model outputs

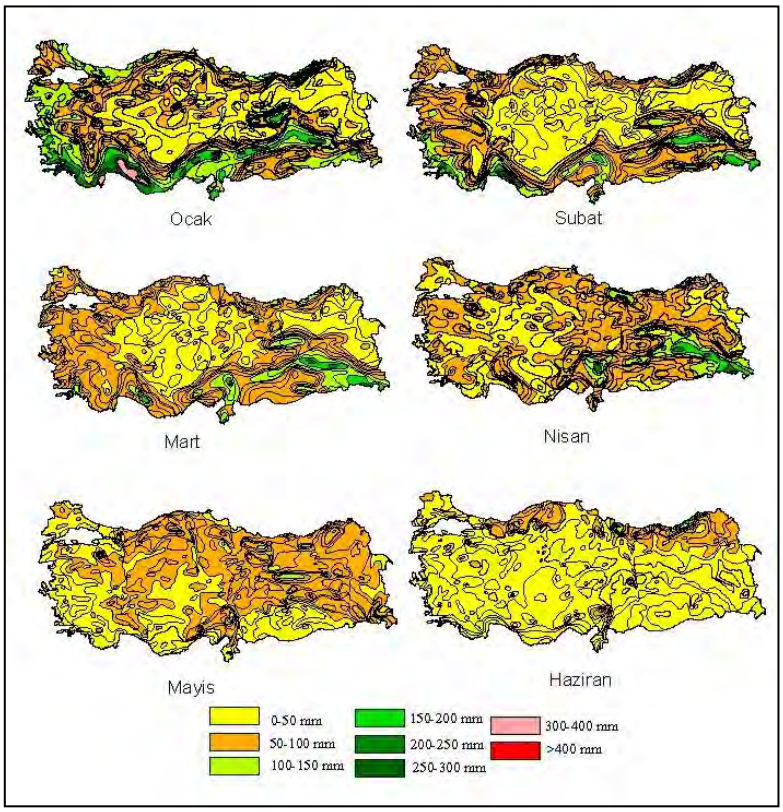

Figure 3. Distribution of average rainfalls of many years between January and June

In consideration of entire Turkey, it is determined that average rainfall obtained from this model in case of $2xCO_2$ decreased for January especially in West Black Sea and Mediterranean regions; and that it would increase for May and June in regions other than the Aegean, Marmara, West Mediterranean and West Black Sea regions. Calibration of such models with more data on the basis of country would ensure to have better results.

3. Water Budget Analysis

A suitable water budget model known as Thornthwaite (Mather, 1978) model was employed for studying the effect of various climate change scenarios obtained from General Circulation Models on the hydrology of basin. The program can determine potential vaporization and other hydrologic components rapidly. Moreover, it is possible to perform sensitivity analyses by changing land use, field moister capacity, height and latitude of runoff gauge station.

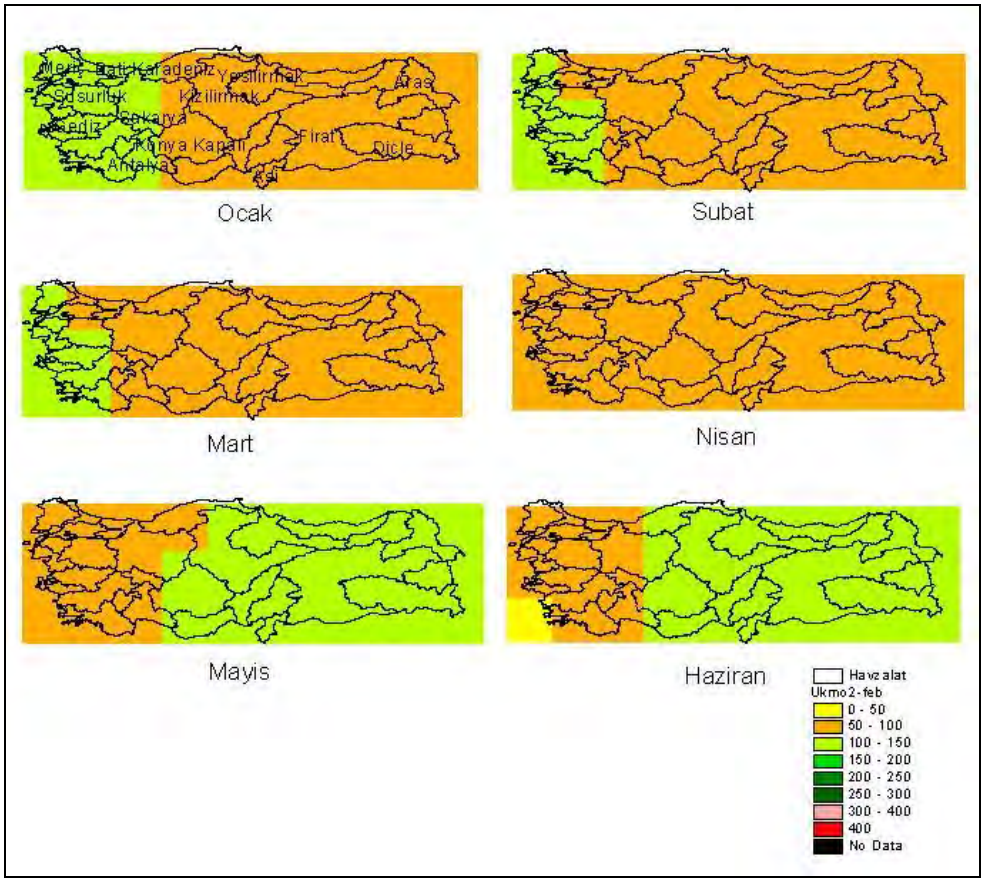

Figure 4. Distribution of rainfall obtained from UKMO model in case of 2 x CO_2

$$R_{t1} = rain_{t1} + snowmelt_{t1} - AEt_{t1} + (\Delta SM_{t1-t0})$$
(1)

(Thornthwaite water budget model, Mather, 1978)

Aet = actual vaporization value

Thornthwaite Water Budget Model was calibrated for years 1980-86 and the model was validated for the years 1987-91. Basin's figurative height was found as 510m from the hypsometric curves of the basin. Average temperature values measured in Bartin meteorological station were brought on the basin's figurative height through lapse rate method; and the average temperature values were moved to the basin's figurative height both in running the model with the measured value and running with the scenarios obtained from climate models. 4 meteorological stations were used for average rainfalls and Thiessen polygons were obtained; and basin's average rainfall value was found by using Thiessen polygon areas in stations with data. For the years without observed values, basin's average rainfall values were obtained through the arithmetic average method. Geographical Information System was employed in the determination of basin's figurative height and obtaining Thiessen polygons and contour lien of the basin was used as the base (Figure 5).

The models compared and the values observed in Bartin runoff gauge station are provided in Figure 6. It is observed with the figure that monthly average runoff values were modeled consistently with the data observed. The results obtained in the modeling for 1990 were below the observed values. With regards to basin height distribution, there is a considerably wide area over 1000m. This shows that snowfall, consequently snow water equivalent should be considered as an important parameter in water budget model studies. However, the meteorological stations used in the study are of low altitudes, resulting in less observed snow water equivalent than the snow water equivalent to be obtained from the basin. This also affects the model results. In addition, the effects that the scenario obtained from climate models would create on monthly average runoff were compared on the basis of seasons; and it was concluded that the runoffs would be affected considerably in case of increase in

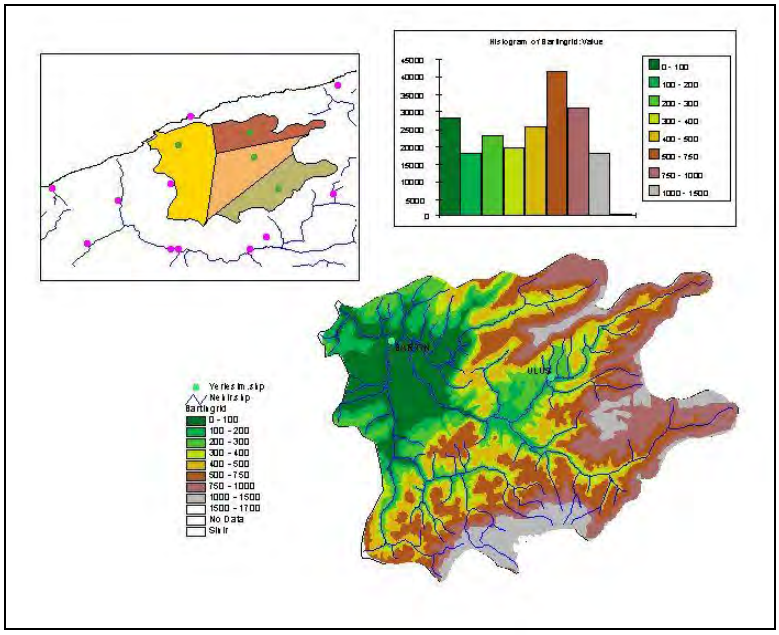

Figure 5. Determination of basin characteristics through GIS

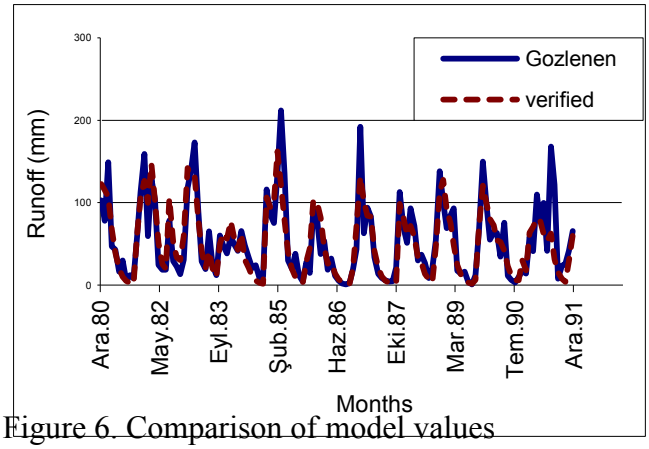

Figure 6. Comparison of model values

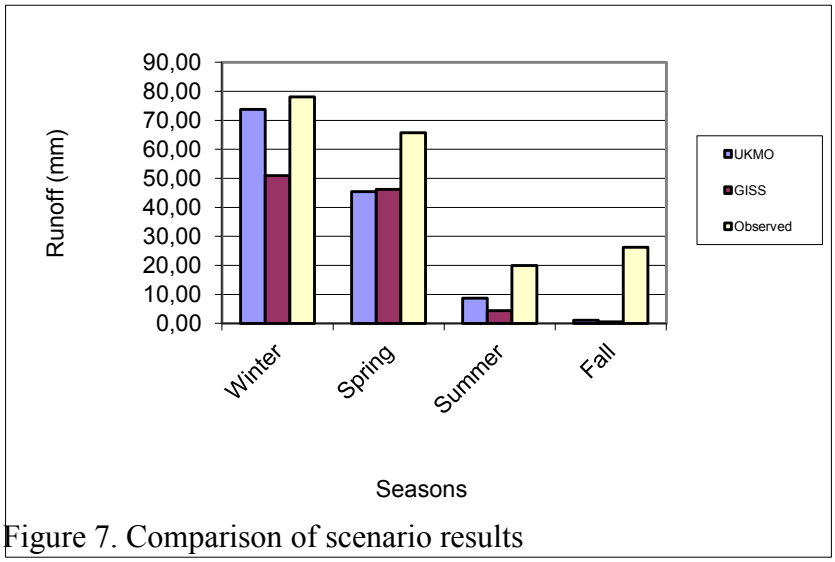

Figure 7. Comparison of scenario results

4. Conclusions

The effects of the scenario obtained from General Circulation Models were examined on the basis of basin. Since cell sizes of General Circulation Models are large, the results obtained from studies performed on the basis of country and even basin would not be an estimate for the future but would be useful in showing the effects of various scenarios on the basis of basin. At least 100 year data would be required for determining climate change. However, studies are important for determining the effects of deviations arising from observed value averages such as flood and drought on the hydrological parameters. It is observed that the possible effects on hydrological parameters are depending on the scenarios. Therefore, such models currently being developed should be improved on the basis of country and models suitable for our country should be developed through calibration with more data.

The scenarios containing possible changes in rainfall and temperature were obtained from two different models. It is concluded that the runoff values obtained from UKMO model scenario results among those results obtained from water budget model were more than the runoff values obtained from GISS model scenario. This shows that rainfall is a more sensitive parameter compared to temperature in Thornthwaite water budget model.

In periods and on basins where snow water equivalent is influential, measuring the snow depth and intensity observed on the basin and performing such measurements in higher altitudes is important for obtaining more accurate results from the water budget model.

It is fundamental to run climate models together with hydrological models in order that the effects of such climate models on hydrological parameters and consequently water resources are determined. Determining possible changes in hydrological parameters such as rainfall, temperature, snowfall on the runoff and vaporization is quite important in the planning of water resources. Furthermore, effective planning of our water sources being reduced and polluted day by day is highly important to be ready against the forces of nature such as flood and drought in the management of basins, in the determination and cultivation of suitable products, and in the selection and construction of suitable water structures.

5. Acknowledgement

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POSSIBLE EFFECTS OF CLIMATE CHANGE ON WATER MANAGEMENT IN ISTANBUL

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Abstract

The effects of global climate change became increasingly sensible. Particularly, precipitation and temperature variations are valid for Turkey in general, as well as Istanbul. Precipitation and temperature changes of Istanbul will cause growth of current water management problems and lead to new problems. In this study, meaning of global climate changes for Istanbul and its effects on water management are evaluated from a geographic perspective.

The effects of global climate changes on water management in Istanbul will be on "water shortage" and "flood and flash flood" first. Both issues will directly and indirectly cause significant problems and losses in Istanbul and their effectiveness will progress under the control of global climate change. In vulnerability and mitigation studies for shortage of water, flood and flash flood problems in Istanbul, "Physical Planning" based on watersheds and integrated perspective must be included; especially for new and large projects, assessments such as "Land Potential" and "Benefit-Cost Analysis" should not be neglected. Urban regeneration projects including such approaches may be an opportunity to reduce possible negative impacts of climate changes on water management in Istanbul.

Key Words: Istanbul, Climate Change, Water Management, Effects, Vulnerability and Mitigation.

Introduction

The results of scientific researches (Christensen et al., 2007; Smith et al., 2008; TWB 2012; EPA, 2013; NOAA 2013) reveal developments and dimensions of global climate changes in more details every day. Increase in average temperatures and changes in precipitation and such changes becoming more evident gradually draw attention as major elements of global climate change. Changes of climatic elements, such as temperature and precipitation, on a global scale are effective on Mediterranean and also Turkey (Fig. 1, 2) and, it is accepted that the effects of climate change in Turkey will be sensible more significantly in the near future (Önol and Semazzi, 2009; Önol et al., 2009; MEU, 2011; Tatlı and Türkeş, 2011; Vardar et al., 2011). Major cities and interaction areas are the sensitive areas of this issue. In this study, it is intended to address possible problems that may be caused in Istanbul and its surroundings by global climate change with a cause and effect and precautions approach. In this context, considering the water supply, rain water and alternative water resources, water needs, land use, constructions, every kind of hardground and urban infrastructure, roads, rainfall, surface runoff characteristics and etc. for Istanbul, main focus is current geographical features and

impacts of climate change on these subjects. The current climate, land use, geological, geomorphological and hydrographic and population data are used. Data analysis was carried out with the Geographic Information Systems and Remote Sensing technologies.

Common result of the researches is in the direction of Mediterranean region, where Turkey is also included, being under the influence of warmer, drier and less windy climate conditions than today during the period of 2000–2100. It is foreseen that the temperatures will be 3–4ºC higher in the seas and coastlines, and in the inner parts 4–5ºC higher than today in Summer, and in winter and fall 2–3 ºC, 3–4ºC respectively, higher than today (Türkeş et al., 2000; Christensen et al., 2007; Dalfes et al., 2007; Lionello et al., 2012; TWB, 2012; Planton et al., 2012; EPA, 2013).

These regional projections also cover Turkey. The effects of these climate changes in global perspective on Turkey will cause dominancy of sub-tropical weather conditions in wider areas than today. Areal expansion of arid and semiarid regions and extension of drought periods in Anatolia in summer are also the expected climatic developments (Türkeş, 1998; Türkeş et al., 2000; Dalfes et al., 2007; Önol and Semazzi, 2009; Önol et al., 2009; Türkeş and Tatlı, 2009; Türkeş et al., 2009; MEU, 2011; Öztürk et al., 2011; Tatlı and Türkeş, 2011; Erlat and Türkeş, 2012; Kadıoğlu, 2012; Önol and Ünal, 2012; Erlat and Türkeş, 2013). The intensity of warm and arid climate characteristics that will influence Anatolia will vary depending on geomorphological features such as altitude, the coastal and inner regions, degrees of aspect and roughness. The ratio of the rise in temperatures and decrease of precipitation that will affect Turkey will vary seasonally under the control of continental degree and geomorphological characteristics.

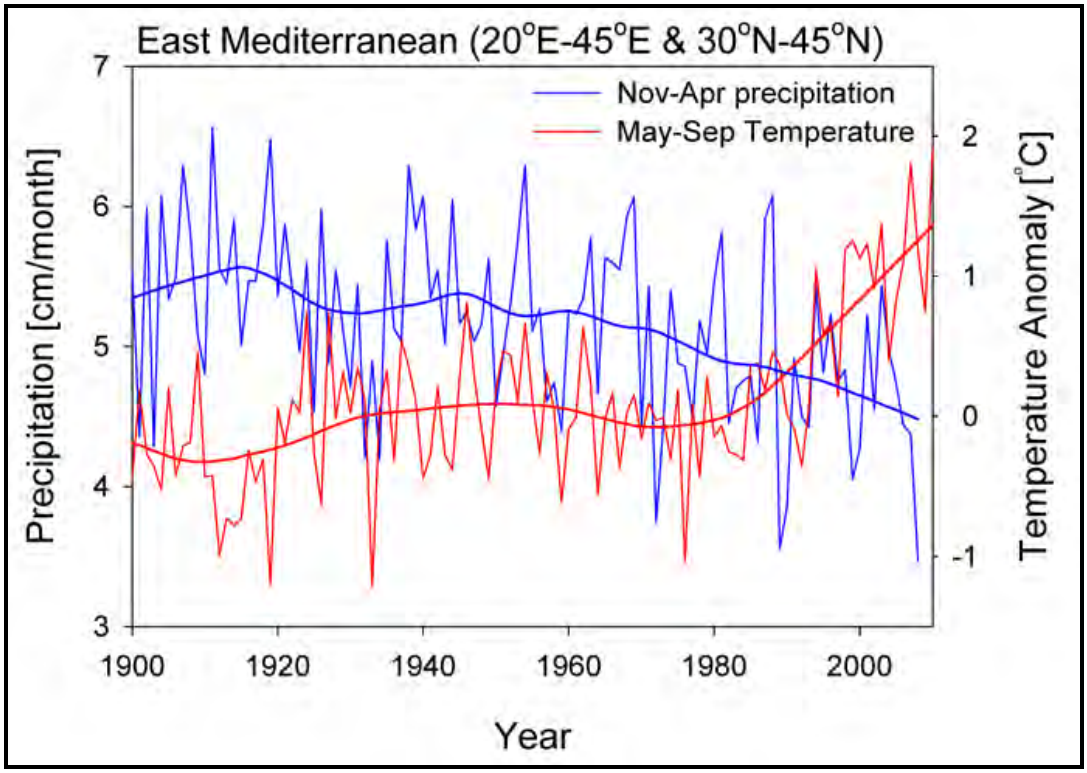

Fig. 1: Observed wintertime precipitation (blue), which contributes most to the annual budget, and summertime temperature (red), which is most important with respect to evaporative drying, with their long-term trend for the eastern Mediterranean region (TWB, 2012).

Fig. 2: Location features of study area.

According to the research results, it is expected that rainfall will significantly decrease during summer; this decrease may vary regionally and it will be between around 10% and 40%, and there will be annually average 25-30% decrease of precipitation than today (Christensen et al., 2007; Dalfes et al., 2007; Lionello et al., 2012; Planton et al., 2012). Another differentiation of precipitation is that, there will be more rainfall, and snowfall will decrease gradually and it will rain mostly during winter and spring. Rise in summer temperatures, longer summer periods and increase in numbers of arid and hot days during the year are the expected developments (Tatlı and Türkeş, 2011; Erlat and Türkeş, 2012; Kadıoğlu, 2012; Önol and Ünal, 2012; Erlat and Türkeş, 2013). Despite the regional differences, warm and arid weather conditions that are foreseen to influence Turkey and summarized above: will bring along agricultural and ecosystem problems, water loss due to severe evaporation, decrease in the amounts of precipitation and consequently decrease in water resources (water scarcity), floods and flash floods caused by sudden and heavy torrential rain, severe erosion, expected desertification depending on the continental severity, forest fires, and etc.

Possible effects of climate change on Istanbul

Historical peninsula and the south of Thracian and Anatolian coasts of the Bosporus being the center, Istanbul has an urban settlement dissemination spreading along the shores of Sea of Marmara in the east, up to Tekirdağ city borders in the west. Urban development and corresponding constructions are on the main axis towards east-west direction, along the southern coast of the historical peninsula (Fig. 2, 3).

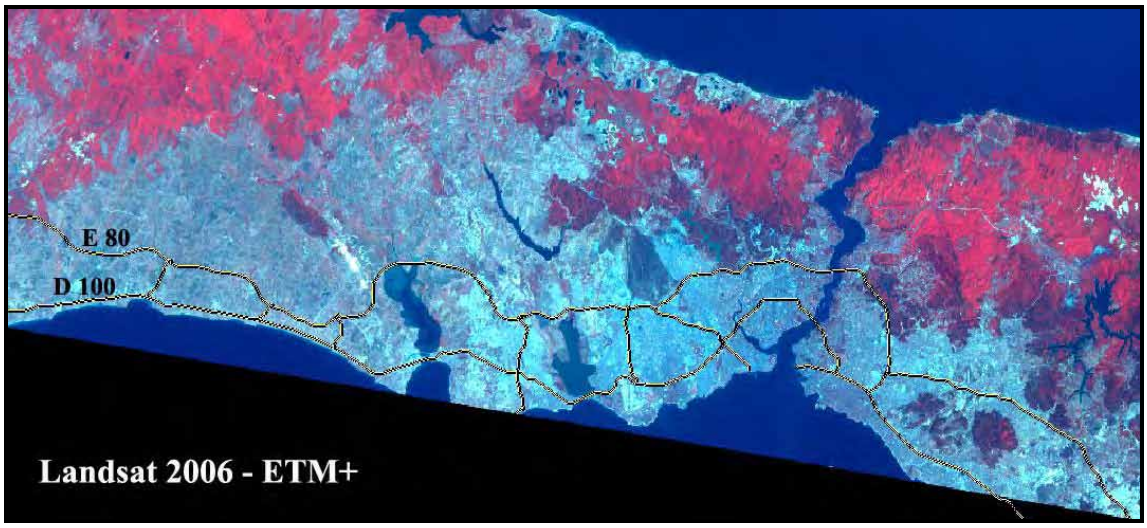

Fig. 3: Satellite image of Istanbul region and motorways. In band 4,2,1 combinations, red color on image represents vegetation.

Because of its latitude (Fig. 2) and effectiveness of atmospheric circulation, Istanbul and its surrounding will feel the effects of climate change more significantly. It is possible to refer to the rise of average temperatures, decrease of annual precipitation, precipitation as rain and sudden and downpour in certain periods of the year, stronger summer heats and their effectiveness in longer periods as projected climatic differentiations in Istanbul and its surroundings.

It is possible to classify the potential adverse effects of climate change on Istanbul and its close vicinity as physical, economic and social dimensions. These effects are in connection with each other and they must be considered as a whole. The main triggering factor is the differentiation, which has been described and summarized earlier, of climate elements like precipitation and wind. The major impact of climate change on Istanbul is related to water. In the next 50 and 100-year periods, Istanbul will gradually feel increasingly severe potable water shortage due to climate change and at the same time will be affected by the floods and flash floods in the magnitude of a disaster and will suffer. These effects will directly or indirectly cause loss of economic, social and unrecoverable natural resources and lead to ecosystem problems.

Water scarcity

As per today"s population characteristics, Istanbul is considered to be in need of daily average 2 million m^3 water (ISKI, 2013). According to the data of Statistical Institute of Turkey (TUIK, 2013), it has been understood that population of Istanbul will continue to grow in the next 50-year period (Avcı 2011). This situation points out that water needs of Istanbul will increase more and more in the future.

Very important water resources for Istanbul are the dams (Fig. 4) and rivers. Both of them will be affected significantly and in a short term by the changes that may occur in the fundamental elements of climate, such as precipitation and temperature. Water reservoirs of Istanbul are the dams; they are fed by the precipitation falling on the dam watershed as rain and snow. Moreover, permanent water flow from the streams out of the dam basin contributes

feeding the dam. Natural water loss of Istanbul dams occurs by the evaporation due to summer temperatures. The change in precipitation because of the decrease in precipitation and climate change in the direction of increase in temperatures will decrease supply of dams and also lead to water losses by evaporation. Therefore, the losses of water collected in the dams due to reasons other than natural causes of human use will increase. Moreover, rising temperatures and short precipitation will contribute to lower underground water levels and increase in water loss. Rising air and water temperatures will lead to an increase of degraded organic materials in water, a change in food chain and a decrease in the amount of dissolved oxygen in water. These changes will cause gradual decrease in the amounts of water collected in the dams, deterioration in the quality of water and insufficiency to meet the water needs of Istanbul.

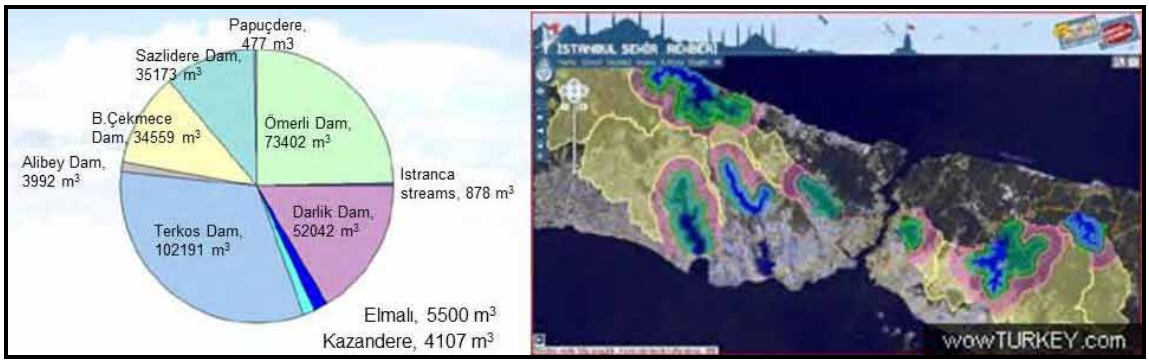

Fig. 4: As of June 28, 2007, the amount of usable fresh water (million cubic meters) according to sources and water basins in Istanbul (ISKI, 2013).

The streams in Istanbul and its close vicinity are the water resources that directly or indirectly contribute to the water needs of Istanbul. Basically, they are fed by rain and melting snow. The expected developments related to climate changes will also influence these rivers and cause changes on their flow and regime characteristics and water quality. These changes will cause decrease in the average flows of these streams contributing to the water needs of Istanbul during the year, gaining a flashflood flow regime characteristic by sudden torrential rainfall and significant damage in water quality because of the organic and inorganic suspended load. This corruption will have a gradually growing trend. Decrease in the amounts of the flow will cause increase in water needs of Istanbul, corruption of stream regimes will lead to disruptions of water supply during the year and damages to the water quality will diminish the usefulness of the coming water.

Floods and flash floods

Population projections and urban regeneration projects indicate that urban area and constructions will continue to grow. Current urban constructional activities are in nature of preventing the surface runoff of Istanbul (Turoğlu, 2010a; Turoğlu, 2010b; Turoğlu, 2011a). In the implementation of structuring and transportation projects, natural flow accumulation and natural flow directions have been ignored. Urban development of Istanbul encouraged main arterial motorways in the east-west direction and connecting roads in the north-south direction. The natural flow directions of Istanbul and its close vicinity from the water section line towards east-west direction are towards the Black Sea in the north (to the north) and Sea of Marmara towards the south (to the south). In this case, main motorways like D100 and E80

intersect these drainage systems in a way preventing the natural flow (Turoğlu, 2010a; Turoğlu, 2010b; Turoğlu, 2011a, Turoğlu 2011b). And also, the North Marmara Motorway (NMM) which is ongoing construction has been designed with the same approach (Fig. 5). Connections of main arterial motorways are always in north-south direction and passing through the valley bottoms (Fig. 6) that have natural flow channels in the same direction. In the implementation of road projects, passages of creek beds were done either by filling or insufficient box or pipe culverts (Turoğlu, 2010a; Turoğlu, 2011a; Turoğlu, 2011b). Defective creek improvement projects are other implementations that block surface runoff. Istanbul creeks that have been taken into concrete channels with inadequate cross-sections cannot be successful on carrying water from extraordinary precipitation. The low bridges that reduce cross-sectional areas are defective projects that block surface runoff of underpasses, which are not in line with natural flow systems of surface drainage, in Istanbul.

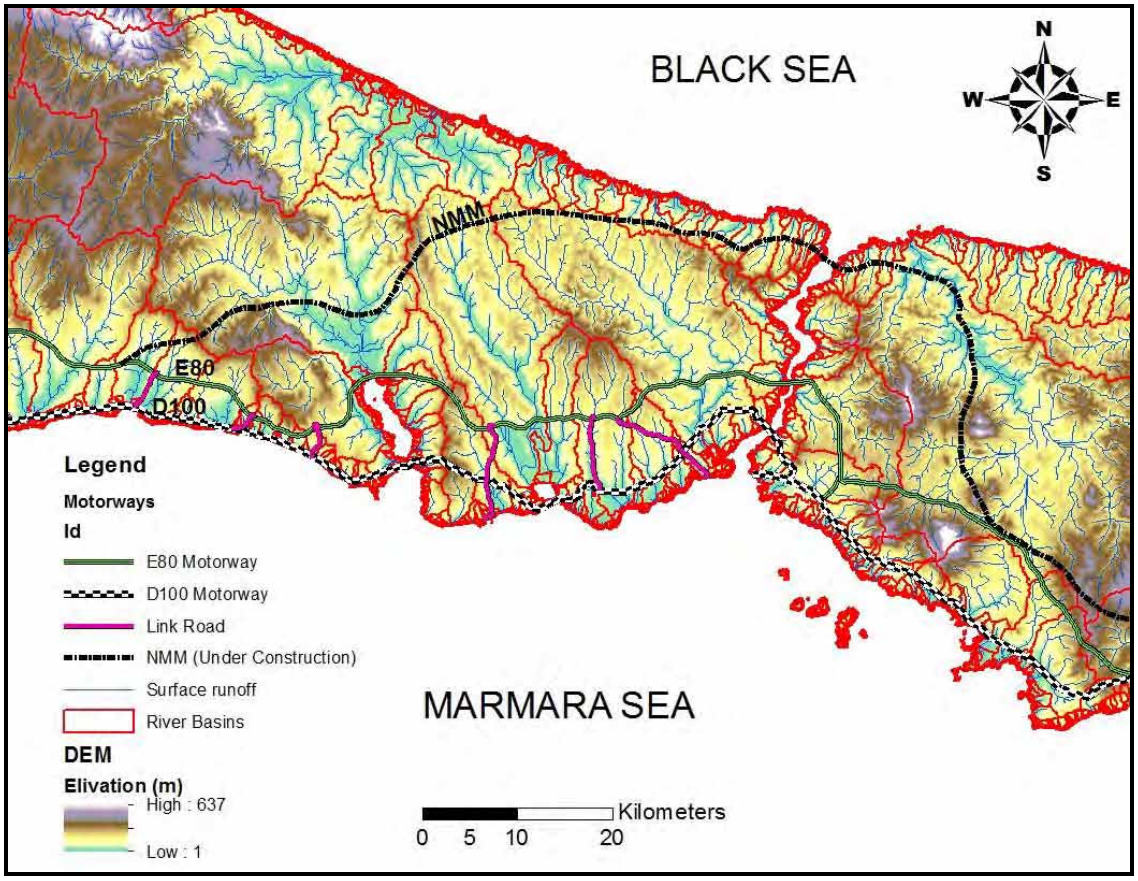

Fig. 5: The natural flow accumulation and flow direction together with Digital Elevation Model (DEM) of Istanbul region. Surface flows in river basins have been prevented by E80 and D100 highways.

Today, Istanbul often suffers from floods and flash floods due to construction problems outlined above. Some of these floods and flash floods occur in the magnitude of a disaster that causes loss of life and property (Turoğlu, 2010a). Floods and flash floods that occur in Istanbul due to climate change will continue while their frequency and severity increase more and more, because sudden and severe torrential downpours will be one of major effects of climate change on precipitation patterns. This significant change of precipitation pattern will cause the floods and flash floods to become a much bigger problem for Istanbul because of

the urban structure outlined above. Insufficient open and closed rainwater drainage systems and malfunction of the existing ones will play a role that increases this effect.

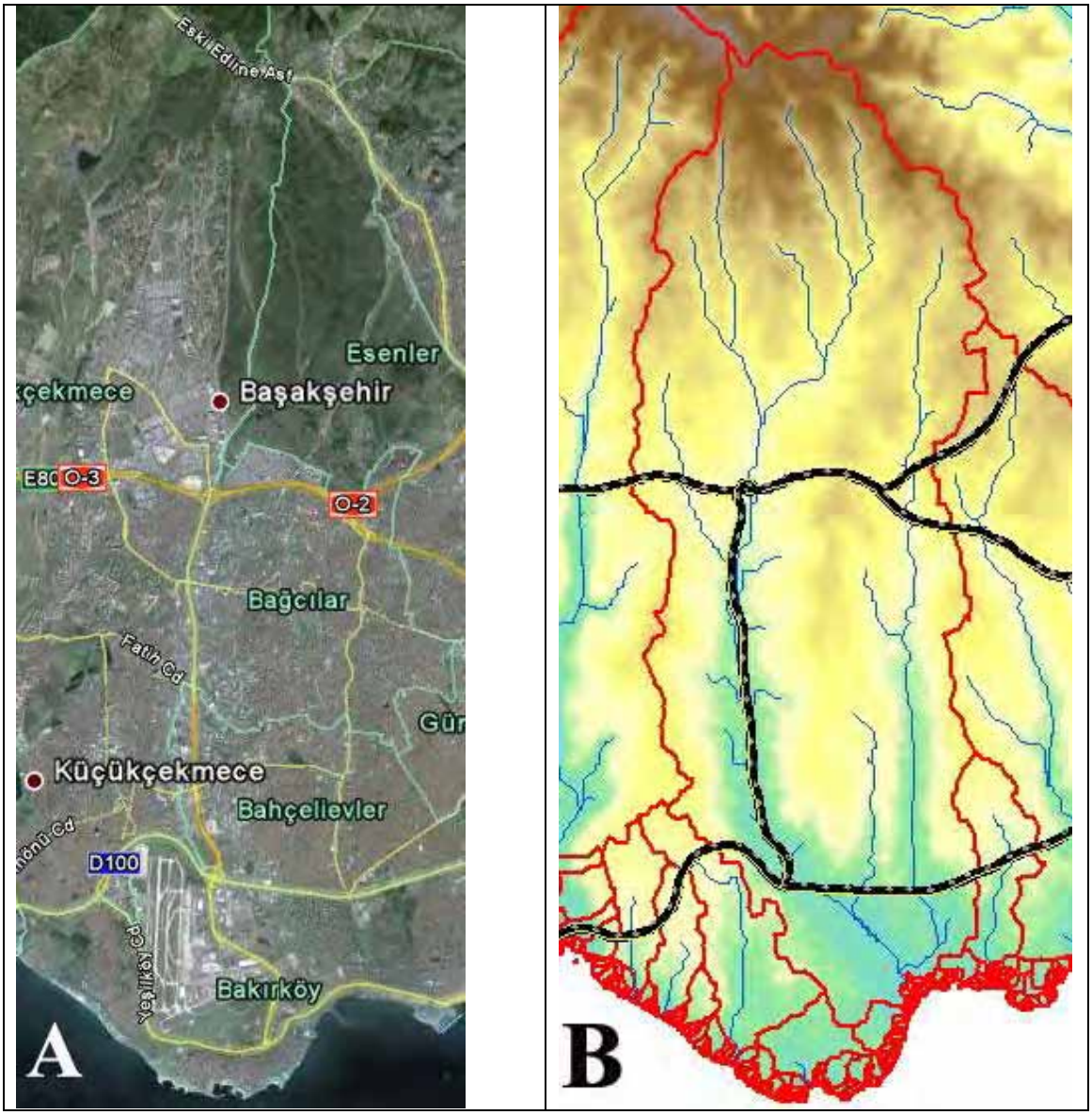

Fig. 6: Mostly, the natural flow accumulation and flow direction overlap one another with motorways in Istanbul Upper. The above example belongs to the Ayamama creek basin in west part of Istanbul.

Climate change, vulnerability, mitigation

For Turkey, climate change adaptation reports have been prepared by various institutions and organizations (UNDP, 2007; Özdemir et al., 2009; RTNCCAP, 2011; Talu et al., 2011). However, vast majority of these reports are studies that cover general principals. Yet, geographical location of Turkey, shape and distribution characteristics of its lands and seas and its landforms and land use characteristics will cause occurrence of the impacts of climate change in specific types and severity in different places of Turkey. Therefore, the problems and results that may occur will vary. Istanbul must be evaluated in this perspective. Geographical characteristics of Istanbul may cause experiencing the effects of climate change in different dimensions than expected. Geomorphological or hydrographic or landuse-

landcover characteristics are striking with their unique characters. In this context, urban development and construction projects of Istanbul already have water management problems even under the current climate conditions. Preventing these problems from reaching larger scales is possible by conducting new projects planned for Istanbul while considering the foregoing approaches and climate change fact. On this subject, "Urban Transformation" project-related implementations can be an opportunity. The sensitivity on taking into account the principles of hardground planning, protection of green areas, natural flow and flow accumulation has a special importance. Watershed-based and integrated "Physical Planning" should not be ignored in the analysis and evaluation of vulnerability and mitigation due to the effects of climate change. Particularly for new and large-scaled projects, Land Potential and Benefit-Cost Analysis must be cared.

Conclusion and Suggestions:

In the near future, climatic and hydrographic differentiation, such as less average annual precipitation, sudden torrential rain in precipitation pattern, flashflood characterized runoff, higher average temperatures and evaporation than today must be expected in Istanbul and its close vicinity.

The vital effect of changing climatic conditions for Istanbul will emerge with the shortage of drinkable and usable water. Drought will cause supply insufficiency of dams that are the water reservoirs and high temperatures will lead to water loss due to evaporation. Despite water shortage due to natural causes, the fact that water needs of Istanbul will increase in the future will push water problem of Istanbul to larger magnitudes.

Changes in precipitation regime will encourage floods and flash floods. Sudden and severe torrential downpours will cause floods and flash floods in the nature of a frequent disaster because of the mistakes on types and choices of common land use and defective infrastructure projects in Istanbul. Frequency and severity of the floods and flash floods will be increasing depending on the effectiveness of the change.

Water management for Istanbul must be handled with an integrated approach, in which climate change, geomorphological characteristics of the region, and geographical features such as stream watersheds, natural flow accumulation and flow directions, any kind of constructions and land use are considered all together.

Urban transformation studies for Istanbul can be accepted as an important opportunity for minimizing the effects of climate change on Istanbul and prevention of damages. In this context, implementation projects for urban transformation must be conducted with "Physical Planning" approaches. Watershed-based studies must be considered; Land Potential and Benefit-Cost analysis must be made for new projects; in addition, Population Projections for 20, 30 and 50 years and socio-economic possibilities and variables must be taken into account.

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IMPORTANCE OF GROUNDWATER PROTECTION CONSIDERING CLIMATE CHANGE

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Abstract

One of the primary target to make both planning and land use decisions is to recover a sustainable water need for living being. The demand for water increases as population, economic activity and agricultural irrigation grow. However the quantity and quality of surface water and groundwater change as a consequence of human activity and climate variability. Groundwater is affected by dry periods and pollution later than surface water system. So groundwater is often reserved for use as the supply of back-up.

Current scientific studies suggest that the demand for groundwater may increase due to the evaporation amount in reservoirs. When considered from this point of view, groundwater management and identification of protection zones are crucial in order to protect the quality of groundwater and to assure a sustainable use.

This presentation considers the impacts of climate change in Istanbul and at the Lakes District and discusses the importance of groundwater protection.

Key words:. Climate change, Groundwater, Istanbul, Lakes District

1. Introduction

One of the primary target to make both planning and land use decisions is to provide a sustainable water need for living being. In our country, authorities have pointed out that neither current laws nor regulations are inadequate to protect water sources. Especially during the last years, for drinking water basins, special provisions have been determined in order to protect water sources. Within this scope first applications have been started for both Egirdir Lake and Atatürk Dam Lake Basins. Similar practices should be performed notably for Istanbul and also country-wide.

Extending over 5400 square kilometers and hosting approximately 14 million people declared according to the 2012 population census Istanbul is one of the most populated cities in the world. It also carries heavy industrial, Commercial, financial and touristic activities.

Depending on the increasing population resulting from distorted urbanization the demand for water increases. Faced with an insufficiency in water supply since it has been founded Istanbul has experienced the same problem during the 2007-8 season once again. The water shortage seems to have been surpassed temporarily at the beginning of a wet period and an increase in precipitation and filling of the reservoirs. General Directorate of State Hydraulic Works (DSI) has almost completed two major projects in order to meet the water needs of Istanbul for the medium and long term. These are namely Yesilcay Project and Greater Melen Project.

The Yesilcay System and the Greater Melen System supply drinking water from long distances (60-180 km) to Istanbul at high cost. However, expectations for aridity that grows increasingly as a consequence of global climate change, population growth and pollution imply that in the future a crucial deficiency in water supply may be encountered. The daily demand for water in Istanbul has been recovered through seven catchment areas. Groundwater is illegally extracted for irrigation and industry.

Evaluating rainfall stations data reveal that climate change processes point out with an increase in precipitation around Istanbul. Seasons are more arid than that of 2007-8 which have been experienced before. But the increase in annual precipitation is related to heavy rains. The change in the precipitation type has been affected negatively by groundwater recharge.

In the same way, the recharge of dams is affected negatively by the change of precipitation type . According to Istanbul Water and Sewerage Administration (İSKİ) data during dry period, reduction amount of water flown into dams was 52.9 % while the reduction amount of precipitation was 44.7%.

The freshwater of Isparta town and the Egirdir District are supplied from the Egirdir Lake. The Egirdir Lake has been polluted rapidly due to various activities carried out in the Eğirdir Lake watershed, and diffuse pollutants discharge into the rivers that recharge the lake. As a result, the current operating status of the lake (drinking water supply, irrigation, fisheries production, recreational use etc.) is adversely affected. At this time, although benefits obtained from the lake are at maximum level, the studies were insufficient to protect and to

prevent contamination of the lake. The Egirdir Lake has been studied and special provisions were defined by a new project.

2. Climate and Meteorological Data

The Marmara climate prevails in the study area. The Marmara climate properties take place between the Black Sea and the Marmara Mediterranean climates . To make an assessment based on a particular type of climate is very difficult in this region. Summers are hot and dry, winters are warm and rainy. Precipitation is generally in the form of rain and rarely snow.
The study area is under the influence of strong winds coming from the Balkans . Wind storm rates in winter can reach to 50-60 km/hour. Evaporation occurs during the summer months because of a temperature rise coupled with the severe impact of wind.
The climate properties of Eğirdir basin appear between the Mediterranean climate and the interior of the Anatolian climate. Summers are hot and dry, and winters are cold and rainy.

For significant meteorological stations elevation and precipitation values in Istanbul are given in the following table and figure.

Table 1. Istanbul meteorological stations and average precipitation

Meteorological Stations	Altitude (m.)	Years	Average precipitation (mm/year)
Florya	36	1937-2012	642
Sarıyer	56	1949-2008	719,4
Göztepe	39	1929-2008	683.3
Şile	28	1986-2012	864.7
Çatalca	170	1964-2008	697
Karacaköy	50	1958-2000	914.5
Bahçeköy	129	1948-2008	1117

Figure 1. Precipitation distribution (Karaca vd. 2009)

As seen in the previous figure the amount of rainfall increases depending on the elevation and the climate of the north Black Sea. The maximum annual rainfall in the north is 1268 mm and it decreases to 521 mm in the south.

Cumulative Departures (Fig. 2. 3. 4) show that in the past there were more arid periods.

Table 2. Changes of average precipitation at different stations

STATIONS and Elevation Values	Annual Average (mm)			January, February Average			June, July Average		
	1937-75	1975-95	1995-12	37-75	75-95	95-12	37-75	75-95	95-12
Bahçeköy 129 m.		1067,3	1224,39		122,8	155,6		21.5	22.7
1975-2006			**157**			32.8			1.2
Sarıyer 56 m. (Kireçburnu)	755.8	523.8	886	92	45	93.3	26.6	26.1	35.1
1949/75-1975/1995		-232	362.2		-47	48.3		-0.5	9
1995-2012			**130,3**			1.3			8.5
Şile 28 m.		815.1	876.9		64	92		37.1	35.7
1986/1995-1995/2012			61.8			28			-1.4
Florya 34 m.	643.2	633.7	651.2	79.1	70,1	76,1	20.8	29.1	23.7
1937/75-1975/1995		-9.5	17.5		-9	6		8.3	-5.4
1975-2012			**8**			-3			2.9
Göztepe 39 m.	671	686.3	739.7	83	77	73	22	28.1	22.7
1929/75-1975/1995		15.3	-1.3		-6	-4		6.1	-5.4
1975-2006			**14**			-10			0.7

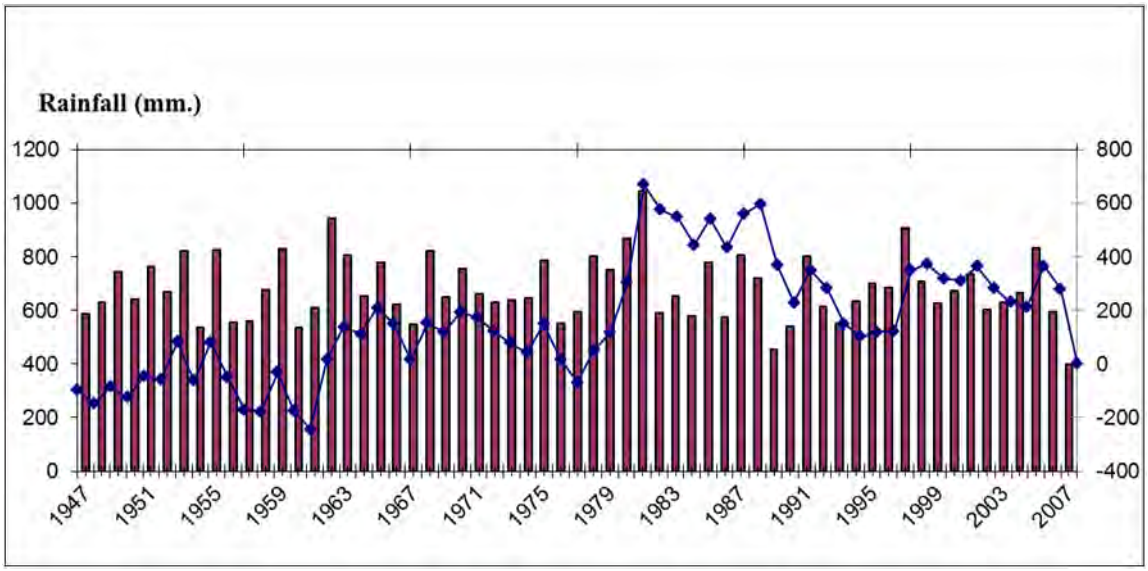

Figure 2. Cumulative departure from average precipitation (Göztepe station)

The driest period was between 1947-1952 according to data of the Göztepe station (Figure 2). The driest period was between 1947-1957 according to the data of the Florya station (Figure 3).

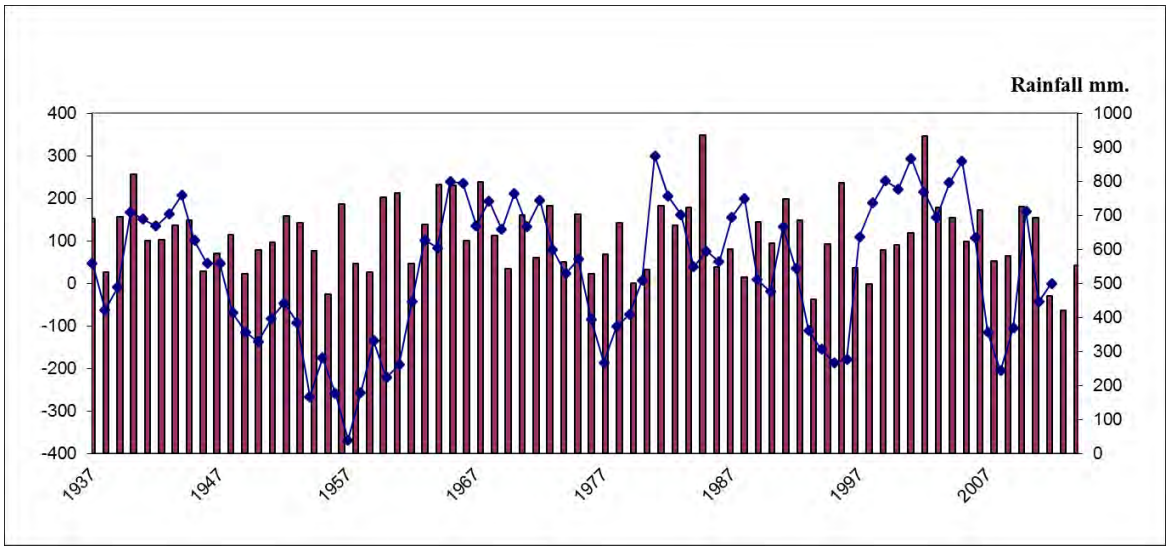

Figure 3. Cumulative departure from average precipitation (Florya station)

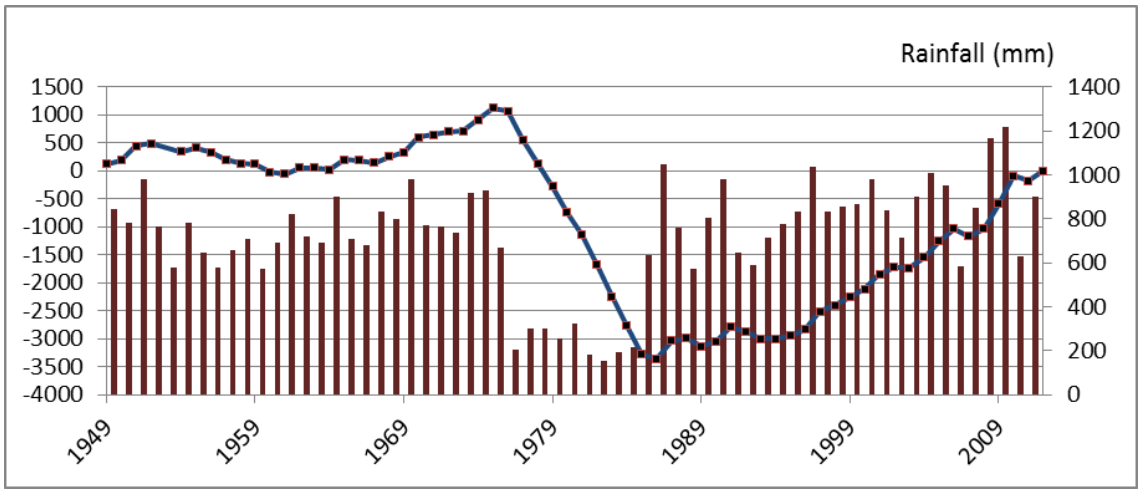

Figure 4. Cumulative departure from average precipitation (Sarıyer station)

According to data from the Sarıyer rainfall station the driest period was between 1976-1987. These results show that the current dry periods are not more than the dry periods encountered in the past. Climate change is reflected in Istanbul as an increase in temperature and in precipitation. Parallel to the increase in temperature there is an augmentation of rainfall in and around Istanbul. But the increase in the annual precipitation amount in the process of warming and drought is related to the increase in heavy rains. Heavy rain flows discharge rapidly through surface runoff. Therefore the rain water doesn't infiltrate into the soil to recharge the groundwater. Climate change modified the precipitation regime as increase for heavy rains and floods (Kantarcı. 2008).

Egirdir Lake: Average rainfall values for many years (1975-2009) of Isparta center, Senirkent, Yalvaç, Uluborlu and Egirdir located within the study area are given in Table 3.

Table 3. Average monthly precipitation values (mm) between 1975-2009

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Σ
Isparta	66.0	55.3	52.9	58.3	46.6	27.8	15.1	13.8	16.2	38.6	51.9	75.9	518.4
Senirkent	82.9	74.7	72.4	73.3	54.9	34.4	17.7	12.2	17.6	46.0	78.6	104.3	669.0
Yalvaç	59.9	53.4	52.9	63.3	43.8	30.7	16.1	9.0	18.1	45.5	57.8	70.1	520.6
Uluborlu	75.4	65.9	66.1	69.2	56.1	29.7	21.7	11.6	21.9	47.0	63.8	87.6	616
Eğirdir	142.3	108.4	89.0	87.8	49.0	22.1	11.2	9.7	20.1	53.9	91.3	143.9	828.7

The average annual precipitation in Senirkent has been calculated as 733.5 mm during the period between 1964-1970; as 676.2 mm. for the period between 1970-1982; as 590.5 mm, between 1983-1993; and 691.1 mm between 1994-2011. When the amounts of precipitation are compared it has been noticed that the winter precipitation decreased during the period between 1994-2011 (Avcı et al. 2013). The average annual precipitation in Egirdir has been calculated as 845.6 mm during the period of 1963-1993; and as 814.75 mm between 1993-2009. The dry period is occured between 1981-2008 years according to data obtained from Egirdir rainfall station (Figure 5).

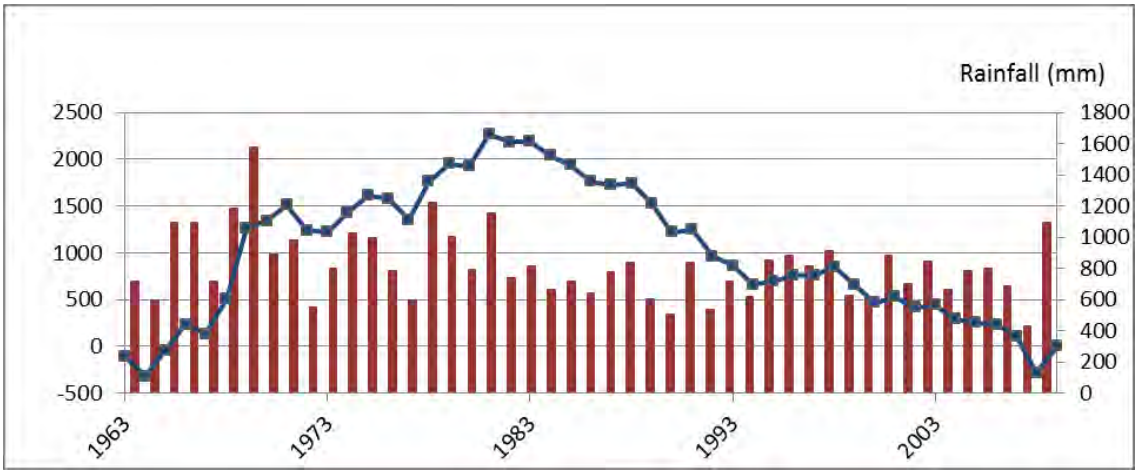

Figure 5. Cumulative departure from average precipitation (Egirdir station)

The level fluctuations of the lake in the period between 1966 and 1995 have been found occurring as long term repeats and annually. Annual level changes are in the range of 30 to 50 cm and the periodical changes reach up to 4 meters. These fluctuations basically depend upon arid and rainy periods (Karagüzel et al., 1995).

The average air temperatures measured by meteorologic stations in the region for some years (1970-2006) are given in Table 4. The annual average temperature throughout the region is around 12 °C.

Table 4. Monthly average temperatures (° C) between 1970-2006

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Avr.
Isparta	1.8	2.6	5.9	10.6	15.5	20.1	23.5	22.9	18.3	12.8	7.0	3.1	12.0
Senirkent	1.4	2.5	6.4	11.3	16.2	21.5	23.8	27.1	18.5	12.7	4.9	0.7	12.3
Yalvaç	0.6	1.6	5.3	10.1	14.9	19.1	22.7	22.5	18.5	12.1	6.6	2.5	11.4
Uluborlu	1.1	1.9	5.8	10.5	15.1	19.4	22.6	22.3	18.2	12.7	6.8	2.7	11.6
Eğirdir	2.1	2.8	6.4	11.0	15.9	20.7	23.9	23.3	19.2	13.7	7.6	3.8	12.5

The average annual temperature value has been calculated as 13 ^{o}C between 1994-2011 (Senirkent station and the average annual temperature values have increased by 0.6 ^{o}C during the period between 1994-2011 compared to the period between 1964-1970 (Avcı et al. 2013). In general, according to the country report presented by the Turkish government and the United Nations Development Program (UNDP), precipitation decreases along the Aegean and Mediterranean coasts and increases along the Black Sea coast of Turkey. Central Anatolia shows little or no change in precipitation. On the other hand, autumn precipitation showed an increased at the stations located mostly in the northern parts of Central Anatolia. Winter precipitation in the western provinces of Turkey has decreased significantly in the last five decades.

Trend analysis applied seasonally to average annual temperatures between 1951 and 2004 in Turkey indicates that the most prominent feature is the widespread increase in summer temperatures. A study has been conducted on what might happen to the water potential of the dams in Istanbul in 2030 and the size of the water scarcity problem based on climate change assumptions. With this study, it is calculated that water in the dams would decrease an average of 14% due to evaporation increase (Züran 2005, Züran et al. 2008). In this case, groundwater gains a special importance because it is not affected by evaporation.

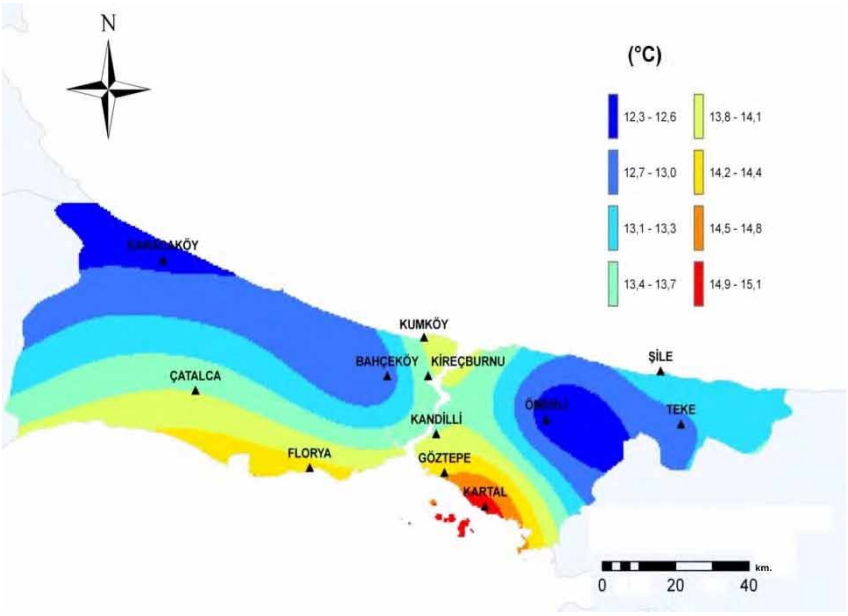

Figure 6. The average temperature distribution of İstanbul (Karaca et al. 2009)

The temperature averages in Istanbul as presented in Figure 6 vary between 12.3 -15.1 °C.

Table 5. Average temperature change (Kantarcı, 2008 renewed)

Stations and Elevation Values	Annual averageTemperature (°C)			January average			July average		
	1930-70	1975-92	93-2012	1930-70	1975-92	93-12	1930-70	1975-92	93-2012*
***Bahçeköy 129 m.**	12.8	12.6	13.1	4.5	4.7	4.7	21.6	21.5	22.7
1948/75-1975/1993		**-0.2**	0.5		0.2	±0		-0.1	1.2
1993-2006			0.3			0.2			1.1
Kumköy 30m.	13.9	13.6	14.2	5.8	5.7	5.9	22.6	22.5	23.7
1951/75-1975/1993		**-0.3**	0.6		-0.1	0.2		-0.1	1.2
1993-2006			0.3			0.1			1.1
Sarıyer 56 m. (Kireçburnu)	13.8	13.4	14.2	5.4	5.6	5.7	22.5	22.1	23.4
1949/75-1975/1993		**-0.4**	0.8		0.2	0.1		-0.4	1.3
1993-2012			0.4			0.3			0.9
Şile 31m.	13.6	13.0	13.8	5.4	5.3	5.2	22.3	21.7	23.5
1938/75-1975/1993		**-0.6**	0.8		± 0.0	-0.1		-0.6	1.8
1993-2012			0.2			-0.2			1.2
Florya 34 m.	13.8	13.9	15	5.1	5.8	6	23.5	23.1	24.6
1937/75-1975/1993		**0.1**	1.1		0.3	0.2		-0.1	0.5
1993-2012			1.2			0.9			1.4
Göztepe 39 m.	14	14.1	14.9	5.5	6.0	6.4	23.2	23.2	24.9
1929/75-1975/1993		**0.1**	0.8		0.6	0.4		± 0	1.7
1993-2006			0.9			0.9			1.7

**Bahçeköy data until 2006*

The world's average surface temperature has increased by around 0.74 °C over the past 100 years (1906 - 2005) according to IPCC Fourth Assessment Report. Temperatures in Turkey increased between 0.5- 0.8 °C according to the Country Report (Turkey's adaptation to Climate Change, implemented by the Turkish government and the United Nations Development Programme (UNDP). The Country Report was presented to the media by the Turkish Minister of Environment and Forestry and UNDP Turkey Resident).
Temperatures mostly decrease during the period of 1970-1992 and increase between 1993-2006 are analyzed in Istanbul stations (Table 5).
The average annual evaporation rates for some stations calculated by the method of Penman are 388 mm in Silivri (Çopuroğlu. 1997), 422 mm in Kartal and 429 mm in Florya. Accordingly, 62 – 73 % of rainfall evaporates throughout Istanbul (Dumlu and Yalcin, 2008) .

3. Water Requirement of Istanbul

Based on İSKİ data 90 percent of the daily demand for water which reaches up to 2.150.000 cubic meters is supplied through seven catchment areas: Küçükçekmece, Büyükçekmece, Terkos, Sazlıdere, Alibeyköy, Elmalı, Ömerli and Darlık. Küçükçekmece basin has lost its characteristic as being a drinking water supplementary basin because of the pollution. Elmalı reservoir has been recovered by establishing a treatment facility.

While population growth rate in general is about 2 % for Turkey that ratio is increased up to 20 % in reservoir areas (Baykal et al. 1999; Coşkun et al.. 2006). Variations in land-use and water quality in catchment areas are observed by remote sensing and geographic information system (GIS) techniques (Musaoğlu et al., 2005; Coşkun et al., 2006; Coşkun et al., 2008).

Changes in land-use and water quality within conservation areas were illustrated numerically and graphically. Depending upon these practices among the regions that are primarily affected by municipal expansions the leading ones are Elmalı, Alibeyköy and Ömerli basins. Road connections and industrial areas falling within these regions attracte great numbers of inhabitants.

As a result of the ease of accessibility by the construction of the Trans-European Motorway (TEM), shanty districts such as Sultanbeyli is developed rapidly. Also Sazlıdere and Büyükçekmece basins are the scenes of similar developments. As being well-distant from the

central district Terkos and Darlık basins are still influenced least by a suppression of urbanization. Rapid growth of new and shanty settlements will not be surprising, because the third bridge on Bosphorus and roads are just being starting to be constructed.

In Istanbul; the number of deep wells authorized by the State Hydraulic Works (DSİ) was 2222 in 2007. The total figure for deep wells drilled directly by State Hydraulic Works is 221, and the number of active users through İSKİ is 6667. Throughout Istanbul, the total volume of groundwater usage determined by İSKİ is 596 348 m^3/day and 217.7x10^6 m^3/year.

Based on unofficial data, throughout Istanbul the number of drilled deep wells is actually more than 20 000. Many plants avoid paying both usage and wastewater fees and manage water resources illegally and pour the polluted water into ground. As a consequence of such impetuous depletion, the groundwater table drops 2-3 meters annually in regions of Istanbul such as Zeytinburnu, Bakırköy, Ataköy (Ercan. 1995a; Dumlu and Yalçın, 2008). The Bakırköy Çırpıcı aquifer, the Tuzla-Darıca coastal/longshore aquifers and the Gebze-Dilderesi alluvial aquifers are lost (Dumlu o., Oran S., 1995b).

The foregoing studies performed suggest that evaporation in dams (reservoirs) will increase because of climate change. In that context evaporation-reducing methods must be applied (Koçak et al.. 2008). Underground dams (reservoirs) giving rise to minimal losses from evaporation ought to be constructed in this century. Aquifers which are the natural underground dams must be protected and put into use in arid seasons.

4. Egirdir Lake

The Lakes District is a rich region considering freshwater potential. The Egirdir Lake is a tectonic lake and it's the second biggest freshwater lake with 4 x10^9 m^3 water volume for Turkey. The length of the lake is 50 km and the maximum depth is 14 m; moreover, its average depth is almost 8 m. The altitude of the lake is approximately 918.96 m above sea level. The Egirdir Lake has been studied within the frame of the "Basin Protection Plan Special Provisions of the Egirdir Lake and Assigning Project" of the Ministry of Environment and Forestry. This study showed that Eğirdir Lake is vastly recharged by groundwater from karstic carbonate rocks and alluvium deposits (Karagüzel et al. 2011). In this sense, groundwater flow fields were prominently used in defining protection zones in addition to surface runoff. Special provisions were assigned for limestones where springs discharge and

recharge areas (Tasevi, Aşağıtırtar, Kemerdamları and Kayaağzı (Figure 7). On the map yellow areas show the redefined absolute protection areas of karstic springs which discharge to the Lake. Yellow lines indicate the border of absolute protection zones specified by Water Management General Directorate of Turkey. According to these regulations, absolute protection distance from maximum water level is defined as 300 m but this distance has been extended to 12 km. for the area where there are karstic springs.

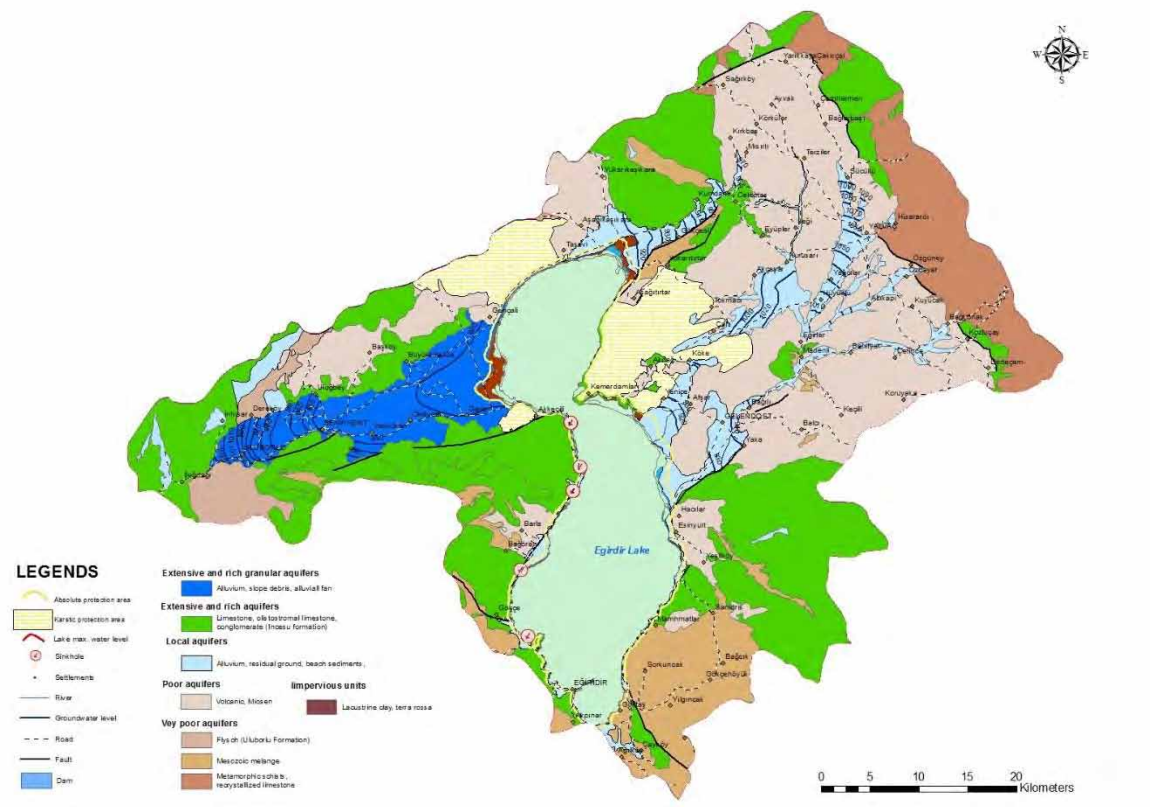

Figure 7. Redefined absolute protection zones of Eğirdir Lake (Tübitak MAM, 2011).

5. Conclusions

Rainfall stations data reveal that climate change process reflected as temperatures mostly decreased during the period 1970-1992 and increased between 1993-2006. The precipitation is increased around Istanbul and is decreased in Egirdir. But, the increase in annual precipitation is related to heavy rains. The change in the precipitation type has been negatively affected groundwater recharge and evaporation in reservoirs.

The drinking water of two districts (Istanbul and Egirdir) are mostly supplied by surface water. It is understood that surface waters will be increasingly affected more than groundwater by both evaporation and pollution under future conditions. Therefore, groundwater management and protection have been conferred a special importance in these areas. The protection zones for groundwater should be defined as Egirdir Lake with new projects. The most important approach for establishing surface/ground water protection areas

is to determine the different criterias for the different aquifers by means of detailed geological, hydrological and hydrogeological investigations.

The studies suggest that evaporation in dams (reservoirs) will increase. In that context, evaporation-reducing methods must be applied. Underground reservoirs giving rise to minimal losses from evaporation ought to be constructed in this century. Aquifers, which are the natural underground reservoirs, must be protected and put into use in arid seasons.
The important aquifers of Istanbul, namely Çukurçeşme granular aquifer and Kırklareli karstic aquifer must be recovered and conserved. Besides that, the lost aquifers in Istanbul should be recovered by remediation projects.

In conclusion, land use decisions should be made by considering protection of water resources, basic requirement for living life, which become important due to global climate change.

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EVOLUTION OF HIERARCY OF SETTLEMENTS IN WATER-BASIN SCALE TOWARDS CLIMATE CHANGE

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Introduction

Climate change appears to be a predominantly environmental issue threatening the life on earth in the last decades. The excess of 0.6°C in the global temperature, 2000 to be the hottest year of the last 150 years, 0.1-0.2 meter rise in ocean and sea levels incidental upon defrosting polar glaciers are some of the indicators emphasized by the European Environment Agency (2013) reveal significance of this issue.

Meanwhile, Turkey is regarded as one of the most countries under the risk of climate change appertains to global warming. [1] The distinguished geography surrounded by seas on three sides and the topography imprint on each region in various dimensions. Accordingly, the southeastern Anatolia under the threat of desertification and semi-humid regions of the Aegean and Mediterranean regions are expected to be affected more in several ways.

This paper focuses on one of the outcomes of basin planning studies investigated at "Re-defining the Measures of the Hierarchy of Settlements" research project.[2] The settlements system / hierarchy to undergo change either in basins which are also proposed by State Planning Organization in Turkey, regional or country scale depending on the probability to be confronted with climate change in near future are the reasons for the topic of this paper.

In the first section the reason for admission as a river basin planning unit and the network between the settlement system and settlements on different hierarchies are described. The second section focuses on the case of Göksu Basin in south of Turkey. The topographic features, the size and mutual relations between the surrounding sub-regions, the probability to be affected by climate change, land use patterns and values to be protected in the Göksu River zone are introduced in the second part.

The third section provides information about the location of Göksu Basin, subregions, economic activities (greenhouse, industry, hydroelectric plant - HEP etc.), irrigation and energy investments in the basin and in the radius of basin (dams, irrigation canals, nuclear power plant).

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[1] Ilgaz, 2013.

[2] „Re-defining the Measures of the Hierarchy of Settlements" Research Project studied by Assoc. Prof. Dr. H. B. Yakar (executive), Prof. Dr. Z. Yenen, Asst. Prof. Dr. N. Erkan, Dr. C. Hamamcıoğlu since 2007. The project is supported by the Scientific Research Project Coordination of Y.T.U) and consulted by Assoc. Prof. Dr. P. Özden and Dr. L. Suri (2010-2013).

Following the descriptive sections on the factors leading climate change, the possible climate change scenarios of Göksu Basin are discussed. The presumptive impacts of climate change in the study field are concerned under the parameters of natural structure, rainfall regime, climate type, variety of products and the distribution of population. This investigation the changes in the amount of irrigated land and water surfaces due to the topography of land. Through the scenarios -in the light of the instruction mentioned in the previous chapters and the parameters based on the investigation- „land use pattern ↔ population" change and „settlement pattern" probabilities are displayed.

The evaluation part where the findings express also includes outcomes for the future of planning discipline.

River Basins as a Planning Unit

The most important reason for the adoption of river basins as planning units is "water" which is the source of life. Although it is a basic scientific fact, vital significance in terms of sustainability and striking predictions in the cases of its insufficiency and deficiency to be faced with has placed "water" issue on our agenda.

Aquatic ecosystems providing appropriate natural environments for major human activities host approximately half of the world population (more than 2,8 billion people) today[3]. The "water" resources, especially the issues related to rivers cover the utilization and protection of soil, vegetation and forest resources what makes sense in the "water - soil - forest" integrity. Likewise, any type of interference in any part of river basins displays positive and/or negative environmental and socio-economic impacts on the rest of it. Accordingly, it is possible to identify defined / holistic living units of river basins as unique geographical modules where the characteristics of soil, geology, flora and fauna and human beings' activities interact.

In the content of river basin-based management actions, the priority is given to the engineering solutions in order to provide the protection of dam reservoirs, acquisition of drinking water and irrigation of agricultural lands between 1970s and 1980s in Turkey and the World. However, following the confrontation of environmental problems such as climate change, pollution affecting especially the water resources, the problems in the utilization and management of river basins are recognized. Thereupon, search for solutions on various national or international platforms and precaution development programs are initiated. At the same time mutual agreements, contracts, policies have been adopted. In this process, the utilization and preservation strategies of the environment in a holistic approach and initiation of management plans for natural resources in order to achieve social, cultural and economic sustainable development is proposed from all countries in the UN Rio Conference Report (Agenda 21) in 1992. In the same report, the management of natural resources is emphasized to be performed in the scale of river basins. [4] Consequently, river basins have been adopted as planning unit in the holistic regulation of natural resources and human activities.

Besides the contribution to the sustainability of natural resources, the role in determining the characteristics of settlements system and their network of relations within the boundaries is

[3] UNESCO; IMO; FAO; UNDP, 2011.
[4] Hooper, 2003; Darghouth, et.all., 2008.

another operative issue in the adoption of river basins as planning units. In other words the river basins, each providing a unique geographical module, reveal settlements‟ pattern which share the same environment with its potentials, deficiencies and “unity of fate”. This aspect of the adoption of the river basin as a planning unit makes significant contributions to the hierarchy of settlements while identifying the locations of settlements, typologies, population size, economic, social, spatial relationships in between and partnerships.

Turkey moved both utilization and preservation of river basins to his agenda by signing agreements on management of water resources. Therewithal, river basins received cognizance as a planning module following the European Union standards of “Nomenclature of Units for Territorial Statistics - NUTS” approach which is also adapted by the State Planning Organization into Turkey. Although legislation developments are discussed in the academic institutions and government levels, handling water management and land use plans by different organizations often results in harmful decisions threating the practice in the basins. In this context, the legislations about laws, regulations and conditions for construction concerning the utilization and preservation of soil, agriculture and forest domain stand as top titles. However, in another part of the same regulations, phrases related to the conditions for construction “… is not allowed but, … in case of … permission or … report decision is available” are stated by asserting globalization, development, growth, investment decisions, rapid urbanization, energy consumption issues. Such a case indicates that the content of river basin-based approach is not adopted at social, political and organizational levels yet.

Besides many forms of life, the possibility of global climate change in the near future entertains risks on river basins and planning endeavors based on this scale. Consequences of global climate change will affect river basins regimes, cycle of natural life, human activities and accordingly the current hierarchy of settlements. Therefore, natural resources such as water-soil-air and human activities in the use of those resources in river basins must be planned interacting with each other. Forasmuch as, the need especially for integrated planning and management taking the possible scenarios of climate change into account will be vital in the future. Putting on the agenda this study considers Göksu River Basin the most at risk from the Mediterranean region in Turkey as an example in order to discuss the possible effects of global climate change on the scale of river basins‟ settlements system / hierarchy over different scenarios.

Characteristics of Göksu Basin

The sources of Göksu River arise in the northern slopes of Taurus Mountains facing inner Anatolia and pour respectively through Antalya, Konya, Karaman and Mersin provinces borders into the Mediterranean Sea via a characteristic delta. The longer arm of the river is 308 km. [5] The longest arm which is on the north is Göksuyu, the southern arm is called Ermenek Stream. Their confluence is at south of city center of Mut District. The study area of Göksu Basin covers more than %80 (945.096,2 ha.) of total basin area (more than 10.000 km²) between Göksu Delta in the south and Sertavul Gate in the north on Taurus Mountains. As of 2013, the population within the boundaries of the study area in Göksu Basin is 195,821 people. The boundary of Göksu Basin is determined considering the natural boundaries. [6] In

[5] DSİ, 2013.

[6] In Turkey, the basin studies (NUTS) are adopted by State Planning Organization in administrative base e.g. province, district … boundaries. However, it does not coincide with the facts "integrity of basin" and "faith of union" mentioned in the introduction part of the study.

this respect, taking water flow directions into account, high altitude peaks and ridges of the Taurus Mountains surrounding the brooks and streams has been instrumental in defining the boundaries. In this case, the study area includes substantial parts of Ermenek district of Karaman Province, Mut, Gülnar, Silifke and Aydıncık districts of Mersin Province (Figure 1).

Half of the population lives on the hilly and mountainous area which composes most of the study area in Göksu Basin. Plains cover %36 of the river basin. Half of the population in Göksu River, who choose to benefit from the potentials of agricultural production agglomerated along the coast (river, sea) and plain settlements. Most of the more than 200 settlements located over the plains (90 settlements) and along the river banks (61 settlements). 8% of the total population that is associated with the culture of nomadic tribes lives on the highlands (Table 1).

The location of ancient traces designate continued identity of Göksu Basin as a major transportation corridor and settled area. Today, a significant portion of the study area in Göksu Basin (70%) consists of sparse vegetation (Table 2). While the forest and scrubs shaping the climate, air quality and hosting wild animals covers %20, agricultural lands composing the backbone of the economic production covers %7 of the basin. The most important reason for this is the limited area of irrigated lands along the river banks and delta due to the topography of the basin. (Table 2).

The study area in Göksu Basin can be divided into four sub-regions according to the geographic and economic peculiarities. Göksu Delta and the Mediterranean coastal zone where the town of Silifke district located is the most economically developed sub-region. Embracing the delta area with a Mediterranean climate this sub-region‟s economy, based on greenhouse activities, production of agricultural products such as peanuts, sesame, tomato, strawberry, citrus fruit, the service sector which meet the needs of the hinterland and tourism functions. D-400 highway that follows the coastline and D-715 chasing the valley and the slopes of Göksu, providing an access to Central Anatolia intersects within this sub-region. Furthermore, Taşucu Port, the only gate from Göksu Basin to the Mediterranean and international ports is also located in this sub-region.

Göksu Delta shaped by the alluvium and sediments is one of the most important asset need to be conserved. In the Special Protection Area of delta protected by the Ramsar Convention, there are two lakes Akgöl and Paradeniz under the risk of salinity. On the other hand, Göksu Delta provide habitat for the animals in danger of extinction such as sea turtles, blue crabs and for different species of birds on the way of bird of passage at the same time. Even so today, summer houses and greenhouse activities threaten the delta and coastal areas which are the most susceptible environments to global climate change in this subregion.

Göksu River Valley zone is a narrow corridor circumscribed by the slopes (%0-10) and separated from the coastal climate where cultivable and irrigable lands of settlements are concentrated. Also this is the sub-region where the river flows through meanders. Due to its natural structure providing advantageous communication corridor (D-715) between the Mediterranean and Central Anatolia, secondary hub of the basin (the town center of Mut District) located in here. Humid and temperate Mediterranean climate carried via the Göksu River determine the diversity of products rather different than the coastal zone, the amount and time of harvest.

The mountainous areas on both sides of the river -due to the hilly terrain of the area- are the sub-regions where the transportation opportunities are reduced, irrigation facilities are limited. Accordingly, these parts of Göksu Basin are socio-economically less developed than the coastal and river valley zones where tertiary town centers (Ermenek and Gülnar) are located. On the hilly terrain parts of Göksu Basin forest areas cover large portion of lands. Rural economy depends on forestry, dry farming and small cattle livestock. Types of agricultural products vary according to the altitude, slopes and climatic conditions. Receiving more than 1000 mm. of rainfall, these highlands nestle rich vegetation and wildlife ecosystems that are also sensitive to global climate change. In Ermenek, besides agriculture, livestock and dry agriculture activities, depending on the irrigation facilities of Ermenek Dam, irrigated agriculture is also carried on in the northwest of the basin. Here the slope rate is partly over %30. However, depletion of vegetation by the fires and etc. and the steep topography increases the risk of erosion.

Northeast part of the basin experiences severe erosion. Dominated by continental climatic conditions with a few amount of rainfall (annually 400 mm), residents provide livelihood with livestock activities in the lack of agricultural land and irrigation facilities. Moreover, weak accessibility due to rough topography is another reason for this zone to be the least developed part of Göksu Basin.

Climate Change and Göksu Basin

There are plenty of factors expediting climate change. The destruction of nature by multitude of reason, consumption of fossil fuels for energy production, industrial, transportation and heating use, increasing dependence on electricity consumption, heating and cooling systems particularly in rapidly growing urban areas are some of these leading factors.

In addition to the natural environment, global warming due to climate change is a fact that may have serious implications on water resources, agricultural production as well as sustainable development today. Climate scientists agree that there are particular changes in the earth's climate system and the impacts of changes are monitored through different disciplines in the last two decades. Rising sea levels, increase in the severity of climatic events, desertification are some of the indicators of global climate change. The most striking and recent prediction that have been considered on the negative impacts of climate change is the ability to reach drinking water. According to that, one of every ten people in the world will not be able to reach drinking water in 2015. [7] If the current progress continues, in the case if the necessary precautions are not taken into account, impacts of climate change due to global warming may directly affect human habitats culminating fundamental changes in the hierarchical system of settlements.

The reports for different scenarios on rising sea levels claim that climate change on the world will experience the most intensive impacts on water environments primarily in the basin and delta areas. [8]. In this context, Turkey is one of the countries which will be mostly affected by the climate change due to global warming. The distinguished geography surrounded by seas on three sides and the variable topographic imprint on each region will indicate the effects of

[7] DPT, 2010.
[8] Parry, 2010; Garcia-Ruiza vd. 2011; Folger, 2013.

climate change in various dimensions. Also the studies on the temperature rates demonstrated record values especially, over the last twenty years of Turkish Mediterranean Region which will expose to the risk of drought in the future. [9] Consequently, Göksu Basin and the Delta in the Mediterranean Region are among the zones that will be directly affected by this process.

It is practicable to explain the factors that expedite climate change in Göksu Basin and the hierarchical system of settlements in the following subtitles (Figure 2).

1. Irrigation and energy investments

In Göksu Basin the construction of water dams in order to meet the demands to irrigate agricultural lands, to use in industries, to supply drinking water and the construction of hydro-electric power plant facilities to generate energy are some of the factors expedite climate change. Depending on the volume of retained water, the dams built on beds of valleys cause some changes in the micro-climate, for example they mild the local climate and increase the humidity. The water and hydro-electric power plant dams also cause other radical direct or inferential risks expediting climate change such as to remain the settlements and cultivable lands under flood, rehousing of the locals, deterioration in the vegetation and habitats of animals, accumulation of organic materials emitting methane gas to the atmosphere, modification of the socio-economic structure (in the downstream). [10] In order to generate energy by spilling water from a certain elevation to return water turbines, river type of hydro-electric power plants entails changes in streambeds, flow of rivers and cause woodcutting due to the construction of tunnels, access roads, transmission tunnels … which damage the nature. [11]

As per 2013, there are three large dams operating in Göksu Basin. While two of these dams are used to generate hydro-electric power, other one is used to collect water. Those two dams, Ermenek and Gezende which generate electricity, are located on the Ermenek arm of Göksu River. While Gezende Dam is in operation since 1990 covers 4.000 hectares, Turkey‟s highest dam, Ermenek, spread 6.000 hectares started to retain water in 2009 (Figure 2).

On Gökdere Stream of Göksu River the construction of Bağbaşı Dam is completed in 2012 as a part of Konya Plain Project. Within the scope of this project the collected waters of Bağbaşı is planned to transfer to Konya plain via a 17 km. long tunnel named as Mavi Tünel (Blue Tunnel). [12] There are also two other dam projects (Bozkır and Afşar) under the construction on the upper streams of Göksu River which are planned to be operated particularly in the content of Konya Plain Project.

Other projects planned to put into practice on Göksu River are Mut ve Kayraktepe dams. However, the construction site of Mut Dam will remain Göksu town under the water; this means that only from this settlement approximately 2.400 people shall move to somewhere. On the other hand, Kayraktepe Dam which is projecting to be built between Mut and Silifke districts on the main bed of Göksu River will involve 13.000 hectares of area under water. And in the case of Kayraktepe Dam construction seven villages (Irmaklı, Yukarı Köselerli, Köselerli, Göksu, Sarıveliler, Karadiken ve Kemenli), with a total population of 3.277 people, will have to be unoccupied.

[9] Tayanç vd., 2009; Ilgaz, 2013.
[10] Yano vd., 2007, Than, 2011, Garcia-Ruiza, vd. 2011. Sowers, vd., 2011.
[11] Ürker, 2012, Şengül, 2013
[12] DSI, 2013.

Today, the number of river type hydro-electric power plants in operation is seven (Bucaklı, Derinçay, Sarıkavak Silifke, Zeyne and two at Yerköprü). Provided that, considering the ongoing and planned projects in Göksu River Basin, this number will increase to 19 in the near future.

2. Akkuyu Nuclear Power Plant Project

Akkuyu Nuclear Power Plant, which is planned to be completed in 2023, started to be constructed at Akkuyu Bay on the Mediterranean coast. (Figure 2) Göksu Basin is also in the effected zone of this plant which will generate %6 of Turkey's energy demand. [13] Although these plants are emphasized to be an environment friendly way of energy production in which the greenhouse gas emissions are low, the use of uranium material, millions of cubic meters of cement, possible emissions and oscillations during the remove of nuclear fuel, disposals are the risks threaten natural environment, human health and settlements future in the process of climate change. Another issue in nuclear power plants is the need for a daily average of 750 thousand liters of water for cooling. However, this requirement will have adversities on the living things that are inhabited in the ecosystem of water resources and river basins. In addition, the decrease or increase in the water level, depending on the climate change, threatens the future of power plant investments located at the water's edge. [14]

3. greenhouse investments

Another investment impinges the climate of Göksu Basin is the intensive agricultural production in greenhouses which spread out extensive areas in several parts of the river basin. Greenhouses allow for greater control over the plants and often used to overcome shortcomings in unsuitable weather circumstances such as a short growing season or poor light levels, and they can thereby improve food production. However, they differ from agriculture sector and show similar effects of industrial facilities in terms of leaving harmful gases to the atmosphere while heating inside. At the same time, greenhouses lead to the formation of heat islands while storing and reflecting the sun's rays on the surface. The greenhouses are concentrated between Silifke - Gazipaşa districts along the Mediterranean coasts and valleys and cover half of the cultivable lands in Göksu Delta. Also, greenhouse economy has become an increasingly common investment activity around Mut District in the basin. (Figure 2)

4. rapid urbanization and increasing energy consumption

The electricity and fossil fuel consumption in the housing areas consume %6 of carbon emissions in the world. This rate rises to %14 in Turkey. [15] As well as the rapid population growth in urban areas, the concept of architecture and urbanism which is not taking the natural conditions such as sun, wind and etc. into account redouble the dependence on energy-consuming (heating and cooling) systems. Unplanned sprawling cities lack of sufficient open areas and green spaces become completely large portions of heat islands and cause local climate change. [16] There are three towns where the population excess 10.000 in Göksu Basin: Silifke (50.000), Mut (30.000), Ermenek (11.000). 1/4 percent of the total population of basin accumulates on the north Göksu Delta which should be under the protection of the Ramsar Convention. As per 2012, the total winter population of this zone composes approximately 65.000 inhabitants including Taşucu, Silifke, Atakent, Atayurt, Arkum settlements. The

[13] Akkuyu NGS, 2011.
[14] Kopytko, N., Perkins, 2011.
[15] IEA, 2012
[16] bkz: Tayanç vd., 2009, Tayanç and Toros, 1997.

population of these settlements, where tourism and summer houses investments are also located exceeds one hundred thousand inhabitants. At the same time, this zone is the center of the basin involving the sub-sectors of agriculture-based economy and the service sector which constantly spreads and sprawls, that is why it separates the climate of Göksu Valley from the Mediterranean climate. Irrepressible urbanization and raising energy requirement gradually threaten the climate of this part of the basin. Specifically, the rising water level in the process of climate change will directly affect the coastal and Delta areas, settlements and also the investments in Göksu River Basin. [17]

5. road oriented freight and passenger transport investments

All the motor vehicles, mainly rubber-wheeled motor vehicles and airplanes have a large share in carbon gas emissions. While the share of roads among the carbon gas emissions is %16 in the World, it occupies %13 in Turkey. [18] In this respect, Mersin-Antalya (D-400) and Silifke-Karaman (D-715) are the major national highways in Göksu River Basin with a daily average number of motor vehicles over 2,000. [19] Instead of Taşucu Port and transportation by sea, the hegemony of road transportation network makes it one of the factors expedites the climate change in the basin. It is understood that the dominance of road transportation will continue considering the ongoing widening and tunnel constructions on Silifke-Antalya highway, Akkuyu Nuclear Power Plant access roads and 1/100.000 Environmental Plan. The highways projects between Ankara-Anamur and Mersin-Mut are on the agenda. The only railway route is proposed between Mersin-Mut-Karaman in the plan.

Besides all these factors explained above forest fires, erosion, landslide and intensive use of chemical fertilizers are other issues expediting the climate change.

Scenarios for Climate Change Impact in Göksu Basin

Following the estimates expressed on the global climate change; two scenarios are tried to be developed in Göksu River Basin, depending on the scope of our research.

In the first scenario, the fiction is structured on the sea-level rise (sea level raised 19 cm. between 1901-2010), accordingly the river water-level rise and the prediction of coastal settlements buried under water. [20] If the sea-level rise 0.5 cm each year, natural and cultural reserves and richness, investments (irrigation infrastructure, port, harbor, other transportation nodes, industrial investments, roads and other communication infrastructures), a group of (rural) settlements, agricultural lands and huge amount of soil will be lost along the coastal areas. In these areas, the coastline, the coastal zone will be redefined; the areas behind the coast in the past will transfer into coastal areas. However, coastal settlements will not be in the earlier forms of water-related livelihoods because of the marine acidification influence on the flora and fauna. The detriments in the resources of Göksu Basin and Turkey will not be limited to this. A similar situation is to be the case for Göksu River Valley. Depending on the natural change in the valley; shares in land use, irrigated – dry agriculture percentages, vegetation, pattern of product and other sources will be varied. This transformation in the

[17] bkz: Ilgaz, 2013.
[18] IEA, 2012.
[19] Turkish General Directorate of Highways, 2012.
[20] See: UNFCCC - United Nations Framework Convention on Climate Change, Geneva, 16.02.2001; Evoluation of Climate Models in IPCC – Intergovernmental Panel on Climate Change (Hükümetlerarası İklim Değişikliği Paneli, 5. Değerlendirme Raporu), The Physical Science Basis, 27 September 2013.

ecosystem will affect the distribution of population in the geographic space, in other words the settlement pattern and sizes. Forasmuch as, living on the water lots / the population living in the settlements that have lost their livelihoods will relocate within or outside the basin. This movement will cause radical changes in the social and economic structures: for example, rural – urban population ratios, shift in the sectorial and sub-sectorial structure, effects on the overall economy… All these formation means variety of life forms occurred in different parts of the basin and new effects on the ecosystem (climate, flora, fauna) as well as on the local cultures also means new challenges.

The second scenario is structured on the decrease in water (drinking, use, irrigation water) amount, namely drought and desertification. The prediction [21] is determined according to the excess in global warming (still increase 0.9°C) and decrease in average rainfall amount per year, possible high temperatures in drought and tropical regions, floods and soil degradation, reduction in agricultural yields in Asia continent, and drought in southern regions of Europe continent. According to this approval, there won"t be any increase on the amount and level of river water, so that the settlements in the valley will not flood, however the productivity and product diversity will decrease in terms of significant reduction in the rate of irrigated agricultural land, a couple of harvest would not be possible per a year. The gabs in agricultural production would lead impoverishment and due to poverty, infiltration of population from rural settlements to urban settlements (within or outside the basin) will be experienced. The hierarchy of settlements in the basin will be rasped and the basin will evolve to a single centered structure with an impoverished and destitute hinterland. Agro-industrial development programs in the basin will be shelved, service sector will gain significance, hidden unemployment and unemployment will increase. In this case the hierarchy of intra-basin settlements will suffer.

The natural and cultural values that are the first and most damaged resources in poor environments; attention to the cultural environment and local diversity will be reduced more in both scenarios. Related to that, there won"t be any expectations about diversification of natural environment and local cultures in tourism industry.

Evaluation

In the scope of this study, the evaluation issue of the basins as a planning unit is reminded (remembered) and „settlement system in the basin" is tried to describe.

Accordingly, located at different natural environments in the integrity of basin, depending on the different sources that have developed their own unique culture of life in different forms of livelihood, the division of labor between the settlements created by different roles and mutual relations in different sizes of settlements based on the distribution of the population system is called as „hierarchy of settlements". This system is exemplified in the context of economic activities - land use - investments relationship, depending on the diversification of settlement in Göksu River Basin from Turkey. The scenarios of Göksu Basin located in the Mediterranean is expected to be the most affected part from the climate change in Turkey is discussed through the possibilities of change in the natural structure, „the presence of water - irrigation - variety of products – efficiency" concepts. In both scenarios for Göksu River Basin

[21] See: UNFCCC, 2001; Evoluation of Climate Models in IPCC, 2013.

where the main function based on the agro-economic activities encountered common results because of the limited agricultural lands mostly in the valley and Delta plain. This conclusion in any case demonstrates that, hierarchy of settlements in Göksu River Basin based on rich agricultural economic identity at the present time will be damaged or removed.

Towards the challenge in the climate, investigating changes in one of the settlement system of basins in Turkey concerns undeniable consequences for the discipline of planning which means the organization of today and future. Global climate change;

- points out the necessity for more and diverse but purpose-focused data to be studied by the planners,
- brings up the perception of planning discipline to be ready for different possibilities with flexible approaches on the agenda.

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Figures

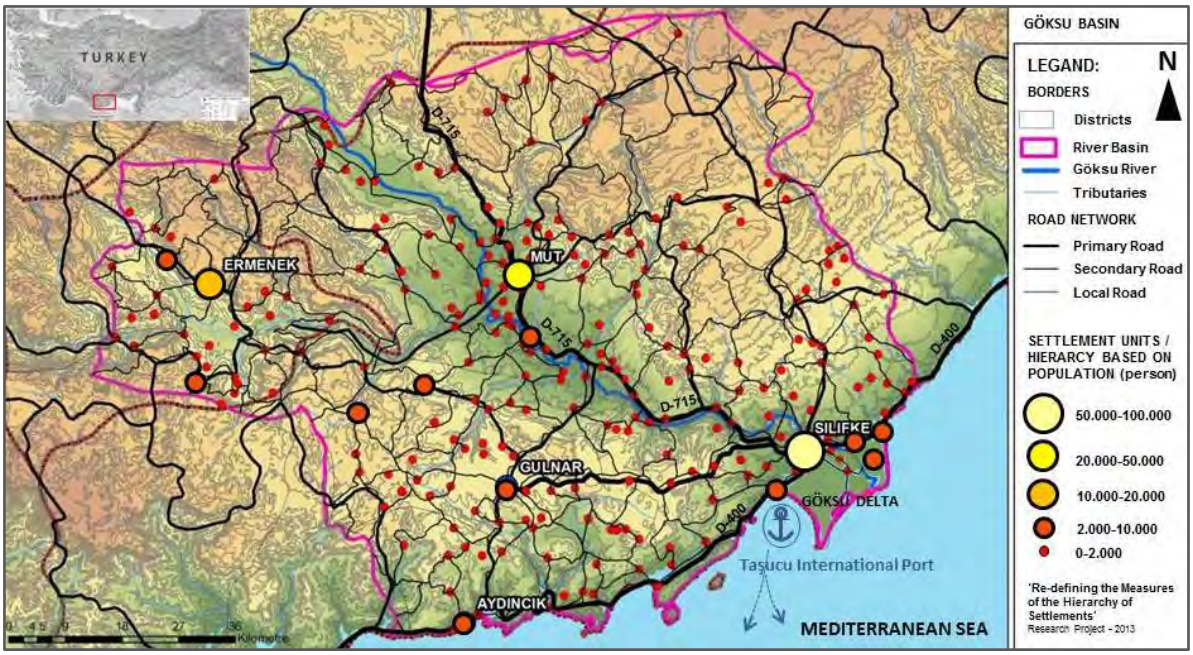

Figure 1. Location, Hierarchy of Settlements and Transportation Network in Göksu Basin, 2013

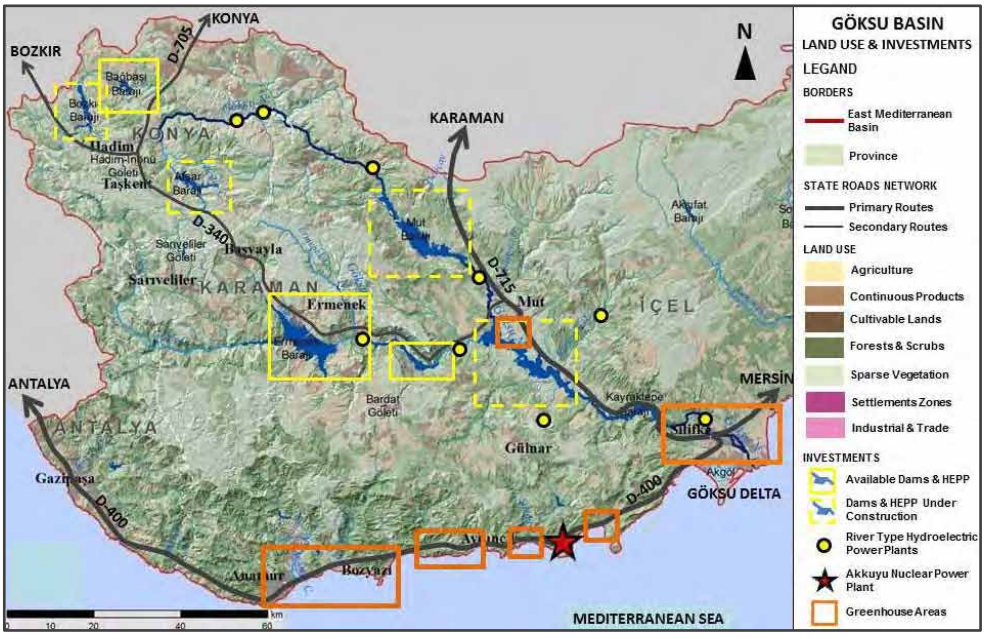

Figure 2. Investments Expediting Climate Change in Göksu Basin

Tables

Table 1. Distribution of Population According to Topographical Features in Göksu Basin, 2013

	River & Plain	**Sloped Land**	**Mountainous**	**Highland**	**Total**
Size of area (hectare)	340,234 ha.	292.979 ha.	245.724 ha.	66.156 ha.	945.096 ha.
(%)	(%36)	(%31)	(%26)	(%7)	(%100)
Population (person) 2012	90.078 per.	50.913 per.	39.164 per.	13.707 per.	195.821 per.
(%)	(%46)	(%26)	(%20)	(%8)	(%100)

Table 2. Land Use in the Studied Part of Göksu Basin

Type of Land Use	**Area (ha)**	**%**
Sparse vegetation	656.751,0	69,5
Forest and Scrub vegetation	180.986,4	19,2
Agriculture	65.578,7	6,9
Grass – pasture – grazing lands	27.647,5	2,9
Rocky	8.539,6	0,9
Beach and dune areas	1.804,6	0,2
Marsh	1.108,7	0,1
Coastal lagoons	599,6	0,1
Total area	945.096,2	100

AGRICULTURE AND ENVIRONMENT RELATIONSHIP WITH SPECIAL ATTENTION TO GLOBAL CLIMATE CHANGE

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Abstract

Environmental problems related with agriculture practices are actual issues in many countries. These problems are emerged from different type of agricultural activities. There are increasing focuses on the contribution of agricultural practices to climate change. Agricultural sector follows energy and industrial sectors by means of greenhouse gas emissions. Greenhouse gas emissions have been increased especially from the 1990‟s due to mechanization, energy demand and technological progresses. Intensive agricultural inputs like fertilizers, manures, pesticides, hormones, antibiotics etc. and fossil fuels are getting more used for agricultural production incrementally. Agricultural production systems have been developed by mechanization, pesticides, fertilizer and productive varieties. These developments led to an increase in energy consumptions at the same time. Beside being a pollutant factor to environment, agriculture, is also the most affected sector from other activities especially from industrial wastes, transportation, mining, tourism activities, urbanization etc. Environmental pollution, especially for soil and water, reduces agricultural yield and causes product losses. The objective of the study is to explore the categories of agricultural activities and input usage which increases the greenhouse gas emissions. Also, it should be discussed how to protect agriculture from climate change with alternative regulations.

Key Words: Agriculture, input usage, global climate change.

Introduction

It could be said that agriculture sector has a complex structure because of the fact that it‟s connected to nature and climate conditions and it covers plant production, animal husbandry, fishery products and land using. Thus there‟s a multidimensional connection between the agriculture sector and global warming. The period from agricultural production to consumption and reproduction contributes the global warming in different levels and it can be affected positively or negatively. According to the long-term researches results, the impact of global warming to agriculture won‟t be experienced equally in every part of the world and it won‟t be the same. For instance, because the elongation of growing seasons connected to the temperature increase eases the forms of photosynthesis, it‟s expected that the yield of cereals and potatoes will increase. However, there‟s a possibility of yield loss in agricultural products due to temperature rises and drought in other parts of the world and because of that situation, starvation may occur. Intensive farming systems are generally responsible for highest emissions of greenhouse gases in agriculture while some low input farming systems in

marginal areas are the most affected ones by climate changes[1,2]. This situation shows that by affecting the product prices, there will be socio-economic inequality in the world and the balance of trade will be in favour of the northern countries where efficiency increase is expected.

To make the agricultural production sustainable, the environmental impacts of agricultural inputs used in production and consumption period (seeds, fertilizers, pesticides, etc.) and energy resources (transport and heating purposes) should be evaluated and alternative solutions should be discussed. It‟s necessary that the agricultural and environmental policies, integrally, should include measures to adapt agriculture to climate change and should be turned in a way that precautions can be taken to reduce greenhouse gas emissions.

In this study, methodologies, literatures, reviews where the previous studies are examined and classified, study findings obtained from secondary data, and finally, policies of reducing climate change caused by agricultural activities are aimed to be discussed.

Methodology

This study is a literature study created with the help of articles and reports including the relationships between climate change and agriculture. In this study, secondary data, models and projections created for present and future are utilized.

Literature Review

The impacts of climate change to agriculture and the impact of agriculture to climate change are assessed as a result of joint efforts of different disciplines. Another study field directly connected with agriculture is the impact of climate change on natural resources. About all these subjects, it can be said that a rich literature has been created especially for recent years. A portion of the work has been prepared by obtaining data for many years as field work. Another part has been built by statistical models and projections related to future periods with the help of available data.

The most comprehensive publications written for relations between climate change and agriculture are as a result of international level summits, meetings or projects. Recently, in the report dated 2007 by Intergovernmental Panel on Climate Change (IPCC) prepared with the contributions of Smith et.al.(2007)[3], it has been explained that how agriculture effects climate change and in what level and how they could be affected.

In a more recently submitted publication, the results of various statistical models and projections are explained in Food Climate Research Network (FCRN) website. Consultative Group on International Agricultural Research (CGIAR) published a program with the Vermeulen et. al., (2012)[4] team about „Climate Change, Agriculture and Food Security‟. United States Environmental Protection Agency (EPA) released U.S. Climate Action Report in 2010 describing the agriculture sector about this subject in national and international level. Furthermore there are studies of EPA conducted jointly with the IPCC. In the book co-written by Organization for Economic Co-Operation and Development (OECD) member countries,

[1] Olesen and Bindi, 2002, p.1-2.

[2] Schils et.al., 2007, p.501

[3] Smith et.al., 2007,

[4] Vermeulen et. al., 2012, 198-200.

Wreford et. al. (2010)[5], in parallel with climate change, is describing the state of agriculture today and in future with international comparisons and explaining IPCC projections. The document of Development of a Farm-Level Greenhouse Gas Assessment project by Arctic and Antarctic Research Institute (AARI), is giving technical information about the greenhouse gas emissions.

There are plenty of studies too which is not connected to the institutions mentioned above and dealing with a single subject in agriculture. About the impact of animal husbandry on climate change there are studies of McMichael et.al (2007)[6], Watson et.al (2001)[7], Smith et.al (2007)[8]. About the economical impacts and costs, Adams et.al.(1998)[9], Parry et.al (2004)[10] and Tol (2001)[11], and about social impacts Fisher et.al. (2005)[12], Morton (2007)[13] and Hertel and Rosch (2010)[14] have studies. Agriculture also has considerable potential to mitigate climate change through sequestering GHGs. About the mitigation potential of agriculture in climate change, there is a journal called "Journal of Mitigation and Adaptation Strategies for Global Change". Moreover, in this subject, there are studies of Cooper et.al. (2013)[15], Verge et. al., (2007)[16], Howden et.al (2007)[17] and others. Since climate change effects on natural resources are crucial for agriculture there are many comprehensive studies which is not mentioned due to the limits of the study.

Research Findings

Agriculture and climate change relation can be categorized in three groups. Greenhouse gases from agriculture, climate change impact on agriculture and agricultural mitigation potential for climate change (Smith et.al., 2007[8]; Dellal, 2008[18]).

A. Greenhouse gases from agricultural sources

The contribution of agriculture to total food system emissions is from 7,300 to 12,700 $MtCO_2e$ (Million metric tons of carbon dioxide equivalent) per year. It"s about 80% to 86% of food systems emissions and 14% to 24% of total global emissions. Land use changing is also very important, because it is ranked second in the total global emission list. About 75% of emissions from land use change are attributed to agriculture[4].

The emissions throughout the agricultural supply chain differ from product to product and from system to system. For instance, if you take a product in the form of raw tomatoes, the process of tomato from farm to our kitchen may change according to the region, tomato

[5] Wreford et. al., 2010, p.79-80.
[6] McMichael et.al., 2007,
[7] Watson et.al, 2001,
[8] Smiths et.al., 2007, p.519.
[9] Adams et.al., 1998, p.19.
[10] Parry et.al., 2004, p.53.
[11] Tol, 2001,
[12] Fisher et.al., 2005,
[13] Morton, 2007,
[14] Hertel and Rosch, 2010,
[15] Cooper et.al. ,2013, p.221.
[16] Verge et. al., 2007, p.255.
[17] Howden et.al., 2007
[18] Dellal, 2008, p.1.

variety, farming system, production scale, and transportation conditions and finally reaching to the consumer. For this reason, estimated numbers and ratios can be given by making some assumptions in calculations. Because the agricultural production is structurally heterogeneous and depending on natural conditions, essential production processes are included in emission calculations.

i. Livestock production and red meat consumption

Livestock production, which has an impact on climate change, negative health consequences including the threat to food yields, is about 20% of total greenhouse gas emissions. The contribution of nitrous oxide and methane to climate change should be considered too. Recently, the methane gas has been evaluated that its contribution to climate change is more than half that of CO_2. Another threat for high emissions is global meat consumption. Climate change can directly affect livestock. The link of stress factors on livestock appetite like high temperature can be given as an example. We can see an indirect influence of climate changes in the requested modification of the quantity. Furthermore it can be seen on the quality of forages from grasslands and the supplies of concentrates[19].

Animals provide not only food, but also non-food goods such as leather, manure, wool etc. Therefore, production of non food animal based products should be taken into account for calculating CO_2 emissions[20].

ii. Deforestation, land degradation, peat land and rice production

Emissions from deforestation, forest degradation and peat land degradation are calculated in different studies. These sources of greenhouse gases account for 12%-14% of total. Peat land degradation has also been found serious in these studies [(3,5)].

Also, where there is water stress and/or heat stress, the world‟s cereal crops shall become vulnerable to even minor changes in temperature. Temperature changes, precipitation changes and increases in the atmospheric concentration of CO_2, have an impact on all crops[21].

[4] Vermeulen et. al., 2012, p.195.
[19] Watson et al., 2001
[20] Garnet, 2009
[4] Vermeulen et. al., 2012, p.198-200.
[21] Wreford, 2007.p.79.

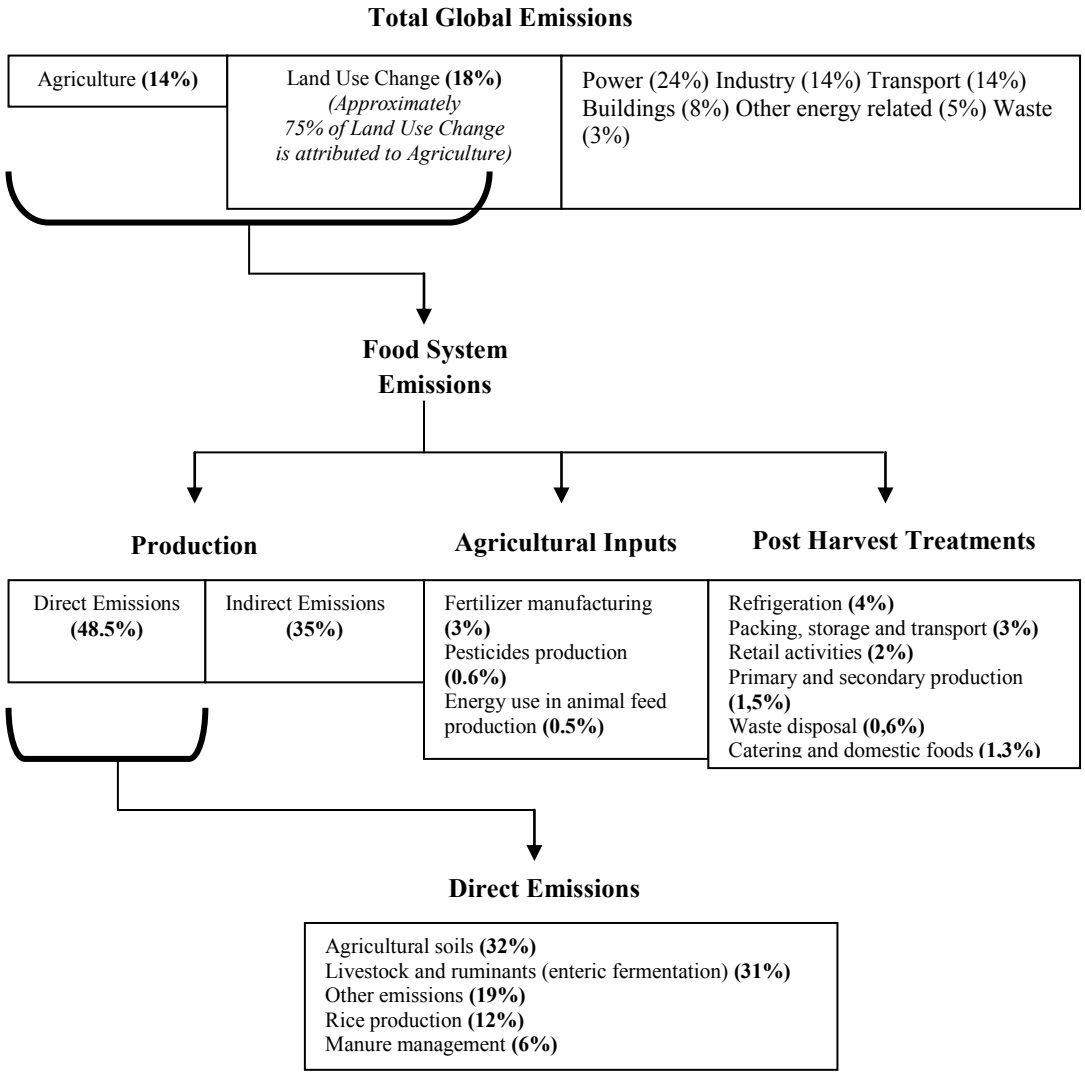

Figure.1. Greenhouse gases from agricultural sources[4]

B. Possible climate change impacts on agriculture

Agricultural activities are mostly affected by climate. The changes in climate have impacts on crop and livestock production, hydrologic balances, input supplies and other agricultural system components[9].

a. Food security: Crop response-yield variability

Climate change has a direct impact on food production and increases food security and malnutrition threats[22]. Even though how the agricultural product yields are affected by climate changes cannot be calculated precisely, some predictions can be made by models and scenarios.

[9] Adams et.al., 1998, p.22.

[22] FAO, 2011, p.1

Agriculture products differ in terms of temperature range needs for a healthy growth within their life cycle. For plant growth, there"s an optimum temperature that the plant can grow as fastest as possible. Which varies depending on the species, the temperature that increases until the optimum degree, generally, speeds up the plant growth by life-cycle phases. When this optimum temperature is exceeded, growth slows down[23].

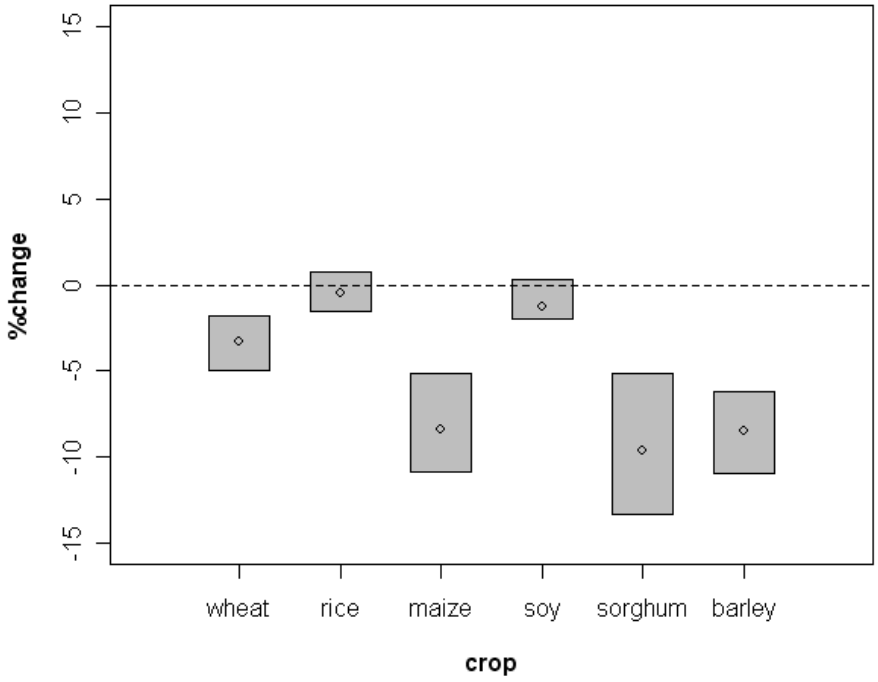

Figure 2. Yield change in % for warming of 1°C[24]

Parry et.al. (2004)[25] discovers a production function model in his study. He inspects the effects of climate change on product yield with different models and scenarios. Mostly, the SRES scenarios lead to crop yield increases in developed countries and yield decreases in developing countries. With expected losses up to 30%, decreases are very important in Africa and in some parts of Asia. An apparent response of global yields to high temperatures is observed for barley, wheat and maize. Having these sensitivities and climate trends, we can predict that warming starting from 1981 has led to annual combined losses of these crops standing for approximately 40 Mt or $5 billion a year, as of 2002 (Figure 2)[24]. As these impacts are not much relative to the technological yield incomes over the same period, the results represent negative impacts of climate trends on crop yields at the global scale[24]. According to Howden et.al. (2007)[26], climate could have subsequent impacts on agricultural structure. For example, El Nino Southern Oscillation phenomenon, with its associated cycles of droughts of flooding events, had changed the global yield in wheat, oilseeds, and coarse grains.

b. Food safety and nutrient losses

[23] Anonymous, 2013. (tarim.gov.tr http://iklim.tarim.gov.tr/Tarimkarbon.html)
[24] Field, 2013; Lobell and Field 2007.
[24] Field, 2013; Lobell and Field, 2007
[25] Parry et.al., 2004, p.66.
[26] Howden et.al., 2007

Food safety and its issues are related with each other. Unacceptable or poor standards of food safety that cause improper food for human consumption, will also impair food security. This situation may force people to consume foods that are of lower quality or contaminated, or that have reduced availability of certain minerals and nutrients[27].

The other problem arises from incremental pesticides usage. The disease is affected by the changes in UV-B, CO_2, and ozone levels. It modifies the physiology and resistance of the host. Changes in temperatures, precipitation and the frequency of extreme events will also affect the disease epidemiology. The relative importance and spectrum of diseases are modified by the geographical distribution changes. This may lead to new disease complexes. Increased fecundity in elevated CO_2 and/or enhanced UV-B radiation may speed up the evolution of pathogen populations. Consequently, resistance of hosts may be overcome quicker. Disease management will be affected from altered efficacy of biological and chemical control options[28]. It"s predicted that the changes in temperature and precipitation due to global warming will lead to epidemic diseases in agricultural products and excessive increases in pests and weeds, therefore pesticide usage will increase. Because the yield will decrease due to temperature rises, it"s expected that more pesticide usage will be necessary in order to protect existing products[29]. Furthermore, according to Pimentel (2008)[30], increasing pesticide usage and lavish use of petrochemical resources may result in the reduction of non renewable resources. So, this situation will increase the possible risks for environment and human health. Also for economical aspects, the pesticide usage increases the product costs. More pesticide usage and improved or genetically modified seeds against diseases increase the production costs of producers and making the producers dependant to the products of big companies.

Besides pesticides, excessive chemical fertilizer use for plant production may different environmental problems beside threat water, soil conditions and food safety. It also increases the concentration of bioactive nitrogen compounds in the global environment[31]. The main source of GHG emissions is fertilizer production, largely owing to its energy intensity but also to some emissions of nitrous oxide (N2O) in the manufacture of nitrate fertilizer[7]. Agricultural N2O emissions are projected to increase by 35-60% up to 2030 due to increased nitrogen fertilizer use and increased animal manure production[3,32].

Climate change eases the spread of some diseases out of their environmental systems. For instance, malaria-carrying mosquitoes will go to the northern hemisphere and at the same time they will speed up the erosion of biodiversity. A review published in 2004 explained that the climate change will lead to the disappearance of 5% of living organisms[33].

C. Agricultural mitigation potential

In agriculture, mitigation and adaptation interact with each other simultaneously. But they differ in their spatial and geographic characteristics. In terms of climate change, benefits of

[27] M.Miraglia et.al. 2009, p.1009.
[28] Chakraborty et.al., 2000
[29] Sik, 2013, p.1-2.
[30] Pimentel, 2008
[31] McMichael et.al. 2007
[32] FAO, 2003
[33] Kempf, 2010
[3] Smith et.al., 2007, p.500

mitigation actions will emerge over decades. But if other policy objectives are achieved, short-term benefits may be observed. On the other hand, enhancing adaptation to climate change impacts will have consequences in the short and long term. For future climate change, most mitigation measures like nutrient management will presumably be powerful, whereas a subset will probably be weak (e.g., irrigation in regions becoming more arid). As the climate changes, a vulnerable practice can be modified and the efficacy of a mitigation measure can be maintained (low agreement, limited evidence)[3].

While climate change mitigation efforts increase, to prevent greenhouse gas emissions, cheaper ways should be identified[34]. There is no universally applicable list of mitigation practices. The proposed practices need to be evaluated for individual agricultural systems according to the specific climatic, edaphic, social settings and historical land use and management. For non livestock mitigation options, mitigation potentials per unit land area for different climate regions (cool–dry, cool–moist, warm–dry, warm–moist) can be defined[3]. For livestock options, mitigation potentials for CH4 from enteric fermentation can be defined for different livestock groups in different regions. In the following sections entitled „GHG mitigation potential in global agriculture", „GHG mitigation potential in European agriculture" and „GHG mitigation potential in UK agriculture", the mitigation potential of agriculture at global scale, European scale and for the UK, is outlined[35].

Organic agriculture can help in mitigating greenhouse gases by farming practices which create soil fertility, avoiding synthetic fertilizer usage and improving carbon sequestration. Organic farmers replace synthetic fertilizers with biomass management. It provides both soil fertility and increased soil carbon sequestration. In the report of IPCC, there are many techniques packed into organic management as relevant mitigation and adaption actions. These actions are the integration of leguminous plants into the crop rotations, ideal soil cover, mixed farming systems and the longevity of ruminants[23]. Flessa et.al (2002)[36], explained that the conversion from conventional to organic farming resulted in reduced emissions per hectare farm and field area, but yield-related emissions were not reduced. Thus, the conversion to organic farming may contribute to the reduction of greenhouse gas emissions from agriculture, if agrarian policy strives to reduce the intensity of agricultural production.

There is a risk that farmers may be reluctant to adopt greenhouse gas mitigation techniques unless they improve profitability. On the other hand, certain techniques have already been adopted for reasons other than climate change concerns. These are no-till agriculture or strategic fertilizer placement and timing. Using proposed mitigation options for mitigation of CO2, CH4 and N2O increases crop and livestock productivity. At least, it improves efficiency of input usage without decreasing yield[37]

Conclusion

Although the impact of climate change on agricultural activities includes uncertainties, it has been trying to be predicted by the studies. The common point of these studies is that the estimated effects won"t be at the same strength throughout the world. As it"s in the other

[34] Burney et.al, 2010
[3] Smith et al., 2007
[35] Smith, 2012.
[23]FAO, 2011.
[36] Flessa et.al, 2002, p.187.
[37] Cole et.al., 1997.

environmental problems, economical development level of countries and to what extent the economical activities (including agriculture) increase the climate change are questioned too. Precisely, the thing which is responsible for this problem is trying to be found. However, only knowing that „which activity increases climate change and how much" is not enough to solve the problem. The unique discourse is needed to shape the common future of humanity. In this instance, within the scope of policies, in case there"s an economic interest of countries or multinational corporations; it may not be easy to carry out action plans.

Neale (2008)[38] argues that there is enough technology in the world to stop the global warming and to use these technologies appropriately; governments should find a solution to this problem in global level by making public works, regulations and heavy spending. Specifying that the governments should act more than companies, Neale emphasizes the public importance of the problem with his words "Governments can do what the markets cannot do because the governments don"t need to profit". Therefore, market based solutions are not ebough for the agricultural mitigation. Agri-environment schemes have the potential to support many adaptation initiatives like Common Agricultural Policy cross compliance measures.

Humanity is concerned about not only the food security issues but also the status of facing hunger especially in the least developed countries after many years. For instance, especially in Europe, it has become almost a fashion to buy product from local producers due to environmental pollution and climate changes. A consumer group has been formed saying "consume your local product even it"s not organic" and their domain is steadily expanding with the social networks. In that case, the devoloping trade of agriculture products and the changes in agricultural production structure, should be discussed more.

In agriculture sector, the initiatives to reduce global warming have came to a point that their control cannot be given to an individual. The revision of agricultural policy instruments to be applied for this purpose, and better consideration of the fields related to environment and climate change issues while maintaining the producers" income levels, are needed.

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[38] Neale, 2008, p.40.

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ECOLOGICAL EVALUATIONS OF THE METEOROLOGICAL DATA IN CENTRAL ANATOLIA OF TURKEY IN THE WARMING PERIOD

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Summary

Central Anatolia is known as the Continental climate properties under hot, dry summers and cold and precipitation poor winter. Meteorological stations are in deep country level (969-1070 m). The precipitation and temperature measurements support the identification of the continental climate. In the lowlands the Nature Forests are nothing. In the high country the rains are more and the temperature is lower. In the higher mountains the Nature Forests come out. The forests can grow in the highlands. Under these climatic variations in the slopes of different plant species come out. With these plant species, the vertical-zonal climatic belts have been divided.

In the last century the rate of CO2 in the Atmosphere of 270 ppm to 394 ppm and the temperature is about 0.5-1.0 °C increases. The air Temperature is also elevated in Central Anatolia. Temperature increase was pronounced after 1994. Depends on the temperature, the vaporization (evapotranspiration) is also increased. In these warming and drought process, the need is increasing for irrigation. This climate change is clearly in the lowlands. Thus, the methods of irrigation in agriculture will become necessary to the new reviews. Dry air masses make over you fields and pastures negative effects. To prevent these effects is necessary in the vast areas of the wind strips and forest plantation. In order to prevent desertification in Central Anatolia has a serious work is needed.

1.INTRODUCTION

The mountain range Black Sea region and Mediterranean region along the Anatolia prevent the Maritime Efect of Central Anatolia. Because of this reason prevail the continental climates with dry summers and cold but dry winter in Central Anatolia.

Especially the Konya basin as a steppe country (Bozkır) is called. This is even after the ancient Literature (> 1100 m) a treeless steppe. The climate properties are due to the growth of forest in the mountain slopes area of lowland. Because the excessive wood cut off and sheep graze for thousands of years the forests in the forest belt are devastated. By this devastation of steppe pasture areas are expanded and the forest area are changed to pasture (Kantarcı, M. D. 2010).

During the warming period since the 1994 the annual medium temperature values are increased between 0.4-1.0 C°. But the average temperature in the summer months is between 1.0-2.0/2.5 C ° rises. Under this high temperature, evaporation - and transpiration values went too high. The meteorological stations in Central Anatolia are between 1050-1100 m elevations. After the temperature rise in Konya basin steppe is expanded approximately 200 m upper belt of the country.

2. THE RELATIONSHIP BETWEEN VALUES OF THE CLIMATE AND GEOMORPHOLOGIC SITUATION AND VERTICALZONAL BELTS IN THE KONYABASIN

2.1.GEOMORPHOLOGIC SITUATION AND VERTICAL ZONAL BELTS IN THE KONYABASIN

Konya basin is a closed water catchment area. Salt Lake (Tuz Gölü) (900 m) is located on the lowest floor. The peaks of the mountains in the surroundings of Konya basin are between 3000-3500 m. The water flow of precipitation (particularly snow) in Bergen to interior lakes and ground water (Map 1, Figure 1).

Map 1.Meteorological stations in the Konyabasin and surrounding area

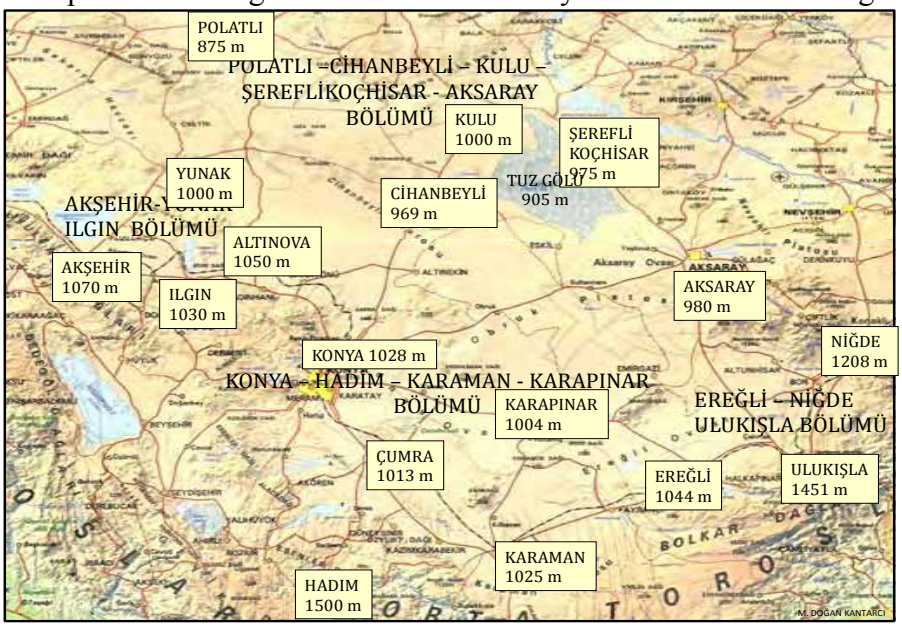
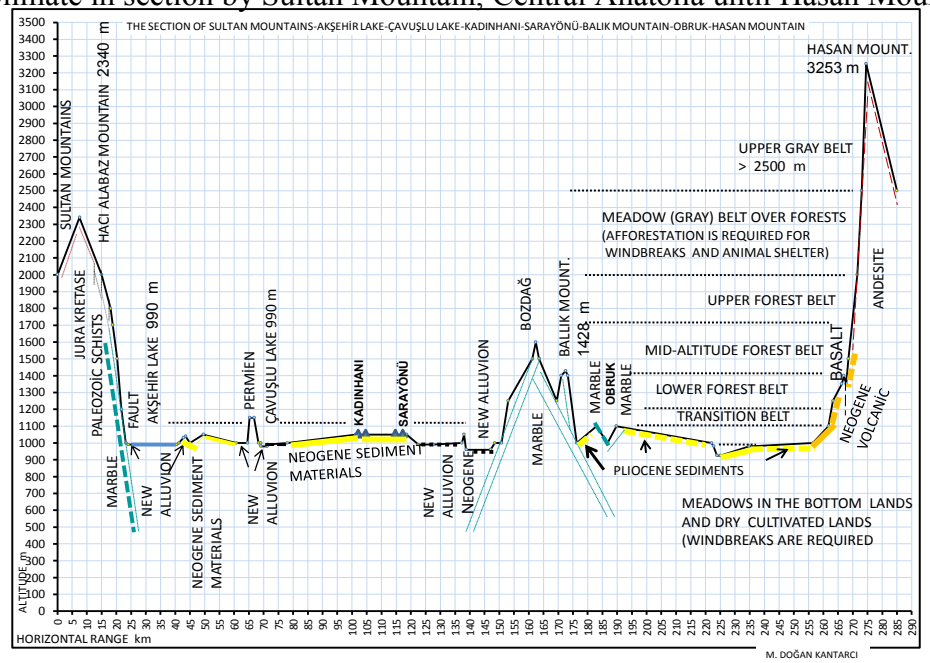


Figure 1. The relations between the geomorphological, geological structure and vertical zonal Climate in section by Sultan Mountain, Central Anatolia until Hasan Mount



2.2. THE METEOROLOGICAL STATIONS AND THEIR MEASUREMENTS IN KONYABASIN

The average temperature and precipitation values of Konya, Karapınar and Ereğli measuring stations are given as an example of periodic climate change (Figure 1, 2, 3).
The temperature - and precipitation averages are given in four periods 1929-1970, 1970-1982, 1983-1993, 1994-2008. Because between the years 1982-1992 are erupting 5 volcanoes and their exhaust and Grayling have been reached about 10 000 m to the Stratosphere. This volcanic gases and Grayling in the Stratosphere have absorbed and reflexiert the radiation from the Sun to the part the part and the temperature of the Earth is about 1 C ° low measured. In comparison the temperature values which show period 1929-1970 and 1994-2008 increased the temperature (Figure 2, 3, 4). However, the precipitation values are not increased. The Ewaporation of water surface in Konya and Niğde are also increased (Fig.5-6). Unfortunately in the other stations the Evaporations are not measured.

2.3. THE VERTICAL/ZONAL CLIMATE BELTS

Konya basin the average temperature values reduce in about 0.5 C ° after each 100 m boost. However, the rainfall and snowfall will increase and also to reduce the Evaporations values. These relationships are calculated between Konya and Hadim climate stations. The values of temperature, precipitation a.o. changed after the exposure of the mountain slopes and the effect of the inner Lakes. The climatic differences of the mountain slopes depending on the altitude and exposure cannot determine with the meteorological measurements. Are climatic variations in the mountains with the tree and shrub species in forests and bushes and growth of tree species in reforestation areas are explored. According to this research, the vertical/zonal belt have been divided (Map 2, Fig. 1.).

3.WİND EROSION AND THE WINDBREAKS TO DRY WIND EFFECTS

3.1. WIND EROSION

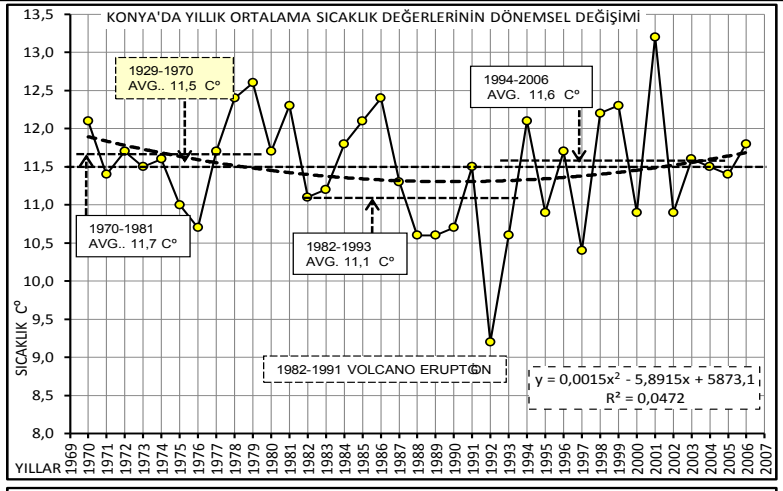
Dominant wind directions are North and South in Konyabasin. The dry air masses come from both directions. In summer months, the north winds are dominant. The southerly winds blow over Northern winds in winter months (Fig. 14). Depending on the speed of the winds wariiert they also transportation power Fig.8). The soil surface is dry and the pasture plants cover less space due to the grazing during summer months. Therefore, the wind erosion is is even clearer in summer (Fig.7, 8, 9, 10). In order to reduce wind erosion get very important reforestation in the previous years (See; Özdoğan, N. 1976, Palta, Ç. At al. 2010, Kantarcı, M. D. At al. 2011/1, 2 ve 2012).

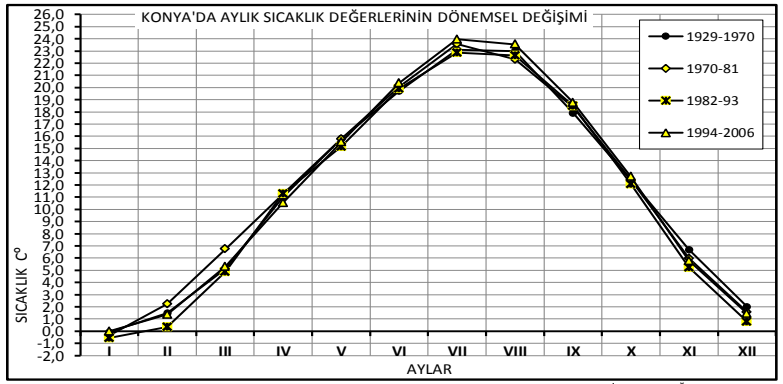
3.2. WINDBREAKS AND THEIR EFFECTS ON THE SPEED OF THE WIND

By increasing the temperature is the drying of soil and wind erosion increase and expands. The dry winds blowing on the floor surface will quickly dry the floor. This means the irrigation water is evaporates faster and the Salt accumulation will arrive in the topsoil.
The forests and windshield prevent the effects of the dry winds. The province of Kadınhanı in the State agricultural area 270 km of windbreaks are created since year 1970 (Fig. 11).

Figure 2.1. Periodical changes in monthly and annual Temperature rates in Konya

KONYA 1028 m	YILLIK AVG. C°
1970	12,1
1971	11,4
1972	11,7
1973	11,5
1974	11,6
1975	11,0
1976	10,7
1977	11,7
1978	12,4
1979	12,6
1980	11,7
1981	12,3
1982	11,1
1983	11,2
1984	11,8
1985	12,1
1986	12,4
1987	11,3
1988	10,6
1989	10,6
1990	10,7
1991	11,5
1992	9,2
1993	10,6
1994	12,1
1995	10,9
1996	11,7
1997	10,4
1998	12,2
1999	12,3
2000	10,9
2001	13,2
2002	10,9
2003	11,6
2004	11,5
2005	11,4
2006	11,8





PERIODICAL CHANGES IN MONTHLY TEMPERATURE RATES IN KONYA

DÖNEMLER	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YILIK ORT. C°
						AYLAR							
1929-1970	**-0,1**	**1,5**	**5,1**	**11,0**	**15,8**	**19,7**	**23,1**	**23,0**	**17,9**	**12,4**	**6,7**	**2,0**	**11,5**
1970-1981	-0,3	2,2	6,7	11,3	15,8	20,1	23,6	22,3	18,4	12,4	6,0	1,6	11,7
1982-1993	-0,6	0,4	4,9	11,3	15,2	19,9	22,9	22,6	18,5	12,1	5,2	0,8	11,1
1994-2006	0,0	1,4	5,3	10,6	15,5	20,4	24,0	23,6	18,8	12,7	5,8	1,4	11,6

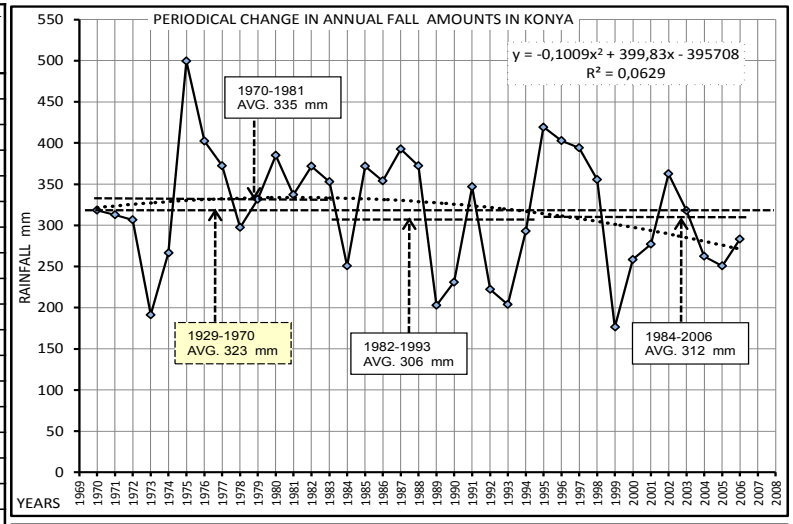
KAYNAK: Devlet Meteoroloji İşleri Gnl. Md'lüğ verilerinden derlenip, düzenlenmiştir.

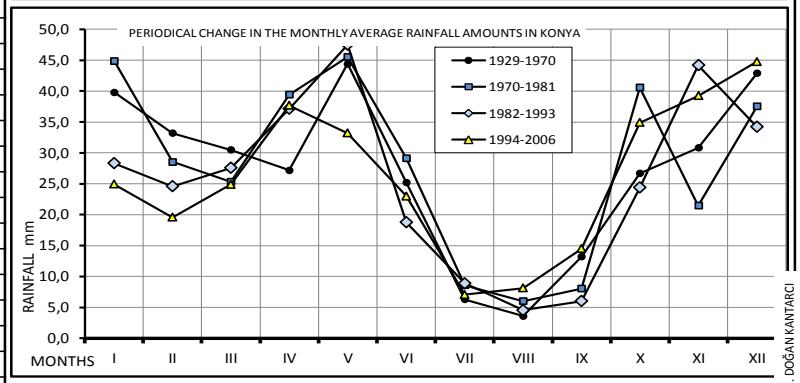
1975 TOLBACHİK YANARDAĞI-KAMÇATKA
1975 PAVLOF YANARDAĞI-ALASKA
1982 EL CHİCON YANARDAĞI (MEKSİKA)
1982 NEVADO DELRUİZ (KOLOMBİYA)
1986 AUGUSTİN ALASKA
1991 UNZEN YANARDAĞI (GÜNEY JAPONYA)
1991 PİNATUBO YANARDAĞI (FİLİPİNLER)
OCAK-ŞUBAT 1991 I. KÖRFEZ SAVAŞI KUVEYT PETROL KUYULARI YANGINI
1994 TAVURVUR YANARDAĞI-METAPİT ADASI
1996 PAPUA YENİ GİNE YANARDAĞI
1997 OLMOK CALDERA YANARDAĞI-ALASKA
2002 PAGO YANARDAĞI
2004 BAGANA YANARDAĞI
2006 TAVURVUR YANARDAĞI-METAPİT ADASI

M. DOĞAN KANTARCI

Figure 2.2. Periodical change ın the monthly average and annual Total rainfall amounts in Konya

KONYA 1028 m	ANNUAL FALL
1970	318,4
1971	312,8
1972	306,6
1973	191,3
1974	266,2
1975	499,5
1976	402,2
1977	372,5
1978	297,5
1979	331,4
1980	384,8
1981	337,1
1982	371,8
1983	353,0
1984	250,7
1985	371,9
1986	353,8
1987	392,6
1988	372,1
1989	202,6
1990	231,0
1991	346,7
1992	222,2
1993	203,6
1994	293,1
1995	419,3
1996	402,8
1997	394,3
1998	355,4
1999	176,1
2000	258,5
2001	277,0
2002	362,6
2003	317,6
2004	262,5
2005	250,5
2006	283,0





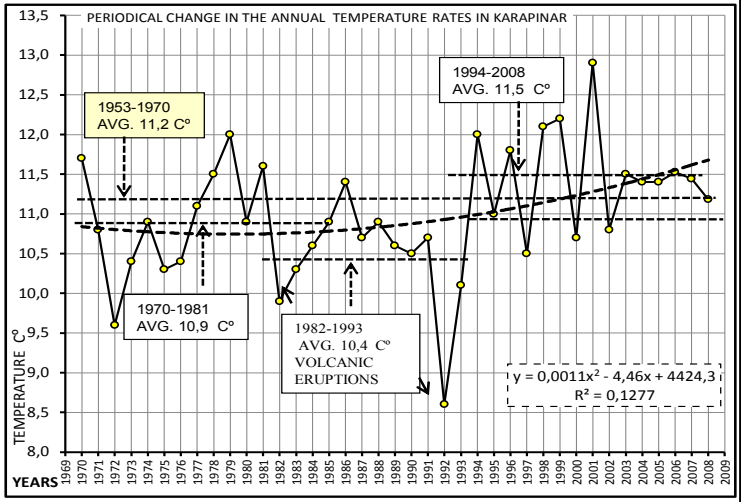
M. DOĞAN KANTARCI

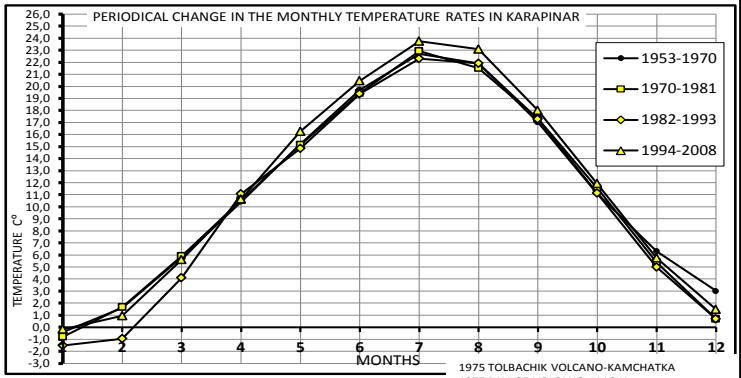
PERIODICAL CHANGE IN THE MONTHLY AVERAGE RAINFALL AMOUNTS IN KONYA

PERIODS	MONTHS I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ANNUAL TOTAL . mm
1929-1970	39,8	33,2	30,5	27,2	44,4	25,2	6,3	3,6	13,2	26,7	30,8	42,9	323,9
1970-1981	44,9	28,5	25,3	39,4	45,5	29,1	8,6	6,0	8,0	40,6	21,5	37,6	335,0
1982-1993	28,3	24,6	27,6	37,1	47,5	18,8	8,9	4,5	6,0	24,4	44,2	34,2	306,0
1994-2006	24,9	19,5	24,9	37,6	33,2	23,0	7,1	8,1	14,5	34,9	39,2	44,7	311,7

Figure 3.1. Periodical changes in monthly and annual Temperature rates in Karapınar

KARAPINAR 1004 m	ANNUAL AVG. C°
1970	11,7
1971	10,8
1972	9,6
1973	10,4
1974	10,9
1975	10,3
1976	10,4
1977	11,1
1978	11,5
1979	12,0
1980	10,9
1981	11,6
1982	9,9
1983	10,3
1984	10,6
1985	10,9
1986	11,4
1987	10,7
1988	10,9
1989	10,6
1990	10,5
1991	10,7
1992	8,6
1993	10,1
1994	12,0
1995	11,0
1996	11,8
1997	10,5
1998	12,1
1999	12,2
2000	10,7
2001	12,9
2002	10,8
2003	11,5
2004	11,4
2005	11,4
2006	11,5
2007	11,4
2008	11,2





PERIODICAL CHANGE IN THE MONTHLY TEMPERATURE RATES IN KARAPINAR

PERIODS	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ANNUAL AVG.
1953-1970	-0,4	1,6	5,8	10,4	15,2	19,7	22,7	21,9	17,0	11,1	6,3	3,0	11,2
1970-1981	-0,8	1,7	5,9	10,5	15,1	19,5	22,9	21,5	17,3	11,6	5,4	0,7	10,9
1982-1993	-1,5	-1,0	4,1	11,1	14,9	19,4	22,3	21,9	17,3	11,1	5,0	0,7	10,4
1994-2008	-0,2	0,9	5,6	10,6	16,3	20,5	23,7	23,1	18,0	11,9	5,7	1,5	11,5

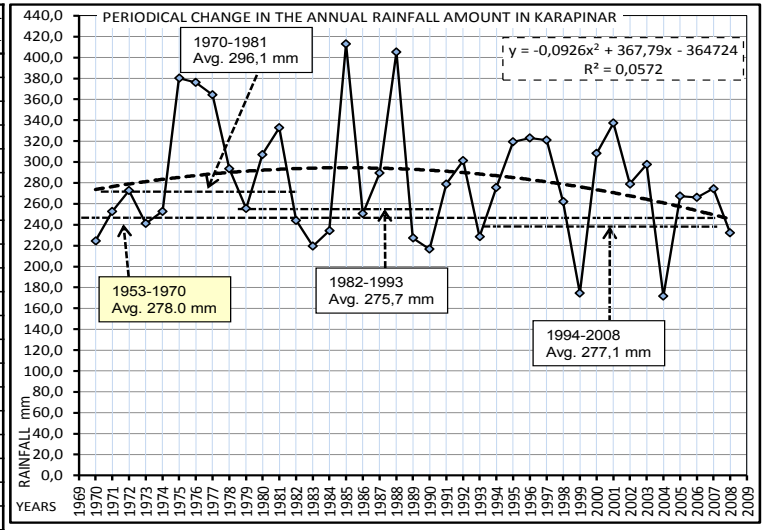
KAYNAK: Devlet Meteoroloji İşleri Gnl. Md'lüğü verilerinden derlenip, düzenlenmiştir.

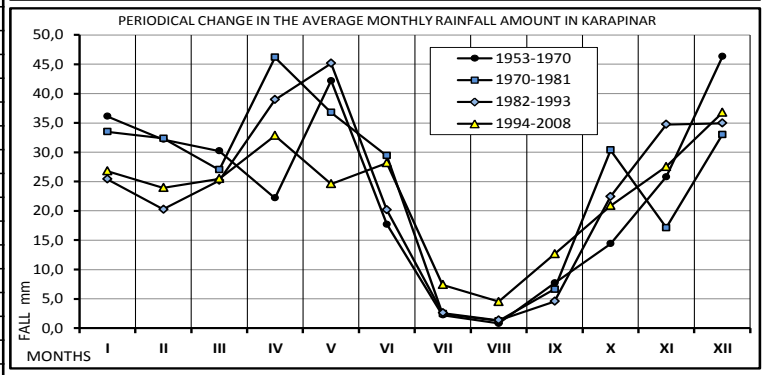
1975 TOLBACHIK VOLCANO-KAMCHATKA
1975 PAVLOF VOLCANO-ALASKA
1982 EL CHİCON VOLCANO (MEXICO)
1982 NEVADO DELRUİZ (COLOMBIA)
1986 AUGUSTIN ALASKA
1991 UNZEN YVOLCANO (SOUTHERN JAPAN)
1991 PİNATUBO VOLCANO (PHILIPPINES)
JANUARY-FEBRUARY 1991 i.GULF WAR KUWAIT PETROLEUM WELLS FIRE
1994 TAVURVUR VOLCANO-METAPİT ISLAND
1996 PAPUA NEW GUINEA VOLCANO
1997 OLMOK CALDERA VOLCANO-ALASKA
2002 PAGO VOLCANO
2004 BAGANA VOLCANO
2006 TAVURVUR VOLCANO-METAPİT ISLAND

M. DOĞAN KANTARCI

Figure 3.2. Periodical changes in the average monthly and Annual rainfall amounts in Karapınar

KARAPINAR 1004 m	ANNUAL RAINFALL
1970	224,3
1971	252,7
1972	272,5
1973	241,0
1974	252,8
1975	380,2
1976	376,3
1977	364,3
1978	293,5
1979	255,3
1980	307,2
1981	332,9
1982	244,2
1983	219,3
1984	234,1
1985	412,9
1986	250,5
1987	289,5
1988	405,2
1989	227,2
1990	216,6
1991	279,0
1992	301,1
1993	228,3
1994	275,4
1995	319,4
1996	322,8
1997	321,0
1998	262,1
1999	174,3
2000	308,2
2001	337,2
2002	279,0
2003	297,6
2004	171,6
2005	267,2
2006	266,0
2007	274,5
2008	232,1





PERIODICAL CHANGE IN THE MONTHLY RAINFALL AMOUNTS IN KARAPINAR

PERIODS	MONTHS I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ANNUAL TOTAL. mm
1953-1970	36,1	32,2	30,2	22,2	42,2	17,7	2,2	0,8	7,7	14,4	25,8	46,3	278,0
1970-1981	33,5	32,4	27,0	46,2	36,8	29,4	2,5	1,2	6,6	30,4	17,1	33,0	296,1
1982-1993	25,4	20,3	25,2	38,9	45,1	20,2	2,6	1,3	4,6	22,4	34,8	34,9	275,7
1994-2008	26,8	23,9	25,5	32,8	24,6	28,1	7,4	4,5	12,7	20,9	27,6	36,7	271,5

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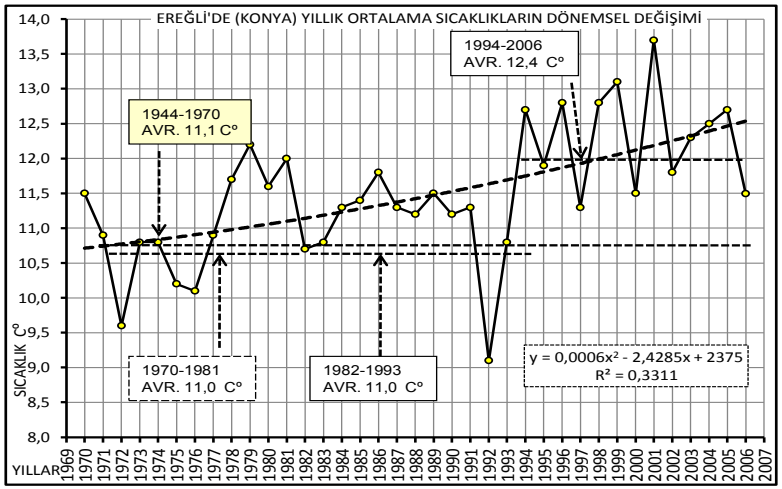
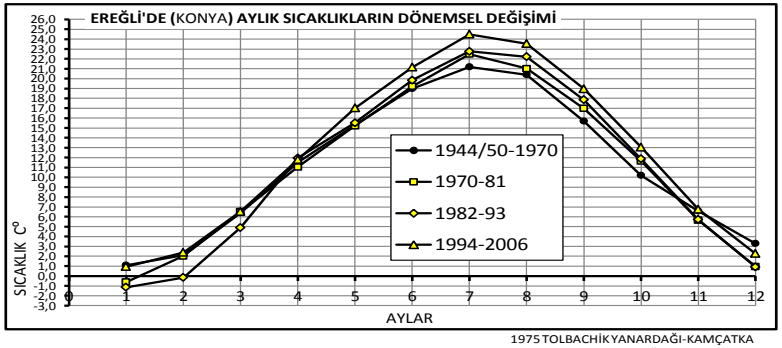
Figure 4.1. Periodical changes in monthly and annual Temperature rates in Ereğli

EREĞLİ 1044 m	ANNUAL AVG.
1970	11,5
1971	10,9
1972	9,6
1973	10,8
1974	10,8
1975	10,2
1976	10,1
1977	10,9
1978	11,7
1979	12,2
1980	11,6
1981	12,0
1982	10,7
1983	10,8
1984	11,3
1985	11,4
1986	11,8
1987	11,3
1988	11,2
1989	11,5
1990	11,2
1991	11,3
1992	9,1
1993	10,8
1994	12,7
1995	11,9
1996	12,8
1997	11,3
1998	12,8
1999	13,1
2000	11,5
2001	13,7
2002	11,8
2003	12,3
2004	12,5
2005	12,7
2006	11,5





PERIODICAL CHANGES IN MONTHLY TEMPERATURE RATES IN EREĞLİ

PERIODS	MONTHS I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ANNUAL AVR.
1944/50-1970	1,1	2,1	6,4	11,5	15,3	19,0	21,2	20,4	15,7	10,2	6,6	3,3	11,1
1970-1981	-0,6	2,0	6,5	11,1	15,2	19,2	22,5	21,0	17,0	11,7	5,7	1,0	11,0
198219-93	-1,1	-0,2	4,9	12,0	15,5	19,9	22,8	22,2	17,9	11,9	5,7	0,9	11,0
1994-2006	1,0	2,4	6,5	11,8	17,0	21,1	24,5	23,6	19,0	13,1	6,8	2,3	12,4

1975 TOLBACHİK YANARDAĞI-KAMÇATKA
1975 PAVLOF YANARDAĞI-ALASKA
1982 EL CHİCON YANARDAĞI (MEKSİKA)
1982 NEVADO DELRUİZ (KOLOMBİYA)
1986 AUGUSTİN ALASKA
1991 UNZEN YANARDAĞI (GÜNEY JAPONYA)
1991 PİNATUBO YANARDAĞI (FİLİPİNLER)
OCAK-ŞUBAT 1991 İ. KÖRFEZ SAVAŞI KUVEYT PETROL KUYULARI YANGINI
1994 TAVURVUR YANARDAĞI-METAPİT ADASI
1996 PAPUA YENİ GİNE YANARDAĞI
1997 OLMOK CALDERA YANARDAĞI-ALASKA
2002 PAGO YANARDAĞI
2004 BAGANA YANARDAĞI
2006 TAVURVUR YANARDAĞI-METAPİT ADASI

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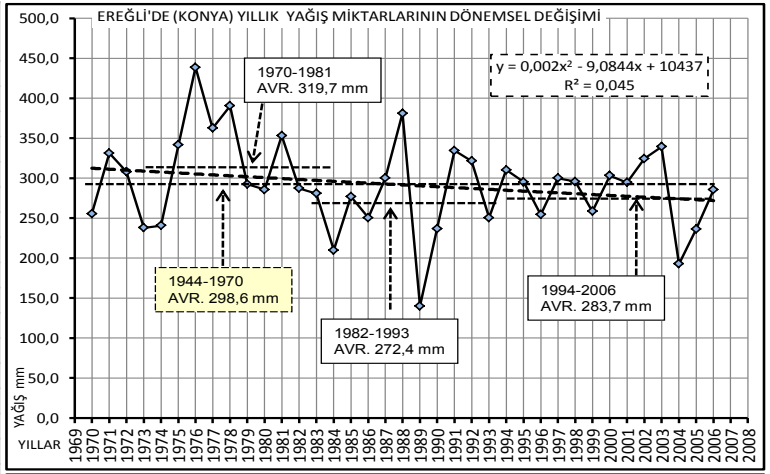
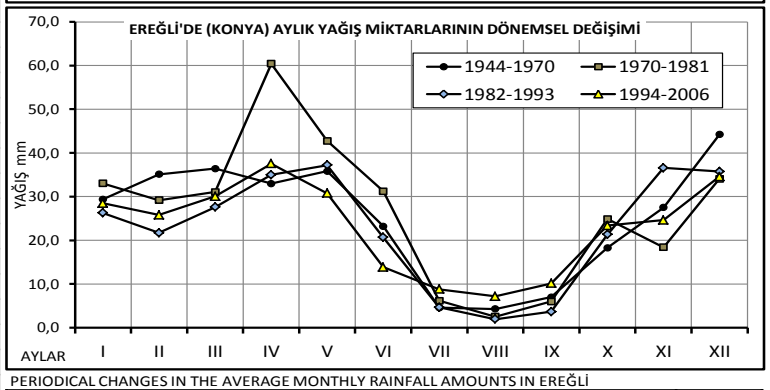
Figure 4.2. Periodical changes in the average monthly and Annual rainfall amounts in Ereğli

EREĞLİ 1044 m	ANNUAL SUMME mm
1970	255,5
1971	331,3
1972	307,9
1973	237,8
1974	240,5
1975	341,4
1976	438,5
1977	362,5
1978	390,4
1979	292,3
1980	285,5
1981	353,2
1982	287,1
1983	280,8
1984	209,7
1985	276,9
1986	250,4
1987	300,1
1988	380,9
1989	140,0
1990	236,6
1991	334,4
1992	321,4
1993	250,4
1994	310,2
1995	295,1
1996	254,2
1997	299,9
1998	295,5
1999	258,4
2000	303,1
2001	294,4
2002	324,4
2003	339,2
2004	192,7
2005	235,9
2006	285,4





PERIODICAL CHANGES IN THE AVERAGE MONTHLY RAINFALL AMOUNTS IN EREĞLİ

PERIODS	MONTHS I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YILLIK TOPL. mm
1944-1970	29,4	35,1	36,4	33,0	35,8	23,2	4,6	4,3	7,0	18,3	27,5	44,2	298,6
1970-1981	33,0	29,2	31,1	60,4	42,7	31,2	6,2	2,5	6,0	24,9	18,4	34,1	319,7
1982-1993	26,3	21,7	27,6	35,0	37,2	20,7	4,7	2,0	3,7	21,4	36,6	35,7	272,4
1994-2006	28,5	25,8	30,1	37,5	30,8	13,8	8,8	7,2	10,1	23,4	24,6	34,6	283,7

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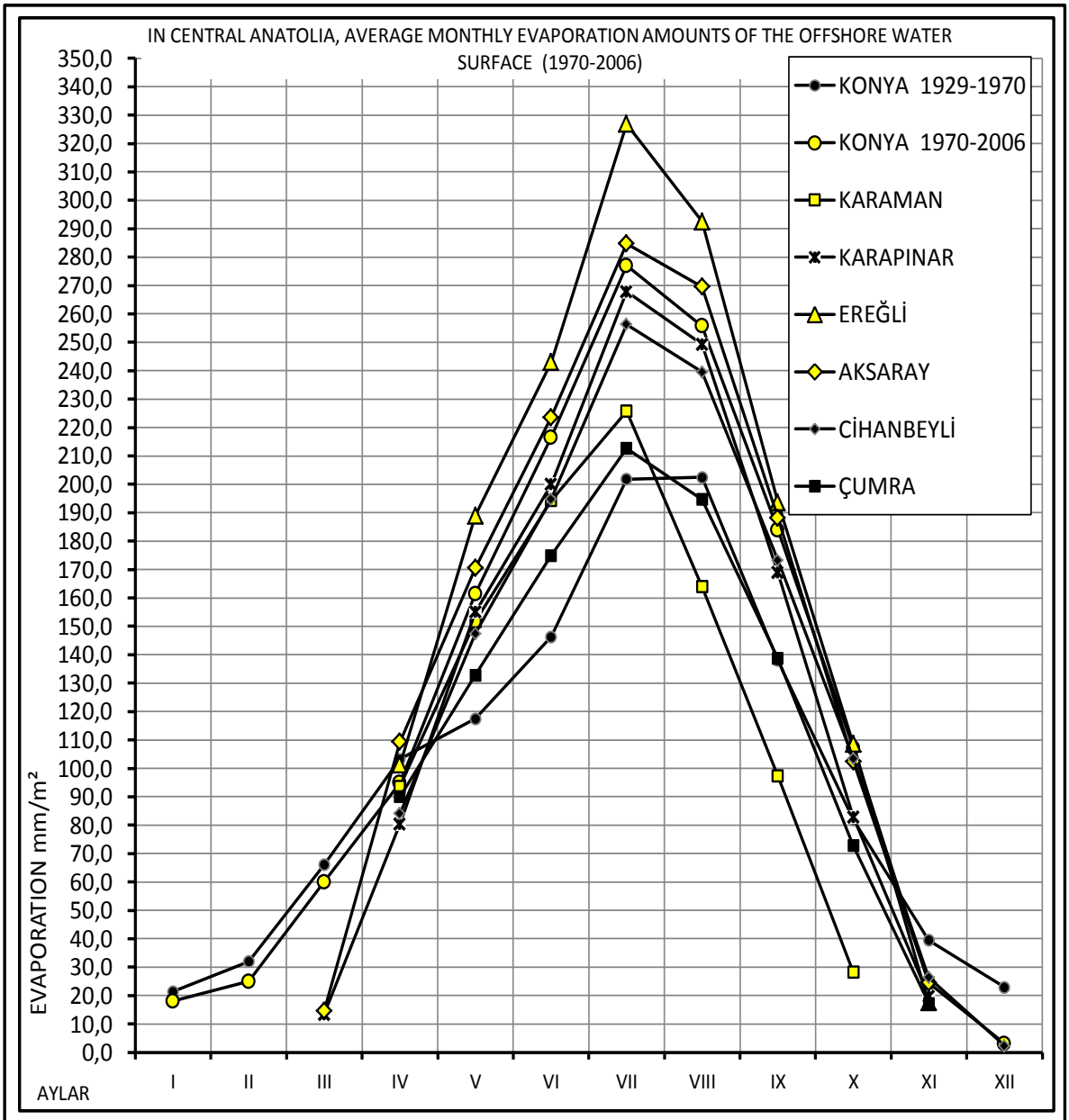
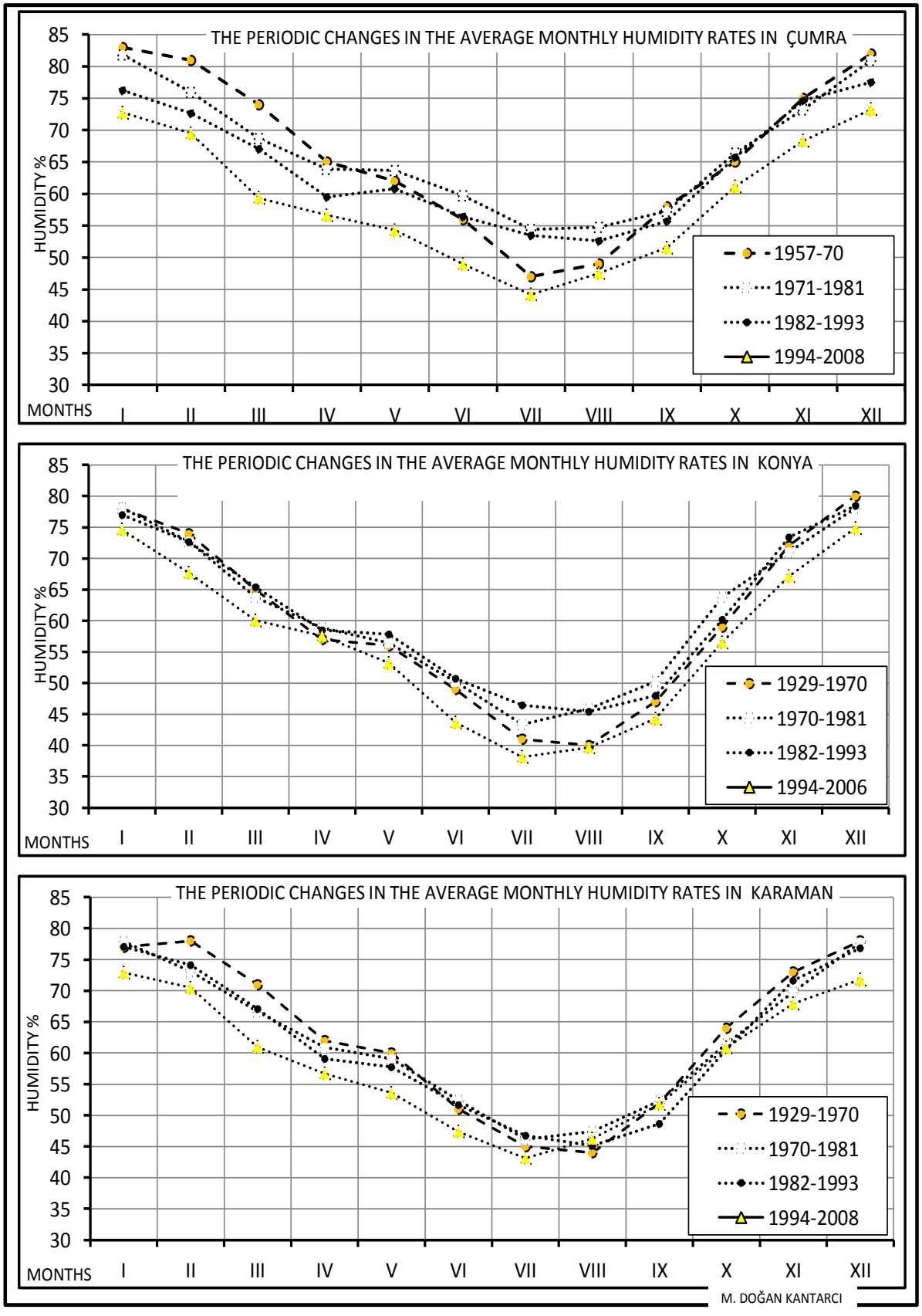
Figure 5. In Central Anatolia, monthly and annual average evaporation amounts (1970-2006)



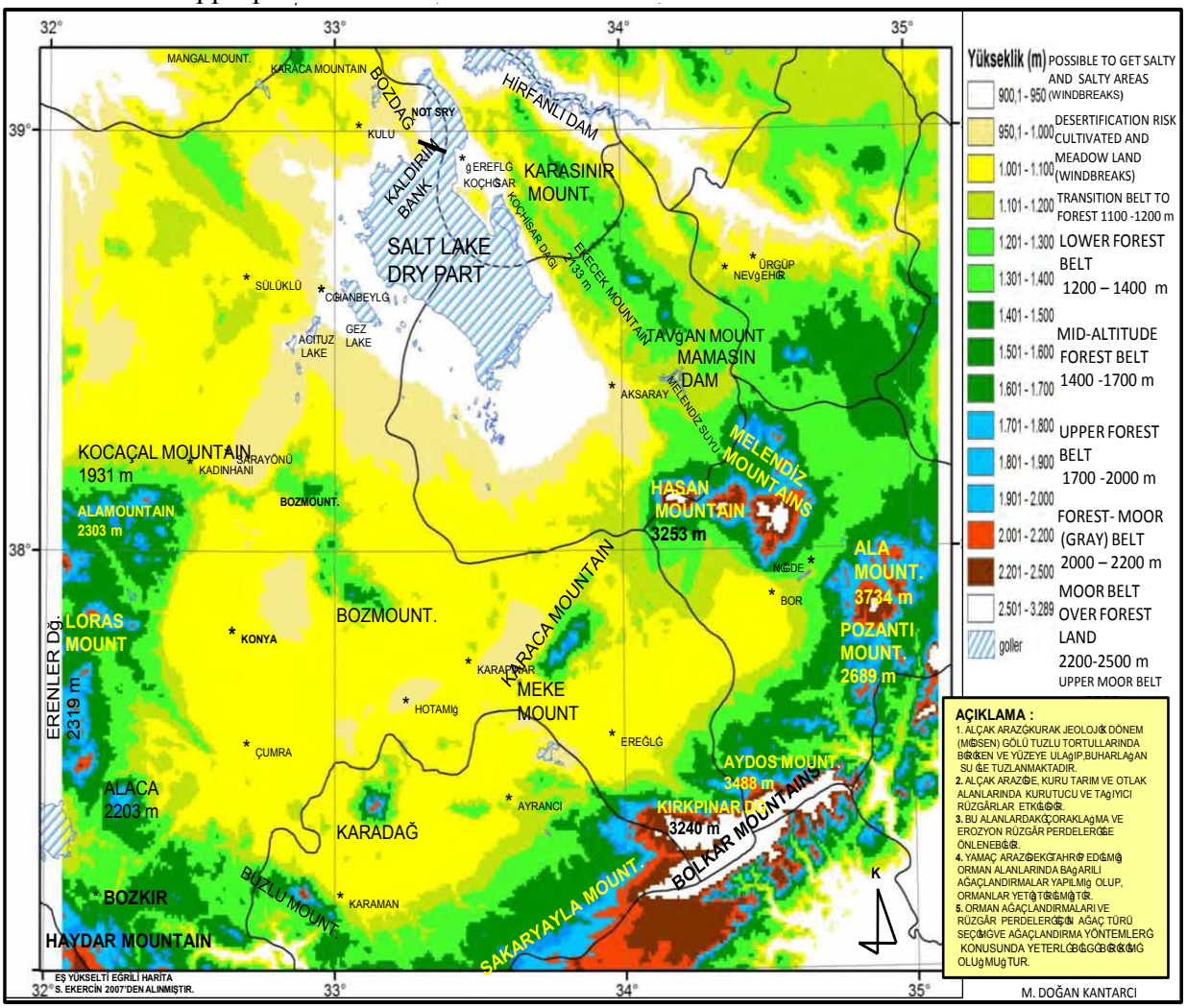
		AVERAGE MONTHLY EVAPORATION (mm/m²)												5 SUMMER MONTHS TOTAL	ANNUAL TOTAL mm
STATION	MONTHS	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
KONYA	1929-1970	21,4	32,0	66,1	103,2	117,5	146,3	201,8	202,5	138,0	81,9	39,5	22,9	806,1	1186,7
KONYA	1970-2006	18,0	25,0	60,0	94,9	161,5	216,5	277,0	255,7	183,9	107,2	24,4	3,1	1094,6	2521,8
FARK														288,5	1335,1
KARAMAN	1970-2006				93,7	151,7	194,3	225,8	164,0	97,3	28,2			833,1	955,0
KARAPINAR	1970-2006			13,4	80,4	155,0	199,9	267,8	249,3	168,9	82,8	19,7		1040,9	1237,2
EREĞLİ	1970-2006				101,3	189,0	243,0	326,9	292,5	193,7	108,6	17,6		1245,1	1472,6
AKSARAY	1930-1970			14,6	109,3	170,5	223,6	284,8	269,6	188,2	102,5	24,6		1136,7	1387,7
CİHANBEYLİ	1970-2006				84,0	147,4	194,8	256,3	239,5	173,3	103,4	26,4	2,3	1011,3	2238,7
ÇUMRA	1970-2006				90,0	132,8	174,9	212,7	194,7	138,7	72,8	17,3		853,8	1033,9

KAYNAK:Meteoroloji Gnl.Md'lüğü ölçmelerinden derlenip, değerlendirilmiştir. M. DOĞAN KANTARCI

Figure 6. In Central Anatolia steppe, the periodic changes in the average Monthly humidity rates in Çumra, Konya and Karaman



Map 2. Altitude of Konya basın / Climate belts, dry agriculture lands, meadows and Lands appropriate for afforestation.



In these windbreaks of forest tree species of Pinus nigra, Cedrus libani, Robinia pseudoacacia, Ulmus campestre planted. About a part of windbreaks (planting year 1987), which is measured growth of the trees and their effect on the wind speed between 5-7.10.2013 (Table 1). According to these measurements, the windshield can reduce the wind speed up to 60-80 m (Fig. 12-13). To prevent the effects of the wind through the fields and pastures, the cultivation is the windscreen lining with distance 70 m and fit with the width of 30 m (Fig. 14).

In these windbreaks Cedrus of forest tree species of Pinus nigra, libani, Robinia pseudoacacia, Ulmus campestre planted. About a part of windbreaks (planting year 1987), which is measured growth of the trees and their effect on the wind speed between 5-7.10.2013. According to these measurements, the windshield can reduce the wind speed up to 60-80 m. To prevent the effects of the wind through the fields and pastures, the cultivation is the windscreen lining with distance 70 m and fit with the width of 30 m. In these windbreaks Cedrus of forest tree species of Pinus nigra, libani, Robinia pseudoacacia, Ulmus campestre planted. About a part of windbreaks (Planting year 1987), which is measured growth of the trees and their effect on the wind speed between 5-7.10.2013. According to these measurements, the windshield can reduce the wind speed up to 60-80 m. To prevent the effects of the wind through the fields and pastures, the cultivation is the windscreen lining with distance 70 m and fit with the width of 30 m.

Figure 7. Wind erosion in Karapınar Plain (In front plan to view the road clear, but in back is the mountain (Karacadağ) invisible behind the clouds of dust.)

Figure 8. Wind speeds that could bear the dust and sand grains in different diameters

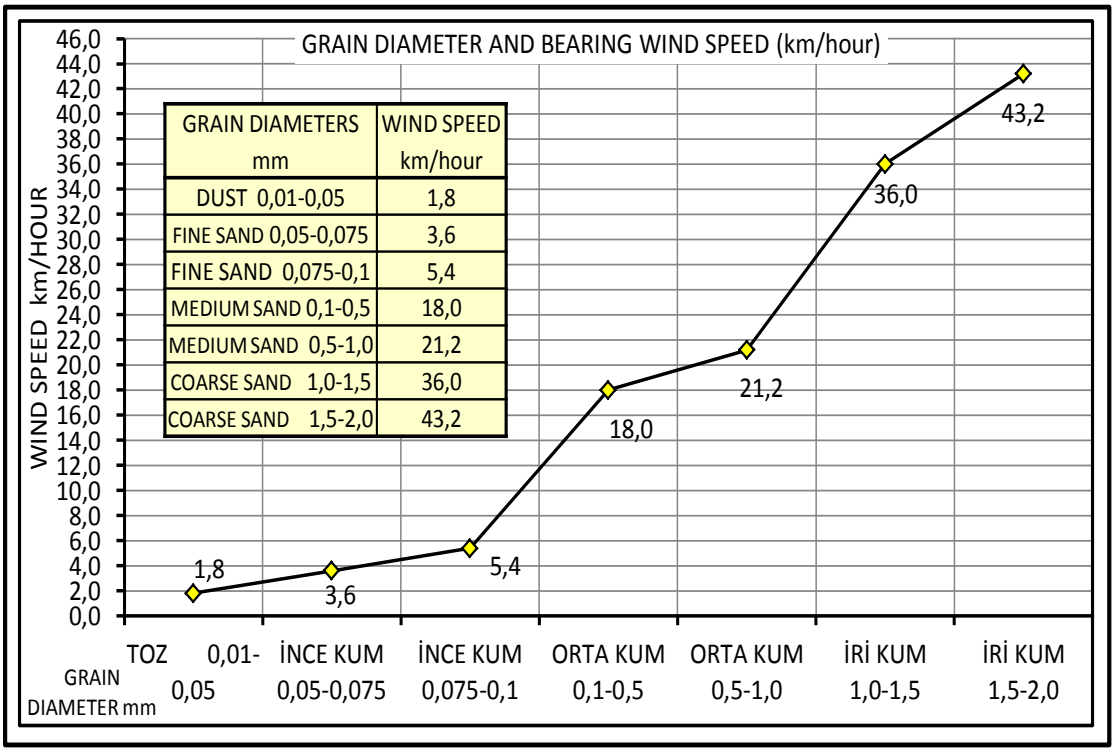


Figure 9. In Derekumca Plateau (28.11.2011) the soil is removed by the North wind and the root of the apricot tree have remained open on the floor.

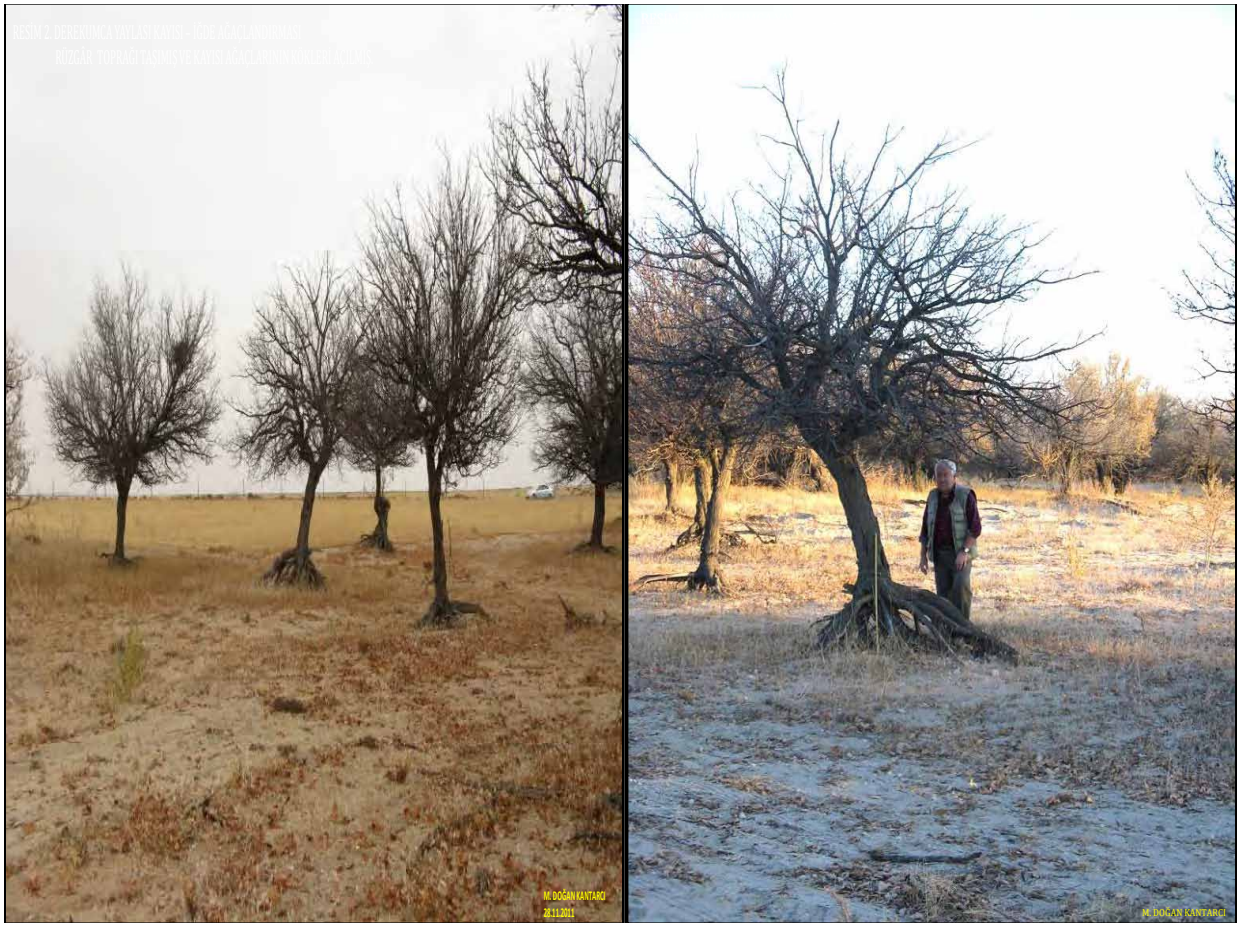


Figure 10. By excessive grazing the wormwood left plants and pay the fine particles of the soil the dry winds

Figure 11. The Pinus nigra and Ulmus campestre trees in a Windbreak grazing at State agricultural area Altınova (October 2013)

Table 1. The growth of the 5 Pinus nigra as sample trees in wind protection stiff in Altınova

YEARS	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Pinus nigra-1	5	15	40	63	92	130	163	213	251	292	330	361	390	425	470	510	555	600	645	685	735	780	825	870	915	955	1000
Fallen tree Pn-32	5	20	65	85	105	133	174	238	288	346	400	460	520	575	623	658	693	740	765	803	835	855	885	920	950	985	1020
Fallen tree Pn-63	5	10	26	38	49	60	81	107	134	177	215	258	293	320	346	380	405	445	462	477	497	520	545	565	585	605	630
Broken tree Pn-39	5	12	30	61	88	144	182	218	256	310	370	430	485	530	580	620	650	685	720	735	750	770	800	825	850	870	890
Broken tree Pn-40	5	10	33	53	70	103	138	180	215	246	290	333	367	394	420	450	470	495	520	535	550	570	595	615	630	650	670

Figure 12. Comparison of annual growth from 5 Pinus nigra as sample trees in wind

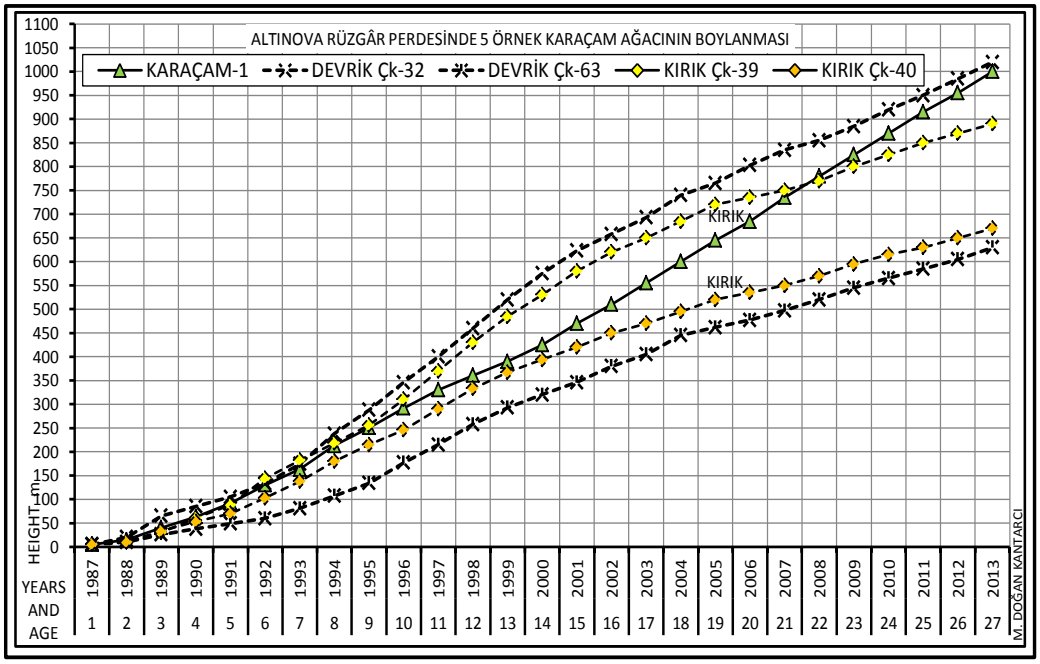


Figure 13 . North-East Section and wind speed in wind protection stripe in Altınova (Measurement date 6.10.2013) (Leaves of Ulmus Campestre are not fallen.)

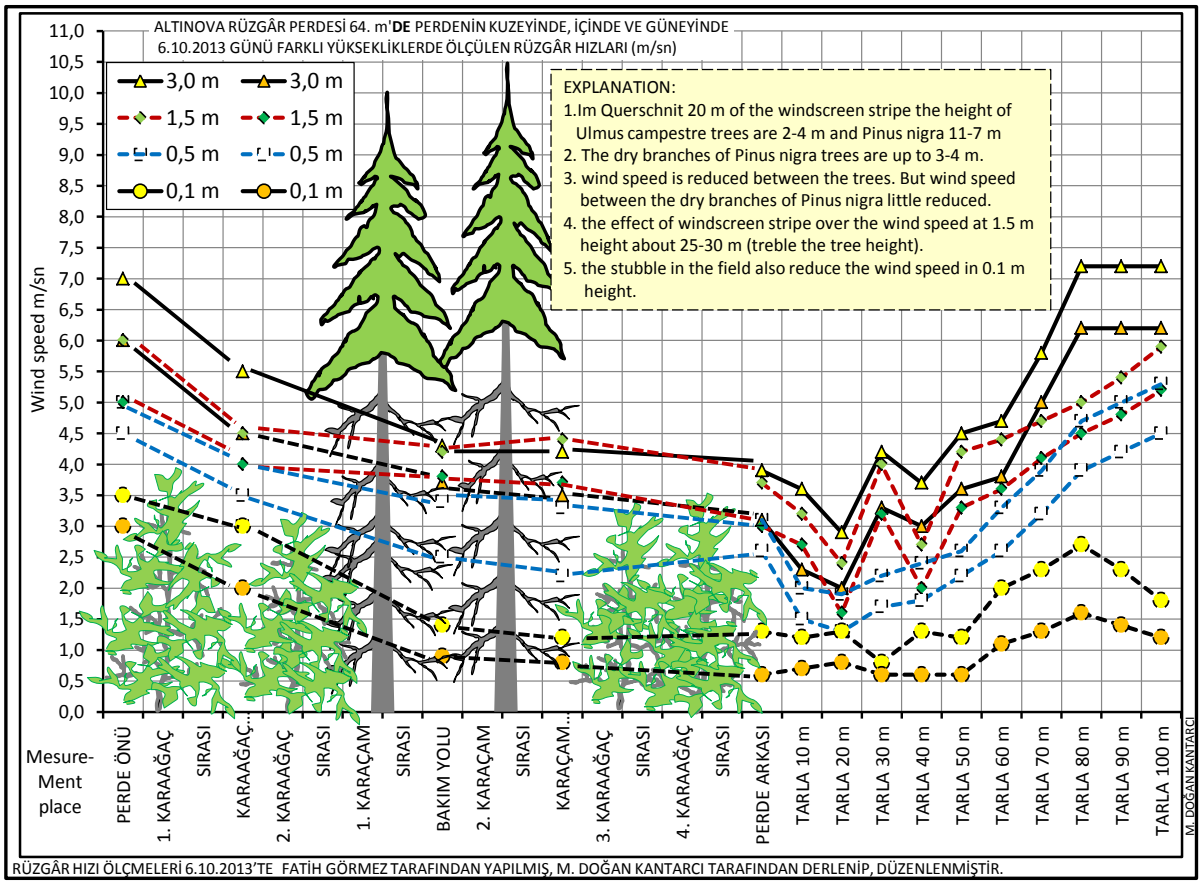
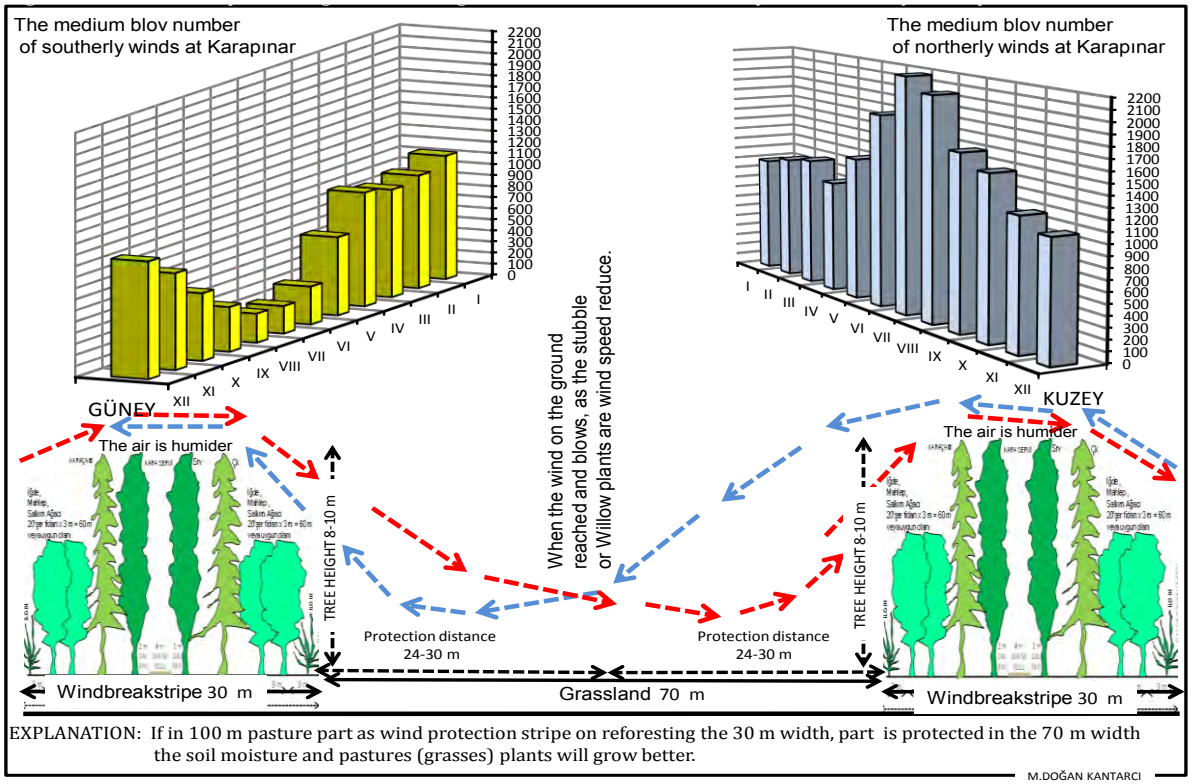


Figure 14. Windbreak stripe model against the damage effects of the North and southerly winds in vicinity of Karapınar



4.CONCLUSIONS

Global climate change has been considered in Central Anatolia than the warming, dryness, and desertion. The water is hard or salty to the part and limited. Also the soils are calcareous place way salty. Due to the strong Evaporation, Salt accumulation is in topsoil place way. Reducing the speed of the dry, warm winds will also decrease evaporation on soil and transpiration on the plants.

The old plantations as forest and Windbreak stiffeners give sufficient teaching materials to creating new plantations. The time is not enough to the new afforestation against dry wind effects and desertion in Central Anatolia.

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A SUSTAINABLE AND MORE INDEPENDENT ENERGY POLICY ALTERNATIVE FOR TURKEY

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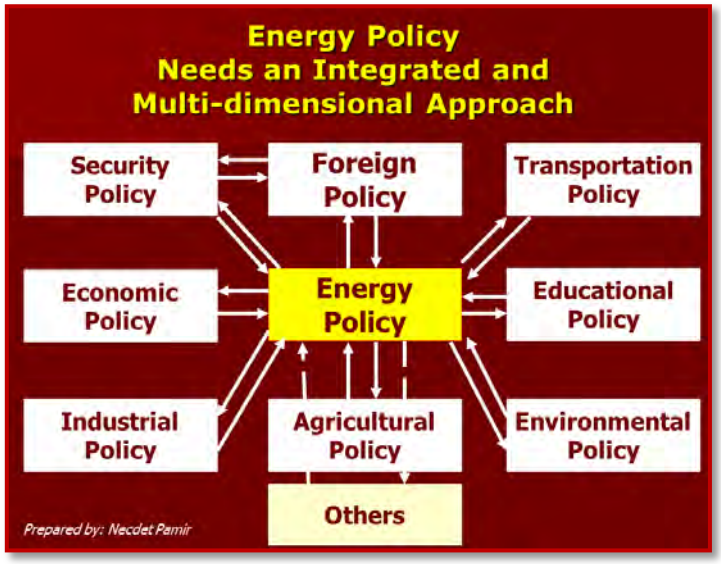
Introduction

Ensuring access to affordable, uninterrupted, reliable and modern energy means is essential for sustainable development and moreover is a human right. Therefore, energy policies should be designed and implemented in parallel with such objectives.

Today, energy issues touch all sectors of the society: Economy, employment, transport, housing, environment, foreign policy, peace and security – only to name a few. The goal of a modern Energy Policy must therefore be to connect all these areas in an integrated approach and to design energy policies in a strategic way. The challenges of the 21st century is eventually to render a country more independent from the scarcity of resources and to contribute to the international solution of the climate and energy crises[1].

Diagram 1: Energy Policy needs An Integrated and Multidimensional Approach



For Turkey, important challenges on this way are the diversification of energy sources and energy production based on correct demand estimates. The indigenous and renewable energy sources should be used in maximum possible percentages within the total energy consumption profile. This is not only a necessity for energy independence but also a prerequisite for a cleaner mode of life and for a responsible approach towards the world and future generations.

Energy policies should focus primarily on the benefits and welfare of its citizens. Energy must therefore be provided to all consumers in an ***adequate, timely, affordable, uninterrupted, clean and socially equal way***. In the final run, energy is the essential prerequisite for sustainable development and welfare of the whole society.

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[1] Meeting the New Challenges A Social Democratic Approach to Turkey's Future Energy Policy; Necdet Pamir, July 2012, Friedrich Ebert Stiftung

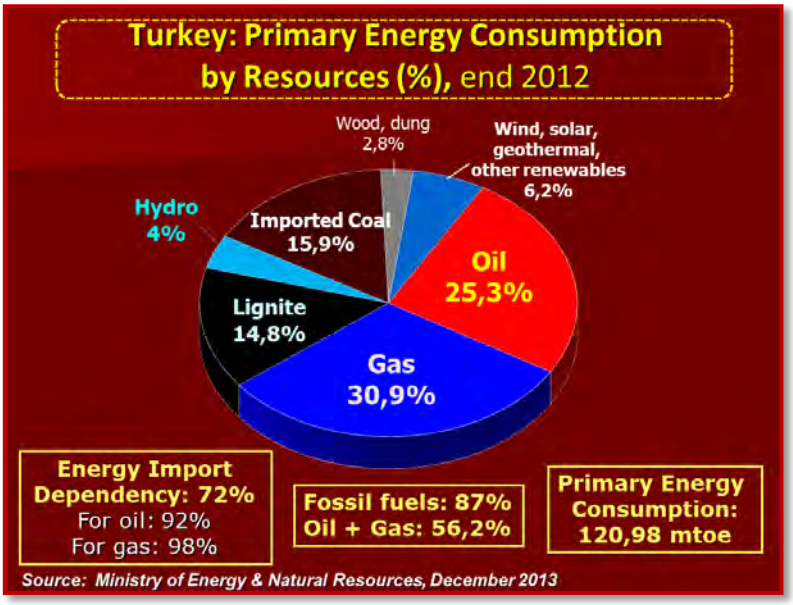
In the first part of this paper, Turkey"s current energy situation will be introduced in a broad manner and analyzed according to the newest available statistical data. The goal is to present the challenges. The second part offers a rational and socially responsible approach for meeting these challenges and shows the ways into a truly sustainable energy future for Turkey.

Turkey's Current Energy Situation – Defining the Challenges

Turkey consumed 120.98 million tons of oil equivalent (mtoe) primary energy in 2012. Electricity consumption has reached 242 billion kWh with a 5 % rise compared to previous year[2]. (In 2013, the increase rate dropped to 1.3%) Dependency to energy imports is in rise and reached to 72% as of 2012[3] while the percentage was 52% in 1990 and 67% in 2000.

Turkey's Primary Energy Consumption

Diagram 2: Turkey's Primary Energy Consumption by Resources, 2012



Turkey"s energy mix (primary energy consumption by sources) in 2012 is as shown in Diagram 2. As can be seen, the share of fossil fuels in total is as high as 87% and, despite claims on the contrary, dependencies both to fossil fuel and imports have a tendency either to continue or even to rise when taking into acccount the new gas and (imported) coal fired plant licences issued by the Energy Market Regulatory Authority (EMRA).

Turkey imports 92% of its oil and 98% of its gas consumption which causes significant vulnerability both in economic and geopolitical terms. Turkey paid US $60.14 billion to oil and gas imports in 2012[4]. This figure is slightly over 25% of our total imports bill and such an economic burden on the budget is not sustainable. Ironically, Turkey has significant indigenous energy resources kept idle due to irrational energy policies.

[2] http://ekonomi.haber7.com/gundem-veriler/haber/972512-elektrik-tuketimi-2012de-yuzde-5-artti

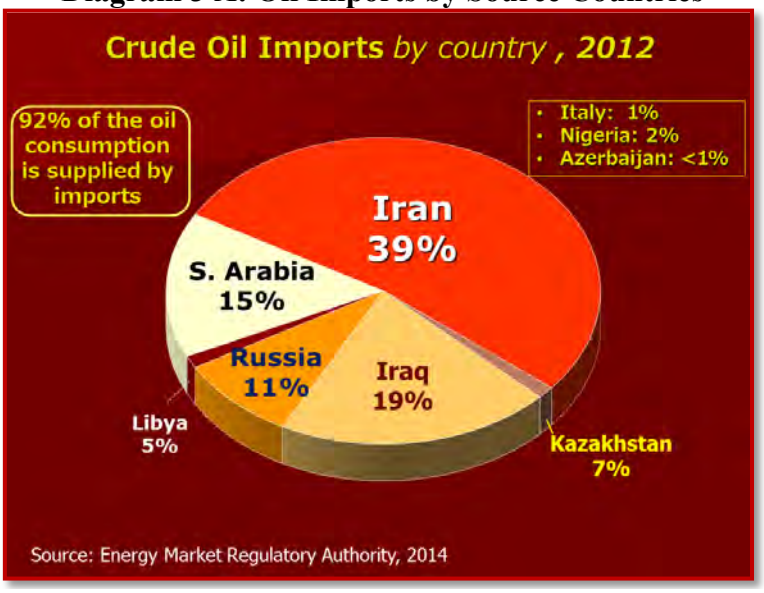
[3] The same rate (72%) in 2013.

[4] The amount dropped to $55.9 billion in 2013, the first decrease in the last decade due to a significant decrease in the rate of energy demand increase.

Energy Import Dependency and Vulnerability

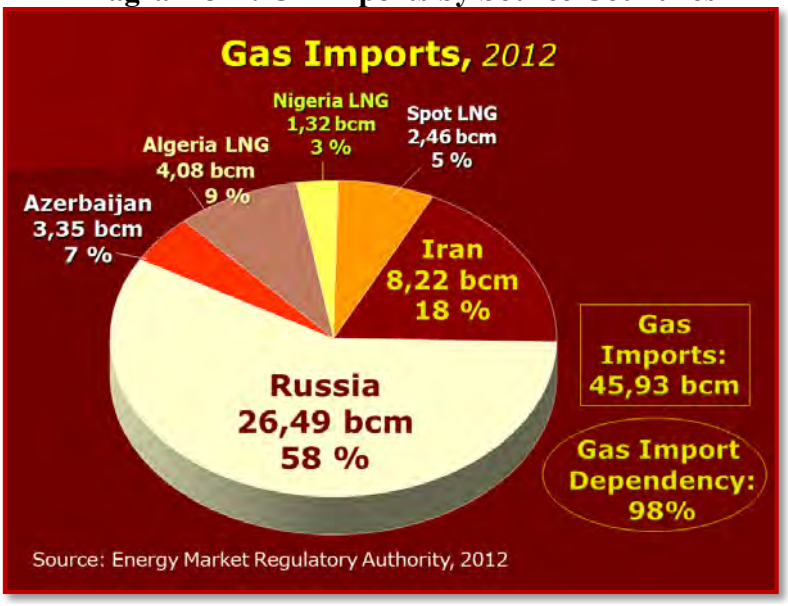
Turkey‟s dependency on energy imports places a heavy burden on the economy and limits the country‟s rational mobility on foreign policy issues. Fifty six percent of Turkey‟s energy consumption is comprised by oil and gas while 92% of oil and 98% of gas is imported.

Diagram 3 A: Oil Imports by Source Countries



Turkey imported 39 percent of its crude from Iran, 19 percent from Iraq and 11 percent from the Russian Federation in 2012. Other countries for oil imports were Kazakhstan, S. Arabia, Libya, Italy and Azerbaijan. Given the foreign policy choices of Turkey, and a total of 69 % dependency specifically to 3 countries (Iran, Iraq and Russia), it is hard to claim that Turkey is secure for its oil imports. Turkey‟s unnecessarily aggressive policy towards Syria, the construction of a NATO missile shield in Kürecik, in the province of Malatya, and the installation of Patriot missiles in Eastern locations have been perceived as direct threats by these 3 countries.

Diagram 3 B: Oil Imports by Source Countries

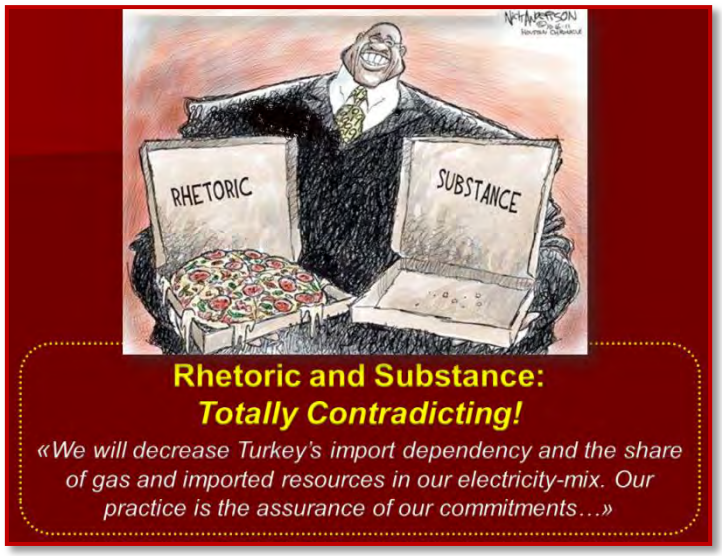


Natural gas is imported from five different countries and also from spot markets (in the form of LNG) in minor volumes. Natural gas consumption in Turkey reached 45.93 billion cubic meters (bcm) in 2012[5]. Of the 45.93 billion cubic meters (bcm) imported, Russia supplied 58% (26.55 bcm), Iran supplied 18% (8.25 bcm), Algeria supplied 9 % (4.24 bcm), Azerbaijan supplied 7% (3.32 bcm) and Nigeria supplied 3% (1.25 bcm). Local production made a minor 2% contribution to the total amount of gas consumed in 2012, and spot LNG had a 5 % stake. Turkey also exported 611 million cubic meters (mcm) of gas to Greece in 2012.

A similar security risk also exists for Turkey‟s natural gas supplies since a total of 78 % has been imported from Iran and Russia which has openly declared their threat perceptions against Turkey‟s above mentioned foreign policy and security choices.

Turkey‟s adventurist foreign policy steps are ending up with confrontations from almost all of its neigbours which totally contradicts with the rhetoric of "Zero problem with our neighbours". Some examples are: The conflicts between Turkey and Israel, Greek Cypriots, Egypt, Syria disabling the safe and uninterrupted exploration efforts in the Eastern Mediterranean.

All these examples indicate that Turkey should increase the percentage of indigenous energy sources (most of which are renewables) not only for environmental and economical reasons but also for energy security purposes. However, our energy import dependency is rapidly increasing in contrast with the government‟s rhetoric claiming that they already have decreased and will further decrease such dependency.



The below given diagram clearly shows that between 2000 and 2012, Turkey‟s energy import dependency incrcrased from 67 percent to 72.5 percent. This is also true for the share of imported resources within Turkey‟s electricity generation-mix (Diagram) showing that the Ministry‟s claims are left only in rhetoric and the practice is totally different. Our dependency to imported sources is rapidly increasing both in primary energy consumption and electricity generation.

[5] Energy Market Regulatory Authority

Diagram 4: Primary Energy Consumption & Production (1990 – 2012)

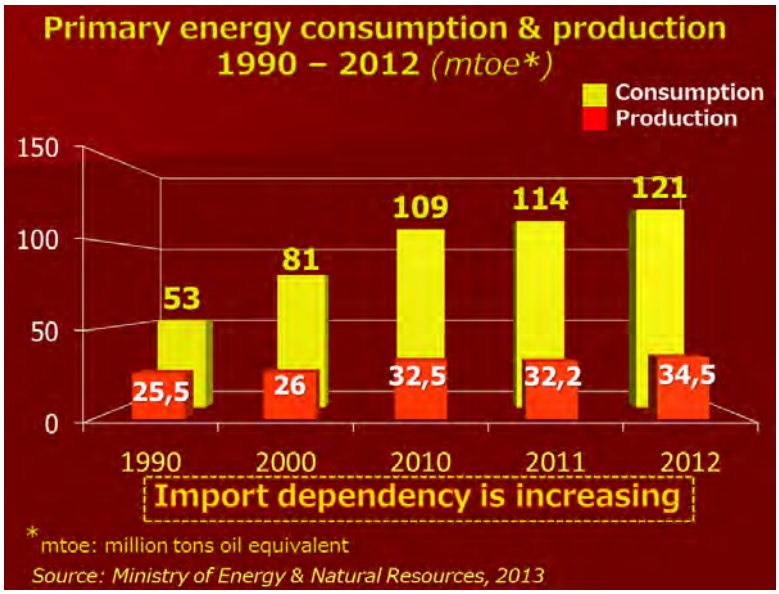
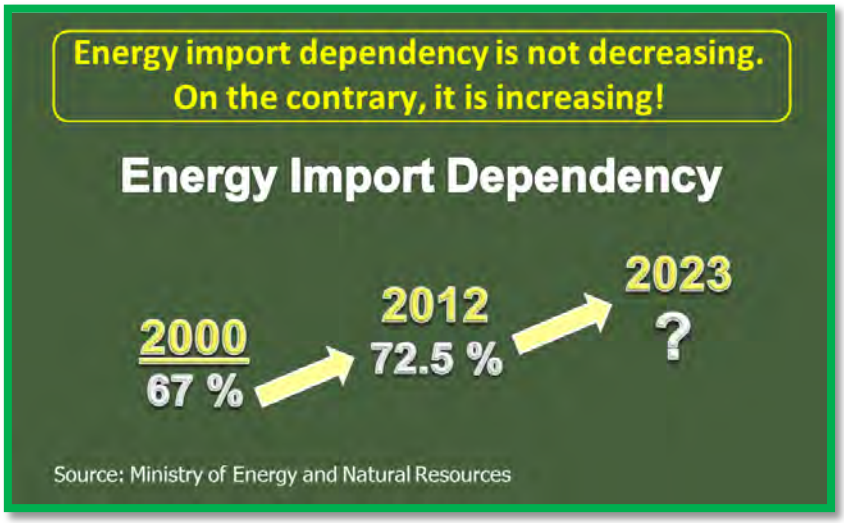


Diagram 5: Energy Import dependency Is Increasing

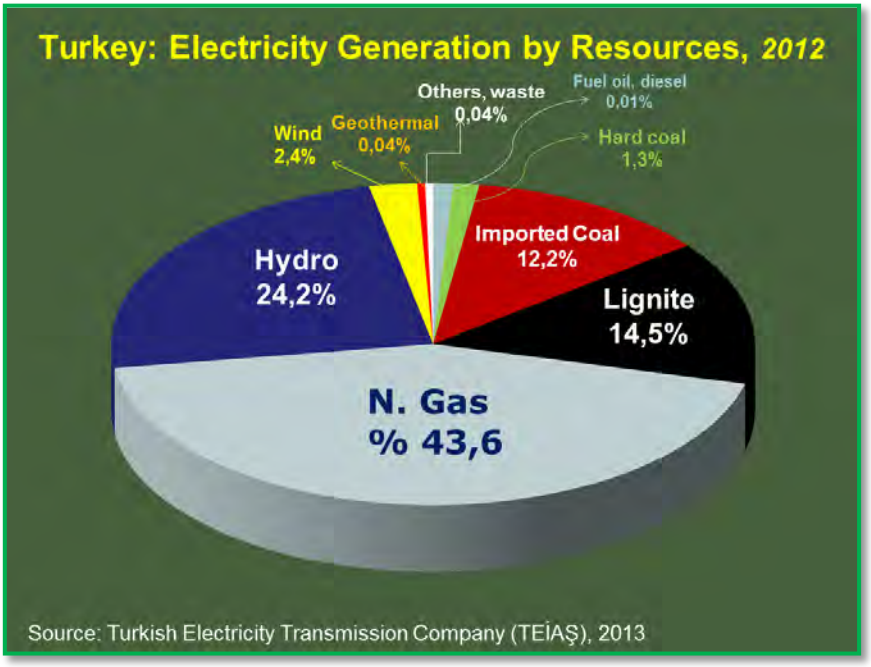


Turkey's Electricity Generation

Turkey consumed 242 billion kilowatt-hours (gross consumption) of electricity in 2012.

The share of resources within electricity generation in 2012 is as follows: Natural gas 43.6%, hydro 24.2%, lignite (brown coal) 14.5%, hard coal 1.3%, imported coal 12.2%, fuel oil and diesel 0.01%, geothermal 0.04%, wind 2.4%, biogas and waste 0.04%.

Diagram 6: Turkey's Electricity Generation by Resources, 2012



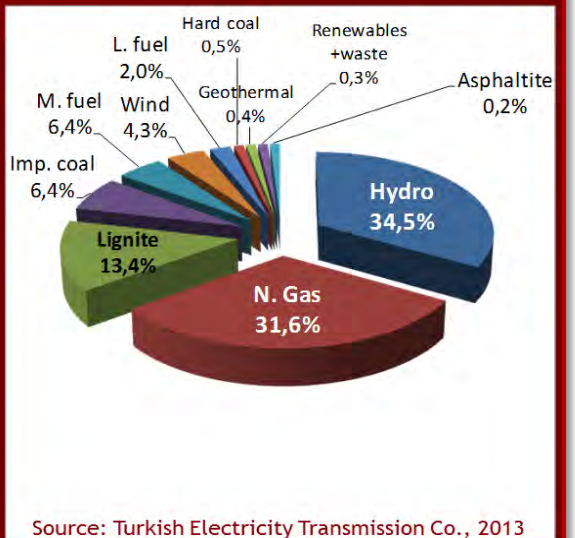
Total installed capacity reached to 57,071 MW as of end 2012 while 32.1% of this capacity is gas-fired, 34.4% hydro, 14.3% indigenous coal-fired, 6.9% imported coal-fired, 2.2% fuel oil-fired plants. Wind installed capacity is only 3.96% and others add up to 6.1%.

The distribution of the electricity installed capacity by resources is given in Diagram 7 as of October 2013.

Diagram 7: Turkey's Electricity Installed Capacity, 2012

Electricity Installed Capacity(MW)
(October 2013)

Source	Installed Capacity (MW)	Share of total (%)
Hydro	21. 723,6	35,1
N. Gas + LNG	19.375,1	31,3
Lignite	8.215,2	13,2
Imported Coal	3.912,6	6,3
Multi-fuel	3.895,6	6,3
Wind	2.688,8	4,3
Liquid fuel	1.203,3	1,9
Hard Coal	300,0	0,5
Geothermal	310,8	0,5
Renewables + Waste	224,0	0,4
Asphaltite	135,0	0,2
Total	61.984,0	100,0



The electricity sector has rather a "patch-work" structure consisting of state-run (EUAS and affiliates) plants, independent power producers, build-own-operate (BOO) plants, build-

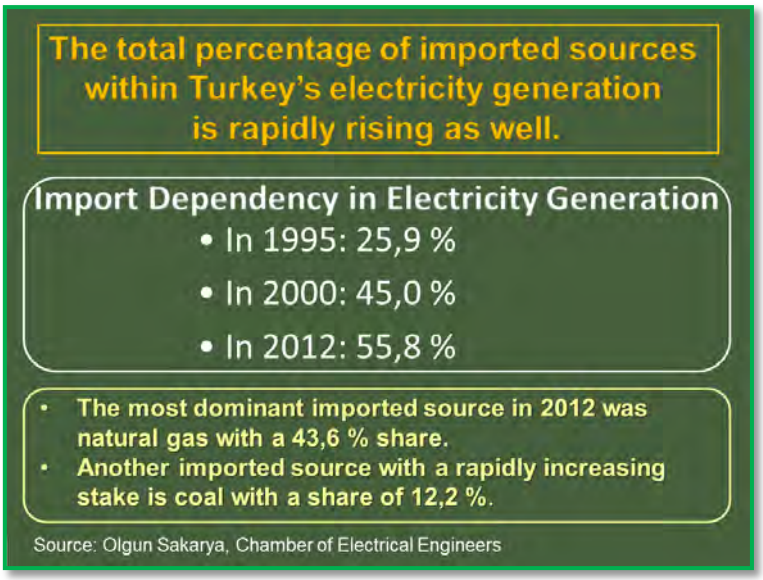
operate-transfer (BOT) plants, auto-producers and transfer of operation rights type of plants. Some of these companies (BOO and BOTs) have electricity purchase guarantees while others do not. The sector is run under the Law No. 4628 (Electricity Market Law) which limits new state-run plant installations and leaves the new plant construction initiative totally to the private sector[6].

Such a chaotic structure limits fair competition since some companies (BOO, BOT) have electricity purchase guarantees while "newcomers" do not. To add to this existing dilemma, new laws are bringing further imbalances. The Nuclear Law gives a US¢ 12.35 – 15.5 per kwh purchase guarantee to the generated nuclear electricity by the Russians which is in it"s pre-construction period. Moreover, according to the agreement ratified by the Turkish Parliament; the construction, operation, fuel supply and waste management of such nuclear plant will 100% be born by the Russians which will deepen Turkey"s dependency and vulnerability to Russia.

Turkey"s current electricity generation mix reflects a high dependency on imported energy resources and therefore is another area of vulnerability. In case of any interruption in gas supplies, not only the gas sector but in a very short time, the electricity sector is significantly being negatively affected. Such effects include electricity balckouts and price increases since 44 % of Turkey"s electricity generation comes from gas-fired plants.

Despite this risky electricity-mix, in contrast with the Ministry"s rhetoric claiming that they are reducing our dependency on imported resources, the share of imported resources is rapidly increasing as shown in the below given diagram.

Diagram 8: Total Percentage Of Imported Sources In Turkey's Electricity Sector



Dependency to imported resources for electricity generation was 25,9 % in 1995, 45 % in 2000 and jumped to 55,8 % in 2012.

[6] Meeting the New Challenges A Social Democratic Approach to Turkey's Future Energy Policy; Necdet Pamir, July 2012, Friedrich Ebert Stiftung

Such dependency (both in primary energy consumption and electricity generation) should gradually be decreased by increasing the share of renewables in the energy mix, diversifying the mix with other sources and improving the current low level of energy efficiency.

Energy Imports Bill

Turkey‟s energy imports bill is rapidly increasing in parallel with the above stated facts related to the increasing import dependency. Turkey paid $ 9,2 billion for energy imports in 2002 while the bill increased more than 6 fold to $ 60,14 billion in 2012. The share of energy imports within Turkey‟s total imports bill also increased from 17,8 % to 25,4 % during the same period.

Diagram 9: Energy Imports Bill & Share In Total Imports

Energy Imports Bill & Its Share Within Total Imports Bill

Year	Energy Imports Bill ($ Billion)	Share Within Total Imports Bill (%)
2002	9,2	17,8
2011	54,1	22,5
2012	60,1	25,4

Source: Turkish Statistical Institute

Energy imports is the main reason of Turkey‟s ever- growing current account deficit and is the biggest overburden on Turkey‟s economy. Ironically, Turkey has a very significant but idle indigenous energy resource potential waiting for development.

Major Problems of the Energy Sector

Turkey‟s energy sector is facing significant problems waiting for immediate and radical changes. Major problems can be listed as follows:

- Energy-mix being heavily based on fossil fuels,
- High import dependency (72%) with an increasing tendency,
- Significant but idle indigenous resource potential,
- Legislative constraints against the development of renewables,
- Irresponsible policies towards environmental risks,
- Over-dependency to Russian Federation (mainly for gas imports and overall trade volumes). Potential to increase with the construction of a nuclear plant in Akkuyu,
- Limited gas storage capacity (2,6 bcm),
- “Take or pay” risks coming from the previously signed gas contracts,
- “Insistence” on exaggerated demand estimates,
- High stake of gas usage to generate electricity (~ 44 %)
- “Patchwork” structure of the electricity sector,
- High energy prices; high taxes on energy prices
- High % of losses (during electricity transmission, distribution, and marketing) and unpayments

- Inefficient utilization of energy (low efficiency)
- Disintegration of the State-run companies, lack of coordination (TPAO and BOTAŞ privatization on the agenda)
- Energy policy mostly based on commercial interests instead of an integrated vision taking the strategic dimension into account,
- Inconsistency between energy policy and foreign policy creating significant security risks,
- Nepotism; incompetent bureaucratic managerial assignments

Exaggerated Demand Estimates

Turkey has a vibrant and rapidly growing economy with a significant young population. However, both the economic growth and the corresponding energy and electricity demand rises are not linear but experiences significant fluctuations. To add to this complicated natüre, Turkey"s demand estimates had frequently been "exaggerated" to justify some inessential gas-fired plants in recent years. Such exaggeration in return is still a risk and burden in the form of "take – or-pay" bills amounting to billions of dollars. While a portion of such "take-or-pay" bills can later be compensated through additional imports in the following years, there is always a risk of unduly payments. Having made this necessary comment, the Ministry of Energy and Natural Resources (MENR) foresees the future demand estimates (energy and electricity) as shown in the below given diagrams (Diagrams 10 & 11).

Diagram 10: Primary Energy Demand (History & Estimates)

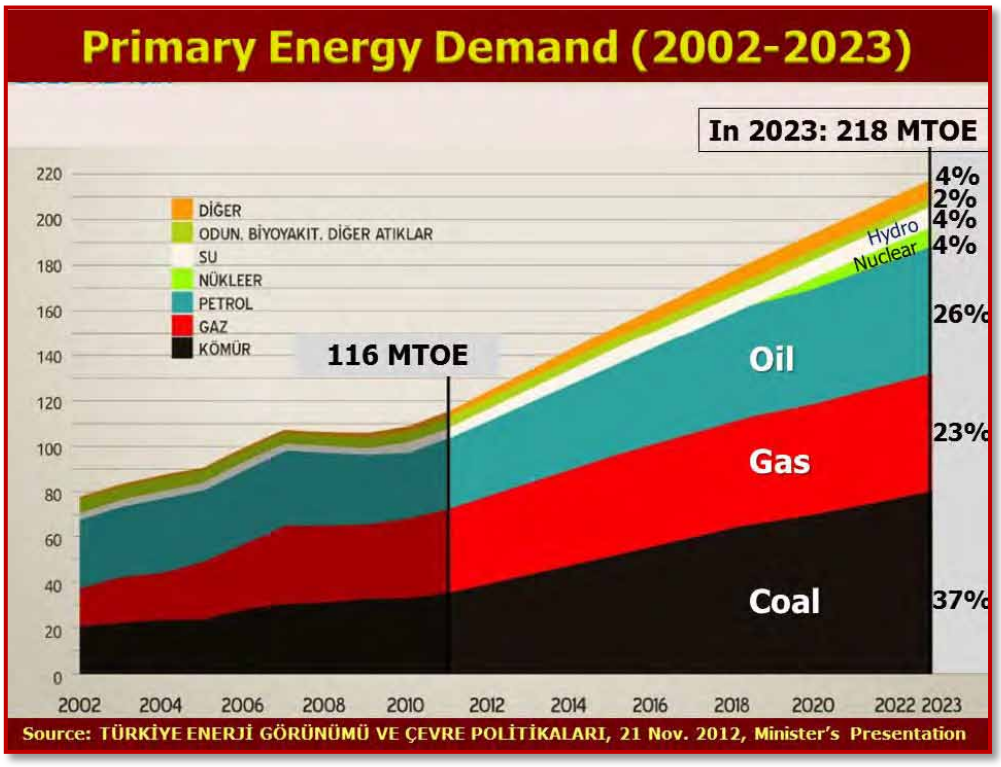
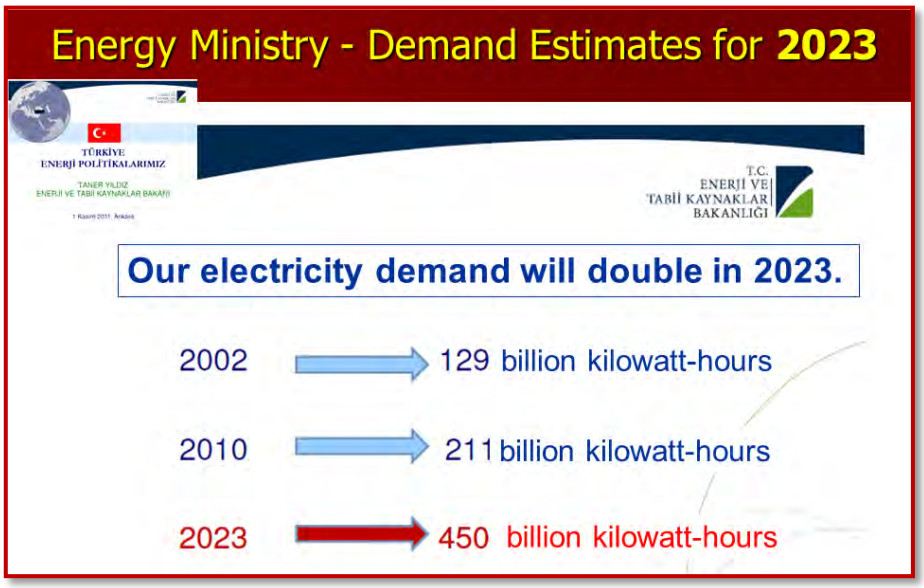
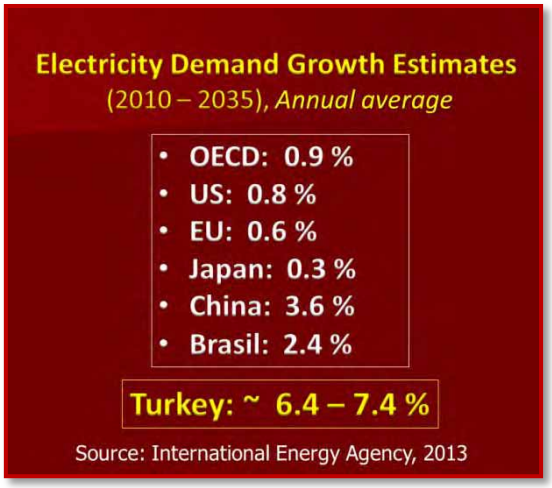


Diagram 11: Primary Energy Demand Estimates for 2023



As seen, the MENR estimates that Turkey‟s energy demand will rise to 218 mtoe in 2023 from its 116 mtoe value in 2011[7]. The electricity demand estimate for 2023 is 450 billion kwh in 2023 compared to 242 billion kwh (high demand estimate) in 2012. Fort he low demand estimate scenario a yearly demand growth of 6.4% and for the high demand case a yearly demand increase of 7.4% is foreseen. The government is almost praising high energy demand figures and tries to show such figures as a matter of modernization and bencmark for development. As an initial comment, it worths having a glance at some prominent actors‟ electricity demand growth rate estimations by IEA.

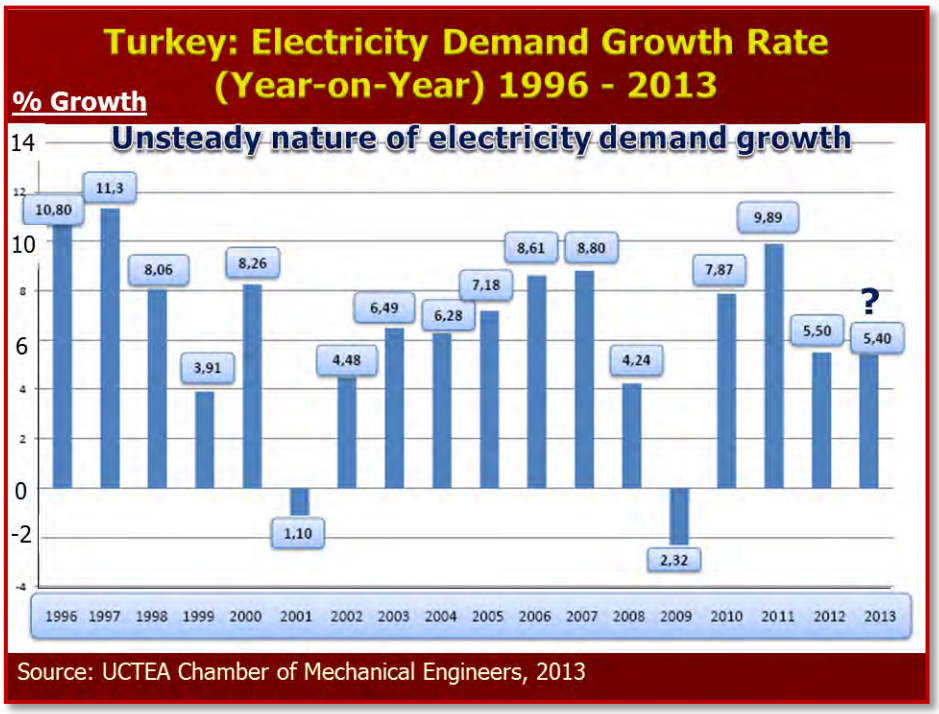
Diagram 12: (Comparing) Electricity Demad Growth Estimates



As can be immediately recognised, the Turkish MENR estimates are almost two fold greater than China‟s expected electricity demand growth rate. Furthermore, as previously stated, Turkey‟s previous growth data shows significant fluctuations as seen in the below given diagram.

[7] Turkey's primary energy consumption was 120,98 mtoe in 2012.

Diagram 13: Electricity Demand Growth Rates (1996 – 2013)



The negative "growth" rates in 2001 and 2009 are also noteworthy. We can therefore conclude that, any expectation of a steady annual electricity demand growth rate around 7% until 2023 seems a bit more than "wishfull thinking" and may lead to unnecessary investments and loss of national wealth.

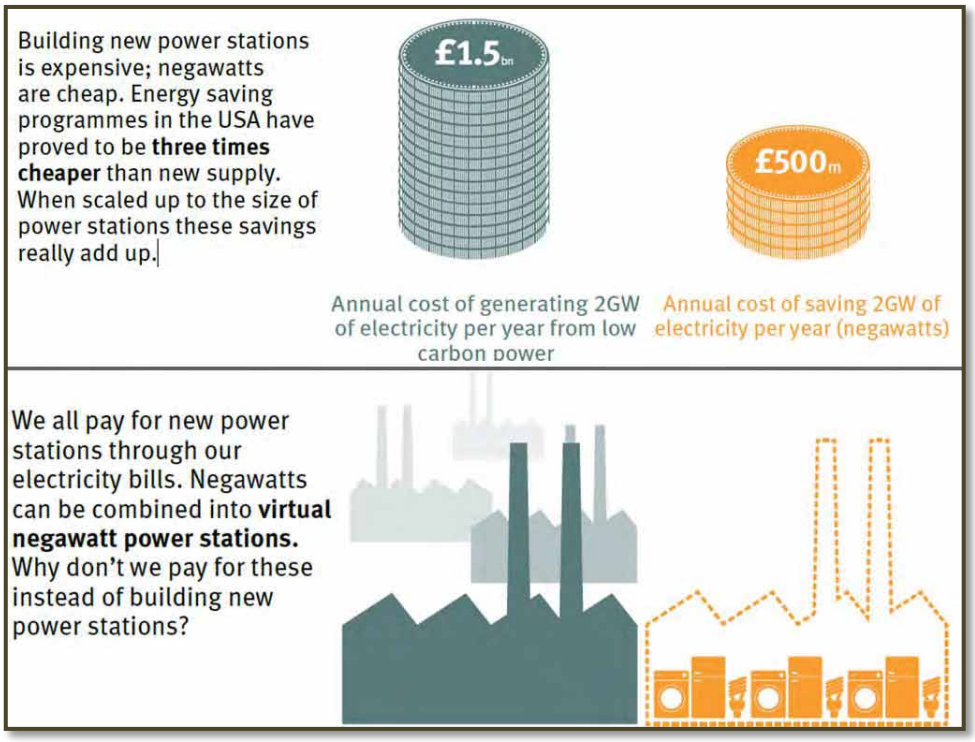
To further complicate the dilemma, Turkey has a significantly high energy intensity (0.18 TPES/GDP – toe/000; 2005 USD) compared to OECD average (0.14 TPES/GDP – toe/000; 2005 USD)[8].

Instead of boasting of with high demand estimate figures, much more rational and sustainable examples could have been followed; namely shifting from a system dominated by finite (fossil and fissile) energy towards a (renewable) flow energy-based system[9], lowering the consumption targets and increasing the energy efficiency levels. As Eckart Würzner, Mayor of Heidelberg and President of Energy Cities states: "They used to think in terms of MegaWatts and they are now starting to think in terms of NegaWatts. They used to consider energy as a supply of gas, electricity and oil; they now rather think in terms of demand based on final needs - heating, cooling, lighting, mobility and leisure. Vertical, centralised energy systems are starting to make room for more flexible and resilient horizontal, decentralised multi-energy systems based on the Internet concept. Energy distribution networks will become smart networks capable also of handling the collection of dispersed energy production."
The Green Alliance has a parallel approach to the solution of current unsustainable energy policies. In their publication "The Power of Negawatts" they refer to the concept of "negawatts". Pointing out the need to cut the emissions of the power sector, they propose to

[8] Key World Energy Statistics 2013, IEA

[9] 30 Energy Cities' proposals for the energy transition of cities and towns; Energy Cities, www.energy-cities.eu

do this by building new low carbon power stations, or through negawatts." But wAccording to their referred document, they clarify the term as follows:
"What are **negawatts**? Imagine a 15 watt lightbulb replacing a 100 watt bulb. The 85 watts saved can be used elsewhere: these are **negawatts.** New, efficient appliances do the same thing as old, inefficient ones, but use less energy. Gaining negawatts from new appliances mean we don‟t have to build so many new power stations. Building new power stations is expensive; negawatts are cheap. Energy saving programmes in the USA have proved to be three times cheaper than new supply. When scaled up to the size of power stations these savings really add up."

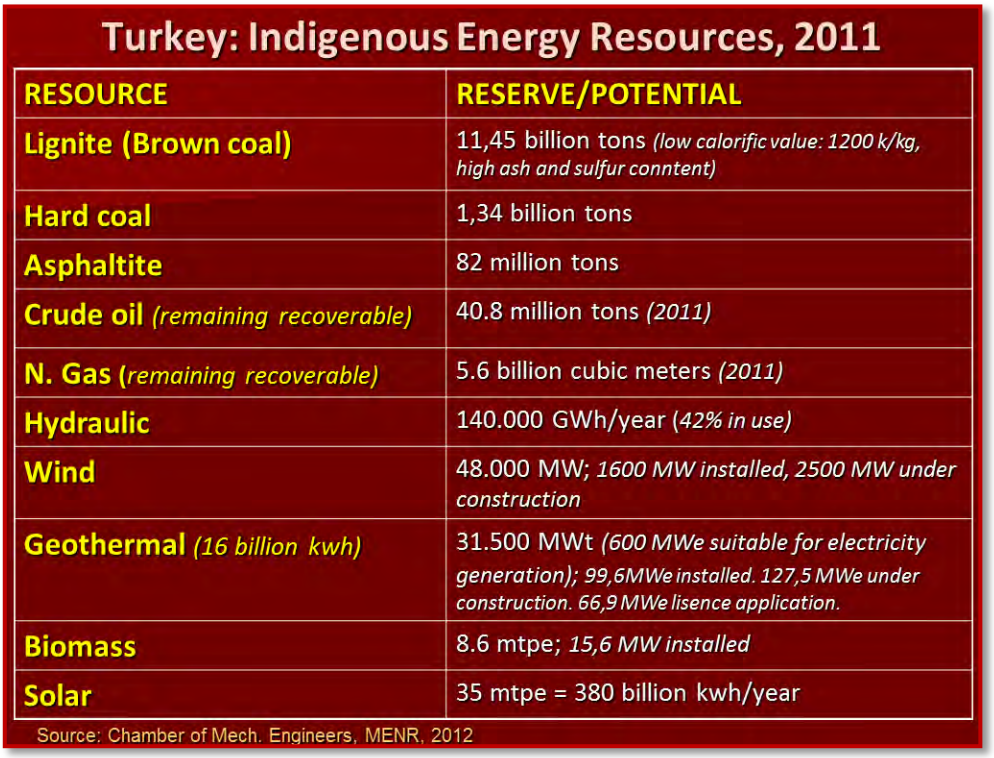


Turkey's Indigenous and Unused (Idle) Energy Resources
As previously stated, within Turkey‟s primary energy consumption profile, the lion‟s share consists of oil (29%) and gas (33%). However, 92% of oil and 98% of gas are supplied by imports. Although offshore locations in the three seas (Black Sea, Aegean Sea and the Mediterranean) surrounding Turkey and within the country‟s deep Paleozoic formations offer a significant "speculative" oil and gas potential, these reserves have not been deeply explored. However, Turkey‟s current oil and gas reserves are totally insufficient and a rational energy policy can not be based on such reserves.

Turkey‟s energy and electricity consumption mix should be redesigned to radically decrease the amount of oil and gas consumed and replaced by indigenous and renewable resources.

Contrary to the common perception, Turkey has significant local energy resources, most of them renewable. Turkey‟s local energy resources and potential for generating electricity are summarized in the below given table. Oil and gas reserves in the table refer to the remaining recoverable reserves.

Diagram 14: Turkey's Indigenous Energy Resources



Turkey: Indigenous Energy Resources, 2011	
RESOURCE	**RESERVE/POTENTIAL**
Lignite (Brown coal)	11,45 billion tons *(low calorific value: 1200 k/kg, high ash and sulfur conntent)*
Hard coal	1,34 billion tons
Asphaltite	82 million tons
Crude oil *(remaining recoverable)*	40.8 million tons *(2011)*
N. Gas (*remaining recoverable)*	5.6 billion cubic meters *(2011)*
Hydraulic	140.000 GWh/year (*42% in use)*
Wind	48.000 MW; *1600 MW installed, 2500 MW under construction*
Geothermal *(16 billion kwh)*	31.500 MWt *(600 MWe suitable for electricity generation); 99,6MWe installed. 127,5 MWe under construction. 66,9 MWe lisence application.*
Biomass	8.6 mtpe; *15,6 MW installed*
Solar	35 mtpe = 380 billion kwh/year

Source: Chamber of Mech. Engineers, MENR, 2012

Turkey"s lignite and hydraulic potentials offer particularly significant electricity generation capacity with higher capacity utilization rates. However, we have to note that Turkey"s lignite generally has low calorific value and high sulfur content. While this potential is still vital for reducing Turkey"s dependency on imports and creating new jobs, the implementation of clean coal technologies and carbon capture and storage facilities will also be critically important to the development of this valuable resource[10].

As previously stated, Turkey consumed 242 billion kWh of electricity in 2012. Listing the potential electricity that could yearly be generated from the country"s still underutilized local resources may demonstrate the country"s local potential and why
there is a vital need for a paradigm change[11]:

- Hydraulic: 80-100 billion kW-hour (kWh)
- Wind: 90-100 billion kWh
- Geothermal: 5-16 billion kWh
- Solar: 380 billion kWh
- Local lignite: 110-125 billion kWh
- Biomass: 35 billion kWh

[10] Meeting the New Challenges A Social Democratic Approach to Turkey's Future Energy Policy; Necdet Pamir, July 2012, Friedrich Ebert Stiftung

[11] Partly under construction (meaning that, still has no contribution to generation), partly under the process of liscencing and partly no liscence application at all. Data provided by the UCTEA Chamber of Mechanical Engineers, 2013

As can be seen, Turkey‟s local energy resources have an enormous potential, and most of them are renewable. To add to this positive picture, it is worth noting the additional 58 billion kWh of potential electricity that would accrue if energy efficiency were improved in Turkey‟s industrial and construction sectors between now and 2020. Rehabilitating existing power plants could allow Turkey to generate an additional 19 billion kWh each year. Adding these values together, the extra electricity that could be generated in Turkey rises to a significant approximate value
of 840 billion kWh a year[12].

Energy Import Dependency Increases Geopolitical Risks

Foreign policy is one of the most important areas that directly relates to Turkey‟s energy policy. Turkey has a strategic geographic location. It can be classified as a Middle Eastern, Caucasian, European or Balkan country. It is a natural bridge between countries that have rich hydrocarbon resources and countries with energy thirsty markets. It is a relatively stable country in the region, and has a relatively advanced legal framework. Nevertheless, Turkey‟s strategic position also makes it vulnerable to potential geopolitical and economic risks. Turkey has common borders and history with many unstable countries in the region, such as Iran, Syria and Iraq. It is over-dependent on Russia for energy imports, mainly gas. Iran is the next most important supplier of energy to Turkey[13].

In 2012, Iran supplied 39 percent of Turkey‟s total oil imports while Iraq and Russia contributed with 19 percent and 11 percent respectively (Diagram 3A). Russia is the major gas supplier with 58 % of Turkey‟s total gas imports and Iran supplied a further 18 % (Diagram 3 B). Such dependency on Iran, Russia and also to Iraq makes Turkey extremely vulnerable, since some of it‟s recent foreign policy orientations have not been received “friendly” by these countries. Turkey‟s unncessarily aggressive policy towards Syria, the construction of a NATO missile shield in Kürecik, in the province of Malatya, and the deployment of 6 Patriot missiles near 3 Turkish cities have been perceived as direct threats by these 3 countries.

A few quotations may be helpful to clarify such perception and reaction from Turkey‟s major energy suppliers. RIA Novosti reported in early December 2011 that “Russia expresses concern about the NATO missile defense system to be constructed in Turkey”. RIA Novosti quoted Russian Foreign Minister Sergey Lavrov stating "This radar will cover a large part of Russia's territory," said today[14]. Medvedev was reported to warn that “Russia will station missiles in its westernmost Kaliningrad region and other areas, if the U.S. continues its plans without offering firm and specific pledges that the shield isn't directed at its nuclear forces. He didn't say whether the missiles would carry conventional or nuclear warheads. We won't allow them to treat us like fools. Nuclear deterrent forces aren't a joke.”[15]

In December 16, 2012, Reuters reported the following Iranian statements: “… In August General Firouzabadi warned Ankara that by aiding the Syrian opposition, Turkey risked bringing the conflict onto its territory. Following the remarks, the country‟s leader, President Ahmadinejad, reportedly cancels his visit to Turkey. On Saturday Iran's Foreign Minister Ali

[12] Meeting the New Challenges A Social Democratic Approach to Turkey’s Future Energy Policy; Necdet Pamir, July 2012, Friedrich Ebert Stiftung

[13] İbid

[14] http://vestnikkavkaza.net/news/politics/20755.html

[15] Associated Press, 23 November 2011

Akbar Salehi promised Tehran will not allow the West to oust President Bashar Assad. „The Islamic Republic of Iran won't allow Western plans and scenarios aimed at overthrowing the Syrian government to succeed," the minister commented on the website for Iranian state TV… " In 11 April 2013AFP reported that "The Iraqi Transport Minister Hadi al-Ameri ordered that Turkish airplanes be forbidden from landing in Iraqi airports to include the autonomous Kurdistan region in north Iraq. Minister Hadi said that „This is a response to a Turkish decision to stop Iraqi airplanes from landing in Turkish airports." Ministry spokesman had been quoted to claim that „The Turkish decision to ban Iraqi flights stems from a dispute with Iraq"s State Oil Marketing Organisation.
They did not find a way to put pressure on Iraq except by stopping our airplanes from landing in their airports".

In addition, Turkey"s current policies force confrontations with Greece and the Greek Cypriots, preventing safe and efficient exploration activities of the oil and gas reserves in the Mediterranean and the Aegean Seas. The recent crisis with Israel has further stirred up conflict and a negative investment environment in the Mediterranean Sea. Even relations with Azerbaijan, a brotherly country, have not yet settled since Azerbaijan strongly and negatively reacted to the ruling party"s so called "Armenian Opening", which set back Turkey"s cooperative efforts over international pipelines like NABUCCO. (Nevertheless, NABUCCO no longer exists and is in a way replaced by another pipeline Project called Trans Anatolian Gas Pipeline-TANAP.)

All these examples clearly show that Turkey needs a new foreign policy approach: one that integrates its energy policies with its overall interests. Such an integrated and rational energy and foreign policy can gradually end the current conflicts and damages that, ironically, have been caused by the government"s "zero problems with neighbors"policy. As seen, government"s energy and foreign policies have remained on rhetoric and the practice is almost moving in the opposite direction.

All these examples clearly show that, it is not a necessity for the sake of environmental concerns only but also for geopolitical conncerns and energy security risks, Turkey should radically decrease it"s dependency to fossil fuels in it"s energy mix.

Increasing Dependency to Imported Sources (mainly to natural gas and coal)
Turkey"s high level of dependency to fossil fuels was 87% in 2012. The total share of oil and gas (92 and 98 % of those sources being imported) was 56,2% for the same year. The MENR and it"s Minister with every opportunity state that, they are to reduce Turkey"s dependency to imported sources and specifically decrease the share of natural gas in electricity generation to levels below 30% by 2023 which is 44% as of 2012
However, as frequently shown, the rhetoric and the substance are strongly divergent for this case as well. The Energy Market Regulatory Administration (EMRA) data clearly shows that a very significant number of liscences are either already issued or the finalisation processes are almost completed for quite a number of NEW gas-fired and (imported) coal-fired plants.

Between 19 November 2001 (the date EMRA was established) and end 2013, among the total (instaleld capacity is taken as the basis) private sector plants; 44,1% were gas-fired plants, 24,4% were hydraulic plants and 15,2% were imported gas-fired plants. Therefore almost 60% of the recently added capacity is based on IMPORTED FOSSIL fuels. In addition to this negative trend, the EMRA had already issued liscences for a total of 18,200 MW capacity new gas-fired plants and these are under construction. There is an additional 20,750 MW

capacity gas-fired plant waiting for the completion of their liscencing processes. To sum up, the total project stock for NEW (additional) gas-fired plants adds up to 30,000 MW which is almost 47% of Turkey‟s current installed capacity. For imported coal-fired (additional new) plants is around 16,000 MW (26% of Turkey‟s current installed electricity capacity).

This is why it is hard to believe in the official statements claiming that Turkey‟s dependency to imported fossil fuels will be decreased and the share of natural gas within Turkey‟s electricity generation will significantly be dropped below 30%.

Recommendations and Conclusion

Turkey has significant indigenous energy resources which can help reducing the country‟s over-dependency to fossil and imported fuels. This is not only an environmentally vital responsibility for the generations to come but also a strategical obligation to reduce our energy security risks. Increasing the total percentage of renewables (which all are naturally indigenous sources) should be complemented with significant R&D and local manufacturing efforts. Otherwise, claiming that we are reducing our import dependency since we are increasing the percentages of renewables would also be nothing more than rhetoric.

We can summarise our (macro) recommendations for a sustainable and more independent energy policy alternative for Turkey under the following headings:

- **A secure supply of energy for all citizens must be guaranteed by the goverment and independent regulating authorities.**

Ensuring access to affordable, uninterrupted, reliable, clean, diversified and modern sources of energy is essential for sustainable development, and, moreover, is a human right. Therefore the state should plan, control and regulate the sector and not leave it exclusively in the control of the private sector. The current Electricity Market Law No. 4628 limits the state‟s investment ability and leaves the development of the electricity sector exclusively in the realm of the private sector. Under the current policies, if the private sector decides that investing in a particular resource is not highly profitable and declines to invest, the sector will suffer from the lack of investment. Therefore, staterun companies should not be further privatized but should instead be reorganized around a vertically integrated structure. The regulatory and competition authorities (the Energy Market Regulatory Authority and the Turkish Competition Authority) should be reorganized as (actually) autonomous entities. Given their current structures, in which the management teams are all assigned by the government, it is hard to expect them to independently regulate the market. Consumers‟ organizations, relevant trade unions and representatives from the Chamber of Engineers should also be represented on the boards of these “independent” authorities and state-run energy corporations[16].

- **Energy security entails reducing Turkey’s import dependency and developing its local and renewable energy sources.**

Turkey‟s dependency on energy imports places a heavy burden on the economy and limits the country‟s rational mobility on foreign policy issues. 56,2 percent of Turkey‟s energy consumption comprises oil and gas, and 92% of oil and 98% of gas is imported. Such dependency should gradually be decreased by increasing the share of renewables in the energy mix, diversifying the mix with other sources and improving the current low level of energy efficiency. This should be done in the quickest way possible, because the burden of

[16] Meeting the New Challenges A Social Democratic Approach to Turkey’s Future Energy Policy; Necdet Pamir, July 2012, Friedrich Ebert Stiftung

energy imports on the economy is not sustainable. That dependency has the potential to make Turkey more vulnerable on other foreign policy issues as well. unique strategy must be designed for each resource in order to produce the most efficient, clean and affordable output possible. The current policies do not serve these purposes. Most of the time, due to irresponsible policies that consider neither environmental hazards nor the social dimension, people resist any kind of plant construction in their locality. Most of the time, an environmental impact assessment is declared unnecessary by the relevant ministries. The current policy allows so-called "investors" to freely construct dozens of small dams on a single river, which irreversibly damages the ecosystem. As a case in point, to develop Turkey‟s rich hydraulic potential, the first step should be a "basin management" approach to be followed by a comprehensive Impact Assesment Report. EU Directive 85/337/EEC, known as the "Environmental Impact Assessment" (EIA) Directive, or Directive 2001/42/EC, known as the "Strategic Environmental Assessment" (SEA) Directive, can be taken as reference documents. Priortiy should be given to plants with an installed capacity of 50 MW and not less. For every resource, a fully integrated master-plan should be developed to conserve the environment.

- **Reducing CO2 emissions is essential for an ecologically and economically sustainable energy policy[17].**

Global warming is a real concern for the world. This is another reason to decrease the preponderance of fossil fuels in Turkey‟s energy mix. With every minute that passes without a dedicated policy promoting renewables, it becomes harder and more expensive to meet our energy security needs and ensure a cleaner future for coming generations. By the year 2023, we propose accomplishing the following goals:

  - Starting with public buildings, energy consumption will be significantly reduced. A 20% reduction in primary energy use compared to projected levels will be achieved by improving energy efficiency.
  - Electricity transmission losses should be reduced to 8%.,,
  - Non-payments should be reduced by social policies. Such policies will include subsidies for poor families in the form of appropriate adjustments to their electricty bills. The amount corresponding to 200 kwh per month should be subsidized.
  - Forty percent of Turkey‟s energy mix should be supplied by renewables before 2025.
  - Greenhouse emissions should be reduced by 20% compared to 2000 levels.
  - Starting from 2017, at least 20% of new buildings‟ annual energy demand should be supplied from renewable energy resources.
  - Strict measures should be applied to ensure that such targets do not remain purely theoretical but are actually put into practice[18].

- **Using energy more efficiently is the best way to reduce Turkey's energy bill and its dependency on imports.**

Energy efficiency is the best policy tool for reducing energy consumption since it reduces our import dependency and decreases our expenditures on imported oil and gas while simultaneously diminishing greenhouse gas emissions. here is a significant potential for improvement in Turkey. The EU foresees a 20% improvement in energy efficiency by 2020. Turkey should aim for an ambitious energy efficiency increasing target of 25% from today‟s

[17] Ibid

[18] Ibid

level) until 2023, the 100th anniversary of the establishment of our republic. The potential savings amount to approximately 25 mtoe. The industrial and building construction sectors have the highest potentials for improvement in this area. Buildings constructed before 2000 consume twice as much energy compared to the buildings permitted under current by-laws. Tax exemptions
or reductions are critical for a successful energy efficiency strategy. The improvement should be initiated by state-run entities, which can set the pace for other sectors. These improvements should target the car fleets, buildings, machinery and industrial
processes used by those state-run companies. In addition, the energy efficiency initiatives will create many new job opportunities[19].

- **Promoting renewable energy resources through higher incentives creates new green jobs, but renewable energy Technologies require significant R&D and local manufacturing efforts.**

The share of renewables in Turkey‟s energy mix should swiftly be increased through rational incentive policies. Such incentives should not be confined to electricity generated from renewables. Purchase guarantees should also go to local manufacturers of turbines for wind and hydroelectric plants and PV panels. Such an integrated approach will also create a significant potential for employement.

- **Nuclear power has proven to be a highly dangerous and unsustainable technology that Turkey should not pursue under the current conditions both in the World and in Turkey.**

Nuclear power requires new examination and a much more responsible approach after the Fukushima disaster. Nuclear energy has significant problems that should be solved before Turkey decides to include nuclear energy in its energy mix. Some of these problems are globally acknowledged, such as high initial investment costs, unreliable operational safety, the unsolved permanent waste issue and the risk of nuclear feedstock falling into the hands of terrorists. Another prerequisite should be a satisfactory answer to the still-unresolved problem of permanent waste removal. We should therefore feel more responsible not only for our nation and our generation but also for future generations. To that end, the role of nuclear energy in our society should be responsibly and scientifically reviewed.

[19] Ibid

EFFICIENT USE OF ENERGY IN THE INDUSTRY

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Abstract

Energy is one of the major inputs that play an important role in the social and economic development of societies. Depletion of the fossil fuels which provide most of the world's energy demand, increase in the consumption in industrial processes, raising the concentration of greenhouse gases in the atmosphere to dangerous levels to human health by destroying the ozone layer, have put energy production and efficient use of energy among the most challenging topics today. Our World is witnessing great changes in several areas in recent years. Crises in sharing the energy sources, steadily increasing environmental consciousness, increasing World population and the economic competition is forcing people to utilize the facilities they have more rationally. Energy has become the main issue in almost all engineering applications in the world today due to its steadily increasing price and its unpredictability.

The key issue to a sustainable development is the balance between the supply and demand of energy, keeping the environment clean, healthy and pollutant free. This topic is very important for Turkey, who is in the process of becoming a member to EU and a co-signer of the KYOTO protocol. Turkey imports more than half of her energy although she has a variety of primary sources. The difference between supply and demand is expected to reach 200 million TOE by 2020.

This paper has been prepared to illustrate the energy efficiency measures and methods utilized in the industry, presenting the outcome of an energy analysis for the consumption for processes, heating and conditioning of production areas and office space heating of a pharmaceutical plant.

Key Words: Energy, Efficiency, Modeling, Sustainability

Introduction

Energy is one of the major inputs that play an important role in the social and economic development of societies. Depletion of the fossil fuels which provide most of the world's energy demand, increase in the consumption in industrial processes, raising the concentration of greenhouse gases in the atmosphere to dangerous levels to human health by destroying the ozone layer, have put energy production and efficient use of energy among the most challenging topics today.

The hole discovered in the ozone layer, in 1986 resulted in the banning of chlorofluorocarbons and were replaced by hydrochlorofluorocarbons (HCFCs) and

hydrofluorocarbons (HFCs) which are not as effective. Today however we know that they have greenhouse effect as well. Climate change has been the focus of environmental protection and sustainability initiatives since 1990 as one of the major problems of our age. Environmental issues have attracted the attention of not only scientists but all kind of groups from the society.

Concerns regarding the environment and the sustainable development expressions in the activity report of the United Nations in 1987 have found ground in several countries around the World and have initiated environmental rallies. European Union countries, USA, Australia and Canada and especially England have supported sustainable development policies by passing laws. As a result nations have found themselves in a discussion platform related to social, ecological, economic and cultural sustainability in addition to their development models and issues. United Nations Framework Convention on Climate Change (UNFCCC),has been made effective on March 21, 1994 to prevent the manmade dangerous influence on climate systems and the greenhouse gas accumulation in the atmosphere. As a first step to limit greenhouse gases on an international level which has the power to apply worldwide sanctions, was arranged in Kyoto, Japan on December 11, 1197, the KYOTO Protocol and made effective on February 16, 2005. 191 countries have signed the protocol as of September 2011.

Our country has been affected from these issues as well, as a result of the pollution experienced specially in large cities; natural gas has been introduced as an environmental friendly and economic way of solving the heating of residences. Wrong politics has raised gas prices and people have started to switch to coal, which is a threat to atmospheric pollution.

Turkey has been working on the subject for several years. The legislations are summarized chronologically.

- May 2, 2007 Energy Efficiency Law, No. 5627
- October 9, 2008 Heat Insulation Regulation, No. 27019
- October 25, 2008 Regulation for the Efficient Use of Energy Sources and Energy [1], No. 27035
- December 5, 2008 Energy Performance of Buildings Regulation, No. 27075
- February 6, 2009 Principles and Procedures for the Delegation, Certification, Reports and Projects covered by the Energy Efficiency Law, No. 5627, No. 27133

Turkey has performed well in the subject and has passed the Energy Efficiency Law in 2007 and the related by – laws and regulations in the following couple of years.

[1] Regulation for the Efficient Use of Energy Sources and Energy, 2008.

Energy balances

Although Turkey has several energy sources, she imports more than half of her energy production. In 2006 the total energy production was 27 million TOE and the consumption 77 million TOE[2]. The energy deficiency was 50 million TOE. Predictions indicate that this figure will exceed 96 million TOE by 2015. Import of oil, gas and coal will continue to cover the energy demand in the future.

The energy consumption profile of Turkey as shown in Figure 1 indicate that the share of buildings is 31%, the industry 40%, transportation 19%, agriculture 5% and other 5%. The fuels consumed are 32.5% oil, 28.2% coal (including lignites), 28.9% natural gas, 8.1% wood and 5.1% hydraulic[3].

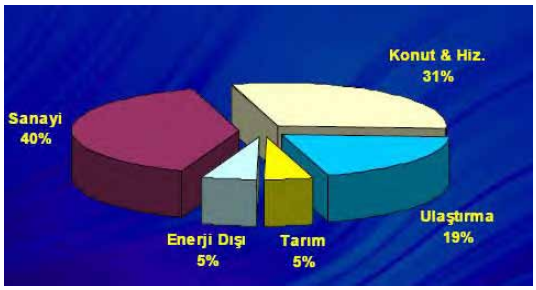

Figure 1 *Energy Consumption for Sectors*

As seen from the figures, combustion of fossil fuels has an important role in the utilization of the energy sources. A slight increase in the combustion efficiency would result in extreme savings. The energy production methods used today have several inconveniences very well known to everybody. They rely on limited resources (fossil fuels), pollute the environment (air and water pollution, waste storage) and enhance greenhouse effect.

Combustion of fossil fuels results in the liberation of carbon in the form of carbon dioxide. This gas is known to be one of the major greenhouse gases created by humans. Today we are experiencing climate changes in the form of draughts, floods, extreme temperatures, diminishing corals and melting of ice blocks in the arctic region. Therefore we are forced to give up on fossil fuels, switch to renewable sources and reduce the liberation of carbon dioxide.

Energy supply of Turkey depends on, 43.1% coal (36.6% lignite), 15.2% oil, 10.9% hydraulic, 0.7% natural gas, 0.1% solar, 0.3% geothermal and 29.6% non commercial sources like wood, animal and plant waste. 47% of the total supply is used by thermal plants [2]. The energy demand of Turkey is provided by 30.9% coal, 13.1% natural gas, 40.9% oil, 4.9% hydraulic, 0.1% solar and 9.5% wood, animal and plant waste [2]. 46% of Turkey's energy consumption depends on oil.

[2] National Energy Congress Final Report, 2009
[3] Turkey's Energy Sector Development and Supply/Demand Projections, 2009

Importance of energy efficiency for the industry

Table 1 shows that the share of the energy demand for the industrial sector has increased from 21% in 1970 to 29% in 1998. Oil is the most important primary energy source with a share of 35.5% [4].

Table 1 *Energy Consumption of Different Sectors (%)*

	1990	**%**	**1995**	**%**	**2000**	**%**	**2005**	**%**	**2006**	**%**	**2009**	**%**
Industry	14542	35	17372	35	24501	40	28282	39	30974	40	25966	32
Buildings	15358	37	17596	35	20058	33	23013	32	23726	31	29466	37
Transport	8723	21	11066	22	12008	20	13849	19	14884	19	15916	20
Agriculture	1956	5	2556	5	3073	5	3359	5	3610	5	5073	6
Other	1031	2	1386	3	1915	3	3296	5	4163	5	4153	5
TOTAL	**41610**	**100**	**49976**	**100**	**61555**	**100**	**71799**	**100**	**77357**	**100**	**80574**	**100**

If we follow the energy prices in the world and Turkey, we see that the price of a barrel of oil was $3 in 1970. After the raise by the OPEC countries in 1973, it became $12, the Iran revolution, $28 and the Iran-Iraq war $34. Dropping to $16 later showed a sharp peak again when Iraq invaded Kuwait, $40. Today it is around $80. Gasoline sells for $2.5 per liter.

The above picture indicates that, more than a half of the energy used by the industrial sector is imported and its price fluctuates drastically according to socio-political reasons. To reduce the foreign dependence of our energy character, alternatives such as;

- Utilizing new energy sources (Solar, wind, biogas, wastes, etc.)
- Applying new technologies (energy storage, hybrid systems, fluidized bed power plants, heat pumps, etc.)

could be considered. But we should not forget that, the most effective means is to reduce the amount of energy used and energy savings. In fact, when we remember the environmental impact (CO2 and green house gases) of the problem, we will deduce that the best solution is the rational use of energy.

[4] 11. National Energy Congress Energy Statistics, 2009

Planning energy savings in the industry

The first step towards the energy analysis of a facility is to establish the energy balance. Points of energy consumption, their energy demand and the load variations have to be assessed carefully. The distribution of the energy bought from the market (like electricity), the efficiencies at the consumption points and the losses are determined. Not only the momentary values, but also the daily, weekly and annual variations have to be considered. From the data, information like the average energy consumption, deviation from these values and the energy per product can be calculated.

In the second stage, energy rejected from each point is recorded. The waste is than compared with the energy demand of other points to find possible utilization. The synchronization of the available energy and the need is also very important; energy staorage should also be considered if possible.

During the third stage, the technology needed to accomplish the energy transfer is investigated; relevant methods and equipment are selected. Feasibility studies are carried out and the return periods are calculated.

The last period of the process is to follow up the performance of the improvements. This stage is also very important because it is the dissemination of the gathered information and the experience to parties of interest.

There are several important elements related to the rational use of energy in industrial facilities.

- Electrical energy savings
- Thermal energy savings
- Mechanical energy savings
- Process energy savings
- Reclamation of materials
- Fresh water supply

Electrical Energy

Electrical energy is used in the industry for heating, as in ovens, to drive electric motors to move machinery and in lighting of production areas, administration buildings, warehouses and other special areas.

The lighting need of office quarters and production areas should be determined correctly during the design process. The most important point is to avoid unnecessary lighting and give up the strategy for general lighting; instead local lighting in accordance with the specific requirements should be adopted.

The type of the bulbs used in the illuminated areas is also effective on the overall energy consumption. Wolfram filament, fluorescent, mercury and sodium vapor lamps are most commonly used in Turkey. Lamps with high luminescence efficiency should be selected. This value is 15 lumen/watt for wolfram filament lamps, 35-40 lumen/watt for fluorescent lamps and 140 lumen/watt for high pressure vapor lamps. Screens, covers, shutters reducing light should not be used and care should be given to cleaning. Special lamps with high luminary flux, available in the market also pose an interesting alternative.

The illumination plan of the facility is as important as the type of lamps used. The lamps should become operational stage by stage as it gets dark and unoccupied areas should not be illuminated except for security reasons. Seasonal variations of sunlight should be considered. Passive measures like the location of windows and the selection of the work areas can also be effective.

The highest fraction of the electric energy used in the industry is consumed by electric motors. Therefore it is of prime importance to keep electric motors under continuous surveillance and regular maintenance to guarantee their operation around their optimum design point.

If motors are operated with low voltage, the current through the coils increase and overheat the system reducing their life cycle and promote losses. The balanced current distribution among the phases should also be followed carefully to avoid heating; this is an indication of probable failure in the future.

Transformers, generators and electric motors operate according to the induction principle and draw magnetization currents to form the magnetic field. This is a reactive current. This current is not transformed into useful power but is necessary for magnetization. Current transformed into light in lamps, into motion in motors and into heat in wires is an active current. It is recorded by the meters and is the basis of the invoice. The grid current falls behind the active current by a phase angle of ϕ due to this reactive current. $\cos\phi$ is known as the power factor. When reactive current is used in a facility, ϕ increases and $\cos\phi$reduces and hence the active current also reduces. Therefore power companies limit the value of the power factor. The limit is set as 0.9 in Turkey. This allows the utilization of half the active current as reactive current. Phase shifters and capacitors can be used to exploit reactive power.

Another effective measure is the staged tariffs used in Turkey recently, which has been effective in western countries since a long period. The timing of the electric power usage can be scheduled to avoid going into a higher tariff zone.

Thermal Energy

Thermal energy requirement at the consumption points can show different characters in energy intensive industrial plants. Some processes require high pressure superheated steam, whereas some processes can take place with saturated low pressure steam. Thermal energy for space heating and social needs can be supplied by hot water and not steam. Hence the correct distribution of thermal energy within the plant could play an important role in the overall energy consumption of the facility.

Thermal energy optimization and saving studies can be collected under three main topics:

- Thermal energyproduction (boiler)
- Thermal energydistribution (insulation)
- Thermal energyutilization (condensate)

The industry uses low, medium or high pressure saturated or superheated steam, pressurized hot water, hot water and hot oil boilers depending on capacity and type. It is important to select the right boiler to meet the capacity of the process. Production is not continuous in all process around the year. Moreover the production of certain goods varies according to the demand from the market. Process changes can also take place and the production of thermal energy does not show a steady regime. Boilers are often operated under part load conditions. The losses of a classical boiler changes with the load; the losses increase [5]. Boiler efficiencies are measured under full load conditions and these values do not represent the real performance and fuel consumption at part load operation. If the boiler is operable under part load during most of the time, the annual operational thermal efficiency should be considered [6]. The annual operational thermal efficiency is the ratio of the useful energy obtained to the total fuel consumed annually. To improve the efficiency, an effective control system to balance the energy supply and demand is required as well as special technology and construction (e.g. modulating burner) [7]

Table 2 *Excess Air, Boiler Efficiency and Specific Consumption at Different Operating Conditions (Flue gas temp. 230 ℃, steam pres. 9 kg/cm^2, boiler feed temp. 63 ℃)*

Information	O_2	Excess Air	Load	Specific Steam Prod.	Specific Fuel Consum.
	%	%	%	Kg Steam/Kg F.O.	Kg F.O./Ton Steam
Normal Operating Condition	15.5	300	72	11.66	85.76
Optimum Operating Condition	13.0	174	83	13.44	74.40
Maximum Efficiency Condition	3.9	25	90	14.57	68.63

[5] Heperkan, etal., 1994, pp. 53-55
[6] DIN 4701
[7] Heperkan, etal., 1994, pp. 36-39

Another topic important for energy saving during energy production in a boiler is the control of combustion and excess air. Extra air compared to stochiometric air is supplied to ensure complete combustion. However, if the excess air increases too much, flue gas losses increase to reduce the overall efficiency of the system. It is important to provide the minimum air to the system that would not cause condensation in the chimney. Condensing boilers available in the market in the recent years condense the water vapor in the flue gases to exploit the latent heat. The best way to assess the optimum combustion conditions for a boiler is to monitor and analyze the flue gases. O_2 and CO must always be measured. O_2 gives the excess air and CO indicates whether the combustion is complete or not. Table 2 shows excess air, efficiency and steam-fuel ratio values of a boiler under different operating conditions [8]. A good control system assesses the energy demand of the system and modulates the generator without turning it off.

It is useful to care for the insulation of valves and flanges used in the distribution network of thermal energy. Although these components are generally overlooked, the heat losses when calculated can reach considerable values, especially for high pressure steam lines. Locating distribution lines in closed enclosures help to prevent the adverse influence of varying outside temperatures on heat losses. Accessibility is also important for maintenance and repair activities.

Other components that have significant effect on energy saving are fuel tanks and stack connections; they should be properly insulated. Facilities using heavy oil must heat the fuel to reduce the viscosity for pumping. At least the bottom sections of the fuel storage tank has to be kept at 50-60˚C. The losses are elevated during winter operation. The heat lost through the stack connection could be recovered utilizing an economizer if insulated effectively

Steam produced in the boiler condenses at the consumption points and the condensate is collected and fed back into the boiler. In the distribution lines however, the steam that condenses due to heat losses, together with the dissolved air and CO2 cause corrosion. Steam traps are used to evacuate the mixture, which is usually discarded. Moreover the condensate from the process lines is also discarded thinking they are contaminated. Flow rates that are small individually can add up to considerable amounts in larger facilities. When collected in a tank in the plant, material and heat recovery is possible.

Table 3 reflects the energy optimization studies carried out for a chemical plant. Recovery potentials are also given. It should be kept in mind that the total energy savings after applying all the measures will be less than the total from the table. If the boiler is operated at optimum conditions, the flow rate of the flue gases through the stack will reduce and the economizer load will decrease. The recovered energy from the insulation will also reduce. Proper insulation on the other hand will reduce steam consumption, decreasing the condensate flow rate.

[8] Heperkan, etal., 1987.

Table 3 *Thermal Energy Losses*

Losses		Heat Loss	Fuel - Oil	Fuel Loss	Heat Loss Cost
		Kcal x 10^7	Equivalent kg	%	MTL/month (1986)
Flue Gas	Optimum Conditions	86.00	88704	13.20	11.0
	Maximum Conditions	130.00	134400	20.00	16.8
Insulation	Fuel-Oil Tank	7.83	10087	1.50	1.3
	Stack Connection Duct	8.17	10540	1.57	1.0
Condensate	Escort Line	16.10	20714	3.08	2.6
	Other	52.80	68069	10.13	8.5
TOTAL *		171.00	198114	29.48	24.4

* Optimum flue gas conditions were assumed during total heat loss calculations.

Mechanical Energy

The potential fields in energy savings in the industry are high pressure air lines, pumps and fans.

It is important to determine the correct need of the system during the design stage while selecting the operating pressure and the compressor; a large compressor for safety purposes is not recommended. Such a selection would increase the investment cost, increase the leakages and losses in the distribution lines and hence the operational cost as well. The pipes should be smooth, components creating pressure losses such as reductions, bends, etc. should be kept at a minimum number and the pressure loss coefficients of valves should be examined carefully.

Air is heated during compression. Heat is a by product of the process and reduces the efficiency of the compressor. Using this energy will increase the overall performance of the system. Controlling the inlet air temperature is also helpful. If we reduce the inlet air temperature, we can increase the mass flow rate by increasing the density. This will also increase the power consumption but the rate is not as high as the density [9].

[9] A.K. Dağsöz, 1991.

Another potential component is the pump. Process technique requires that, the flow lines should be designed with minimum friction, without armatures and bends, keeping the velocities low to reduce losses, hence improving the performance of the pump. During operation, the valves should be fully open and flow through by-pass lines should be avoided. Pumps should not be kept under idle conditions and care should be given to operate at the most efficient point of the pump curve. The pump characteristic and the system load curve should intersect at the maximum of the efficiency curve.

As in almost every field of engineering, recent advances in electronics have brought innovative improvements to pump technology. It is possible to control the speed by changing the frequency of the voltage. Pumps have a range of operation freedom for pressure drop, flow rate and speed to achieve optimum conditions. The performance declines at other points. Systems usually operate under off design conditions. Part load operation causes the specific consumption of pumps to rise. With an appropriate control system, a frequency converter enables the pump to operate at the optimum point even under part load conditions by adjusting the speed. When a thermostatic valve throttles the flow by 15%, the heating efficiency reduces only 3%, on the other hand adjusting the speed with a converter decreases the power consumption by 50%.

Energy analysis of an industrıal facility

The measurement parameters and measurement points have been established. 9 energy zones have been chosen; the zones are summarized in Table 4. Steam flow rates and temperatures have been used to assess the energy consumption of the processes. Temperatures were recorded continuously and the steam flow rates in groups to minimize the number of flow meters. Temperatures and production programs were used to determine the operation periods.

Table 4 *Energy Zones for Steam Consumption*

Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Energy Zones	Boiler House	Pen. Process	Pen.Space Heating	• Office Heating • Old Office Building • Solids Manufacturing	Non-Pen. Process Liquids Manufacturing Solids Manufacturing	Non-pen. Space Heating	Ceph. Space Heating	Ceph. Process	Diessel Room + Distillation

Steam flow rates measured using 22 orifice plates and 5 flow meters. Two electronic flow meters were mounted on the 2 main steam lines and recorded continuously. The meters were calibrated at the beginning and end of the measurement periods. Temperatures were measured with J and T type thermocouples and recorded by 12 data loggers. The measurements were taken every 20-30 minutes. Data was processed with Excel-Macros. Flue gas analysis and fuel meter readings were also recorded regularly. Winter measurements were taken in February and March, summer readings in August and September. Production was 8 hours a day.

Tables 5 and 6 summarize the results of the measurements both for winter and summer. The total steam production calculated from the fuel meter readings have been distributed among the two major lines according to the measurements recorded by the flow meters. This consumption was then distributed among the various processes and equipment. The actual reading from the flow meters, the real values (Values of Fuel meters) and the total found as a result of the redistribution were compared for checking. It can be observed that the difference between the values is well within the error limits typical for such on-site studies.

Sankey Diagrams were prepared to illustrate the share of each process or unit group in the total energy consumption.

Table 5 *Distribution of Steam Consumption between Processes and Heating in the Winter (Production, Night, Weekend)*

	Production			Night			Weekend		
	Process (%)	Heating and Ventilation (%)		Process (%)	Heating and Ventilation (%)		Process (%)	Heating and Ventilation (%)	
		Process Area	Office		Process Area	Office		Process Area	Office
Line-1	19.1	11.0	12.3	10.4	14.5	20.0	13.4	9.7	18.8
Line-2	14.1	42.2	1.4	8.5	45.4	1.6	13.7	42.6	1.6
Total	33.2	53.2	13.7	18.9	59.9	21.6	27.1	52.3	20.4

Table 6 *Distribution of Steam Consumption between Processes and Heating in the Summer (Production, Night, Weekend)*

	Production			Night			Weekend		
	Process (%)	Heating and Ventilation (%)		Process (%)	Heating and Ventilation (%)		Process (%)	Heating and Ventilation (%)	
		Process Area	Office		Process Area	Office		Process Area	Office
Line-1	25.3	5.5	0.2	40.4	1.7	0.0	38.8	0.9	0.4
Line-2	30.2	38.8	0.0	22.1	35.7	0.0	26.6	34.4	0.0
Total	55.5	44.3	0.2	62.5	37.4	0.0	65.4	35.3	0.4

Conculusion

The final distribution of the total steam consumption between the various processes and heating in winter and summer respectively are summarized in Tables 5 and 6 for production, night and weekend operations. The share of heating has been given for the production areas and the offices separately. It can be observed that, roughly 30% of the total consumption is consumed for the processes, 50% for heating and conditioning of the production areas and 20% for office space heating in the winter. In the summer roughly 55% of the total consumption is consumed for the processes, 45% for heating and conditioning of the production areas. Office space heating isn't applicable during the summer. Only domestic hot water is consumed but the relative share is negligible.

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MASTER PLAN 'ENERGY TRANSITION 2025' - A NEW APPROACH IN THE CITY OF DORTMUND

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Abstract

Since a few years Germany has started a new policy approach aiming at a fundamental energy transition with a mid-term perspective of a bit more than one decade[1]. A successful implementation of this policy needs responding activities on the local level. Several German municipalities have started to establish a corresponding local energy and/or climate protection policy. In 2012 the council of the city of Dortmund decided to develop a master plan „energy transition 2025" in dialogue with scientific institutions, stakeholders of the local economy, political decision makers and civil society. This process is based on existing initiatives, such as master plans „environment" and „mobility", „action program climate protection 2020" and others. It is aiming at considering future potentials for energy efficiency, mobility and energy provision in political decision making and therefore has a bundle of spatial and environmental implications[2]. Special goals of the master plan „energy transition 2025" are 1) the co-ordination of projects in the fields of efficiency improvement of the utilization of resources, mobility, and energy; 2) further development of existing knowledge and stakeholder networks; 3) development of future perspectives and strategies for the „energy location" Dortmund, considering scientific and practical expert knowledge; 4) implementation of the holistic approach of the master plan „energy transition 2025", reflecting and monitoring results and experiences[3]. Finally, the paper reflects potentials, obstacles and contradictions emerging in the case of the city of Dortmund.

Key Words: Energy transition, urban policy, master plan

Introduction

Since the Kyoto Protocol was adopted, German government has put much effort on climate protection to reach the national Kyoto target. This required a reduction of greenhouse gas emissions from 1990 to 2010 by 20%. Germany reached this goal in 2008, yet[4] by implementing a new energy policy, especially supporting renewable energy, such as solar power, geothermal energy, wind power and bio energy. Another important group of measures was dedicated to reduce energy consumption, by introducing new low energy technologies in

[1] Gruehn, 2013, p. 231.

[2] The City of Dortmund, 2012 a, p. 1-5.

[3] The City of Dortmund, 2012 b.

[4] Federal Environment Agency, 2011, p. 7.

daily life. This comprises technologies in the housing sector, such as low and zero energy houses or even energy plus houses for new development as well energy saving heating systems and windows as well as house insulation measures for existing buildings[5]. Further goals of the national climate protection policy in accordance with international agreements are the reduction of greenhouse gas emissions by 40% until 2020, by 55% until 2040, and by at least 80% until 2050, compared to 1990[6].

Additionally, the German Federal Government terminated a national adaptation strategy to cope with less or more likely problems resulting from climate change[7]. The character of this strategy is highly integrative, addressing need for action in a broad range of fields comprising human health, civil engineering, water management, coastal protection, sea environmental protection, soil protection, biodiversity, agriculture, forestry and fishery, energy management, financial management, transport infrastructure, industry and business, tourism, and spatial, regional and urban planning[8].

The Fukushima Daiichi nuclear disaster in 2011 has induced a fundamental environmental policy paradigm shift in Germany. The first time after the anti-nuclear movement emerged in the 1970ies, a broad consensus among major political parties (from the left to the right) was achieved, supported by the majority of the public, and resulting in the decision on the nuclear power phase out in 2011 within a time frame of only 11 years[9]. Major reasons for this agreement are the insight that is impossible to reduce nuclear risks to an acceptable level, especially in densely populated countries, the unsolved final deposition of nuclear waste, and the fact that Uranium sources are limited, which makes increasing commodity prices likely. After the Fukushima Daiichi nuclear disaster in March 2011, eight nuclear power plants in Germany have been closed down, from which seven plants were cut-off immediately. The remaining 9 nuclear power plants will be closed down stepwise until 2022[10].

In the result, the decision for a nuclear phase-put until 2022, reduces the degree of freedom to implement the above mentioned climate protection policy as well national adaption strategy, because the CO2-neutral nuclear power technology cannot be used as transition technology after 2022 to replace coal, gas and oil in the mid-term. To fulfill future international greenhouse gas reduction targets the replacement of non-renewable by renewable energies has to be accelerated. This needs a concerted action of further research, a rapid information transfer into the production sector, and high acceptance of the renewable energies especially among decision makers and investors[11].

[5] Gruehn, 2013, p. 232.

[6] GFME, 2012, p. 16; Federal Environment Agency, 2012, p. 15.

[7] German Federal Government, 2008.

[8] Gruehn, 2013, p. 232.

[9] Gruehn, 2013, p. 231.

[10] Gruehn, 2013, p. 233.

[11] Gruehn, 2013, p. 233.

A successful implementation of this policy needs responding activities on the local level. Several German municipalities have started to establish a corresponding local energy and/or climate protection policy. In 2012 the council of the city of Dortmund decided to support the governmental energy transition policy by a local energy transition policy and to develop a master plan „energy transition 2025" in dialogue with scientific institutions, stakeholders of the local economy, political decision makers and civil society.

This paper reflects potentials, obstacles and contradictions emerging in the case of the city of Dortmund in comparison to other local initiatives or policies in or outside Germany.

Methodology

The paper is based on a literature review and follows a hermeneutical methodological approach. Within this framework Dortmund"s master plan „energy transition 2025" with its" qualitative and quantitative features is described and compared with the development in other cities. Hence, the applied methodology can be delineated as mainly explorative, descriptive, and comparative. Especially the comparison with more or less similar cases is used as basis for a critical assessment of the energy transition policy of the city of Dortmund, expressed in the master plan „energy transition 2025".

Literature Review

Recent publications on the issue of energy transition give evidence of the timeliness of this topic. The high complexity of the topic is mirrored in a large variety of viewpoints and focuses, chosen in the different publications.

One important approach is linked with the impacts of 2050 European climate mitigation targets on national energy systems, especially for countries like Ireland, which are characterized by a growth in GHG emissions ("24 % increase between 1990 and 2005")[12]. Other authors focus more on the different transition pathways to reach a national low carbon future[13]. Another group of authors deal with spatial or geographical problems or challenges of energy transition[14]. Furthermore, there are substantial publications on partial technological problems or solutions[15] or dealing with positive side-effects of energy transition[16]. Meanwhile there are an increasing number of publications following a comparative approach[17]

[12] Chiodi et al., 2013, p. 169.

[13] Foxon, 2013, p. 10.; Sovacool, 2013, p. 829.

[14] Bridge et al., 2013, p. 331; Clark, 2013, p. 413.

[15] Kranzl et al., 2013, p. 17; Schade et al., 2013, p. 28.

[16] Mc Cubbin & Sovacool, 2013, p. 429.

[17] Schade et al., 2013, p. 28; Morlet & Keirstead, (2013), p. 852.

concerning specific technological issues[18] or dealing with urban energy governance[19]. Up to now there are only few publications available, which could be used for a city internal assessment how far energy transition has been managed compared to other cities.

Research Findings

The council of the city of Dortmund has decided to develop a master plan „energy transition 2025" in the year 2012. The master plan will be established in dialogue with scientific institutions, stakeholders of the local economy, political decision makers and civil society and will be carried out by the administration of the city of Dortmund. Originally, the master plan should be finalized in autumn 2013[20], but the current schedule is arranged until spring 2014[21].

The dialogue-oriented process master plan „energy transition 2025" is based on existing initiatives, such as master plans „environment" and „mobility", „action program climate protection 2020" and others. Its task is not only to compile existing concept to a single „energy transition" strategy, but also to further develop the existing concepts[22]. From a juridical point of view it is worth mentioning that the federal state government of North Rhine-Westphalia has recently adopted a new climate protection law, which forces municipalities to support climate protection to fulfill the above mentioned climate protection targets[23].

The master plan „energy transition 2025" is aiming at considering future potentials for energy efficiency, mobility and energy provision in political decision making and therefore has a bundle of spatial and environmental implications. Special goals of the master plan „energy transition 2025" are[24]

1) the co-ordination of projects in the fields of efficiency improvement of the utilization of resources, mobility, and energy;
2) further development of existing knowledge and stakeholder networks;
3) development of future perspectives and strategies for the „energy location" Dortmund, considering scientific and practical expert knowledge;
4) implementation of the holistic approach of the master plan „energy transition 2025", reflecting and monitoring results and experiences.

[18] Schade et al., 2013, p. 28.

[19] Morlet & Keirstead, (2013), p. 852.

[20] The City of Dortmund, (2012 a), p. 1.

[21] The City of Dortmund, (2012 b).

[22] The City of Dortmund, (2012 b).

[23] Gesetz zur Förderung des Klimaschutzes vom 29. Januar 2013.

[24] The City of Dortmund, (2012 a), p. 4-5.

The master plan process is supported by periodic public workshops for the following topics, which are accompanied by a scientific monitoring procedure[25]:

- energy and energy economics,
- efficiency of resources,
- mobility, especially electric mobility,
- climate protection, adaptation to climate change,
- promotion of skilled labor,
- public relations.

The workshops follow a specific philosophy pointed out in figure 1: from critique at the current situation via phantasy to realization[26]. This indicates the character of the master plan „energy transition 2025" as a means for supporting discussions and networks, creating increased knowledge, awareness and motivation for action. Hence, the stakeholders in Dortmund rely on the persuasive effects of the master plan in an open-minded civic society. Therefore the master plan will not fix binding measures for individuals or companies. This is scheduled subsequently and is also provided by federal as well as federal state law. In other words the master plan „energy transition 2025" fills the gap between the political goals, which were put into binding law on the one hand, and the local potentialities, responsibilities, communication and activities on the other hand.

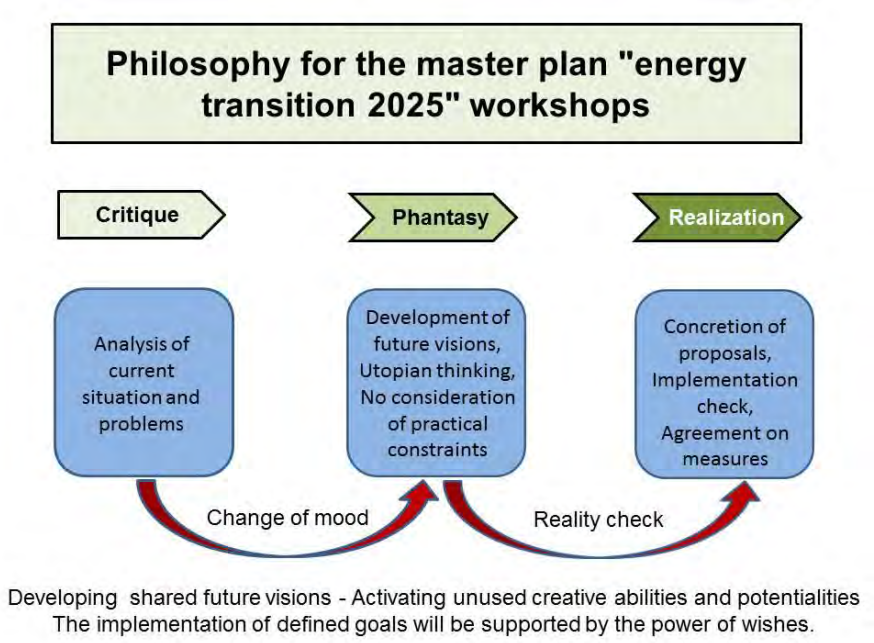

Figure 1: Philosophy for the master plan workshops (The City of Dortmund, 2012 b)

[25] The City of Dortmund (2012 b).

[26] The City of Dortmund (2012 b).

The foundation of the master plan reveals the self-sense of the city of Dortmund. The city claims to[27]

1. be the largest city of the Ruhr region,
2. be the economic and trade center of the Ruhr region,
3. be a hot spot for energy economics and future technologies,
4. reach a leading position in integrating sustainable mobility and renewable energies in urban structures,
5. be a pioneer in electric mobility,
6. realize best practice with the master plan „energy transition 2025" within European Union,
7. be a competence center for smart grid, virtual power plants and saving technologies.

Even if Dortmund is actually not the economic and trade center of the Ruhr region (this is still the city of Essen), the above list indicates the ambitious policy of the city of Dortmund to become a leader in this field.

Discussion/Conclusion

The city of Dortmund claims to become a leader in governing the process of energy transition. On the one hand this could be regarded as laudable act. On the other hand the severe question arises, whether or not the master plan „energy transition 2025" will have the power to support the federal or federal state policy? Another pressing question is, whether or not the master plan will create a measurable surplus compared to the above mentioned policies. The fact, that the master plan itself will not fix binding measures or regulations, makes it difficult to prove an expected surplus. But literally the master plan is aiming at to further develop existing concepts of the city of Dortmund. This means in turn that the master plan necessarily aims at creating additional values. It will be one important task during the still ongoing process of the master plan to define measurable goals from a specific local perspective. This implies that policy goals and measures defined by European, federal or federal state authorities can be clearly identified, separated and allocated to the authorities. Otherwise the master plan could consist of an arbitrary mingle-mangle of measures, defined, stipulated and/or financed by EU, federal government or federal state government, but not by the city of Dortmund. Under these circumstances a surplus of the master plan „energy transition 2025" would be questionable.

A comparison with other cities in and outside Germany reveals that there are many other cities dealing with energy transition concept until 2025 or even 2050. In the year 2012 19 communities, mostly cities, were selected by the German Federal Ministry for the Environment to be supported in their efforts to establish a master plan „100% climate protection"[28], including the cities of Frankfurt, Göttingen, Hannover, Heidelberg, Osnabrück, Rostock and others. The city of Münster started with a local climate protection initiative in 1995[29], yet, and reduced CO2-emissions from 1990 to 2005 by 25 %, while the required reduction of greenhouse gas emissions in Germany from 1990 to 2010 was 20%. Therefore,

[27] The City of Dortmund, (2012 a), p. 2-4.

[28] GFME, (2012); p. 18.

[29] The City of Münster, (2007), p. 3.

2006 Münster was awarded capital of climate protection. Another example is the city of Växjö, Sweden, where politicians decided to free the city from fossil fuels in 1996[30].

Hence, these examples illustrate that Dortmund is not the only city in Germany, which has established an ambitious program aiming at an energy transition and climate protection. To justify the claim to be a real leader in this field, the city of Dortmund has to define measurable indicators to assess the surplus of the master plan „energy transition 2025" in the long term, especially in comparison to the local energy transition and climate protection policy of other cities.

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EFFECTS OF INDUSTRIAL DISPOSALS ON GLOBAL CLIMATE CHANGE

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1. INTRODUCTION

With the development of industry, the need for energy sources has been increasing day by day. Especially the methods used to obtain energy has become a serious impact on natural life. Inefficient use of energy source and need for more energy is increasing the thread. The absence of a source that can be stored, being consumed immediately at the time of production and being produced as needed are the other encountered problems. When all these issues are considered, many methods used in energy production have become elements that contribute to and accelerate the global climate change.

For this reason, efficient use of energy and becoming able to do more work with less energy especially in industry is essential. Rapid consumption of natural resources and harmful gases released into the atmosphere has reached to a life threatening dimension. Within the context of this article, the sources of energy and the effects of these sources on the nature will be discussed briefly. Later on, the issue of how to use energy in a medium-sized manufactory in furniture industry (MSE) more efficiently and consequently the measures that can be taken by the manufacturer on global climate change will be discussed.

2. OBTAINING ENERGY and CARBON EMISSIONS

The unsolved problem of not being able to store energy in huge amounts and the loss during the transfer of energy, indicates that the issue is open to development. Energy obtained through fossil fuels, which is commonly used in many countries, hydroelectric power plants and nuclear power plants threaten the nature and mankind seriously. In these methods, the basic principle of obtaining energy is turning the tribunes with the help of water or water vapor. In addition, under the name of clean energy, energy is obtained through wind energy, solar energy, wave power and geothermal power plants without damaging or with the least damage to the environment. Not emitting any harmful gases from these plants to the atmosphere does not mean that they are harmless. Fields filled with giant propellers or large solar fields are required in order to obtain huge amounts of energy. The systems set up for obtaining energy from waves or currents threaten the natural life. Figure 1 and Figure 2 show

the power plants established to obtain energy from wind and solar power, on the use of renewable energy sources.

The development of industry and technology and the increase in the world population are pushing the limits of natural life. In recent years the amount of greenhouse gases such as carbon dioxide, methane, ozone and nitrous oxide in the atmosphere has increased due to human activities and caused significant increase in the earth's temperature. The increase in the greenhouse effect is shown as the most important factor in warming of the troposphere and cooling of stratosphere.[1]

Figure 1. Solar Power Plant (SPP)

Figure 2. Wind Power Plant (WPP)

Burning of fossil fuels, industry, transportation, change in land-use, solid waste management and agricultural activities contribute to the increase in the amount of greenhouse gases. As a result of human originated greenhouse gas emission to the environment, global carbon balance cannot hit the target.

[1]*Intergovernmental Panel on Climate Change (IPCC), Final Declaration, 2002, Environment Online, What is Global Warming,http://www.cevreonline.com/kuresel/kuresel%20isinma%20nedir.htm, Access September 16, 2013.*

In addition to the normal flows of the global carbon cycle, 1.6 billion tons of carbon through change in land-use and deforestation and 6.3 billion tons through burning of fossil fuels with a total of 7.9 billion tons each year have been emitted to the environment.[2]

Earth's climate has been changing since the industrial revolution. Temperatures kept their stability in the 19th century. They slightly increased in the first half of the 20th century and showed a decreasing trend in the second half, especially between the years 1950-1970. However, they started to increase later. Global temperatures increased by an average of 0.6 ° C in the last century. What causes such a concern within the current situation? The reason for concern is not so much related to temperature increase. Previous climate changes on earth were caused by either the angle during the rotation of the earth or the changes in the distance between the earth and the sun. But this time the situation is different. Because, nowadays intense effects of emissions of human originated greenhouse gases mostly due to fossil fuel burning thermal power plants especially those that use coal as fuel and are called death generators on climate systems have emerged.[3]

3. EFFICIENT USE OF ENERGY

The most obvious and effective method for eliminating or minimizing the above mentioned effects during the use of energy, which is one of the most important inputs of industry, is improving the method of obtaining energy. However, the improvement in the use will provide important contributions in terms of effects on environment as well as being economic. Minimizing the consumption of energy especially by auxiliary equipment and auxiliary machinery which are necessary for the operation of the main machinery existing in the production line of the enterprises and the energy consumed during machinery adjustment times shall be an important achievement. All activities that do not generate added-value at production enterprises are the elements that raise the costs. Therefore, the customer does not want to pay for these activities or the expenditures. In short, it is a fact that when the elements such as energy not generating added-value, labor, materials and so on are eliminated, the costs will be brought down and efficiency will be increased. In this context, as it is known in wood industry, the wood dust/sawdust from cutters are vacuumed by high powered fans in order to

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[2] *Intergovernmental Panel on Climate Change (IPCC), Final Declaration, 2002, Environment Online, Global Warming, http://www.cevreonline.com/kuresel/kuresel%20isinma%20nedir.htm, Access September 16, 2013.*

[3] *Taner, A.C., 2008, Advanced Nuclear Power Plants Mechanisms of Climate Change, Global Warming and Climate Change Scientific Reports, The Chamber of Physics Engineering Publications, http://www.fmo.org.tr/_yayinlar/faydali-bilgiler/, Access, September 17, 2013*(Taner, 2008)

be removed from the environment and stored in silos/bags. The energy spent for this purpose moves an activity that does not contribute to the product; in other words an activity that does not generate added-value. However, it is not possible to eliminate completely this process. Thus, the less energy spent for it, the less harm given to the environment.

3.1. Dust Extraction Systems in Wood Industry

Vacuum dust extraction systems which are used for the removal of the dust coming from the cutting tools during the processing of the wood or derivatives of wood from the machine, often work all day long. In the event that 2 or 3 machines are connected to a single fan, which is a common application at enterprises, although one or three of them are running, the suction fan operates at full capacity. In this case, being operated at full capacity instead of running at the rate of 1/3 power causes unnecessary expenditure of energy. Besides, running of fans during the adjustment and cleaning of the machines also causes an unnecessary expenditure.

The number of enterprises engaged in the production of wooden furniture in Turkey is 14 692 according to 2013 data.[4] 18% of this number includes the enterprises employing 50-249 number of people. Large scaled enterprises minimize the loss as a result of their corporate structure and with the coordination of production flow. Samples have been prepared considering this situation and assuming that maximum loss is observed in the 18% segment since small scaled enterprises do not use large dust extraction systems.

The systems are usually furnished according to the calculations made for the amount of the machines at the beginning. However, due to additional machines, the system starts to run insufficiently later and becomes a system with high cost of energy consumption. Therefore, wasted energy contributes negatively to the global climate change in terms of the method of energy obtaining as well as high costs. Climatic effect will be reduced correspondingly when the energy spent in this process is reduced.

Units with storage bags are used in standard dust extraction systems especially at the level of SMEs. The capacity of these systems are between 2.000m^3/h and 100.000m^3/h and they are applied easily to all kind of machines. They are the units with low investment but higher operating costs. Figure 3 indicates the shape of such a unit.

[4] *Middle Black Sea Development Agency, Wood Products and Furniture Sector Report 2013, p.24-25*

Figure 3. Bag Type Filter Dust Extraction System [5]

Bag type systems are the most preferred ones in the sector due to the advantages of economic, easy installation and quick mounting. However, they have constant capacities and there is no chance of making any connection to an additional machine which means that dust bearing capacity cannot be expanded and therefore, as the load increases the capacity will decrease and cause waste of energy. When exposed to high sawdust load while running, the system causes blockages. Figure 4 indicates an example for a broken fixture due to overload of wood dust that piles up in the pipes because of the blockage.

Figure 4. Wood dust / Sawdust Piled up in the Pipes

As seen in Figure 4, wood dust that piles up in the transfer pipes in time reduces the efficiency of the system and causes high amounts of energy consumption. Eliminating these problems and running the system more efficiently will both provide energy saving and a decrease in indirect negative impact on the climate and the environment by the same rate.

[5] *Airpak Dust Extraction Systems Product Catalog*

In this system, pressure needs to be applied in transfer pipes along the line which lies along the factory to have the dust transferred to the storage area. Consequently, the same power used for vacuuming of the dust from machine links has to be spent throughout the line Yet, if a carrier conveyor transfers the vacuumed dust from the machine links to the storage area, the same process will be carried out with less energy. To do this, according to the size of the factory, one or two carrier conveyor lines carry the dust vacuumed from the cutting tools of the machines to the storage area. (Figure 5). The conveyor does this with a small engine drive.

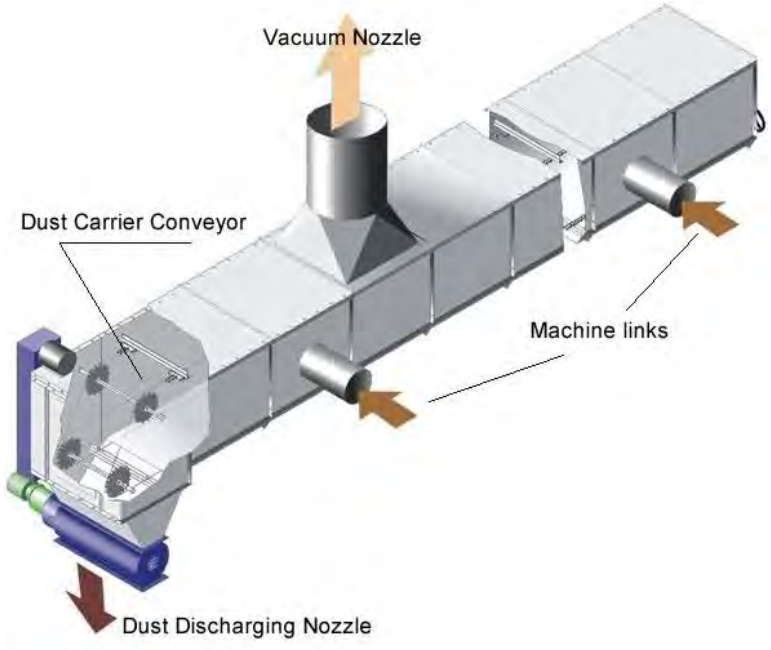

Figure 5. Diagram of a Dust Extraction System with Conveyor

In the system shown schematically, thin and light dust is sent to the filter by vacuuming from the upper vacuum nozzle. The filter system used here is called negative pressure system which means that the fans are placed after the filter within the system (Figure 6). So, it is not possible for the dust to stick on the fan blades and cause an extra burden or imbalance. Positive-pressure filter system, which is used commonly, is also shown schematically in Figure 6. In this system the fans are placed before the filter. Vacuumed dust is hold by the filters and then sinks into the bags. In this system the fans are always under burden and the filters lose their permeability after a certain time both of which cause increase in energy consumption.

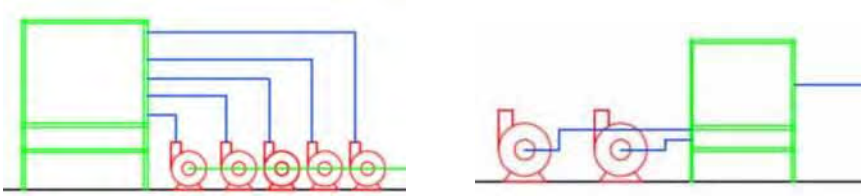

Figure 6. Positive Pressure System and Negative Pressure System

3.2. Comparison of the Systems

Dust extraction systems are necessary first of all for the sake of workers' health and safety at work in wood industry. As briefly mentioned above, the same work is being carried out using different methods. The most important issue is removing the dust from the environment with the least cost which is considered as profit for the enterprise. Static pressure calculation for the sample conventional dust extraction system in Figure 7; pressure calculation for the dust extraction system with conveyor in Figure 8 and the comparison analysis results in Table 1 indicate that dust extraction systems with conveyor do the same work with 50 % less energy consumption (Yılmaz, 2010).

Static Pressure in the Conventional Dust Extraction Unit

,

$$Total\ Pressure = Link\ Arms + Main\ Duct + Filters + Fans$$

Pressure on link arms	≅ 90 mmSS
Main duct (70 + 55 m) pressure	≅ 250 mmSS
Pressure on filter	≅ 45 mmSS
Pressure on fans	≅ 39 mmSS

Total = 90 + 250 + 45 +39 = 424 mmSS

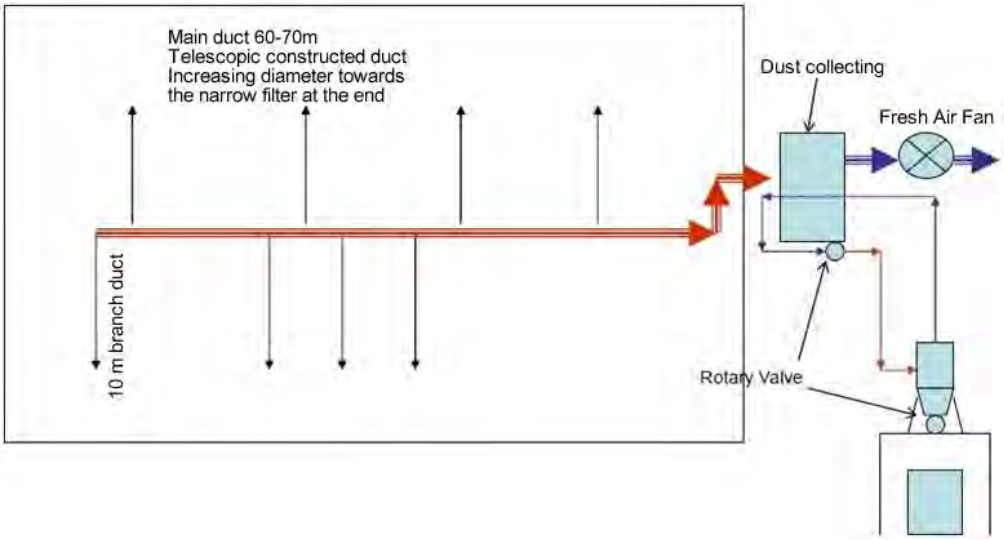

Figure 7. Diagram of a Conventional Dust Extraction System

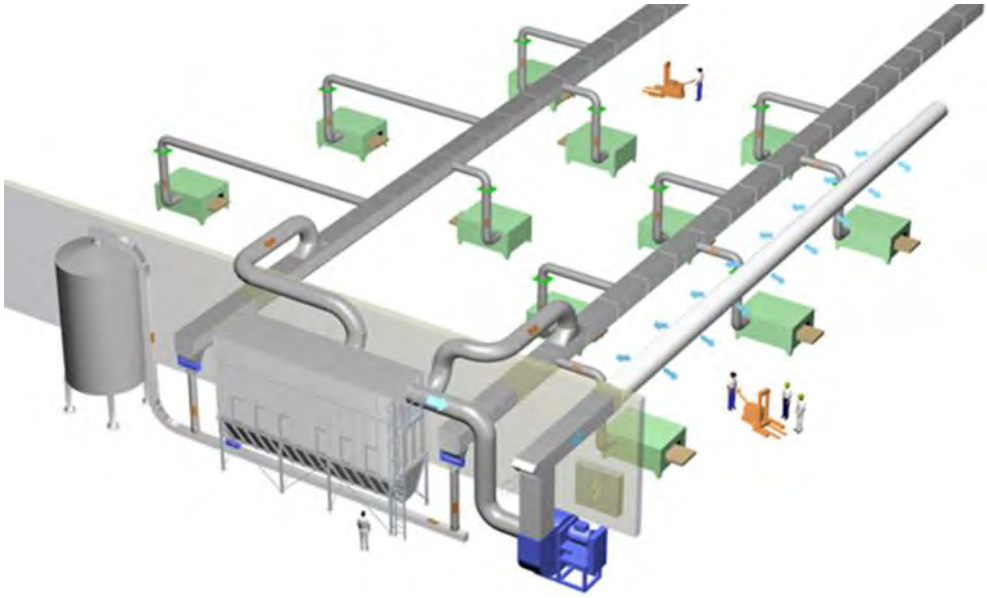

Figure 8. Factory Sample of a Dust Extraction System with Conveyor [6]

Static Pressure on Dust Extraction Unit with Conveyor;

Pressure on link arms	≅ 90 mmSS
Pressure on conveyor duct	≅ 7 mmSS
Main duct pressure	≅ 50 mmSS
Pressure on filter	≅ 45 mmSS
Pressure on fans	≅ 39 mmSS

Total = 90 + 7 + 50 + 45 + 39 = 231 mmSS

[6] *Product Catalog of Timsan Makine Sanayi Ltd.Şti.*

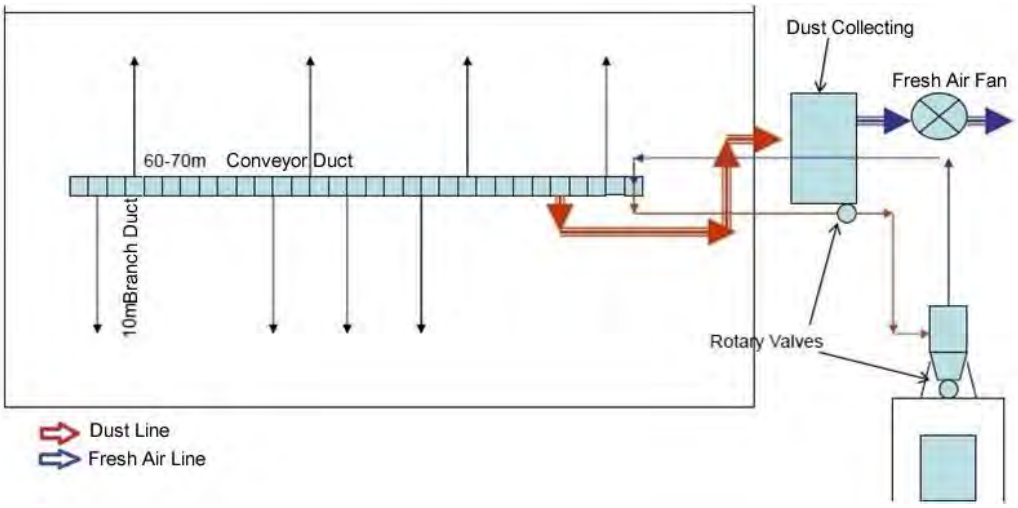

Figure 9. Diagram of a Dust Extraction System with Conveyor

When we calculate power according to the following formula;

$$P_{kW} = 0{,}56 \times \text{Static Pressure(mmSS)} \times \text{Flow rate } (m^3/h) \times 10^{-6}$$

it can be obviously understood that the static pressure directly affects energy consumption proportionally. The data are analyzed comparatively in Table 1 and it has been concluded that dust extraction systems with conveyor provides energy saving of 48 %.

Table 1. Energy Outputs of the Systems

	Power Used KW	KW/h Costs	Cost Per Hour	Daily Cost (24 hours)	Weekly Cost (5 days)	Annual Cost (52 weeks)	Saving
Conventional System	424	₺ 0,22	₺ 93,28	₺ 2.238,72	₺ 11.193,60	₺ 582.067,20	-
System with Conveyor	231	₺ 0,22	₺ 50,82	₺ 1.219,68	₺ 6.098,40	₺ 317.116,80	₺ 264.950,40

The annual energy consumption of an enterprise working with 24-hour shift is 100kWh x 24h x 5days x 52weeks = 624.000kW when conventional system is used. In accordance with the calculation, the 18% of 14 692 enterprises have been considered within SME scale in Turkey, and these enterprises are confirmed to use 100kWh of energy in the direction of the capacity of their dust extraction systems.

If 46% of energy saving is provided with the use of conveyor, then the annual energy consumption of the same enterprise shall be 336.900kW which means approximately 288.000kW of energy saving.

Thus, when harmful gas emissions are calculated considering the mentioned energy saving, it can be clearly seen the extent to which the harm given to the environment decreases.

First of all, when 2 645 enterprises are assumed to use a conventional dust extraction system, the energy demand is 2.645 x 624.000kW = 1.650.480MW. However, through a dust extraction system with conveyor, this demand is 2.645 x 336.900 = 891.000MW.

1.650.480MW – 891.000MW = 759.480MW is the amount of saved energy. The amount of CO2 and SO2 gas emission and decrease in waste ash are given below in the case that the obtained saving could not be made and comparison has been made with the size of energy derived from thermal power plants. To make this comparison annual coal consumption and the amount of waste generated by a 1.000MW-thermal power plant in a year is given in Table 2.

Table 2. Data of a 1000MW-Thermal Power Plant

Power MWh	CONSUMPTION Million Ton/Year	WASTE AMOUNT (Ton/Year)		
		CO_2	SO_2	Ash
1.000	2,5	6.000.000	120.000	600.000

When an evaluation is made over the data given in Table 2 for the annual energy saving of 759.480MW through conveyor, with an energy recovery of 46 % only in wood industry emission of 521 000 tons of CO_2, 10 500 tons of SO_2 and 52 100 tons of ash to the environment per year shall be prevented.

4. CONCLUSION

As a result of conducted researches, with the use of conveyors, positive contributions will be made in product costs as well as efficient use of energy with a saving of 45%. Also furnishing the conventional system with extinguishing systems against the risk of fire due to static electric load created by the friction of the transferred dust with a speed of 25m/sec through the transfer pipes brings about extra costs. When compared with the system with conveyor, the higher burden on the filters within the conventional system affects the engine's energy consumption negatively, as well. The maintenance costs also increase due to the placement of the fans before the filters in the conventional system. The most important point is that, the system needs an additional fan for each additional machine and even a new system in the event that filters become insufficient.

The conventional system, which is preferred because of cheap initial investment costs and quickness, increases the costs in the long term with its high operational costs. The conveyor system, on the contrary, has high initial investment costs but, as a result of smooth running in the long term, does not bring additional high costs. Energy saving of up to 50% from time to time allows the conveyor system to redeem its investment costs within a short period of time.

Harmful gas emissions to the environment will significantly decrease when the proposed dust extraction system with conveyor in this study becomes widespread across the sector. The example given under the Notification is only from furniture industry. When this study is popularized in the general sense across the wood industry, the amount of savings and the increase in harmful gas emission will be perceivable.

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EXPERIMENTAL INVESTIGATION of a RENEWABLE ENERGY SOURCE ASSISTED HEATING and COOLING SYSTEM at RENEWABLE YILDIZ ENERGY HOUSE

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Abstract

Today's most important and controversial problems are usage of energy resources and their processes. Ensuring the sustainability of environmental resources, minimum amount of environmental sources will be used to produce energy. This will also help to minimize environmental damage.
The cost of energy is so high and in an increment trend. Also greenhouse effect due to CO_2 emissions and unhealthy combustion products of fossil fuels are increasing rapidly. Hence, Hybrid Renewable Energy Systems designed as optimum have been considered with regard to as the solution the KYOTO Protocol. Solar energy and ground source heat pump can be used as a renewable energy sources seperately. They can also be combined as a hybrid renewable energy system. In this study; wall heating and cooling systems (WHCS), vertical ground source heat pump (V-GSHP), solar energy (SE), and Latent Heat Storage (LHS) were combined in a building. This hybrid renewable energy system has been utilized at Renewable Yildiz Energy House located at Davutpasa Campus of Yildiz Technical University, İstanbul-Turkey.
Exergy environmental analysis, based on the exergy flows, is used to perceive the comperative enviromental impacts of the systems and this analysis consists of manufacturing process, operation process and waste process of the product. It is necessary to use results of energy, exergy and exergo economic and environmental analysis together to decide on the system performance. In this study, laws of Thermodynamics has been used for energetic and exergetic analysis. As result, performance graphics of hybrid renewable energy system have been drawn.

Key Words: Renewable energy, hybrid systems, solar energy, ground energy.

1. Introduction

Due to the technological and industrial development and the increase in human population, environmental pollution is getting worse. This problem increases the necessity for the renewable energy sources. Decrease in fossil energy resources affects the economy of most of the countries significantly and increase their external dependence. This also affects the global balance of economic power. In addition, uncontrolled usage of fossil fuels seems a serious threat for human health and world's future. Air pollution caused illnesses and global warming forced researchers to do research about new and renewable energy sources. Within this context, in last 20 years, studies on the way of increasing efficiency of renewable resources;

especially SE, wind energy and ground source heat pump (GSHP) have been rising. There seems to be a necessity to make provisions for the sharp decrease of the amount of fossil fuels.

Nowadays, fossil fuels that national energy systems depend on, are limited and predicted to be an insufficient and expensive source for the future. In addition to this, common energy demand, especially in heating sector, is rising day by day. Utlu et al. [1] has made several researches about the utilization of energy in residential-commercial sector including space heating applications. It was found that the highest share of fossil fuel consumption takes place in heating sector with 45%. Beside this, environmental impacts such as climate change and atmospheric pollution are increasing. Greenhouse emissions attract attention as the primary factor of climate change. Within this context, various international organisations such as Kyoto Protocol are working on this problem [2].

GSHP systems make use of renewable energy stored in the ground for building heating and cooling. They are suitable for a wide variety of building types, provide high levels of comfort, and are particularly appropriate for energy saving and environmentally attractive [3-9]. Many theoretical and experimental works on GSHP systems has been accomplished, since late 1940s. GSHP systems are inherently more effective than air source heat pumps because the ground maintains relatively stable source and sink temperatures. This situation provides a better COP for the GSHP system. For the ground heat exchangers, vertical ground source heat pump (V-GSHP) systems are usually preferred. They are more efficient and less ground area is required [10–14].

Wall heating and cooling systems (WHCS) have low operation temperature benefit. This creates substantial energy savings for heating and cooling compared with conventional systems. The energy savings from a WHCS may reach more than 30%, as demonstrated in some theoretical and experimental case studies. Main advantages of WHCS are enabling better thermal comfort, providing better indoor air quality with low air velocities and homogenous heat distribution, being available to use waste heat and low-enthalpy renewable energy resources, and having low initial investment, maintenance, and operating costs [15]. Researchers have mostly determined the convection heat transfer coefficient of heated and cooled walls. They have solved the natural convection problems in enclosures. In these studies, heat distribution from floors, walls, and ceilings were investigated for heating and cooling situations. All studies considered in the literature about WHCS emphasized that this system was comfortable, economical, and very suitable to use with renewable energy systems. Because of this reason, a real V-GHP system, combined with a WHCS, has been analyzed experimentally in our previous research. Energetic aspects of the system were introduced. However, exergy analysis of the system hasn't been represented yet [18-20].

Exergy analysis is widely used for to scale a process's thermodynamic ideality. This helps designing efficient and cost effective systems that also meet environmental conditions. In addition to the energy analysis, exergy analysis must be used to identify the components where inefficiencies occur. Improvements should be done to these components to minimize the irreversibilities and optimize the system [19-21]. In recent years, exergy analyses of space heating/cooling in buildings and GSHP systems have been developed [22–28]. These studies focused on the building heating mode, and few on the building cooling mode.

For most people all over the world, solar energy is evaluated as a primary energy source for the future. Whilst research about new and renewable energy resources is vital, improving

energy storage systems is as important as benefitting from new energy resources. Storage of energy in an appropriate way and developing systems to make it available when needed are the key missions of today's researchers. Storing energy in a suitable way, not only provides equilibrium between supply and demand but also increases performance and utility of energy systems. Energy storage systems enable economical usage of fuels. As a result, they reduce the amount of waste energy. By this way, these systems improve the performance of energy systems in economical aspects. [29].

There are many studies about heat storage systems in literature; [30-39] which made several numerical and experimental analyses for investigating energetic and exergetic performances of solar assisted heat storage systems. Various types of heat storage methods have been evaluated and compared in energetic, exergetic and economical aspects [40-41]. There are many researchs about heat storage system in greenhouse applications [42-43]. Also many researches about hybrid heating systems combined with SE and heat storage systems [44-47].

Jagedheeswaran at all [48], developed numerical energetic and exergetic analysis methods for investigating the performance of heat storage systems. In another study, Dincer [49] investigated heat storage systems from technical, economical and environmental perspectives. Some researchers has made reviews about various elements used as a heat storage material [29, 50-52]. They also reviewed the phase change materials and made classifications about them.

2. System Description

In this study; wall heating and cooling systems (WHCS), vertical ground source heat pump (V-GSHP), solar energy (SE), and Latent Heat Storage (LHS) were combined to form a hybrid renewable energy source in a building. The system is located in Renewable Yildiz Energy House at Davutpasa Campus of Yildiz Technical University, Istanbul-Turkey. (WHCS)s were built in 3 different rooms of Renewable Yildiz Energy House and a saloon of a hall for heating and cooling applications.

The compressor was controlled by an inverter to meet the need of cooling load under actual V-GSHP operating conditions. The boreholes were drilled down to 65 m under the ground to obtain the stable temperature of circulating water in the ground heat exchanger. V-GSHP system with a 1.7kW scroll type compressor feeds this system. The parameters such as the outdoor air temperatures, inlet-outlet temperatures, mass flow rates of both ground heat exchanger and circulating water were monitored. The heating performance of the V-GSHP system was determined by measuring the input power and heating capacity. Hybrid renewable energy system is designed for the energy requirement of 92 m^2 place. This system is original, because different renewable energy sources are used together by means of an automatic control system.
On the wall heating/cooling serpentines, 14 mm inner diameter and 16 mm outer diameter polythene pipes were used. Total pipe length mounted to walls is 441 m (Fig 1 a, b). WHCSs are important because of their low temperature heating benefits. This results with a substantial energy saving for heating and cooling compared with the conventional systems. The energy savings from WHCS may reach more than 30%, as demonstrated in many theoretical/experimental case studies.
Because the SE is a cyclical energy source, storing excess energy during daytime and using it at night time will increase utilization of solar energy. Heating demand were compensated with 3 solar collectors that has 4.86 m^2 area.

Figure 1 : (a) Wall heating serpentines (b) Ground source heat pump

In LHS paraffin which melts between the range of 42-44°C and easy to find in Turkey was used. The shell that paraffin was stored in has a volume of 0,063 m^3 and the paraffin shell is located in an outer shell which has a volume of 0,22 m^3. Heat transfer fluid circulates inside the gap between the inner and outer shell. There is also a 0,1 m diameter gap in the middle of the inner shell to increase heat transfer surface area.
All inclusive system diagram of energy building given below (Fig. 2: a, b). This hybrid system has been examined in two parts: WHCS and V-GSHP systems; SE and LHS systems.

2.1. Associate operation of WHCS and V-GSHP systems

2.1.1. Analysis and Computational Model

In the analysis of the system, the following assumptions were made for the V-GSHP;

- The system is steady state in one second intervals
- The efficiency of the evaporator and condenser are assumed constant $(\eta_{cond} = \eta_{eva} = 0.85)$
- 3 pumps in the system are equivalent and have same power (W_p = 0.132 kW)
- R410A flow rate is calculated and assumed constant during a second

In the analysis of the system, data of teleControl software which can be used by Helioterm heat pump software are transferred to a MySQL database by a generated C++ code which is named as DISS-Parser. Another developed C++ software, DISS-An is used to analyse system data (Fig.3). Data were recorded for each second and converted to a MySQL database. Collected data were arranged and transferred to other software for calculations and analysis. Refrigerant (R410A) properties were taken from Solkane 6.0, and water properties were taken from EES (Limited Academic version) software. Microsoft Excel pages were formed for calculations.

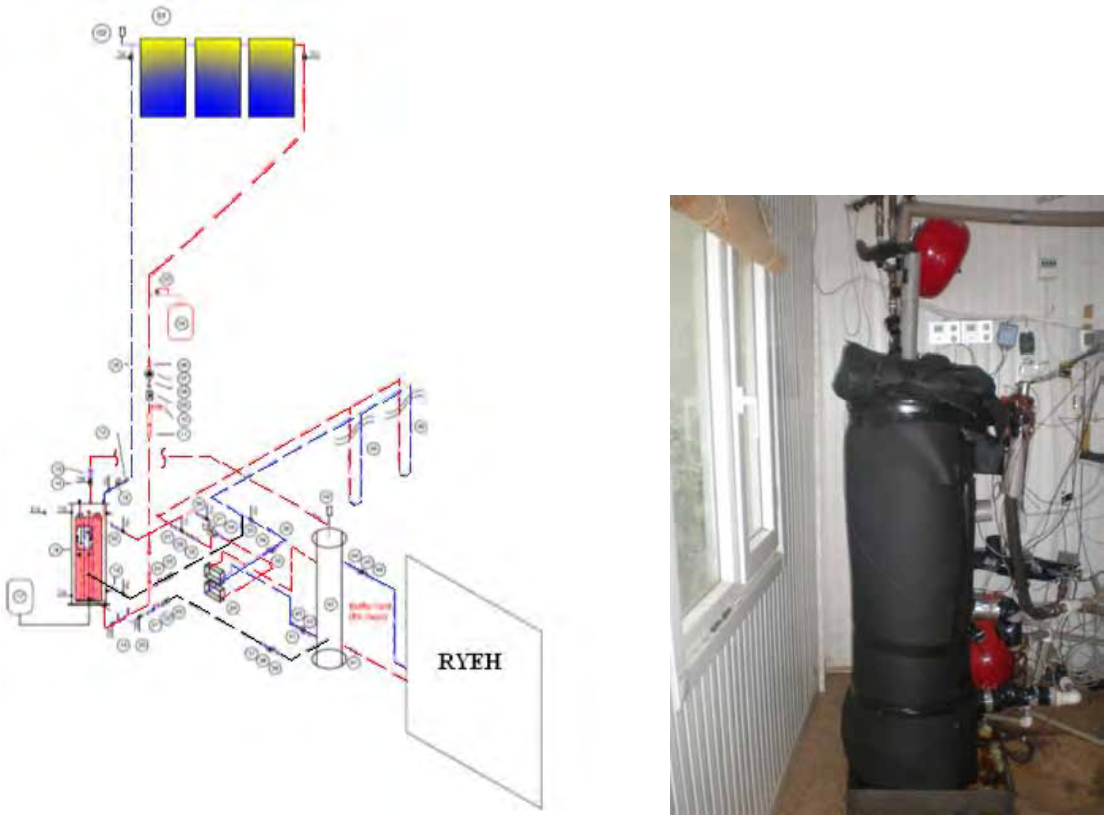

Figure 2 : (a) Hybrid system diagram (b) latent heat storage system

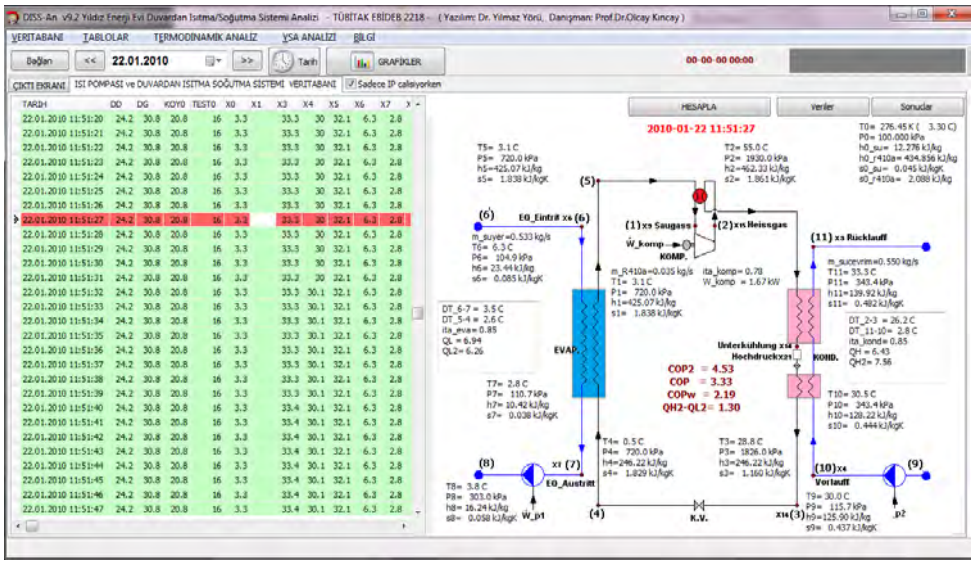

Figure 3. Developed DISS-An Software in analysis and system (Heating Session)

In the energy analysis of the heat pump system mass balance equation, first and second laws of thermodynamics have been used. By this way, COP of the heat pump system and all its components could be derived. Basically, all equations for a steady-state and steady-flow process were used.

The investigated V-GSHP system with the WHC is shown in Fig. 4. For generating the ground-loop heat exchanger, 240 m DN40 polyethylene composite pipes were used in a vertical direction and 45 m in horizontal. There are three circulation pumps and an isolated 500 lt accumulation tank in the system. In the WHCS system, 840 m DN16 and 40 m DN20

polyethylene pipes were used. Systems were set up for holding the test room temperature at 20°C on the heating and 24°C on the cooling mode. For this reason, 31°C and 18°C V-GSHP operating temperatures were chosen especially to maintain comfort and prevent condensation on wall-mounted serpentines. Heating season was analyzed using data collected between Jan. 1 and March 31 and cooling season was between July 1 and Sept 30, 2010.

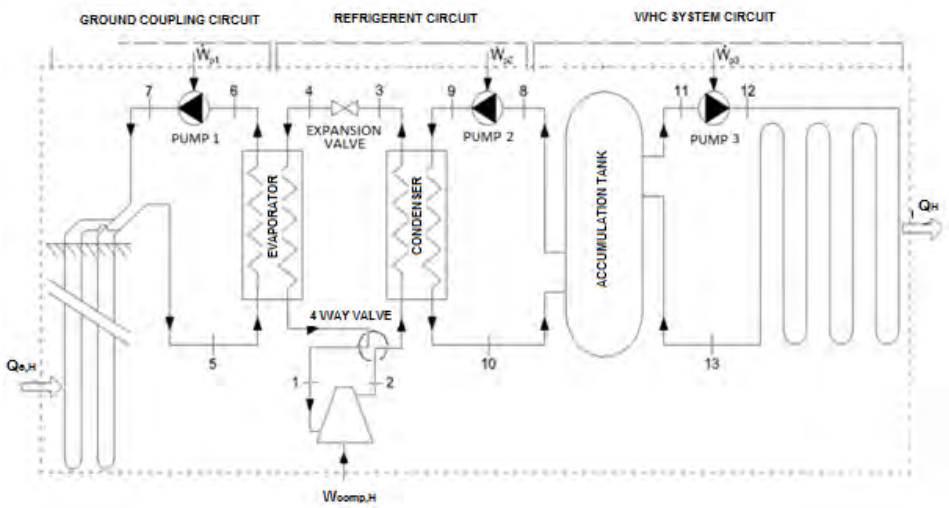

Figure 4. Schematic of investigated V-GSHP and WHCS on heating mode

2.1.2. Results and discussion

For the heating season, calculated overall system energy efficiency was 67.36%, while the V-GSHP unit's efficiency was 85% (Table 1). Adding to that, overall system COP was 2.76, while the V-GSHP unit's COP was 4.13.

For this season, the exergy efficiency peak values for the expansion valve and accumulator tank has become 95% and 87.6% respectively. During the calculations energy loss from the expansion valve were neglected. Therefore, energy and exergy efficiency values for these components are suitable for these working conditions. The tank is well isolated. On the contrary, the exergy efficiency values are lowest for the evaporator and three circulation pumps. Whole exergy is destroyed on the pumping process. However overall system's energy and exergy efficiency values are 67.36% and 22.00% respectively and definitely we should develop some system components. Main indicator for this consideration is exergy destruction rate. That's why compressor, WHCS and the ground heat exchanger must be developed respectively. Improvements on the compressor will also affect on the performance of the condenser positively if the gas temperature of compressor outlet can be reduced.

For the cooling season, calculated system efficiency was 74.90%, while the GSHP unit's efficiency was 80.76% (Table 2). Furthermore, overall system COP was 4.38 while the GSHP unit's COP was 4.78. Electrical energy consumption by system components is as follows: compressor, 1.07 kW; ground heat exchanger pump, 0.088 kW; accumulator tank circulation pump, 0.097 kW; and WHCS circulation pump, 0.100 kW.

Table 1. Energetic and exergetic analysis results for representative unit in the heating session ($\dot{E}_{input}$: Energy input, $\dot{E}x_{input}$: Exergy input, ηı : energy efficiency, ηıı : exergy efficiency)

No	Name of element	$\dot{E}_{input}$ [kW]	$\dot{E}x_{input}$ [kW]	ηı [%]	ηıı [%]
I	Overall system	8.609	2.254	67.36	22.0
II	V-GSHP unit	8.312	1.840	85.00	37.9
III	Pump1	0,130	0.092	70.75	1.1
IV	Ground heat exchanger	6.509	0.230	100.00	57.9
V	Evaporator	6.601	0.134	97.63	0.5
VI	Compressor	1.711	3.838	74.10	58.3
VII	Expansion valve	8.592	2.238	100.00	95.0
VIII	Condenser	7.712	0.886	91.65	79.3
IX	Pump 2	0.130	0.114	87.69	4.4
X	Pump 3	0.130	0.108	83.08	4.4
XI	Accumulator tank	7.182	0.708	91.73	87.6
XII	WHCS	6.696	0.625	86.61	79.4

During heating season, the heat extracted from the ground was found to be, on average, 6.51 kW. Also, during cooling season, the heat discharged to the ground was found as average 7.053 kW. This corresponds to a heat rejection rate of 54 W/m of bore depth for the heating period. The pumping brine average flow rate was stable during the whole year and found to be 1.584 m^3/h with an average pumping power of 13.94 W/kW.

For the cooling season, the exergy efficiency peak values for the expansion valve, ground heat exchanger and accumulator tank 99.2%, 80.9% and 80.4% respectively. The expansion valve and accumulator tank present similar results in the heating and cooling sessions because of the reasons explained above. However, the ground heat exchanger works very different. There is a huge difference in the exergy efficiency values. Because the ground heat exchanger water inlet temperatures are too different 3.94°C and 24.63°C respectively. There is a bigger heat transfer coefficient due to water molecules activity at 24.63°C temperature and also 3.94°C is very near to dead state. However in both cases the exergy destruction rates are close, 0.097 kW and 0.103 kW respectively.

2.2. Associate operation of SE and LHS systems

2.2.1. Analysis and Computational Model

Within this study, a numerical analysis of utility of the LHS as well as experimental energy and exergy analysis of solar collectors and heat storage system for charging process was presented.

In building applications highest energy demands are needed for heating and cooling to reach comfort conditions. This study was done by using real data obtained from a prototype structure built as part of a project. Necessity of heat storage systems, during the usage of SE and V-GSHP systems for heating was investigated. By this way, different techniques used for heat storage were researched and compared. Efficiency of LHS constituted by utilizing latent heat of phase change material was analysed through thermodynamic analyses of the heating system which works with solar panels, V-GSHP and a LHS which uses paraffin as a phase change material. Lastly for various ground temperatures and solar radiation, changes in amount of heat storage in LHS system was analysed. Also in this study focuses on energy generation from solar panels due to time was analysed. Thus, supply ratios of hourly energy demand of the inspected building were investigated. The heating system diagram of energy building is given in Fig 5.

Table 2. Energetic and exergetic analysis results for representative unit in the cooling session ($\dot{E}_{input}$: Energy input, $\dot{E}x_{input}$: Exergy input, ηı : Energy efficiency, ηıı : Exergy efficiency)

No	Name of element	$\dot{E}_{input}$ [kW]	$\dot{E}x_{input}$ [kW]	ηı [%]	ηıı[%]
I	Overall system	0.130	1.892	74.85	29.9
II	V-GSHP unit	8.623	1.470	80.76	36.4
III	Pump1	0.130	0.130	67.69	3.0
IV	Ground heat exchanger	7.053	0.539	100.00	80.9
V	Evaporator	7.558	0.404	91.91	65.1
VI	Compressor	1.066	1.066	60.60	40.0
VII	Expansion valve	8.164	2.194	100.00	99.2
VIII	Condenser	7.593	0.671	91.73	79.7
IX	Pump 2	0.130	0.130	74.54	2.7
X	Pump 3	0.130	0.130	76.85	3.1
XI	Accumulator tank	7.469	0.498	95.93	80.4
XII	WHCS	7.068	0.567	90.29	87.2

Solar collectors were connected to the LHS serially and the gained energy through collectors was transferred to the LHS with a closed cycle. The flow of heat transfer fluid was provided with a 100 W pump. The pump is controlled with an on-off control system.

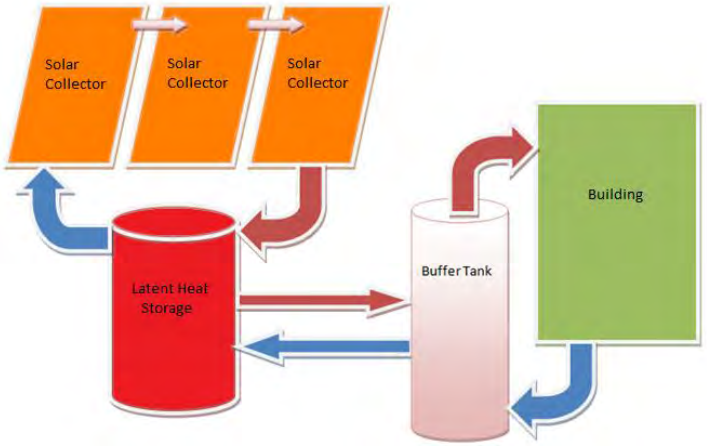

Figure 5. Schematic of investigated SE and LHS on heating mode

Measured temperatures of various parts belonging to system components also the environment conditions can be viewed via the computer software DALİ (Data Acquisition and Logging Interface) and the data can be saved in Microsoft Excel format. This programme has a large database, thus it is possible to make long-term record and view data in instantaneous, minute's or hourly periods. Interface of Dali Programme was given in Fig. 6.

2.2.2. Determination of Heat Losses of Building and Heat Gain of Solar Collectors

Charging process of LHS unit was investigated in two parts. In first part solar collectors and in second part LHS unit was analysed. In this study 6 month heating season between October, 2012 and March, 2013 was investigated. For analysing the system, hourly avarage solar irridation and air temperature for each day was used [10]. By utilizing this data hourly avarage building heat load and heat gain of solar collectors were calculated. Accumulated excess energy during daytime was analysed and storable thermal energy for night time were determined (Fig 7).

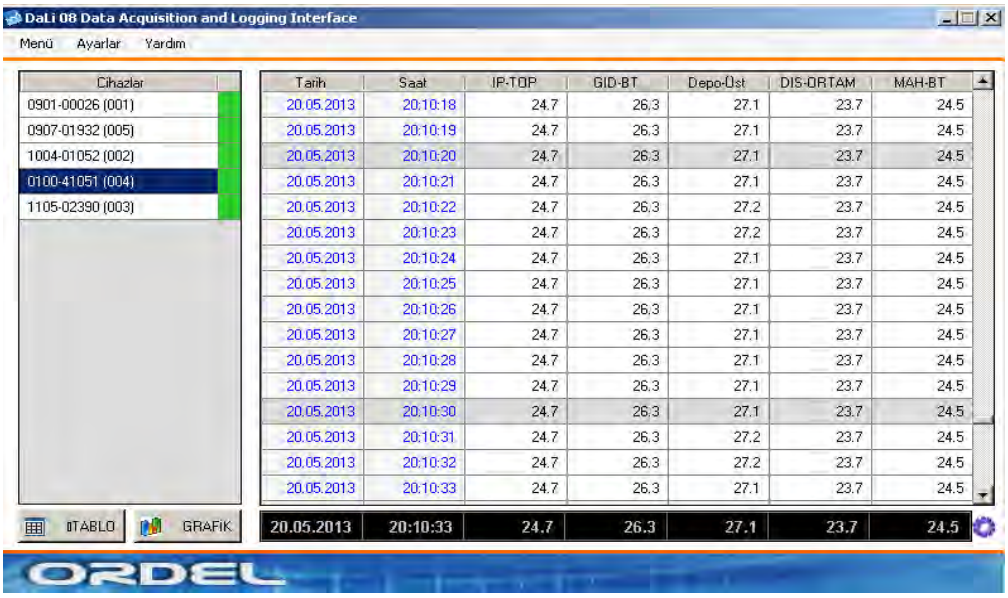

Figure 6. Interface of Dali Programme

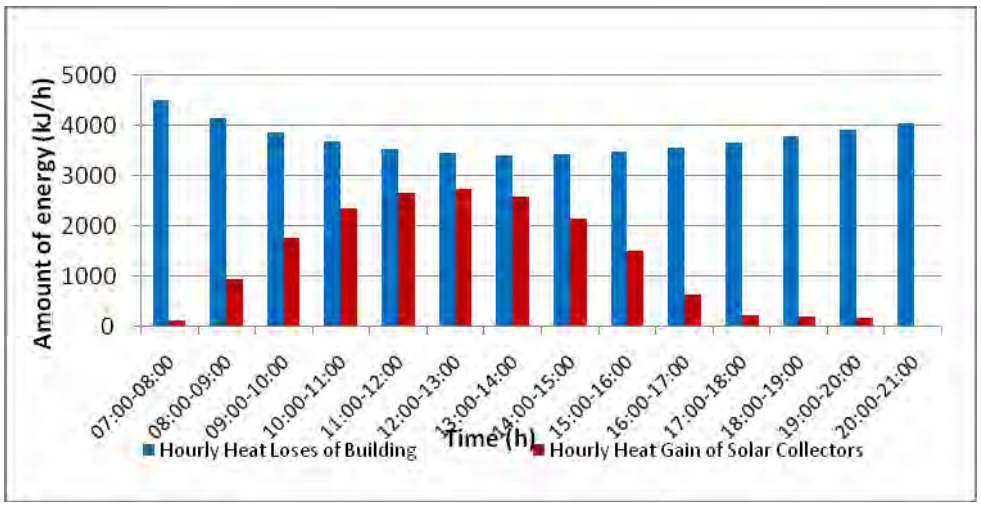

Figure 7. December 2012, building heat lose-collector heat gain diagram

Although figures which correspond to 6 months have been drawn, only December's figure has been illustrated. Building Heat Load-Collector Heat Gain graphic given above, shows hourly changes in heat loses of building against thermal energy absorbed by collectors. Concordantly due to this results between the months December 2012- February 2013, the three month period, because of the heat load of the building rose sharply storing energy gained by collectors seems not presentable. On the other hand in spring and winter period (November and December 2012, March 2013) especially between the hours 10:00-15:00 utilizing from thermal storage seems possible. During this period storable excess thermal energy is available. Stored heat can be used at night time while the solar energy run out.

2.2.3. Determining Amount of Excess Storable Energy

Daily amount of storable, excess energy shown in the diagram below (Fig. 8). It is clearly shown from the figure that especially in November and October 2012, March 2013 high amount of storable energy is available. In the last decade energy demand have been increasing from day to day however energy supply decrease in the similar trend. For this reason utilizing from renewable energies such as solar energy and wind energy is a necessity. Studies in the way of increasing efficiency of energy systems are important for improving utility of this sources. However storing energy and using it in the time while energy demand increases, will contribute our country both economically and provide demand-supply balance. Concordantly heat storage systems seems worth for research and develop studies to increase their efficiency.

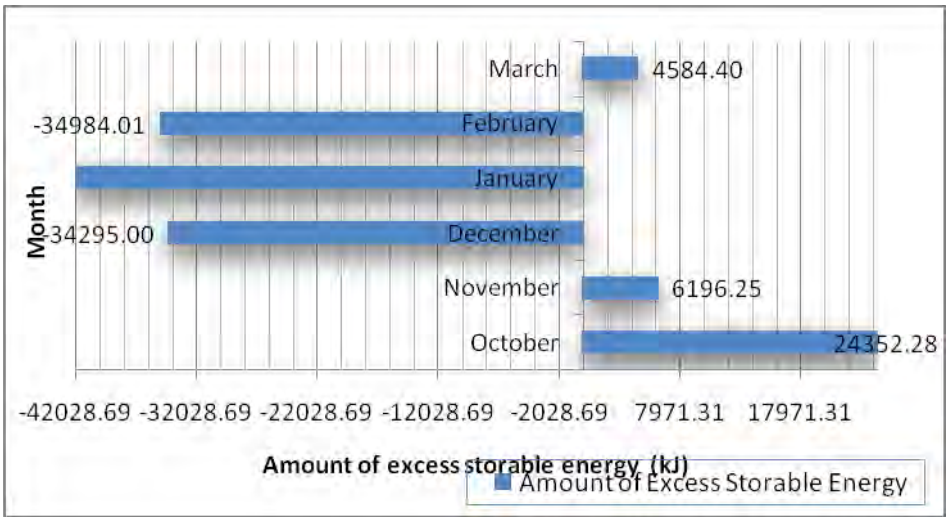

Figure 8. Monthly amount of excess storable energy.

2.2.4. Results and Discussion

The analysis results of solar collectors and LHS systems were given and evaluated in three parts as energy analysis, exergy analysis and efficiencies (Table 3-4). In Table 3 t(h); daily total working hour of the pump, I; solar irridation in terms of (W/m^2), E_{input}; total solar irridation fall onto the absorber plate of solar collectors, E_{output}; net heat gain of HTFfrom the solar collectors, E_{loss}; heat loss from the collectors to the environment. E_{accum}; acummulated energy in absorber plate of collectors. Solar radiation changes in a wide range between 84 W/m^2 and 832 W/m^2. As a result of this, net heat gain from the solar collectors ranged from 0,183 kW to 1,839 kW. Exergy destruction in solar collectors seems very high from the Table 3. In spite of the high utility of solar irridation, gained utility from the collectors are in low values. Total solar radiation exergy varies between 256 W to 2520 W however thermal exergy gained from the collector was in the range of 3,4-72,1 W. Input energy rate to the LHS unit and the break down of it was given in Table 4. It is clear that the lost energy is far less than the stored energy and high percent of the input energy stored in the LHS unit, which is in the range of 0,18-1,5 kW.

Table 3. Average experimental results for solar collector analysis

Working hours	Ambient Temperature	Solar Radiation	Pump energy consumption
t(h) [h]	T_{avr} [K]	I [kW/m^2]	W_{pump} [kW]
6,78	286,9	0,400	0,100

Average energy break-down	Input energy	Output energy	Lost energy	Accumulated energy
	E_{input} [kW]	E_{output} [kW]	E_{loss} [kW]	E_{accum} [kW]
	1,295	0,895	0,212	0,187

Average exergy break-down	Input exergy	Output exergy	Lost exergy	Destroyed exergy	Accumulated exergy
	Ex_{input} [kW]	Ex_{output} [kW]	Ex_{loss} [kW]	$Ex_{destruction}$ [kW]	Ex_{accum} [kW]
	1,211	0,034	0,014	1,150	0,011

Efficiencies	Total energy efficiency	Net energy efficiency	Total exergy efficiency	Net exergy efficiency
	ηι(t)	ηι(n)	ηιι(t)	ηιι(n)
	0,704	0,629	0,025	0,023

It was found that average exergy gain rate from solar collectors was 34,5 W although the average exergy transfer rate to the LHS unit was 27,2 W. According to this performance, average exergy transfer efficiency from collectors to the LHS was 78,2%. On the other hand this value is 86% for average energy transfer efficiency. As a result of sharp decrease of ambient temperature, energy and exergy loss from LHS to the environment increased sharply. Total exergy efficiency ranged from 14% to 53% however net exergy efficiency was in the range of 0,6-15,3% W.

Table 4. Average experimental results for LHS analysis

Working hours	Ambient Temperature	Pump energy consumption
t(h) [h]	T_{avr} [K]	W_{pump} [kW]
6,78	286,9	0,100

Average energy break-down	Input energy	Stored energy	Lost energy
	E_{input} [kW]	E_{stored} [kW]	E_{loss} [kW]
	0,770	0,690	0,080

Average exergy break-down	Input exergy	Stored exergy	Lost exergy	Destroyed exergy
	Ex_{input} [kW]	Ex_{stored} [kW]	Ex_{loss} [kW]	$Ex_{destruction}$ [kW]
	0,027	0,010	0,002	0,017

Efficiencies	Total energy efficiency	Net energy efficiency	Total exergy efficiency	Net exergy efficiency
	ηι(t)	ηι(n)	ηιι(t)	ηιι(n)
	0,74	0,62	0,37	0,07

3. CONCLUSION

The hybrid system in Fig. 2 a. has been investigated in two stages and results of them presented in each section separately. Also, in general conclusion section each of them will be scrutinized separately.

3.1. Associate operation of WHCS and V-GSHP systems

The present study deals with an exergetic analysis and assesment of a V-GSHP combined with a WHS in a building. This study is an experimental investigation of a real building's heating and cooling system. Energetic and exergetic model is obtained by applying mass, energy and exergy equations for each system component.
Heating season is assumed to be between 1 January and 31 March 2010. As average results on heating season 6.509 kW heat energy is extracted from ground and 5.799 kW is used in the WHS. On this process electrical energy consumption of system components are; compressor 1.711 kW, ground heat exchanger pump 0.092 kW, accumulator tank circulation pump 0.114 kW and WHS circulation pump 0.108 kW. For heating season, calculated overall system efficiency was 67.36% while GSHP unit's efficiency was 85%. Adding that, overall system COP was 2.76 while GSHP unit's COP was 4.13.
As for the cooling season, calculated system efficiency was found 74.90%, while the GSHP unit's efficiency was 80.76%. Furthermore, the overall system COP was 4.38 while the GSHP unit's COP was 4.78. Also, during cooling season, the heat discharged to the ground was found 7.053 kW. Total exergy destruction is found 1.759 kW and largest exergy destruction occured in the compressor as 0.714 kW. The exergy efficiency values for the individual components of the system were found within the range of 58.3% to 98.4%.
Heat extraction rate of 50 and heat rejection rate of 54 W/m of bore depth for the heating and cooling periods, respectively, remain within the range reported in the literature. But ground heat exchanger still has a development capacity. It is expected that the model would be beneficial for evaluating low exergy heating systems which use ground source as renewable energy.

3.2. Associate operation of SE and LHS systems

Present study focuses on utilities of the investigation of LHS systems in space heating applications and the storage performance of SE by using phase change material. According to the study's results;
As first part of present study, hourly building heat loss and collector heat gain was calculated and compared with each other for determining the appropriate time periods to store excess heat. Obtained results indicate that, in winter, storage of solar energy is not possible however October and November 2012, March 2013 is suitable for storage.
In the second part of present study, charging process of LHS was analysed with an experimental approach. Total energy efficiency of solar collector was calculated 70,4% however total exergy efficiency was found only 2,5%. On the other hand average input energy and exergy rates to the latent heat storage were 0,770 and 0,027 kW respectively. According to the calculation results, 74% of input energy and 37% of input exergy could be stored. During the experimental period average daily working time of the system was found 6,78 hours and average ambient temperature was measured 286, 9 K.

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THE RECENT DEVELOPMENTS OF REFRIGERANTS, A REVIEW

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Abstract

In this study, development of refrigerants have summarized from finding the first refrigerants for vapor-comparison cycle to the present. Alternative refrigerants have examined in view of thermodynamics properties, COP, GWP and ODP values. Reference refrigerants have been got as CFC-R12, HFC-R134a, Ammonia, HC- R600a, HFC-R32 and HFO-R1234yf.

Key Words: Refrigerant, COP, GWP, ODP

Introduction

Refrigeration process goes back to ancient times that were used stored ice, and other evaporative processes and vaporization of water. Until the 1850s natural ice was the only available source to meet the demands for conservation and transportation of fresh foods, manufacture and storage of some alcoholic and non-alcoholic beverages, butter and frozen creams, besides other improved living conditions for the population of every day larger cities. Experiments in order to obtain artificial reductions of temperature, and thereby producing ice, were made as far back as the XVI century. Later, Oliver Evans first proposed the use of a volatile fluid in a closed cycle to freeze water into ice [1]. Refrigerants are an intermediary substance that enables transmissions of heat from one medium to another in the vapor-comparison cycle. The first successful use of refrigerant had been made by Jacob Perkins in 1834. HVAC and refrigeration systems have been rapidly begun improving since that date. From 1830s to 1930s used refrigerants has familiar properties.

1 Calm, 2008, s.1124

In this continuum used refrigerants have been classified first generation refrigerants. The first generations of refrigerants nearly were neither flammable nor toxic, or both. At the same time some refrigerants were also highly reactive. When Carbon Dioxide (CO_2) was first used as a refrigerant in 1866, Ammonia (NH_3) was first used in 1873, which are member of naturel refrigerant with water (H_2O). The second generation was distinguished by a shift to fluorochemicals for safety and durability. Repeated leaks, of then prevalent methyl formate (R-611) and sulfur dioxide (R-764), retarded early efforts to market domestic refrigerators to replace iceboxes. With direction that „„the refrigeration industry needs a new refrigerant if they expect to get anywhere,"" Thomas Midgley, Jr., and his associates Albert L. Henne and Robert R.McNary first scoured property tables to find chemicals with the desired boiling point. This situation has led to the emergence of chlorofluorocarbon (CFC)s. Commercial production of R-12 began in 1931 followed by R-11 in 1932 [1]. Later, these refrigerants have been followed by hydrochlorofluorocarbon HCFCs refrigerants. From that date CFCs and HCFCs have been dominantly used refrigeration, air-condition and etc. Because of the fact that CFCs and HCFCs have been used high amounts and have high chemical stability of these refrigerants, researchers have investigated their effects on environment. Molina and Rowland determined that chlorine based refrigerants are stable enough to reach the stratosphere, where the chlorine atoms act as a catalyst to destroy the stratospheric ozone layer which protects the earth surface from direct UV rays in 1974[2]. Owing to these situations, in 1987 Montreal protocol has been signed to limit or to phase out these refrigerants. Since the protocol signed, most of developed countries decreased consumption and production of CFCs and HCFCs. So, hydrofluorocarbon (HFC)s have emerged as alternatives of CFCs and HCFCs. Thus, third generation refrigerants have emerged in that process. Because, HFCs have zero ODPs, these refrigerants have been dominantly selected in terms of CFCs and HCFCs as alternative refrigerants. But, these refrigerants have been understood to have high global warming potential (GWP) values. In response to these situations, Kyoto protocol has been signed in 1997 and alternative refrigerants have researched in place of these refrigerants.

1 Calm, 2008, s.1124.

2 Mohanraj, 2009, s.1442.

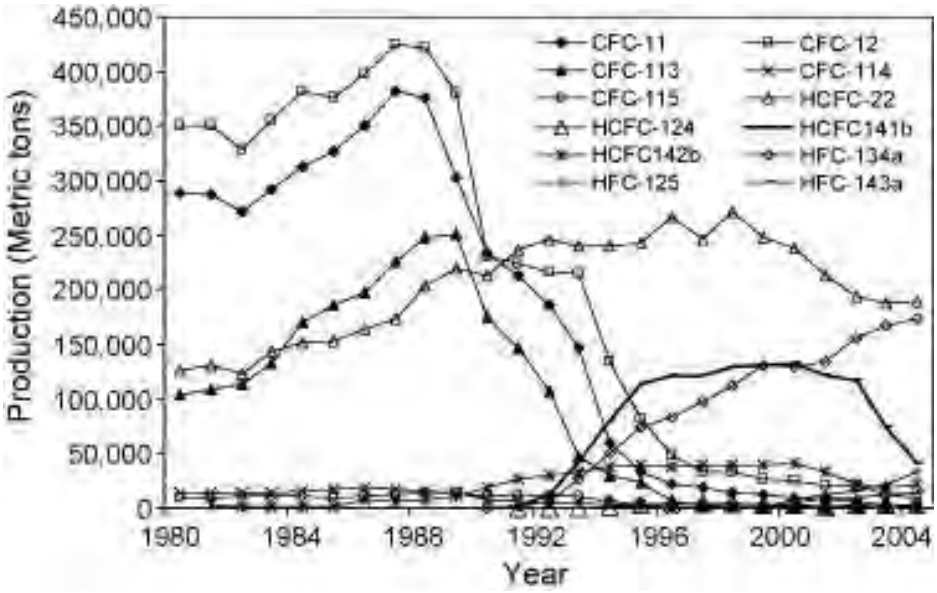

Figure 1. Production of halocarbon refrigerants[2]

In Figure 1, halocarbon refrigerants have been observed in terms of production amounts according to years.

Generally, wanted properties of refrigerants are high COP values, low/zero ODP values and zero GWP values, no flammability, no toxicity and lower atmospheric lifetimes. The use of "naturel fluids" as refrigerant have attracted renewed interest during the last decade. There are numerous publications on the topic in recent years and several IFF/IIR conferences have been devoted to the subject, such as the ones in Hannover, Germany, 1994, in Aarhus, Denmark, 1996, in College Park, USA, 1997, in Oslo, Norway, 1998 and at the Purdue Conference in West Layafette, USA, 2000; the last two arranged under name of "The IIR-Gustav Lorenzen Conference on Naturel Refrigerant"[3]. Another option has been Hydrocarbon(HC) in that process. HC having a very low GWP values have firstly emerged so as to use in place of HFCs. But, these refrigerants are flammable. Because of that property, these refrigerants have generally restricted usage of in existing systems. Another alternative is coming to mind mixing of refrigerants particularly HFCs with HCs refrigerants. Use of as other alternatives refrigerants are fluorinated substances like ethers, ketones, sulfur compounds and etc. Carbon dioxide (CO_2) has received importance interest as a refrigerant for air-conditioning systems owing to its environmental advantages which include zero ozone depletion potential and minimal global warming potential compared to commonly used hydrochlorofluorocarbon and hydrofluorocarbon refrigerants.

2 Mohanraj, 2009, s. 110.

3 Granryd, 2001, s. 15.

Another issue, refrigerants have been used in automotive applications. In particular, the European Union‟s F-gas regulations specify that beginning on January 1, 2011 new models and on January 1, 2017 new vehicles fitted with air conditioning cannot be manufactured with fluorinated greenhouse gases having global warming potentials (GWP) greater than 150. Possible candidate refrigerants that possess GWP < 150, and that are being considered, include R-152a, R-744 (CO_2), and R1234yf. R-152a has been investigated in the recent years in several applications[4]. The interest for long term solutions has been towards natural environmentally friendly refrigerants. Among different natural refrigerants such as water, air, isobutene (R600a), and ammonia, CO_2 (R744) is an attractive candidate. CO_2 has been proven to be nontoxic and nonflammable with zero ozone depletion potential and negligible global warming potential compared to HCFC and HFC refrigerants[5].

In the second phase of in this study, selected six refrigerants have been examined in terms of performances by us. If vapor-compression machine is used for heating or cooling systems, we must consider a lot of properties its: flammability, toxicity, critical and operational pressure, critical and operational temperature, critical density, ODP, GWP, COP and etc.

Table 1: Thermodynamics properties of selected refrigerants by us

Refrigerant	**Chemical Formula**	**Molar Mass (kg/ kmol)**	**Critical Tempe-rature (°C)**	**Critical Pressure (bar)**	**Critical Density (kg/m³)**	**Ozone Depletion Potential (ODP)**	**Global Warming Potential (GWP)**
Ammonia	NH3	17,030	132,250	113,330	225,00	0	0
R12	CF2CL2	120,910	111,970	41,361	565,00	1	8100
R32	CH2F2	52,024	78,105	57,820	424,00	0	650
R134a	CF3CH2F	102,030	101,060	40,593	511,90	0	1430
R600a	CH(CH3)3	58,122	134,670	36,400	224,35	0	3
R1234yf	CF3CF=CH2	114,040	94,700	33,822	475,55	0	4

Ammonia is a member of naturel refrigerants is indispensable refrigerant in large scale industrial applications for about 130 years. Toxicity and high operational pressure is disadvantages. R12 is a well-known CFCs refrigerant.

4 Zilio, 2010, s.6110.

5 Nunez, 2010, s.668.

But, the refrigerant had dropped out of use for owing to its high ODP value. In this paper, CFC-R12 refrigerant is a reference refrigerant in terms of development of thermodynamics properties refrigerant. HFC-R32 is thought as a new refrigerant. Especially, it is used Far East countries for the purpose of air- conditioning. GWP value of this refrigerant is less than in comparison with a lot of HFC refrigerants. HFC-R134a is commonly used air-conditioning both automotive and domestic applications. Owing to the fact that it has high GWP value, use of this refrigerant has been planned to abolish until 2030s. The other name of R600a is isobutene. The refrigerant is members of naturel refrigerant family. In the last years, they are particularly used to begin domestic refrigerator. HFO-R1234yf is the one of newest refrigerant. This refrigerant especially has been purposed to use instead of HFC R134a for automotive air-conditioning.

METHODS

In this paper, we have compared six refrigerant R12, R32, R134a, R600a, R1234yf and ammonia which have or had been commonly used in the HVAC system and industrial application, in terms of change of T_{evap}(from -20 °C to 0 °C and T_{con}=50 °C constant) with COP and change of T_{evap} with operational pressure. Also, evaporation power has been taken value of constant 2 kW. Isentropic efficiency of compressor had been accepted %100. For finding thermodynamics properties of selected refrigerants had been used Refprop 9 package program. The calculations have been made according to ideal vapor-compression cycle is a system used to transfer heat from low temperature reservoir to high temperature reservoir with the help of working refrigerant.

In Figure 2, we have seen pressure-enthalpy diagram for ideal vapor-compression cycle.

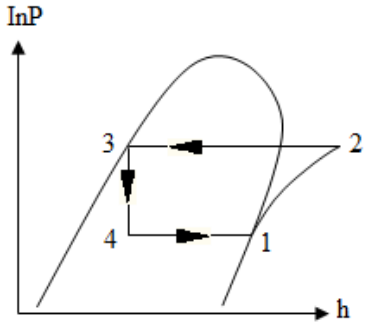

Figure 2. Pressure – enthalpy diagram of ideal vapor-compression cycle

$$\dot{W}_{comp} = \dot{m}_{ref}.(h_2 - h_1) \quad (1)$$

where $\dot{W}_{comp}$ is compressor power, $\dot{m}_{ref}$ is mass flow of refrigerant, h_1 is enthalpy of refrigerant at the evaporator outlet and h_2 is enthalpy of refrigerant at the compressor outlet.

$$\dot{Q}_{evap} = \dot{m}_{ref}.(h_1 - h_4) \quad (2)$$

where $\dot{Q}_{evap}$ is evaporator power, $\dot{m}_{ref}$ is mass flow of refrigerant, h_1 is enthalpy of refrigerant at the evaporator outlet and h_4 is enthalpy of refrigerant at the throttling valve outlet.

$$COP = \frac{h_1 - h_4}{h_2 - h_1} = \frac{\dot{Q}_{evap}}{\dot{W}_{comp}} \quad (3)$$

where COP provides a measure of performance for vapor-compression machine.

Table 2. Enthalpy values of refrigerants for T_{evap}= -10 ^{0}C (constant)

Enthalpy (kJ/kg)	**R12**	**R134a**	**R32**	**R600a**	**R1234yf**	**Ammonia**
h_1	348,29	392,66	513,02	541,67	193,3	1593,9
h_2	375,63	428,42	553,09	610,85	224,54	1714,3
h_3	249,71	271,62	297,49	322,98	75,884	583,77
h_4	249,71	271,62	297,49	322,98	75,884	583,77

Enthalpy values of selected refrigerant have been seen in Table 2 for T_{evap}= -10 ^{0}C, T_{con}=50 ^{0}C.

RESULTS

In Figure 3, selected refrigerants have compared in terms of pressure values with different evaporation temperature. Pressure is very important vapor-compression machine for choosing refrigerants. Refrigerant pressure is wanted low values in vapor-compression machine. As shown Figure 3, when the lowest pressure values are HC-R600a pressure, the highest pressure

values are HFC-R32 refrigerant in compared refrigerant. Pressure of HFO-R1234yf which especially has been emerged alternatives to HFC-R134a has submitted good pressure range.

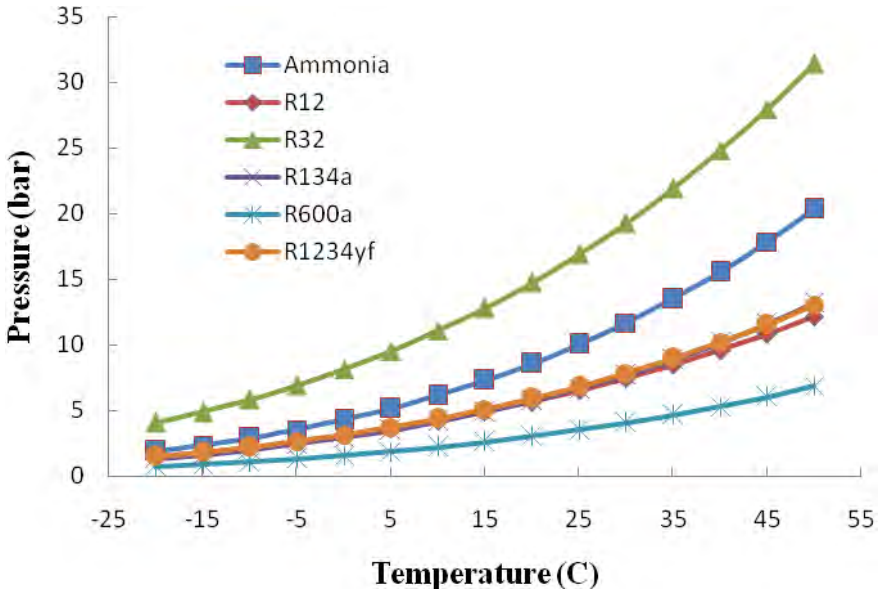

Figure 3. The change of pressure of refrigerants with different operation temperature

In Figure 4, selected refrigerants have compared in terms of mass flow with different operation temperature. With decreased evaporation temperature, mass flow have been seen to decrease linearly. When vapor-compression machine has been selected, mass flow is very important. Mass flow directly effects system size and cost of system.

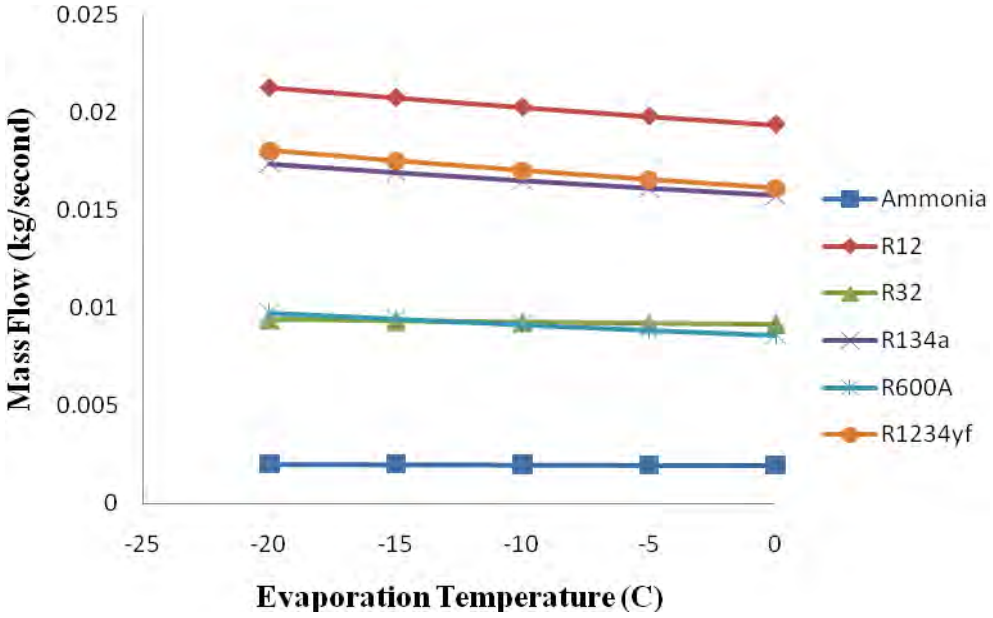

Figure 4. The change of operational pressure refrigerant with different evaporation temperature

In Figure 5, selected refrigerants have compared in terms of COP value. We have seen in Figure 5 that COP value of ammonia is the best value among compared refrigerant. Also, we have seen that HFC-R32 refrigerant give good COP value. HFO-1234yf is a one of the newest refrigerant giving good COP value among compared other refrigerants. As seen Figure 5, COP value has increased with decreasing evaporation temperature.

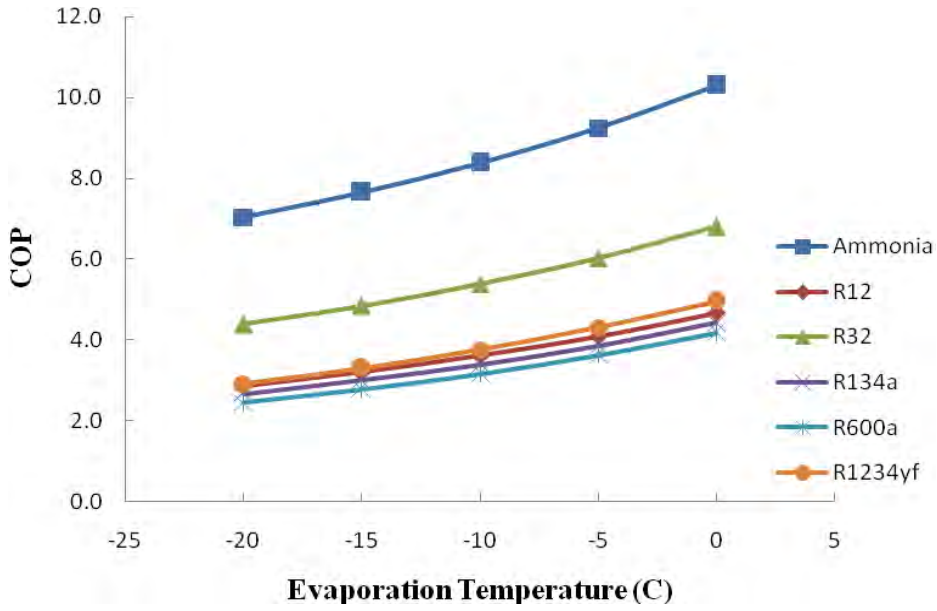

Figure 5. Comparison of refrigerants in view of COP value

DISCUSSIONS

In this paper, we have summarized history of development refrigerants and have compared refrigerants that are used often in HVAC systems. Refrigerants have been separated four generations until the present. In reviewing the literature, we have seen that researchers have studied both experimental and theoretical investigations to find out the various factors impacting the performance of vapor-compression refrigeration system. General objectives of these studies are to find refrigerant which have high performances and don"t harm the environment and people"s health. Especially, they have studied to have zero/low ODP values and low GWP values of refrigerants. But, properties of refrigerants still have not desired level at the present time. So, these situations have highlighted naturel refrigerants as Ammonia, CO_2 and H_2O. Later, we have compared six refrigerant R12, R32, R134a, R600a, R1234yf and ammonia in terms of performances. Ammonia and HFC-R32 have been offered that

figures have been examined. But, these refrigerants have worked high operational pressure. HC-R600a will be frequently used owing to low working pressure in domestic refrigeration. HFO-R1234yf has been good performances value by comparison HFC-R134a and CFC-R12. This refrigerant will be often used in the future in place of HFC-R134a.

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A NEW CONCEPT AND CONCERN FOR NATIONAL AND GLOBAL SECURITY: ENVIRONMENT AND ECOLOGY

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ABSTRACT

The concept of international security including the concern for human security immediately recalls the facts of the imminent danger of war, coercion, military clashes, belligerent activities or even a nuclear war. The days we are living in are full of several other types of international and human security concepts such as poverty, natural disasters, narcotics, genocides, ethnic cleansing, terrorism of anti-state or state based, energy deficit, food and water inadequacy even malnutrition and droughts which are quite different from the militaristic issues but, as far as the consequences are concerned, there is no difference between them at all.

This paper will try to analyze a very real and also very significant security issue: environmental and ecological security of the nations and even the Globe on which we are living in most of them global warming and climate change is playing a vital role.

Key Words: Global Environmental Problems, Climate Change, International Security.

INTRODUCTION

When one begins to talk about security the first image and concept comes to the minds of so many people is the imminent danger of war, coercion, military clashes, belligerent activities or even a nuclear war. However, the days we are living in are witnessing several other formats of security concepts such as poverty, natural disasters, narcotics, genocides, ethnic cleansing, terrorism of anti-state or state based, energy deficit, food inadequacy (Canada 2005) even malnutrition and droughts which are quite different from the militaristic issues but, as far as the consequences are concerned, there is no difference between them at all. In this paper a very real and also very significant security issue will be analyzed: environmental and ecological security of the nations and even the Globe on which we are living.

This article is about the national security. Therefore, at the very beginning the meaning of the national security must be explained and defined. The national security is basically and traditionally tied to the concept of sovereignty and independence. Any act threatening the sovereignty and independence of any State is a national security issue for the concerned countries. Typically threats of war, belligerence, violence and assaults and use of coercion are in this category. These kinds of threats should be averted by the necessary steps to be taken otherwise large scale losses of lives, territory, economic and material wealth will be inevitable. When taken from this point of view, there are so many other activities in the real

life other than the war that could cause same types of losses and even more than wars. Poverty, hunger, control over natural resources including oil and natural gas, hurricanes, melting polar caps, rising level of sea water, floods, nuclear accidents and so many others may cause the emergence of similar consequences. Since the consequences are similar to the threats against sovereignty and independence, these issues should also be accepted as national security concerns. Wherever the threats would come from either military or non-military sources the human security will be at stake. And, since the human beings are the most valuable item to be protected by the states against every kind of danger then the national security concept should also encompass the human security meaning that human welfare and well being is the ultimate objective of the national security concerns. This, if accepted, takes us to a new definition of national security concept. This paper aims at taking the attention of concerned circles to the non-military and basically environmental and ecological aspects of the national security.

There are dozens of case studies today in the World to prove the importance of scarce resources and environmental matters on security issues. In order to indicate the significance of the ecological and environmental security issues some of these cases will be briefly analyzed in the paper. These cases include the "Transboundary Water Problems between Turkey and Syria" which will also help to explain the current crisis between these two neighboring countries, the "Aral Sea" which explains the rivalry between the economic ambition and preservation of natural resources for future generations, the "Global Warming" and "Climate Change" which is currently being observed all over the World, the cases of "Chernobyl, Fukushima and Bhopal" which underlines the significance of nuclear and toxic chemicals and lastly "Biodiversity Loss and Desertification" which points out the extinctions of rare species including soil resources.

TRANSBOUNDARY WATERS: SYRIA AND TURKEY

Euphrates and Tigris are the major rivers in the south eastern Turkey. For centuries these rivers provided water and fertility to both Anatolia and further down to the territories of the Basra Gulf. In 70s, Turkey has decided to control the waters of these rivers and use them for hydro electric power generation and agricultural irrigation. Both objectives are logically in harmony with the overall esteems of a developing country to provide leverage for national and regional development. The expected outturn was great and Turkey has realized a big leap forward so far in terms of electricity production and diversifying and increasing the agricultural production in the region thus helping to alleviate the pains caused by high rate of unemployment and low level per capita income.

Since 1985, a very high rate of (56.4%) financial investment has been incurred for the Project called as "South Eastern Turkey Regional Development Plan" (GAP). This ratio has gone up to 83 percent for energy and 24.5 percent for agriculture. So far, eight hydroelectric power plants have been completed such as Karakaya, Ataturk, Dicle, Kralkizi, Birecik, Karkamis and Batman. This comprises 47 percent of total hydro electric power production in Turkey. When thermo electric power and wind energy are taken into consideration the ratio of GAP Region electricity production is 11.6 per cent of the total production.

Although irrigation in the Harran Plain has begun in 1995, a lot more has to be done to complete the Project. Out of total 1.7 million hectare area to be irrigated, so far only 15 percent has been irrigated at the moment. Number of persons working in the agriculture is diminishing and the number of persons working in industry and service sector is increasing.

However, these economic and infrastructural developments in south eastern region of Turkey has culminated different reactions in the neighboring and adversely affected countries namely Iraq and especially Syria under the President Hafiz Asaad. Syria has claimed rights over the waters of incoming rivers and diplomatically complained that the developments in Turkey will be detrimental for the economic interest of Syria. These reactions did not create any favorable result for Syria and Turkey continued on her path for regional social and economic development for the south eastern part of the Country.

These years also coincide with the years of establishment of the PKK (Kurdistan Workers Party) which aims at autonomy if not independence for the same region through armed struggle against the Government in Ankara. President Hafiz Asaad has decided to use PKK factor to defend his causes over the transboundary waters to further strengthen his position against Turkey and opened a refuge for and provided support to the Kurdish armed separatist in northern Syria and also established a base for them for their assaults to the targets in Turkey.

Turkey and Syria has a very long border of more than 1.100 kilometer which is very difficult to control in every segment of the border. The PKK has utilized this opportunity gifted by Hafiz Asaad and kept on aggressive activities against Turkey for decades.

Hafiz Assad"s strategy to use an insurgent group against Turkey has been labeled as a hostile, unfriendly and non-neighborly policy by the Turkish officials and as a final step a four star army general was sent to the Syrian border to warn Hafiz Asaad and threaten him with a large scale military operation to capture the PKK leader. Such a military action has been prevented by the expulsion of Abdullah Ocalan, the founder and the leader of PKK from Syria and his eventual capture by the US intelligence service and handing him over Turkey.

As has been explained above, the real reason of the tension between Turkey and Syria was the waters of both Tigris and Euphrates. This issue had brought these countries to the brinks of a war and may help to explain the current status of relations between these two neighboring countries despite a common religion and common cultural and historical past. The conflict is still not resolved and relations between Turkey and Syria can be named as severe as possible. No prospective and good neighborly relation is expected for the near and medium term future.

So, it is possible to state that the water shortage or lack of water can become a very solid reason for animosities, rivalries and military confrontation amongst the States.

Since 1984, the date of serious PKK revolt in the region around 40.000 people died and billions of dollars has been spent for armament, military equipment and compensations of civilian losses. This has become the basic reason for the low level realization of GAP Project objectives.

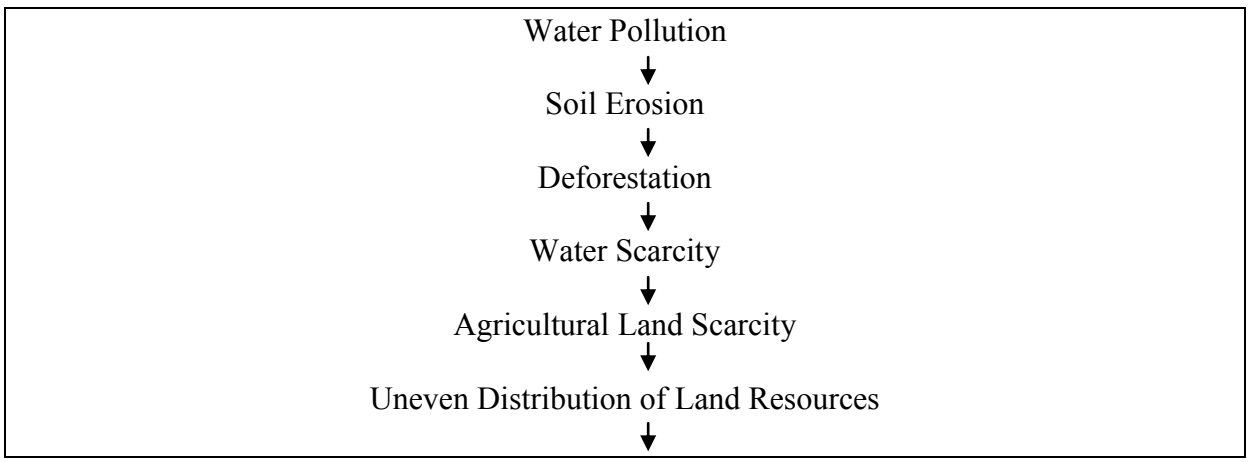
Similar events are taking place all over the World simultaneously. According to the recent report prepared by UNEP (UNEP 1999) experts, 47 different cases of water related international disputes have been spotted in recent decades. The countries involved are numerous: Angola, Argentina, Bangladesh, Botswana, Brazil, Cambodia, Chad, China, Czechoslovakia, Ecuador, Egypt, El Salvador, Ethiopia, Ethiopia, Honduras, Hungary, India, Indonesia, Iraq, Israel, Jordan, Kazakhstan, Kenya, Laos, Libya, Mauritania, Mexico, Namibia, Niger, Nigeria, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Senegal, Somalia, Sudan, Syria, Thailand, Turkey, Turkmenistan, United States, Uzbekistan and Vietnam.

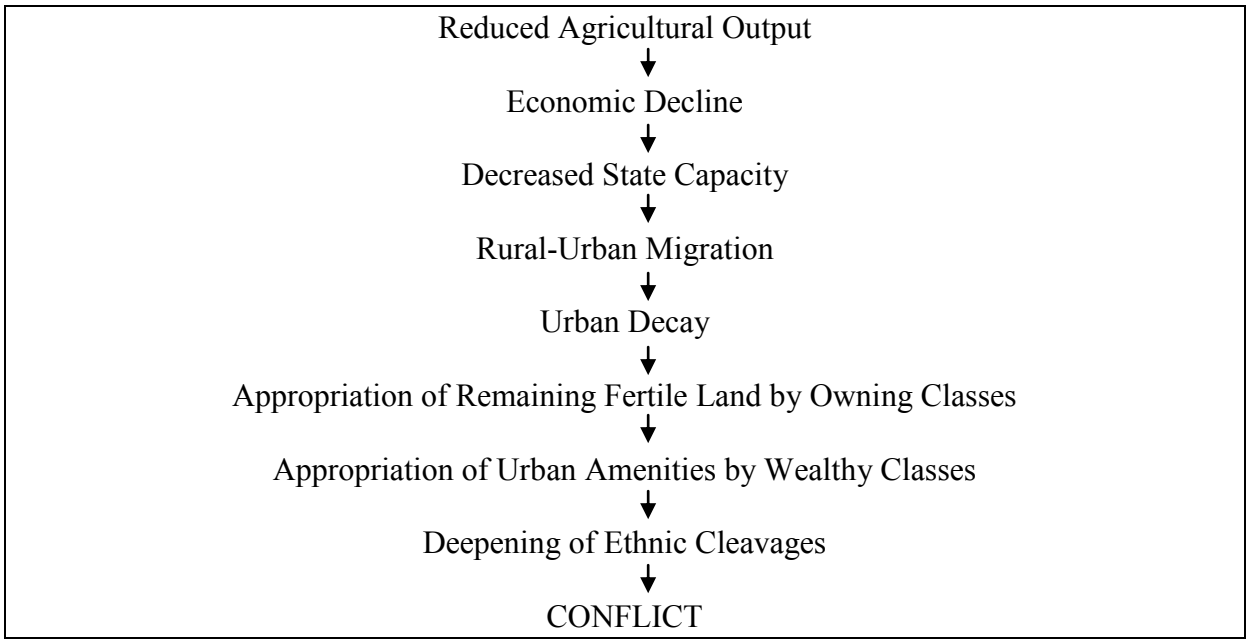
According to the same report the key environmental factors leading to crisis and their numbers are given below: agricultural pollution (2), over pumping of aquifers (4), cropland scarcity, dam construction (2), deforestation (9), desertification (3), diversion (5), drainage, ecological degradation of land, flooding (4), inappropriate cultivation practices, Industrial pollution, irrigation, overfishing, over-grazing of bush, pollution (3), pollution from oil exploration, mine tailings, resource extraction, salinity (3), scarcity, shrinking sea, water siltation (2), soil degradation and erosion (9), toxic contamination, water allocation, water flow (9), water pollution (2), water rights and water supply (3).

Same report identifies the key social and economic factors causing international frictions as follows: agricultural decline, agricultural land scarcity, competition for resources (2), declining agricultural output, ecological and social marginalization, economic decline (5), fundamentalism, health problems, increased competition for scarce resources (3), increased opportunities for uprising, increased relative deprivation of peasants, loss of legitimacy by Palestinian Authority, marginalization, mobilization of marginalized people (2), migration (9), perceived lack of economic benefits (2), poverty (3), reduction of agricultural land, relative deprivation, resentment for over pollution from mine (2), shifts in political power, uneven distribution of benefits from resource extraction.

The nature of the international conflict, according to the report, ranges from war to anti-government campaign (3), ethnic and group conflict (9), group rebellion and uprising (2), group-government conflict, group-state conflict, military confrontations (2), protracted confrontations and urban group conflicts.

The report, as an example, also indicates the logical flow of events leading to conflict as follows:





The case of water sufficiently proves that scarcity of ecological and environmental resources and their uneven distribution are the sources of security concerns for the people and for the states.

Even one more serious concern should be emphasized before ending this section: the possibility of contamination of water reservoirs with nuclear or toxic chemicals. (Parthemore 2010) It is largely feared that this possibility is always considered by terrorist organizations and the rival states during military confrontations. Such environmental and health problems are certainly national security issues which require and even mandate the armed forces of any State must be ready to deal with. (ENVSEC 2002)

It is quite visible that the military would be heavily dependent upon the cooperation and collaboration with the civilian institutions thus paving the way for a better cooperation (ENVSEC 2009) between the armed forces and civilian institutions in every country.

THE ARAL SEA CASE: A DISSAPPEARING GIANT SOURCE OF WEALTH AND LIFE SUPPORTING SYSTEM

Aslov, in his paper (Aslov 2004) to workshop in The Hague describes the situation of the Sea of Aral as follows: *"Until 1960, Aral Sea covered an area of about 66,000 square km and had volume of more than 1,000 billion cubic meters (BCM). The inflow from Amy Darya and Syr Darya is about 120 BCM annually, precipitation is about 6 BCM and groundwater is about 5 BCM. Evaporation from the surface of the Aral Sea is about 63 BCM annually. With these inflows and outflows the level of Sea was stable between 50 to 53 m (Baltic Sea system). 1960-90 water use mostly for irrigation in the basin increased from 63 BCM to 117 BCM what leaded to declining of the inflow to 9 – 12 BCM by 1990 and 2-3 BCM by 2003. Sea level dropped by 23 m to current level of 31 m and lost more than 70 % of the sea's area. Expansion of irrigation, associated with the diversion of river water from the Aral Sea, since the late 20th century and, in particular, in the years between 1950 and 1990 when the irrigated area almost doubled to 8 million ha, created serious environmental problems*".

Upon the dissolution of the Soviet Union (SU) the emerging lack of power to control the allocation of water rights amongst the newly independent states (NIS) has resulted in an environmental calamity. Since the main income sources of the region‟s NIS is agriculture and productivity in agriculture depends on irrigation all these states were extremely eager to use the water of the Aral Sea for irrigation schemes especially for cotton production. (ENVSEC 2009)

The Aral Sea Basin is a closed drainage system. The Amu Darya and Syr Darya rivers are discharging their waters into the Aral Sea. Most of the irrigation water is pumped from these rivers and major portion of used water is not returning back to the reservoirs and the minimal amount of returning water is containing excessive amount of agricultural (fertilizers and insecticides) chemicals thus polluting the Aral Sea considerably. (Granit 2010)The resultant unsustainable use of water is causing ecological, hydrologic and environmental damages.

In addition to irrigation, several countries taking place in the region have constructed dams for hydro electric power thus further diminishing the water reaching the Aral Sea. (Gleick 1993)

These economic activities have caused detrimental and irretrievable impacts on the Aral Sea. Since the dissolution of the SU, the Aral Sea which was the fourth largest lake in the World has been downsized somewhat by 80 percent. Today this lake is virtually eradicated and disappeared as a result of harmful human activities.

Another report (Bigas 2012) prepared for the Aral Sea concludes as follows: *―The shrinking Aral Sea in Central Asia is one of the best recognized examples of this crisis and competition. Once the world‘s fourth largest inland body of water, the Aral Sea has lost 80% of its water since the rivers that feed it, the Amu Darya and Syr Darya, were diverted to provide irrigation water for a burgeoning cotton industry. Where there was once a thriving, productive ecosystem that supported prosperous fishing livelihoods, there is now a parched inland seabed dotted with rotting and rusting ships”.*

The disappearance of the Aral Sea did not only create environmental and ecological losses but also caused economic losses for the people living around the Aral Sea. Before 1980, the Uzbekistan one of ex-Soviet state, taking place in the region, had a very large fishing fleet and industry providing a powerful economic base for the surrounding cities and industries in the region. As a result of the pollutants the chemical and physical characteristics of the water changed and fishing was not possible anymore in the Aral Sea. This caused then loss of 60.000 jobs in the region.

In addition to the economic losses, an incredible amount of ecologic and environmental degradation took place n the region such as loss of very big water reservoir as wetland and home for wild animals. (Schwartz 1999) Increasing level of drought and desertification and loss of some species should be added to the list of unwanted outcomes.

The Aral Sea case is described by Mosello (2006) very effectively: *―The 2006 UNDP Human Development Report contends that _oneproblem with the polarized debate generated by the water war rhetoric is that it has diverted attention from more pressing and more relevant human security concerns‘. Indeed, the human dimension is fundamental when speaking about water-related issues, as _water is not necessary for life, it is life. In this sense, water sharing should never be understood as a zero-sum game, in which one country‘s gain is another‘s loss. Just as interdependence through trade can expand the economic benefits for all, so can*

cooperative interdependence in water. However, the opposite is also true. Where cooperation fails to develop or breaks down, all countries stand to lose: social and ecological disasters are the inevitable consequences of this scenario. The case of the Aral Sea is the most visible and dramatic example of non-cooperation over water resource management".

The tragedy of the Aral Sea certainly adds four new concepts into security literature: biodiversity security, water security, food security and human security.

GLOBAL WARMING AND CLIMATE CHANGE

Dr. Pumphrey (2008) summarizes the relation between global warming and the security as follows: *"Interest in climate change as a national security issue developed even later. Although the Central Intelligence Agency (CIA) did commission a study to look into the security implications of climate change in the late 1970s, the issue had little resonance until the late 1990s when the Senate Armed Services Committee declared that environmental destruction, including global warming, was 'a growing national security threat'. The Intergovernmental Panel on Climate Change (IPCC) was created in 1995 in part to allay fears. And then, in 2003, the rather notorious report commissioned by the Pentagon, 'An Abrupt Climate Change Scenario and its Implications for United States National Security', provided a worst-case scenario, which suggested that climate change might have a catastrophic impact, leading to rioting and nuclear war".*

However, despite this bare fact, the number of States which classifies the environment as a national security concern is rather limited. Even the USA has just begun to incorporate the environment as a national security issue in her legislation. (Chalecki 1988)

Another critical question remains here to be answered is whether the environment is a national security concern or not and, if it so, which organizations and/or institutions would be responsible to take remedial and mitigation actions to alleviate the pains of ecological and environmental harms. (Pumhtrey 2008). In other words would it be armed forces or other civilian organizations to be responsible in dealing with the problem and the consequences.

The second critical issue is related to the concept of environment. By definition environment is a very wide concept covering almost every aspect of the life. Then question becomes whether all the areas of environment will be accepted as national security concern or a restricted portion of it. Therefore, both of the concepts of `national security` and `environment` should be redefined taking into consideration the impacts of both on present and future generations.

Another issue to be resolved is where the environmental and ecological problem is taking place and where the people concerned with it are living in. In most of the cases the people living next to problem are not aware of the significance of impacts such as the case of South America tropical forests loss on climate change and the case of industrial pollution of Northern UK and the impact of acid rain in Scandinavian countries. That further complicates the ways and means of dealing the problem and its consequences.

However, since these questions are related to the practicalities of the issue, redefinition of these concepts will not be attempted in this paper. Whatever the answers would be to the above mentioned issues there is no doubt that traditional security experts and advisors will have some new members in the team experienced in environmental and ecological matters.

Parallel to this, the military will have to cooperate and collaborate with non-military organizations to avert the future environmental crisis.

People and societies are taking lessons from the disaster as in the case of 9/11 terrorist attack on twin towers in New York. Before 9/11, it was very difficult to include environmental and ecological concerns in the security legislation. Now it is observed that the US began to make alterations in several environmental legislations to include the national security issues. However, the Environmental Protection Agency (EPA) of the US while is becoming more responsible for national security issues it is not possible to say that US Department of Defense (DOD) is becoming more environmentally oriented in terms of legislations. *—Although the needs of national security and aims of environmental regulation have often been at odds, the paradigm shift that occurred in the years since September 11 has changed the relationship between national defense and the environment. Environmental regulations may properly be considered part of the homeland security landscape, and lawmakers can look to past experiences with environmental regulation to create better homeland security policies."*

Although it has been theoretically discussed for more than 100 years now, the global warming has recently begun to be taken into consideration seriously. Briefly speaking, the global warming is a result of fossil fuels burned for heating, transportation and energy production. As a result of the combustion process in addition to the release of energy, several gaseous (COx, SOx, NOx, HC) and particulate materials known as greenhouse gases are released into the environment. These materials are forming an artificial barrier between the sun and the earth thus affecting the passage of x-rays from the sun onto the earth surface. Some portion of the x-rays is being absorbed by the terrain, some portion is reflected back into the atmosphere and some portion is being trapped by the artificial barrier created by the greenhouse gases. Consequently the temperature of the surface is increasing more than used to be leading the way for more evaporation, melting polar and mountain ice caps, increasing level of sea water, increasing amount of humidity, changing patterns of winds and so many other meteorological parameters.

Impacts are now visible as in the cases of Superstorm Sandy and Katrina in the USA, in Cuba and in Caribbean countries. Highest temperature records are all broken in the last decades in every country. The nature and characteristics of major meteorological events such as excessive and/or lack of precipitation, increasing velocity of storms, increasing episodes of floods, inundations and landslides are changing.

The irreversible and immitigable impacts of global warming can be seen on water resources, urban infrastructure, erosion, agricultural activities, sea level rise, electricity outage, demolished houses, biodiversity loss, air quality reduction, wetlands, human lives, human health, economy, public transportation and metro and all social services. An example of this is lived in the hurricane Sandy in 2012 October in New York and New Jersey just 7 years after the tropical storm Katrina in New Orleans which took place in 2005. Katrina has been labeled as the costliest natural disaster in history. The cost of Katrina was 81 billion US dollar and the cost of Superstorm Sandy is expected to be around 55 billion US dollars. As a result of Katrina 1.800 people died and Sandy cost 55 lives. These costs are comparable to the classic national security cases such as wars, rebellions, sabotages and suicides. The physical damage of 9/11 was 55 billion US dollar and over 3.000 people lost their lives in the biggest terrorist event seen in the history. Superstorm Sandy devastated the shore of the City of New York and had detrimental effects in public transportation including freeways, tunnels and subway systems. Same should be expected as an outcome of sea level rise in Manhattan if the

level of sea increases by 1 meter caused by global warming, melting polar ices and increasing sea level. In Egypt, the fertile agricultural land in front of the Aswan Dam which produces almost all of agricultural output will surrender to the salty sea water thus causing an alarming economic devastation. Furthermore, more than half of the World population of 7 billion which is currently living in coastal areas will be affected socially and economically to a very large extent.

However, as a final evaluation, it is generally accepted that the climate which was slowly changed in the past, is now changing drastically and will be even more drastically changing in the future if necessary steps not to be taken in time by the human beings. Tackling the problem will require a reduction of greenhouse gas emissions to curb the effects of climate change and also an increase in the use of alternative energy sources. The climate change can threaten national security of every State. Katrina and Superstorm Sandy are good examples to indicate the size of the threats possible. However, the solution is not as easy as it seems to be. The cost of compliance is very heavy for those countries where the industry is old and outmoded and rehabilitation is beyond the capacity of concerned countries.

The armed forces should begin to take steps on its own to prevent climate change and mitigation measures. This may range from diminishing operational readiness to increasing the capacity for humanitarian assistance. However, the armed forces alone cannot resolve the problem. There is a need for accelerated cooperation and collaboration amongst the related institutions. There is no doubt that the armed forces should incorporate climate change issues to their strategic and tactical planning processes.

What is not comprehensively agreed upon yet is related to what constitutes the climate change and the boundaries, concepts and relationships amongst its subcomponents. The second issue related to disagreement is the level of urgency and priority of climate change compared to other issues of national security. Although it is generally accepted that the military forces and perhaps other security forces should collaborate on global warming and climate issues it is not known whether this is shared and committed by all segments of the armed forces or not.

To conclude this section I would like to refer to a very recent official document which has been published by the Defense Science Board of the USA on October 4, 2011 titled as "*Report of the Defense Science Board Task Force on Trends and Implications of Climate Change on National and International Security".* In his submission letter Dr. Paul G. Kaminski, the Chairman, summarizes the findings of the Committee as follows: ―*..The report offers important considerations for the Department of Defense related to this subject. The task force examined the implications of climate change from a global perspective, with a special focus on the African continent, and makes recommendations that can improve the U.S. approach to addressing the many challenges of climate change. First, they identified a need for a strong climate information system database, managed by the Department of Defense. Second,* ***the task force recommends a whole of government approach to mitigating the effects of climate change and highlights the importance of engaging*** *with* ***international leaders in identifying global solutions.*** *Climate change will only grow in concern for the United States and its security interests. This report offers guidance to the Department of Defense on how to become a leader in mitigating and adapting to its growing effects…"*

With this report the USA openly accepts that climate is a growing national and international security interest for all States in the World. According to the report, the challenges associated with the climate change can be classified as: "*Population support system resiliency (water*

and food security, health, energy), human security (population dislocation, armed conflict), political continuity (continuity of governance), economic viability". The report concludes that *—..this is a challenge that cannot be solved'. Instead, it must be managed for the long term".*[1]

NATURAL RESOURCES, BIODIVERSITY AND NATIONAL SECURITY: NATURAL SECURITY

There are some distinct features of the natural life for the last several decades which are rather different from the previous life patterns in the nature. The extinction of rare species has gained continuity and therefore the Globe is under a big threat. As the losses in biodiversity increase some certain failures are observed in the ecological systems. Some of the extinction of species dates back to 500 million years on this Globe. The biological heritage of the mankind is rapidly decreasing. The rate of extinction is 10 times higher than the past. Even the present rate is halved the rate of extinction will be bigger than the rate at the beginning of the last Century. The population of rare species is continuously decreasing and several decades later it will be impossible to sustain these species.(Kirchner 1980)

However the human kind is dependent of the services provided by the ecosystems. According to the WHO the number of those without safe drinking water was 1.7 billion in the year 2000 comprising the 28 per cent of the World population. The number of people died because of polluted water, bad hygiene and non-descent housing conditions was 5 million. The rate of untreated discharged water into the water bodies such as rivers, lakes and shores in the developing countries at the same year calculated to be 90 percent causing widespread diseases such as *diarrhea, ascariasis, dracunculiasis, hookworm, schistosomiasis* and *trachoma. (WHO 1996 and* WRI et al. 1996:21) However, in 1997, the whole World spent 42 billion US dollar to bottled drinking water. (Beverage Industry 1999) Even in 1996 the US consumers spent 1.4 billion dollar for home water treatment systems. (Trust for Public Land 1997:24) The people in Jakarta, Indonesia has spent 52 million US dollar (in 1987 prices) per year on kerosene to boil the unhygienic city water sterilization. (Bhatia and Falkenmark 1993:9) According to UNEP the cost of sea water treatment for domestic use is 1.00 - 1.50 US dollar/m3. (UNEP 1999:166)

Despite these expenditures the ecosystems are providing so many amenities with no charge. Wetlands are treating the polluted waste water in urban areas. The value of this service provided by the 5.5 kilometer long wetland system in the USA (Alchovy River, Georgia) is calculated to be around 3 million US dollar per year. (Lerner and Poole 1999:41)

The basic results of ecosystem failures are reflecting themselves as floods, drought and desertification, loss of species, hunger and collapse of natural balance, local climate changes, degradation of forests and forest fires, single crop production, accumulation of chemicals, wind, water and coastal erosion.

So, what is needed is the definition of individual genetic code of organisms, protection of landscape diversity and establishing and maintaining the procedures for biodiversity management. (Philippe 2001)

[1] Report of the Defense Science Board Task Force on Trends and Implications of Climate Change for National and International Security. October 2011. p.11.

Beginning with the 70s, several reports have been published for the World audience stating that if public policies unchanged through the end of the Century a number of serious World problems will become worse. The World population reached to 6.4 in 2000 and 7 billion in 2012 which was only 4 billion in the seventies. The GNP will still be low in developing countries in the near future. The food problem will be unsolved in developing countries, irrational distribution of fossil fuels will continue and there will be more pollution.

In 1980, the International Union for Conservation of Nature and Natural Resources (IUCN) has published a Report again stating that the Earth has a limited supply of natural resources and the decay of nature and environment is a great threat.

In 1987 a very famous UN Report, "*Our Common Feature"* was published. It is plainly stated in the Report that the wealth in the World increased but unequally distributed. The Report developed the concept of sustainable development which means to ensure that the development goals meet the needs of the present generation without compromising the ability of future generations" to meet their own.

In 1976, another very striking Report has been published by the Club of Rome based upon dynamic systems theory titled as *"The Limits to Growth"*. The Report announced the findings as follows: *"Our conclusions are: If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity. It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential. The behavior mode of the system is that of overshoot and collapse. In this run the collapse occurs because of nonrenewable resource depletion. The industrial capital stock grows to a level that requires an enormous input of resources. In the very process of that growth it depletes a large fraction of the resource reserves available. As resource prices rise and mines are depleted, more and more capital must be used for obtaining resources, leaving less to be invested for future growth. Finally investment cannot keep up with depreciation, and the industrial base collapses, taking with it the service and agricultural systems, which have become dependent on industrial inputs (such as fertilizers, pesticides, hospital laboratories, computers, and especially energy for mechanization). For a short time the situation is especially serious because population, with the delays inherent in the age structure and the process of social adjustment, keeps rising. Population finally decreases when the death rate is driven upward by lack of food and health services. The exact timing of these events is not meaningful, given the great disaggregation and many uncertainties in the model. It is significant; however, that growth is stopped well before the year 2100. We have tried in every doubtful case to make the most optimistic estimate of unknown quantities, and we have also ignored discontinuous events such as wars or epidemics, which might act to bring an end to growth even sooner than our model would indicate. In other words, the model is biased to allow growth to continue longer than it probably can continue in the real world. We can thus say with some confidence that, under the assumption of no major change in the present system, population and industrial growth will certainly stop within the next century, at the latest."*

The authors of *—The Limits to Growth"* have repeated their study almost 20 years later in 1991, and showed that *—the world has already overshot some of its limits and, if present trends continue, we face the prospect of a global collapse –perhaps within the lifetimes of children alive today".*

Therefore the natural security concept has found a very strong basis in the security literature. A recently published report titled as *—Sustaining Security: How Natural Resources Influence National Security"* [2] explains the concept of natural security as follows: *—The security of nations depends increasingly on the security of natural resources, or _naturalsecurity'. Local communities, as well as the economies of key nations and critical regions, rely on the availability of potable water, arable land, fish stocks, biodiversity, energy, minerals and other renewable and nonrenewable resources to meet the rising expectations of a growing world population. Natural resources contribute directly to the economic development and stability of countries; hundreds of millions of people depend directly on agriculture, fishing and other resources for their livelihoods. Reliable and sustainable supplies of natural resources are by no means assured. As population growth continues to rise and more nations continue down the path to development, natural resources are likely to come under increasingly severe strain, and this strain can harm economies and individuals. Much of the world's population depends directly on natural resources for its livelihood. Today almost 70 percent of the world's poor live in rural areas that depend on agriculture. About 30 percent of the world's population uses fuel wood or other natural biomass as their main source of energy. These pressures can lead to instability and conflict if not addressed and abated… The national security community is not yet well attuned to these challenges."*

A similar concern has been voiced in another report by Jeffrey A. McNeely of IUCN for the tropical forests: *—As one of the world's last remaining strongholds of unexploited resources, tropical forests often serve as a point of contention as they become the focus of social, ecological, political and economic changes. Poor management of forest resources and the absence of an established set of equitable sharing principles among contending parties lead to shifts in resource access and control. Resulting tensions and grievances can lead to armed conflict and even war. Many governments have contributed to conflict by nationalizing their forests, so that traditional forest inhabitants have been disenfranchised while national governments sell trees to concessionaires to earn foreign exchange. Biodiversity-rich tropical forests in Papua New Guinea, Indonesia, Indochina, Myanmar, Sri Lanka, Central Africa, the Amazon, Colombia, Central America and New Caledonia have all been the sites of armed conflict, sometimes involving international forces. While these conflicts have frequently, even invariably, caused negative impacts on biodiversity, peace is often even worse, as it enables forest exploitation to operate with impunity. Because many of the remaining tropical forests are along international borders, international cooperation is required for their conservation; as a response, the concept of international —peace parks" is being promoted in many parts of the world as a way of linking biodiversity conservation with national security. The Convention on Biological Diversity, which entered into force at the end of 1993 and now has nearly 180 State Parties, offers a useful framework for such cooperation."* [3]

[2] Sustaining Security: How Natural Resources Influence National Security.

[3] Jeffrey A. McNeel. Biodiversity, Conflict and Tropical Forests. Conserving the Peace: Resources, Livelihoods and Security Edited by: Richard Matthew Mark Halle, Jason Switzer. 2002 by the International Institute for Sustainable Development and IUCN, the World Conservation Union.

However it should not also be neglected that the armed forces can be a very serious source of pollution the following remarks of Wheeler [4] is of importance: *—Pollution is another area in which environmental concerns and national security intersect. National defense is one of the largest causes of pollution in this country. Eighty percent of federal Superfund sites are controlled by the Department of Defense (DOD). The Navy alone produces thirty-five million pounds of hazardous wastes each year, and in 1981, the military produced 92,000 metric tons of hazardous waste. Environmental legislation designed to protect public health and safety is equally as critical when applied to these defense activities as it is when applied to private industry".*

It should also be elaborated that the natural richness is always very attractive to others who do not have it or for those who intend to have a share in it thus causing use of threat and even coercion, wars, political destabilization attempts, occupation and exploitation. Sudan is a good example of it. A very poor in terms of per capita income but rich in terms of oil and other natural resources such as aluminum and copper and strategically located in the Central Africa on the route of south to north and east to west trade routes of the Continent, Sudan, all of a sudden has been divided into two states -North and South- along the basis of religious differentiation. It is apparent that some powerful states have some intentions to control this richness and division of the state of Sudan would not have been possible without external interventions. The following is taken from a Report submitted to US Congress: [5] *—Revenues from Sudan's oil reserves, which were discovered in 1978 and are largely concentrated in the south, primarily benefitted the north, in particular state elites in Khartoum. Oil money also financed the government's countering of domestic insurgencies with force—first in the south, and then also in the west and east. Sudan's counter-insurgency campaigns did not discriminate between fighters and civilians and the government repeatedly questioned the neutrality of international aid agencies and restricted their access to affected populations. The rebel groups persisted, and among them the SPLA was the most successful in gaining ground against the more heavily armed Sudanese military. The SPLA faced internal divisions in the 1990s, largely along ethnic lines, that Khartoum fueled these splits by financing and arming from breakaway factions. Along the north-south border, Khartoum also used its oil revenues to finance local Arab militias, collectively referred to as the Popular Defense Forces (PDF), as a front line against the south. Civil war took the heaviest toll on the south—more than two million deaths; massive, long-term displacement; and decades of suspended development—but it also came at a significant cost to Khartoum. By 2002, as the government and the SPLM prepared to sign the first in a series of accords that would end the war three years later, another armed uprising was brewing, in Darfur. In response, as it had done with the PDF, Khartoum trained and armed local Arab militia, often referred to as the Janjaweed. The secession of South Sudan was a major financial blow to Sudan, which lost 75% of its five billion barrels of known oil reserves. Throughout the war, the south received little benefit from its oil resources, which were controlled by Khartoum. From 2005 to 2011 revenues derived from southern oil were to be split evenly between north and south. Prior to separation, when the revenue sharing arrangement expired, oil represented 90% of Sudan's export earnings and 60% of government revenues. Once oil revenues began to accrue to Juba under the CPA, they comprised 98% of the south's total revenues. When the land-locked south became independent, it remained reliant on northern infrastructure to export its oil, which*

[4] Kristen D. Wheeler. Homeland Security and Environmental Regulation: Balancing Long-Term Environmental Goals with Immediate Security Needs

[5] Lauren Ploch Blanchard. Sudan and South Sudan: Current Issues for Congress and U.S. Policy. October 5, 2012 CRS Report for Congress. Prepared for Members and Committees of Congress.

was pumped through pipelines to the northern city of Port Sudan on the Red Sea for refining and export."

This analysis reveals two important conclusions: natural resources can be very significant issue for the national security including the division of the country and natural resources can attract the ambition and desires of others thus paving the way of losing sovereignty and control over some parts of the territory.

Another very vivid example is the island dispute between China and Japan. The disputed islands known in Chinese as the *„Diaoyu"* and as the *„Senkaku"* in Japanese have rich fish stocks as well as gas-drilling projects. Therefore both countries like to control the area and claim sovereignty over the islands. Furthermore, Japan is very much concerned with the military ambitions of China and her penetration into the new areas in the disputed waters where energy sources are seemingly rich. (Lohmeyer 2008) If China starts drilling activities in the region Japan will reciprocate immediately thus heightening the tension to a worrying level including the possibility of military clash. The relations between these two countries are suspended at the moment. Japanese companies with huge investments in China are now considering moving out of China to other destinations in the region.

Natural gas issue is also a big source of conflict between Turkey and Greece including Israel. The Greek Cypriots have signed an agreement with Israel for the exploration and utilization of natural gas in the Mediterranean. The Turkish government immediately responded with a similar counter approach and sent a gas exploration ship to the same area. Israel, the third party in the dispute, offered military assistance to Greek Cypriots. Turkey has responded by sending aircrafts to monitor the same area. Once the restraint and control which is now prevailing in the area is lost Turkey, Greece, Israel, Greek side of Cyprus and the Turkish side of Cyprus will find themselves in the middle of military confrontations.

The international disputes over the natural resources are not only related to the sovereignty and/or property rights but also to the techniques applied for the harvesting as in the case between the USA and Mexico for tuna fishing. In the Pacific Ocean, tuna fish often swims under dolphins. Tuna is harvested with nets and most of the time so the dolphins. However, dolphins caught in the net die if they are not released by the fishermen. The US Marine Mammal Protection Act in order to protect dolphins has developed some standards (dolphin safe label) for their fleets which also apply to those countries which are exporting tuna fish to the USA. The USA rejects through applying embargo the imported item if it is thought to be caught against the standards not to the country of export but also to the „intermediary" countries. Same sanction has been applied to Mexico as the exporting country and to Costa Rica, Italy, Japan and several other countries as intermediary. Under the GATT system Mexico complained about the US attitude and filed a case against this county. Subsequently, a GATT panel was formed and panel decided that application of the embargo by the US is wrong. The panel decided that the US cannot apply embargo because the product is harvested against the US standards but is compatible with the catching countries" standards. However, panel decided that it is legal for the US if she thinks that quality of the imported item is not acceptable according to the US standards. As it is seen clearly in the example, even the process of harvesting a natural resource can be an issue in international relations. In July 2011, this time the World Trade Organization once again concluded that Mexico is right in her case against the USA in the case which started in 1991.

NUCLEAR AND TOXIC CHEMICALS: CHERNOBYL, FUKUSHIMA AND BHOPAL

Chernobyl. Russian engineers and scientists began a test on the cooling capability of Chernobyl nuclear power plant reactor number 4 in a case of emergency from a controlling room in Moscow through remote controlling and directing system on April 25, 1986. Scientists in Moscow decided to measure the impacts of diesel generators for the coolant pumps in case of external power outage. Experimentation was not successful and turned into a historical tragedy when the scientist in Moscow was not able to control the complex system in Chernobyl. The resulting temperature was more than 2000 degree Celsius and there is no material in the world that cannot melt at this temperature. Consequently, fuel rods melted and ignited and the roof destructed releasing considerable amount of radiation into the atmosphere. Radioactive clouds reached to Finland, Scandinavia and Belgium between April 27-30, to eastern and central Europe, southern Germany, Italy, Yugoslavia, Ukraine and Turkey (Black Sea) between28 April - 2 May, to the Balkans, Romania, Bulgaria and Turkey (Thrace) between May 1-4 and to Turkey after May 2. Almost 4.200 tons of lead and sand are dropped on the nuclear reactor till May 5 and on May 6 the fire is brought under control.

Many people died. Many people physically disabled. Many people exposed to radiation. Homes were disappeared. Families left their homes as new environmental refugees (Boano 2007) and Chernobyl and surrounding area turned into a ghost town. Children are exposed to radiation causing cancer and mutation. A geographical area in a radius of 30 kilometer around the nuclear power plant was proclaimed to be a “death zone” and the surrounding territories (total 160.000 km2 area) of Belarus, Ukraine and European Russia as contaminated territory. Altogether 9 million people are affected and 400.000 people lost their houses and properties. Later, changing wind patterns spread the radioactive cloud all over Europe.

It is known that a high dose radiation will breakdown the immune system immediately causing uncontrollable bleeding and anemia, damaging gastrointestinal tract, harming internal organs and the central nervous system and producing tumors as a long-term effect. Even a low level radiation can cause cancer. Some newer studies also revealed that low level radiation can lead to genome instabilities, mutations of DNA, malformations and increased cell aging. A working group of the WHO calculated 50.000 cases of thyroid cancer within the next 30-50 years amongst children 0-4 years of age at the time of the accident will take place. In some regions Belarus, cancer incidence rate rose by 56% doubling breast cancer rates, as well as a shift towards younger women. Three times more increase of childhood leukemia has been measured in the affected regions. Rise of brain tumors amongst small children in Ukraine reached to 580%. 5.000 additional deaths occurred amongst small children in Europe.

Increase in cardio-vascular diseases by 22%, a sharp rise in gastrointestinal and CNS-diseases, accelerated aging due to damage to antioxidant systems were observed in the adults and 70% of children of affected parents were registered as chronically ill. Additionally, 13 times rise in childhood diseases in Belarus are observed. These are very conservative numbers. The Russian Ministry of Environment estimated the number of people affected by Chernobyl is around 1.3 million.

Fukushima. A magnitude 9.0 earthquake in Richter scale stroked the area 370 kilometers in northeast of Tokyo on Friday, March 11, 2011 at 02.46 PM. The offshore quake, measured as the fifth largest worldwide sparked a major tsunami across the Pacific. In a very short notice sea water up to 9 meters hit the Japanese coast. The Fukushima Plant was designed for the earthquake of magnitude 8.2. An 8.9 magnitude earthquake is seven times greater than 8.2 magnitudes earthquakes. On the same day the Japanese government declared an emergency at Fukushima Daiichi power plant and authorities revealed that the cooling system at the plant is not working and admitted they are "bracing for the worst". The following day, the radiation level at Fukushima is reported to be rising and Trade Minister of Japan warned that a small radiation leak could occur at the plant. Later on the same day it is announced that radioactive substances may have been leaked at Fukushima. Japan's Nuclear and Industrial Safety Agency reported that radiation near the plant's main gate was more than eight times more than the normal level. The same agency later revealed that a small amount of radioactive material escaped from the power plant. On the same day a hydrogen explosion at Fukushima's blew the roof off the containment structure. The residents living within 20 kilometers of the plant were told to evacuate the area. Around 200,000 people left. Authorities insisted that no harmful gases were emitted as a result of the explosion at the Fukushima plant, blaming the blast on "water vapor that was part of the cooling process." On Monday, March 14, hydrogen explosion at the reactor damaged the cooling system. A wall at the plant collapsed. Officials said that the containment vessel surrounding the reactor remains intact. Authorities begin pumping a mixture of sea water and chemicals into reactor to cool its nuclear fuel rods. Those residents living within 20 kilometers of the plant who have so far ignored evacuation orders are warned to stay indoors. Up to 2.7 meters of the No.2 reactor's control rods are left uncovered because the pump which keeps them cool has run low on fuel after being left unattended. It caused them to heat up generating radioactive steam. On Tuesday, March 15, a second "explosive impact" rocked the reactor. Later, Chief Cabinet Secretary said that he cannot rule out the possibility of a meltdown at all three of the plant's damaged reactors. He said that radiation levels at the plant have increased to "levels that can impact human health" and warned those living 20 and 30 kilometers of the plant to remain indoors. Fire broke out in a cooling pond used for nuclear fuel at the No.4 reactor which had been shut down before the quake. Japanese Prime Minister warned that "there is still a very high risk of further radioactive material coming out" but urged the public to remain calm. The government imposed a no-fly zone within a 30-kilometer radius of the plant. The second fire in two days was discovered in the building of the No. 4 reactor at Fukushima Daiichi. A day later the U.S. Nuclear Regulatory Commission recommends that U.S. residents within 80 kilometers of the Fukushima reactors evacuate the area. Japan's Nuclear and Industrial Safety Agency raised the crisis level, putting it on a par with the 1979 nuclear incident at Three Mile Island in Pennsylvania, the USA. The International Nuclear Events Scale says a level five incident means there is a likelihood of a release of radioactive material, several deaths from radiation and severe damage to the reactor core. On Saturday, March 19 Japan's National Police Agency said 7,348 people were confirmed dead and 10,947 were missing. The agency said 2,603 people have been injured.

Bhopal. On the 3rd of December 1984, 20.000 people were killed and another 120.000 people was severely affected as a result of gas leakage (methyl isocyanate of 27 tons) from a fertilizer factory in Bhopal, India owned by Union Carbide Corporation. Roughly the 500.000 people exposed to the gas. Leakage caused respiratory disorders such as irritation to the lungs, causing coughing and shortness of breathing, building in pulmonary oedema and asthma in addition to sudden deaths. Other health impacts have been witnessed included cancer hazard, mutation, reproductive system hazards, fertility damages in men and women. Traces of many toxins were found in the breast milk of mothers which were transmitted to the recipient babies.

CONCLUSIONS AND PROPOSALS

Several cases of environmental and ecological disasters have been briefly analyzed above. The common denominator of all these cases is the tragedy of human security which is identical with all other security issues such as wars, belligerent activities, terrorist activities, human trafficking and child abuse and so on. It is quite clear that the threats coming from the conventional type security concerns and from the non-conventional ones are all destined to reduce the level of human security. (Levy 1995) Therefore, as the main conclusion, it should be firmly stated here that environment and ecology is an integral part of national security issues and should b treated accordingly.

In this regard, the following proposals are considered to be essential for the future management of national security and environmental matters.

First of all, since the overall task of the security services is to maintain and enhance the conditions related to human security, the environmental security systems should also be established, maintained and upgraded throughout the Globe by the security forces.

Secondly, it is obvious that the threats to human security from non-conventional sources are increasing in numbers and becoming more diversified. Therefore, both the civilian experts on environmental and ecological issues and the experts in armed forces including police forces who have expertise is security issues should combine their efforts to establish a more secure living condition for human beings and for the flora and the fauna taking place in the surrounding environment. Environmentalists should learn insights from the security officials how to deal with the security aspects of the potential environmental tragedies and catastrophes and the security officials should learn the environmental and ecological aspects of the security issues from the experts of the environment and ecology.

Thirdly, it is quite important that both the experts of the environment and the security should learn the essential techniques and methods of environmental management. These include command-and-control strategies of environmental management, voluntary compliance with the environmental rules and regulation and finally the economic, financial or market tools of environmental management ranging from green taxes to marketable pollution quotas.

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THE EFFECT OF THE GEOMETRICAL ARRANGEMENT OF BOREHOLE HEAT EXCHANGERS ON THEIR ENERGY EFFICIENCY - IN LAB TESTS AND FE-COMPUTER MODEL - INSITU AND STEADY-STATE ANALYSES

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Abstract

Along with the impact of the globally-changing climate is the demand to reduce the stresses induced by these changes on our limited natural resources, and to develop alternatives to maintain our standard of living through the economical and efficient utilization of naturally-occurring renewal resources. One exploitable possibility is the use of geothermal energy, which already has a long history. The application of this resource is continually being studied and investigated in many countries.

In Germany at the University of Siegen Geotechnical Institute, model experiments showed that the exchange of heat energy from the underground with radially-configured borehole heat exchangers follows other mechanisms than with the case of adjacent vertical drillings of the same overall length. To evaluate the results of the model tests, the differences between vertically and radially arranged boreholes were studied in different depth layers using finite element analysis.

The results are as follows: The finite element analyzes (steady state) of the development of the temperature around the borehole showed that in the most favorable case the amount of heat extracted per day by means of radial bores amounted by up to 114% over that of a field from short vertical wells with equal length in total. This results in a significantly higher energy efficiency resulting from the low mutual interference of radially-inclined boreholes. Transient finite element analysis, which takes into account the impact of seasonal variations in surface temperatures, confirmed the output from the equilibrium analysis.

The thermal behavior of short boreholes, that is down to about 50 m depth (inclined or vertical position), differs significantly from the thermal behavior of vertical borehole heat exchangers, which extend to a depth of 99 m below ground level; shallow boreholes are over a large portion of their heat-exchanger surface strongly influenced by the solar heat input, while deep probes are significantly affected by the characteristics of the geothermal flux.

By transient finite element analysis over time it was shown that with flattened radial holes the brine temperature in the long-term average of many years is higher than with deep vertical drillings. The resulting cumulative savings of the operating cost compensates for approximately 30% - 50% of the incurred drilling costs. By finite element analysis it could be shown, thus, that the flattened inclined geometrical arrangement has a clear advantage over the deep vertical configuration in the economics and life span of a borehole heat exchanger.

Key Words: Geothermal, radial drilling, steady-state analyses

1. Experimental Studies at the University of Siegen

1.1 General

Concrete test specimens of scaled-down boreholes were prepared, and subjected to cooling and heating cycles in order to obtain estimates with regard to energy efficiency.

For the cooling experiments, first the entire experimental assembly (with inserted glass U-tubes) was cooled down to a steady-state condition in order to evaluate, thereafter, the passive warming up. During the heating experiment (active energy input into the borehole models) heating coils were substituted for the inserts, and the heating around the borehole models was measured by thermography.

Four experimental models were built and compared, in which each U-tubes were inclined opposite to each other at angles of 30, 45, 60 and 90 degrees measured from the horizontal surface of the model (Fig. 1).

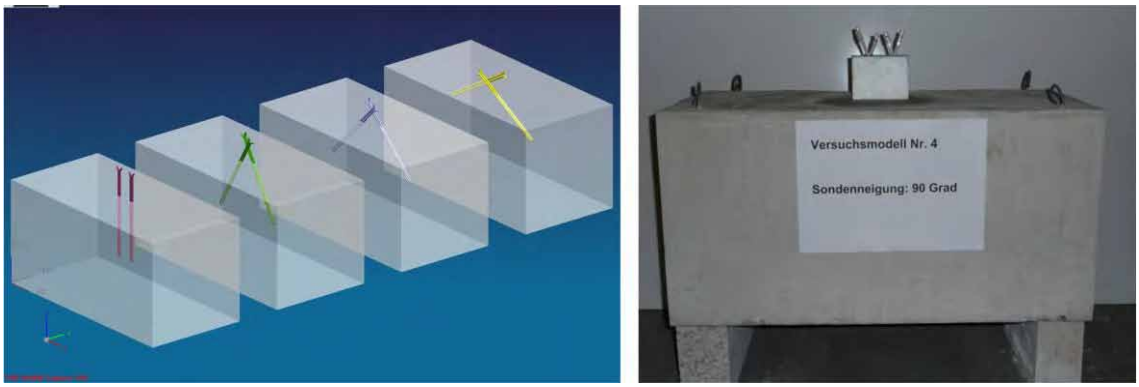

Figure 1: The four test models with divergent angles (left) and a test specimen (right)

The experiments were carried out in the laboratory at a constant room temperature. The measured room air temperature was used, thereby, as the reference temperature of the test body. It was on average 23.5 degrees Celsius; the maximum deviation from the average temperature was + / - 0.2 degrees Celsius.

1.2 Establishing the Measuring Intervals

The first preliminary tests showed that very short measurement intervals of one or two seconds yielded no advantage over a measurement interval of 10 seconds. On the contrary, with short measurement intervals, the recorded data for a period of 40 minutes clearly is much greater than with a measurement interval of 10 seconds. For further processing the smaller records were advantageous. Moreover, it was found that with the smaller measurement intervals the temperature jumps were stronger. The temperature profiles then were more like a line on an oscilloscope

2. Performing the Measurements in the cooling Trials

2.1 Measurements in Trials No. 1 thru No. 4 with inclinations from 30 to 90 degrees

The specimen with an angle of 30 degrees (from the horizontal surface)was used for the first attempt. The glass U-tube probes were embedded in the concrete with the bottom 9.9 cm below the surface. The distance at the surface between the tops of the probes was 0.5 cm,

which corresponded to a distance of one meter in actual production. This distance was significantly less than for the vertically-arranged probes, since in the radial drilling technology on site all probe connections are installed in a pit approximately 1 meter in diameter.

The test specimen used for the second experiment had a probe angle of 45 degrees. The embedment depth of the bottom of the U-tubes was 14.2 cm below the surface. The probe spacing is in this experimental model was also 0.5 cm.

The specimen with an angle of 60 degrees was used for the third attempt. The embedded depth of the tip of the tube was 7.3 cm below model surface. Again, the distance was 0.5 cm between the top of the two tubes.

For the last test of the series, the sample test specimen with a probe inclination of 90 degrees was used. The depth of the bottom tip of the probe was 20 cm. The distance between the top of the two glass U-tubes was 3 cm. At a scale of 1:200, this corresponded to a difference at full-scale of 6 M. The typical distance between two geothermal boreholes is in the range of 3 - 10 M.

3. Evaluation

After completion of all measurements and analysis of the obtained results, it could be ascertained that there were significant differences in the warming-up time between the different experimental models. Taking the longest warming-up phase of the 90-degree experimental model (No. 4) as a reference for the other three models, the following time-difference values were determined:

Model No.	Preheating time to 20°C	Time difference in sec.	Time difference in %
Test model No. 4 (90°)	1480 sec.	Difference: 0 sec.	100%
Test model No. 3 (60°)	1320 sec.	Difference: 160 sec.	89.12%
Test model No. 2 (45°)	1270 sec.	Difference: 210 sec.	85.81%
Test model No. 1 (30°)	1190 sec.	Difference: 290 sec.	80.41%

Table 1: Overview of the time differences of the warm-up phase for $\Delta T = 20$ [°]

The results showed that the flatter borehole heat exchangers in the comparison models tested, heated the contained liquid faster.

A borehole heat exchanger at an angle of 60 degrees compared to the vertical arrangement produced in terms of energy efficiency an advantage of about 11% ≈ 10%.

A borehole heat exchanger at an angle of 45 degrees compared to the vertical arrangement produced in terms of energy efficiency an advantage of about 14% ≈ 15%.

A borehole heat exchanger at an angle of 30 degrees compared to the vertical arrangement produced in terms of energy efficiency an advantage of about 19% ≈ 20%.

The knowledge gained, however, can only provide an estimate of the influence of the angles in the models (2D). The energetic advantages lies in the range of 3 - 5% per 15 degree spread. For simplicity, the modeled boreholes were arranged in a single plane. For more accurate results, the arrangements would have star-shaped, i.e., spatially arranged as is the usual

Geothermal Radial Drilling - GRD method. Because of experimental limitations this could not be realized in the context of the work performed.

3.1 Heating- Thermography

For the verification, i.e. evaluation of the experiments for the power efficiency and temperature distribution, an investigational procedure with the extraction of heat on the modified models were affected after completion of the model tests.

The models were sawed into two halves in the plane of the borehole heat exchangers, and heating wires were inserted to replace the glass tubes. Opposite to the first test series, heat energy was input into the experiment with the rejoined models. After a specified time, the models were separated and thermal images were recorded.

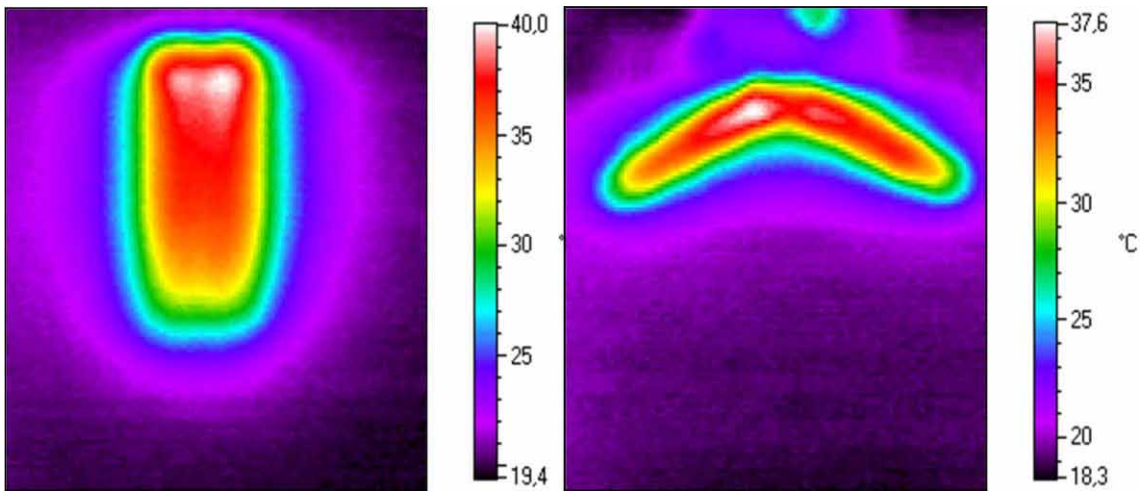

Figure 2: Thermographic records after 30 minutes. Model 4 (90 °) and Model 1 (30 °)

The results showed that in particular a spreading of the power probes positively affects the thermal power efficiency. The thermographs show an agreement between the lab tests and the results of the numeric modeling (See Chapter 5). The mutual influence in the vertically-configured borehole heat exchangers over their entire lengths is recognizable in Figure 2.

4. The behavior of Vertical and inclined Borehole Heat Exchangers with Finite Elemente Anaylyses

In order to further evaluate the results of the experimental tests at the University of Siegen, by means of the software package Temp/W of 2007 finite element analyzes of divergent probe configurations were accomplished at equilibrium (Steady State) and transient analyzes “plan view “(2D). The model space selected had a width of 200 m, a depth of 150 m, and the number of elements in the model space consisted of approximately 30,000. In the area around the borehole heat exchangers the element sizes were greatly reduced, and the dimensions of fictitious boreholes were inserted.

The following uniform geology was the basis of the model room:

- Quartzite with a 10% water volume in fractures
- Lambda of the formation, if not frozen: 412.23 kJ/day/m/K = 4,77 W/(m*K)
- Lambda of the formation in the frozen condition: 470 kJ/day/m/K = 5,44 W/(m*K)
- Volumetric heat capacity of the formation, if not frozen: 2310 kJ / m / K
- Volumetric heat capacity of the formation, if completely frozen: 2080 kJ/m³/K

In terms of a conservative assessment of the modeling results, only the conductive heat transmission in the model space has been considered. In the steady-state analysis a constant surface temperature of 10°C and a constant subsurface temperature of 11.6°C at a depth of 150 m as boundary conditions were applied. In the transient analysis the full-year data from Potsdam at 1 m below ground level as established in 2006 was specified as the surface temperature and cycled over 20 years (moderate continental climate).

In each case, two modeling approaches were made with the following borehole heat exchanger configurations:

- Vertical: 1x99 m total length, 2x 49.5 m lengths conforming with VDI spacing of 5 m; 3 x 33 m lengths at VDI spacing of 5 m
- Inclined boreholes: 2 x 49.5 m lengths at an azimuth angle of 180° and inclinations from the horizontal of 35° and 65°

The models were subjected to identical defined thermal stresses for all calculations:

- The borehole wall temperature over the entire borehole length was reduced by 10K to calculate the amount of heat removed.
- Along the borehole wall over the entire borehole length of 99 m, a heat quantity of 7500 kWh x year was removed, and the borehole wall temperature were determined.
- Daily transient loads followed for the length of time of 20 years, and each 30.42nd calculation step was plotted. The yearly thermal stresses varied as follows:
- The surface temperature fluctuated between 1.48°C and 23.84°C in the annual cycle
-.The specific abstraction capacity of the individual probe on the borehole wall fluctuated between 1416 kJ/day/m (= 16.4 W/m) in January and 0 kJ/day/m in June / July / August, pursuant to the default heating load distribution of Earth Energy Designer 3.14.

5. Results of the Steady State Analyses

5.1 Steady State Analysis: vertically-oriented borehole heat exchangers

By means of Steady State analysis, the statement is made that the parameters in the model space changed after constant energy input (constant geothermal and atmospheric flux) and constant energy output (terrestrial heat probe in continuous operation during an infinite period) so that a flow equilibrium established itself.

The probes are considered as isothermal system and the borehole wall temperature is kept constant at 0 ° C, resulting in the model for different probe configurations in the equilibrium state following temperature distributions (Fig. 3):

If the borehole heat exchangers are regarded as an isothermal system and if the borehole wall temperature is kept constant at 0°C, the following equilibrium temperature distributions resulted in the model for various borehole configurations (Fig. 3).

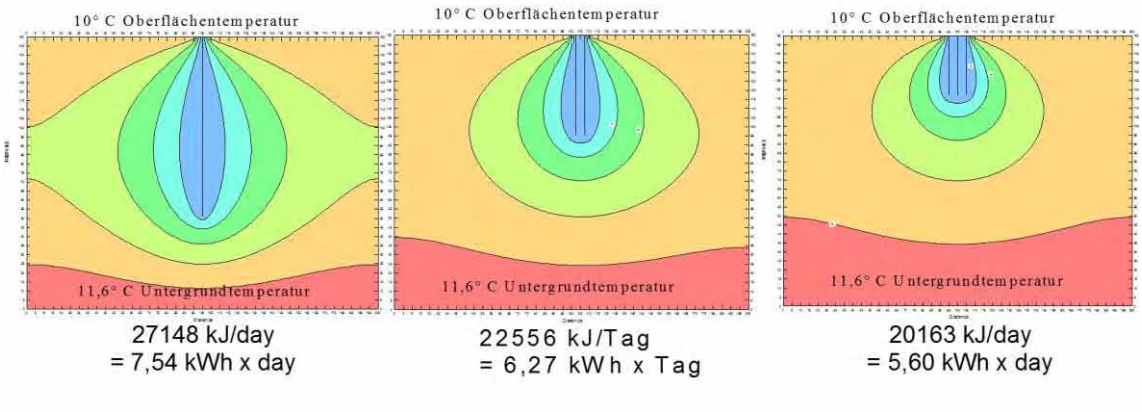

Figure 3: Temperature distribution in the model for the vertical configurations 1 x 99m, 2 x 49.5 m (linear configuration: 5 m spacing) and 3 x 33 m (linear configuration: 5 m spacing; isotherms intervals 2°K)

It shows that a single long probe in thermal equilibrium has a one-third higher yield than any of thermal energy provided by a combination of several, possibly even shorter borehole heat exchangers.

It is not surprising, therefore, that the heat-affected area with a single borehole is larger than an area based in a combination of individual boreholes.

5.2 Steady-State Analysis: inclined boreholes

The same conditions were valid as with the modeling of vertical borehole heat exchanger configurations. The following temperature distributions established themselves in achieving equilibrium (Fig. 4):

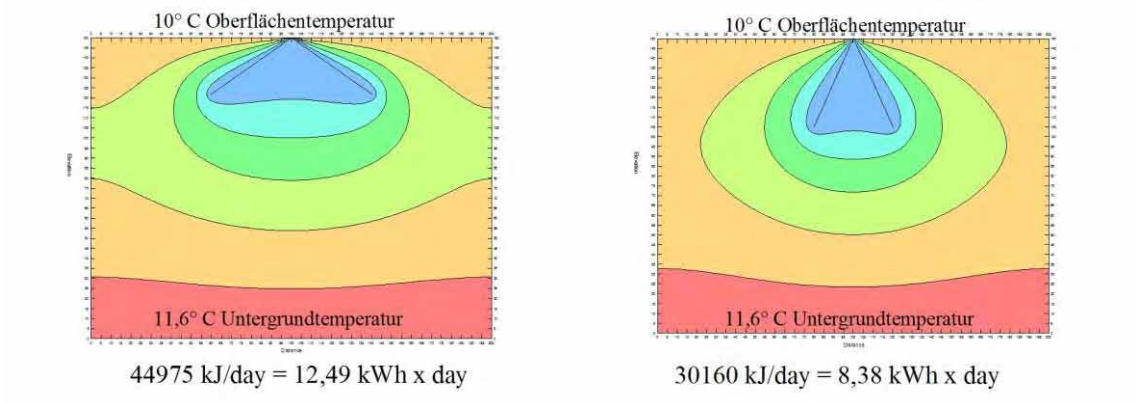

Figure 4: Temperature distribution in the models for the borehole configurations 2 x 49.5m at 35° and 65° inclination to the horizontal (Isothermal intervals = 2°K)

It turns out that two boreholes with 35° inclination to the horizontal in thermal equilibrium with the boundary conditions of the model space could provide mathematically about 54% higher heat output than two boreholes inclined at 65° to the horizontal (the azimuth angle distance in each case 180 °).

Also demonstrated by steady-state analysis was that a similarly high efficiency as for inclined holes can be achieved by the distance to each other of vertically oriented holes being increased significantly. Figure 5 summarizes the results from the steady-state analysis for vertical and inclined boreholes.

Important for interval measurement in the field is the vertical distance between the midpoints of two mutually inclined boreholes. As CUI et. al. (2006) demonstrated mathematically, the distance between the centers of inclined probes can be defined as the horizontal distance between vertical borehole heat exchangers to define a vertical field with the same efficiency as a radially-inclined geothermal borehole heat exchanger installation.

This can be illustrated by an example: The middle-point distance of two oppositely-inclined boreholes each with a length of 49.5 m at an angle of 35° is about 40 m. At a 65° angle of inclination it is about 21 m. To construct a vertical field with the same borehole heat exchanger capacity, two boreholes with the respective vertical intervals from one another should be installed.

Within the allowable property geometry, several short vertical borehole heat exchangers exceed the heat exchange capability of an individual, long borehole heat probe.

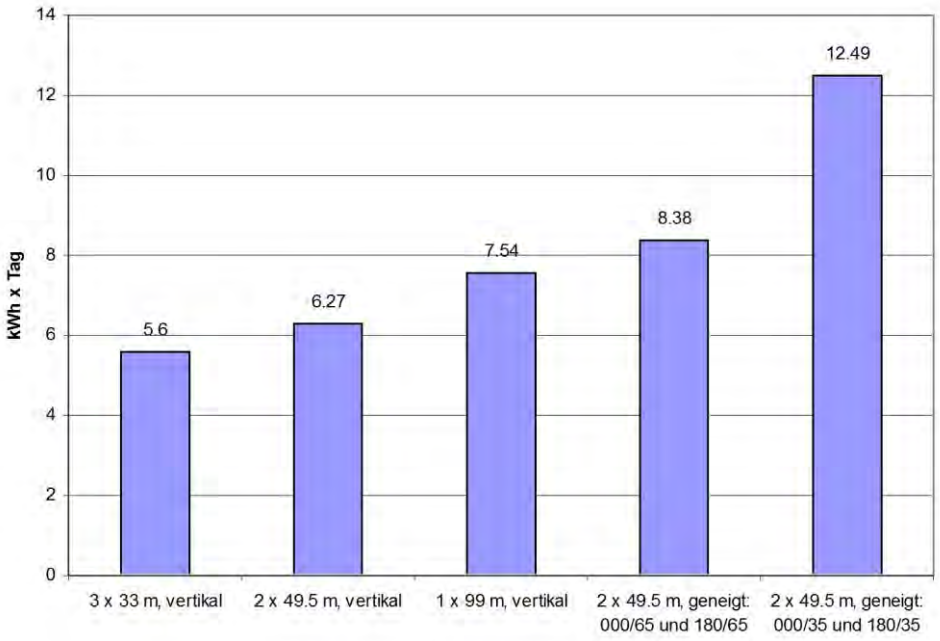

Figure 5: Comparison of the extracted heat energy (kWh x day) of different configurations in the finite-element model.

6. Results of the Transient Finite-Element Analyses

For comparison of the transient analyses, the surface temperature in the model soil from Potsdam, as measured in 2006 1 m below ground level, was cycled daily for 20 years.

Only considered were the two most efficient borehole configurations, i.e., two inclined boreholes of 49.5 m lengths at inclinations of 000°/35° or 180°/35°, and a vertically-oriented borehole heat exchanger with a length of 99 m.

The cumulative heat extracted from the ground over the year should be 7500 kWh x years in the model year and was distributed according to the default curve for the base-load distribution of EED 3.14 (Figure 6). The maximum thermal stress was 16.4 W/m.

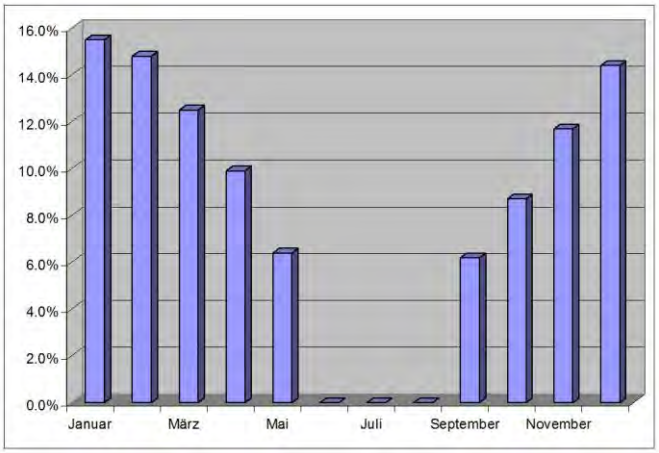

Figure 6: Monthly distribution of the monthly heat extraction in percent

The fluctuations of the temperature in the wall of the inclined boreholes had a yearly variation of up to approximately 5,5° K, while the borehole wall of the vertical boreholes fluctuated up to approximately 4°K (Fig. 7). These differences are explained by the seasonal fluctuations of the ground temperatures in the upper 20 m of the earth's crust. The inclined borehole heat exchangers are over a large part of their bore length within this 20 m zone.

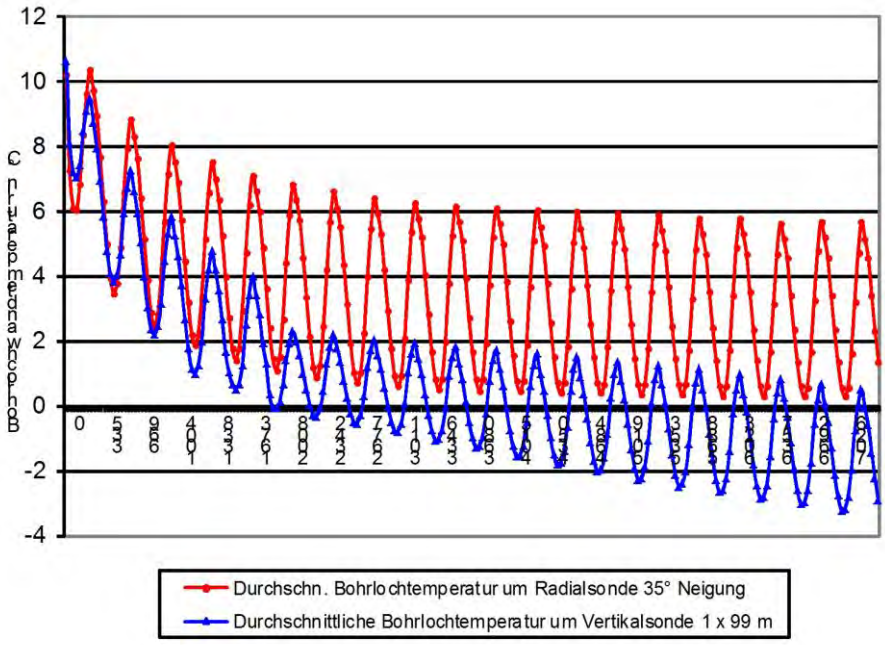

Figure 7: Comparison over 20 years of the average borehole wall temperature between a vertically-oriented geothermal borehole with a length of 99 m and two radial boreholes, each 49.5 m in length that have a separation angle of 180° in azimuth and an inclination to the horizontal of 35°. The numbers on the x-axis indicate the cumulative days. The numbers on the y-axis is the average of the borehole-wall temperature in degrees C. Yearly extraction was 7500 kWh (0 to 16.4 W/m specific extraction energy).

The influence of the phase transition from water to ice, and the resulting release of latent heat makes the vertical borehole heat exchanger at the end of the 5th Year noticeable (Day 1825): The annual variation of the borehole-wall temperature was halved temporarily after the temperature fell below the freeze/thaw point for the first time.

In subsequent years the range of variation increases again, and regains a similar amplitude. The entire water in the formation is frozen. The minimum borehole-wall temperature of the vertical borehole heat extractor continues to fall constantly thereafter, with no flattening of the curve to the end of the calculation period.

The minimum borehole wall temperature of the inclined geothermal borehole heat extractors never falls below 0.3°C during the calculation period. Even here a clear leveling off of the temperature curve after 6 years can be detected. After approximately 10 years the borehole wall temperatures continue to vary constantly with same amplitude, without the general curve hardly falling. Even after a computing time of 20 years, the 0°C mark is reached.

7. Conclusion

Experimental research investigation results at the Geotechnical Institute of the University of Siegen show that shallow inclined borehole heat exchangers compared with vertically oriented borehole heat exchangers can produce substantially greater heat with the same borehole wall temperatures.

These results stand in agreement with the results from the Steady-State Analysis for two borehole heat exchangers angled opposite from each other at an angle of inclination of 65° (delta azimuth = 180°), according to which with inclined borehole heat exchangers the benefit in the power efficiency is at least 11% in comparison to a vertical borehole arrangement.

This statement can be extrapolated to the effect, however, that at shallower angles, the efficiency values (for geothermal usage) in the computational models are consistently higher than in the laboratory experiments. These variations result from the boundary conditions in the model test on a flat 2D model and the boundary conditions for the short term test periods to the long-term cyclical considerations in the numerical modeling.

Both model considerations agree, in spite of the difference between the results due to the different boundary conditions, that it is generally more useful for reasons of energy efficiency to drill several short inclined holes instead of a long vertical borehole.

The reason is the tendency for higher borehole wall temperatures. This is advantageous for the operating costs of a heat pump, as per °C higher brine temperature the operating costs drop by approximately 4%. Calculations of production costs show that in this way over the duration of 20 years savings in the operating cost would be theoretically between approximately 1500 € to 6000 €, an amount which would compensate about 30% - 50% of the drilling costs.

In addition, the computations showed clearly that several short vertically oriented boreholes tend to be less energetically favorable than a long vertical hole when drilling depths are designed in accordance with VDI 4640. This statement is consistent with experience in practice.

Nevertheless, a planner can implement a field of short boreholes highly efficiently, when simulation software, such as the Earth Energy Designer is used. Unfortunately, only in rare cases with correspondingly large borehole spacings for drilling is this feasible, because the available land area is usually not sufficient.

In the typical construction-operational practice there remains, therefore, only the choice of a central drilling location with geothermal boreholes inclined radially into the ground. The machine manufacturer Tracto-Technik from Lennestadt, Germany, has perfected the Geothermal Radial Drilling – GRD concept into a technically and economically proven geothermic solution.

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THE IMPACT OF CLIMATE CHANGE ON THE MOUNTAIN SEMI-NATURAL GRASSLAND MEADOWS IN NORTHERN PORTUGAL USING A TIME-FREQUENCY APPROACH

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Abstract

This paper analyses the impact of climate on vegetation growth for a rural, mountainous region in North-Eastern Portugal. In particular, we measure vegetation growth by using the ten-days synthesis dataset (S10) from SPOT-VEGETATION satellite imagery from 1998 to 2011. We examine the dynamic patterns of vegetation growth inferred by the normalized difference vegetation index (NDVI).We test whether the growth pattern of the NDVI has changed due to climate variability and we test the relationship of NDVI with temperature and available soil water. In order to check for changes in the growth cycles we use a time-frequency approach based on Kalman filter regressions in the time domain. We find a change of the cyclical pattern for the spring season and different changes if we take into account all seasons. This suggests that individual seasons may undergo cyclical changes which are different to other seasons. Our analysis shows that temperature and available soil water are the main drivers of vegetation growth. We can also recognise a shift of the relative importance away from temperature to soil water.

Key Words: Normalized difference vegetation index NDVI, time varying spectra, Kalman-filter, mountain-meadows, climate variability

1 Introduction

In the Mediterranean area, the variability of climate is a serious challenge for many agricultural systems' policy developers, natural resources managers, insurances, researchers and farmers. They are naturally interested in modelling the impact of climate in the vegetation dynamics[1,2].

Based on the most recent estimations of global and regional climate change, the Mediterranean region may experience substantial drying with precipitation reductions of more than 25% and warming by 3-5ºC by 2080[3,4]. At the same time, interannual variability is projected to increase, especially in summer .

Climate changes are particularly serious for mountainous regions because they are amongst the most fragile environments in the world and are recognized as the key supporting ecosystem service related with natural resources conservation, as defined by the Millennium Ecosystem Assessment[5] .

For this reason we study the mountainous grassland system in the northeast of Portugal in this paper. The traditional landscape of the mountainous region of north-eastern Portugal is characterised by the ancestral agro-pastoral or grassland system extensively used for hay and grazing locally called lameiros. To preserve these meadows, it is essential to gather useful

[1] Hill, Stellmes, Udelhoven, Roder and Sommer, 2008, s.
[2] Quiroga and Iglesias, 2009, s.
[3] Giorgi and Lionello, 2008, s.
[4] IPCC, 2007, s.
[5] Assessment, 2005, s.

information for the sustainable management of semi-natural grassland ecosystem and grazing activities. Hence, modelling the vegetation responses to the inter-annual climate variability could help to develop conservation strategies. In this paper we use the time series of satellite imagery to monitor grassland dynamics.

Remote sensing of agricultural lands at regional and field scale is often pursued using the VEGETATION sensor, on board the most recent Satellite Pour l'Observation de la Terre (SPOT) - SPOT_VGT. Results from previous works show that the normalised difference vegetation index (NDVI) profile fits well the characteristics vegetation growth dynamics and associated management practices in the semi-natural meadows of the mountainous region of northeast Portugal[6,7,8]. Hence, in this paper we use the NDVI time series based on SPOT_VGT sensor imagery to infer about the impact of climate in these semi-natural meadows and to model vegetation dynamics.

Vegetation indices time series based on remote sensing imagery have been shown particularly useful to characterise land ecosystem dynamics2[9,2] . As part of this process, several approaches based on temporal trajectory analysis have been proposed for smoothing and detecting temporal changes in vegetation dynamics. Reviews of the merits and limitations of these techniques can be found in[10,11,12,13,14]. According to this literature, stationarity assumptions, data quality, sensor noise and complications of the methods can make it challenging to quantify the separate sources of information that influence the signal and to determine what constitutes a significant change. Moreover, none of these methods are capable to integrate and quantify the seasonal and inter-annual impact of climate on the cyclical behaviour of satellite derived vegetation growth.

Therefore, a time-varying spectral approach, capable of separating out changes at different cyclical frequencies (including trend) in the grassland growth, is needed to provide the flexibility to capture these features.

This work provides a temporal analysis of the cycles in vegetation greenness in mountain grassland of northeast Portugal, as assessed from SPOT-VGT imagery from 1998 to 2011. We are engaged in identifying the importance of variability of climate for cyclical properties in the satellite based grassland growth rate, and consider how the impacts of these events may be predicted.

The time-frequency approach applied here does not only give us the cyclical properties, but also how they changed over time (if they changed at all) possibly due to climate variability.

2 MATERIAL AND METHODS

A. Study area

The region of analysis covers a large area of the mountain region of Montalegre, northeast Portugal. The large pixel size of SPOT_VGT images (1 km) determines the criteria for selection of test site, which have to include large contiguous areas with *lameiros* fields. Therefore one suitable test site was selected in Montalegre municipality, location of Paredes do Rio (PRR). The test sites have 2x2 pixels (of 1×1km), in a compact groups of contiguous pixels, all with 65% or more lameiros coverage. The PRR coordinates (Datum WGS84) of the upper left site corner are: 7º55'04W and 41º48'32"N.

[6] Cunha, Pocas, Marcal, Rodrigues and Pereira, 2010, s.
[7] Poças, Cunha and Pereira, 2012, s.
[8] Rodrigues, Marcal and Cunha, 2013, s.
[9] Cunha, Marcal and Silva, 2010, s.
[10] Atzberger and Eilers, 2011, s. Ibid.
[11] Coppin, Jonckheere, Nackaerts, Muys and Lambin, 2004, s. Ibid.
[12] Hird and McDermid, 2009, s.
[13] Lhermitte, Verbesselt, Verstraeten and Coppin, 2011, s. Ibid.
[14] Zhu, Pan, He, Wang, Mou and Liu, 2012, s.

These meadows are conveniently located in areas of high water availability, loamy soils and over 700-800m high. In this region the Atlantic climate favours high precipitation occurrence (1531 mm/year), mainly occurring from autumn to spring, autumn-winter temperatures lower than 12ºC and mean monthly temperatures ranging from 3.5ºC to 17.2ºC.

B. Meteorological data and soil water balance

We use meteorological observations for the years 1998 to 2011 from the weather station of Montalegre (41º49'N: 7º47'W: 1005m of elevation) located in the proximity of the test site. The meteorological data consist of daily observations of maximum and minimum temperature and precipitation. These general meteorological parameters are used to derive other variables: mean temperature (Tm, ºC), Potential Evapotranspiration (ETP, mm) and other variables related with soil water balance.
The Thornthwaite- Matter[15]mass conservation climatic water budget model is then performed to simulate ten days soil water balance. Dekadal ETP is estimated using the empirical Thornthwaite equation that relies on mean temperature and average day length (hours.day^{-1}).

C. Satellite data

In this paper we use the satellite imagery provided by SPOT_VGT for period 1998 (April) to 2011 (March), to examine the dynamic patterns of grassland grow inferred by the NDVI. This satellite has an intermediate spatial resolution (1 km) and the images are corrected for radiometric, geometric and atmospheric effects. Ten-day composites SPOT_VGT products (S10) are obtained from the compilation of daily data.
The NDVI is a variable which is truncated (it can only adopt values in between -1 and 1). A truncated distribution is the part of an untruncated distribution that is above or below some specified value (result: non-normal distribution). This implies that either one has to adopt an estimation technique that takes truncated variables into account or we have to transform NDVI data into a non-truncated variable. For this reason, we transformed NDVI into a growth rate. This growth rate is not truncated anymore, so common estimation techniques can be used.
In this paper we work with aggregated data on seasonal level and we use annual growth rates rather than level values.
To make the approach consistent, we also use the same growth rates for temperature and soil water. Hence, in all regressions to come all variables refer to the same time period and have the same dimension, namely percent.

3 EMPIRICAL TECHNIQUES

A. Estimation in the Time Domain

In the first step, we estimate the cyclic behaviour of the growth rate of each individual variable, i.e. NDVI, ASW and Tm. In order to do so, we have to estimate an Autoregressive Model of order "p" (AR(p)), where p is determined by statistical tests. In order to allow for the possible changes in the parameters, we will employ a time-varying model AR(p) by applying a Kalman filter to the chosen model as follows:

[15] Thornthwaite and Mather, 1955, s.

$$y_t = \alpha_{0,t} + \sum_{i=1}^{9} \alpha_{i,t} y_{t-i} + \varepsilon_t \quad (1)$$

with

$$\alpha_{i,t} = \alpha_{i,t-1} + \eta_{i,t}, \text{ for i=0...9} \quad (2)$$

and $\varepsilon_t, \eta_{i,t} \sim \text{i.i.d. } 0, \sigma^2_{\varepsilon,\eta_i}$, for i=0...9 .

We employ a general to specific approach (starting with p=9) to obtain a final specification for eq. (1), eliminating insignificant lags. The maximum number of lags was determined by the Akaike Information Criterion (AIC). For each regression we applied a set of diagnostic tests, shown in the tables in the following sections, to confirm the final specification found.

Using the specification above implies that we get a set of parameter values for each point in time (here a point in time is one season). Hence, a particular parameter could be significant for all points in time; or at some periods but not others; or it might never be significant. These parameter changes are at the heart of this paper as they imply changes in the lag structure and hence changes in the spectral results. If a parameter was significant for some periods but not others, it was kept in the equation with a parameter value of zero for those periods in which it was insignificant. This strategy minimised the AIC criterion, and led to a parsimonious specification. Finally, we tested the residuals in each regression for auto-correlation and heteroscedasticity.

The final specification (eq. 1 and 2) was then *validated* using two different stability tests: Ploberger et al.[16] detects *discrete* breaks at any point in time and to LaMotte and McWorther[17] is designed detect *random* parameter variation. We also test for autocorrelation of the residuals.

It should be noted, that all our tests are being conducted in the time domain, *before* transferring to the frequency domain. This is because no statistical tests exist for calculated spectra (the data transformations are nonlinear and involve complex arithmetic). Stability tests are important here because our spectra are sensitive to changes in the underlying parameters.

From this AR(p) we can then *calculate* the short–time Fourier transform as outlined below, and as originally suggested by Gabor[18] , in order to *calculate* the associated time-varying spectrum.

B. Spectrum analysis

The time-varying spectrum of the growth rate series can be calculated as follows (see also[19,20,21] :

$$P_t(\omega) = \frac{\sigma^2}{\left| 1 + \sum_{i=1}^{9} \alpha_{i,t} \exp(-j\omega i) \right|_t^2} \quad (3)$$

where ω is angular frequency and j is a complex number. The main advantage of this method is that, at any point in time, a power spectrum can be calculated instantaneously from the updated parameters of the model. Hence, we are able to generate a power spectrum even if we have a short time series and even if that time series contains structural breaks.

[16] Ploberger, Krämer and Kontrus, 1989, s.
[17] LaMotte and McWorther, 1978, s.
[18] Gabor, 1946, s.
[19] Cunha and Richter, 2012, s.
[20] Hughes and Richter, 2009c, s.
[21] Lin, 1997, s.

C. Cross-Spectrum Analysis

In this paper we also investigate the linkage between different NDVI-based vegetation growth cycles. In the frequency domain, the natural tool to do that is the coherence.

Suppose now we are interested in the relationship between two variables y_t and x_t, where y_t is the grass growth rate and x_t is the temperature variability for example. We assume that they are related in the following way:

$$V\ L\ _t y_t = A\ L\ _t x_t + u_t,\ u_t \sim \text{i.i.d.}\ 0, \sigma^2 \tag{4}$$

where $A(L)_t$ and $V(L)_t$ are filters, and L is the lag operator such that $Lz_t = z_{t-1}$. Notice that the lag structure, $A(L)_t$, is time-varying. That means we need to use a state space model (we use the Kalman filter again) to estimate the implied lag structure. That is

$$v_{i,t} = v_{i,t-1} + \varepsilon_{i,t},\ \text{for i = 1, ..., p and } \varepsilon_{i,t} \sim\ 0, \sigma^2_{\varepsilon_i}$$

$$a_{i,t} = a_{i,t-1} + \eta_{i,t},\ \text{for i = 0, ..., q and } \eta_{i,t} \sim\ 0, \sigma^2_{\eta_i} \tag{5}$$

As before, we test for the random walk property using the LaMotte-McWorther test. And for structural breaks, we employ the fluctuations test . Finally, we use our previous general to specific approach to estimate (eq. 4); starting off with lag lengths of nine and p=q, and dropping those lags which were never significant (as we did before).

Having estimated the coefficients in equation 4, we can calculate the gain, coherence and cross spectra based on the time-varying spectra just obtained. This allows us to overcome a major difficulty in this kind of analysis: namely that a very large number of observations would usually be necessary to carry out the necessary frequency analysis by direct estimation. That would be a particular problem in the case of structural breaks, since the sub-samples would typically be too small to allow the associated spectra to be estimated directly.

For the Cross Spectral Analysis, we use the methods introduced in Hughes Hallett and Richter[22,23]. The time-varying cross spectrum, $f_{YX}(\omega)_t$, using the STFT can be written as:

$$f_{YX}\ \omega\ _t = \left|T\ \omega\ \right|_t f_{XX}\ \omega\ _t \tag{6}$$

where $T(\omega)_t$ is the transfer or filter function is defined by equation 6 and calculated as follows:

$$T\ \omega\ _t = \left(\frac{\sum_{b=0}^{q} a_{b,t} \exp\ -j\omega b}{1 - \sum_{i=1}^{p} v_{i,t} \exp\ -j\omega i} \right),\ \text{for t = 1, ..., T} \tag{7}$$

The last term in equation 6, $f_{XX}(\omega)_t$, is the spectrum of predetermined variable. This spectrum may be time varying as well. However, in this paper we are interested in the coherence and in the composition of the changes to that coherence over time. So we need to establish expressions for the coherence and gain between x_t and y_t to show the degree of association and size of impact of x_t on y_t. The spectrum of any dependent variable is defined as [ex. 24]:

$$f_{YY}\ \omega\ _t = \left|T\ \omega\ _t\right|^2 f_{XX}\ \omega\ _t + f_{vv}\ \omega\ _t \tag{8}$$

From equation 3 we get the time varying residual spectrum

$$f_{vv}\ \omega\ _t = \frac{f_{uu}\ \omega\ _t}{\left|1 - \sum_{i=1}^{p} v_{i,t} \exp\ -j\omega i\right|^2} \tag{9}$$

[22] Hughes and Richter, 2009a, s.
[23] Hughes and Richter, 2009b, s.
[24] Wolters, 1980, s.

and the gain as $A\ \omega_t = \left|T\ \omega_t\right|^2$.

Finally, given knowledge of $f_{YY}(\omega)_t$, $\left|T\ \omega_t\right|^2$, and $f_{XX}(\omega)_t$, we can calculate the coherence at each frequency as:

$$K^2_{YX,t} = \frac{1}{1 + f_{VV}\ \omega_t \Big/ \left|T\ \omega_t\right|^2 f_{XX}\ \omega_t} \tag{10}$$

The spectral coherence K^2_{XY} is a statistic that can be used to examine the relation between two signals or data sets. Values of the coherence will always satisfy $0 \le K^2_{XY} \le 1$. For a strictly proportional linear system with a single input x_t and single output y_t, the coherence will equal one. If x_t and y_t are completely unrelated then the coherence will be zero. If K^2_{XY} is less than one but greater than zero it is an indication that output y_t is being produced by input x_t as well as by other inputs. Hence, the coherence is nothing else than the R^2 in the frequency domain. Since we are calculating the coherence using the short time Fourier transform, the coherence may also be time-varying. So we have to extend K^2_{XY} by a time index. For the rest of this paper we will write $K^2_{XY,t}$.

For example, if the coherence has a value of 0.6 at frequency 1.2, then it means that the temperature cycle at frequency of 1.2 determines NDVI-based vegetation growth cycle at that point in time by 60%. Similarly a gain of 0.5 means that half the variance in temperature cycle at that frequency is transmitted to de NDVI.

4 RESULTS

A. NDVI based growth of semi-natural grassland

Figure 1 presents the annual growth rate of NDVI. The aggregation of the ten-day data for the period 1999-2010 results in 48 seasons (12 years x 4 seasons/year).

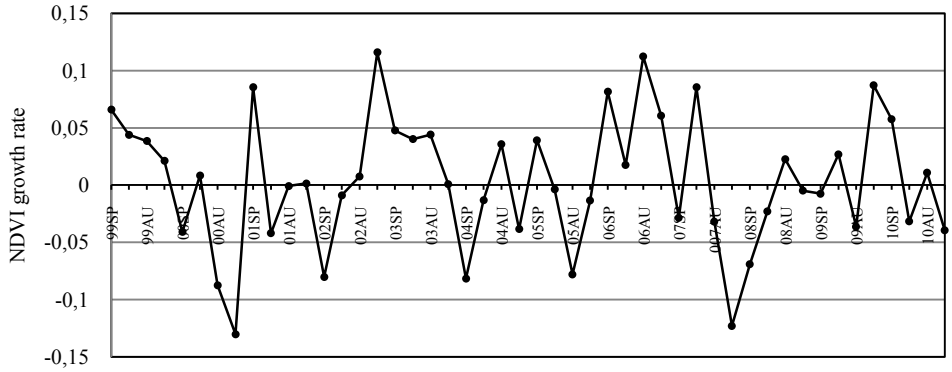

Figure 1. Annual growth rate of NDVI for the period 1999 to 2010.

Interestingly, the growth rate fluctuates between +15% and -15% (Fig. 2). Seasonal effects are visible but maybe not as clear cut as one would have expected. Although it does hold that in winter the growth rate is usually negative, it is not always positive in spring. Figure 3 compares the growth rate of NDVI, for spring time only.

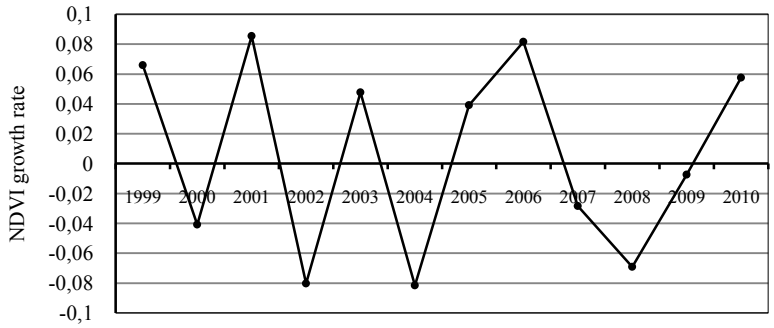

Figure 2. Spring growth of NDVI.

For the first half of the sample there seems to be a two-year cycle: starting in 1999, the growth rate is positive, it then becomes negative and in 2001 it is positive again. However, one should bear in mind that a negative growth rate does not imply that vegetation is not growing in spring. It merely states that in 2000 vegetation growth was 4% less than in 1999. In other words a "good" year is followed by a "bad" year, which is then followed by a "good" year again.

Importantly, from 2005 onwards, the two-year cycle becomes a four-year-cycle. Hence, a "good" year is followed by another good year and this one is then followed by two "bad" years.

Aggregation of the data reveals a symmetric behaviour of the natural NDVI spring cycles as opposed to seasonal cycles. This refers to the amplitude (±8%) as well as the clear cyclic behaviour, which also changed recently. At this point, it is too early to conclude that the change of the spring cycle is caused by climate variability. We are merely describing a cyclical behaviour without applying any statistical method. Hence, we cannot say at this stage, what causes it.

B. Spring vegetation growth and climate

In the next step, we compare the spring NDVI cycles with the spring temperature cycles. A first indication of this link can be seen, if we combine both growth rates of NDVI and temperature in one figure (Fig. 3).

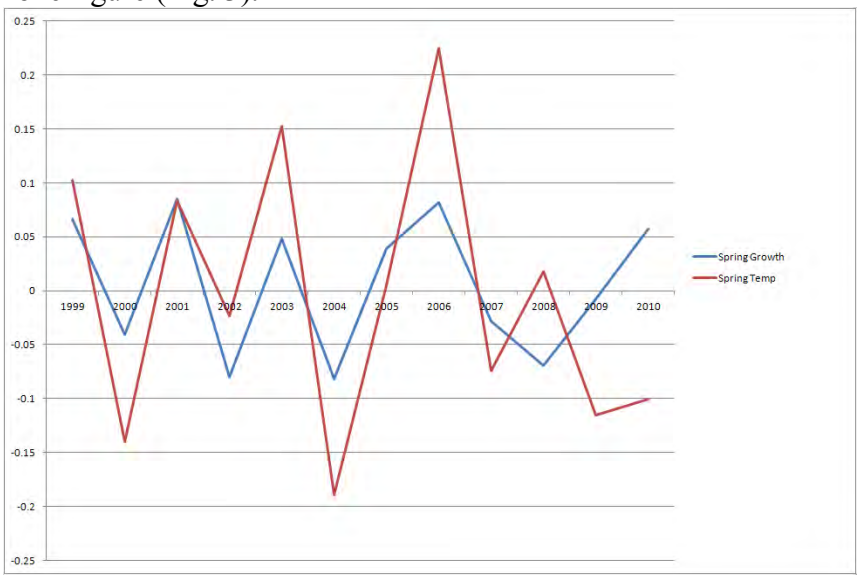

Figure 3. NDVI and temperature growth rates

As in the case of the NDVI growth rate, there are two-year cycles visible up to 2007, where the cycle potentially becomes a four-year cycle. In difference to the NDVI growth rate, temperature variability is bigger. The temperature varies at some points in time (1999, 2005) by more than 15%.
The NDVI growth rate and the temperature growth rate behave in a cyclical way to each other until 2008. From 2008 onwards the link is different. Especially for the years following 2008, it looks as if temperature and NDVI behave anticyclically with each other (Fig. 4). Despite the obvious link of the two variables, it is remarkable that the higher fluctuation of temperature has only a reduced effect on the variability of the NDVI growth, if at all.
Last but not least, we also look at the growth rates of the spring NDVI and the available soil water (ASW) (Fig. 4). The variability is higher than for the other two variables (Fig. 2 and 3). The maximum is -50% in 2009. From 2001 to 2010 there is a two-year cycle visible, only once interrupted in 2005. Moreover, there also seems to be a nine-year cycle visible namely from 2001 to 2010.

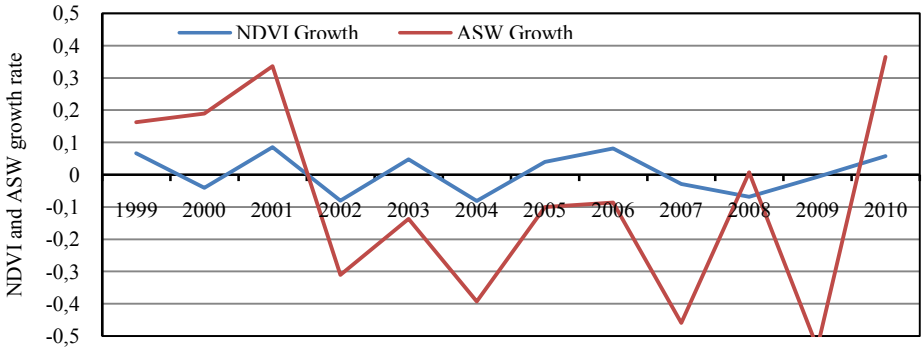

Figure 4. NDVI spring growth rate and Available soil water (ASW).

Despite their different variability, both variables seem to move in line until 2008. As with the temperature the relationship between NDVI and ASW should be positive.
In summary, these indicative results clearly show the existence of *natural* growth cycles. We discovered two-year cycles, but also longer term cycles. Moreover, we could also see that the cycles are not constant. For the NDVI spring series in particular, the two-year cycles seem to have changed to four-year cycles.
The variability of the three variables under consideration differs and so does their relationships.
The indicative results imply several issues: We need to detect which cycles are the most important one, when we consider all seasons. We need a method that takes into account that cycles are not (necessarily) constant. Finally, we need a method that allows us to test the changing relationship between NDVI, soil water and temperature.
For this reason, we decided to use a time-frequency approach that can tackle all the issues above. In what follows, we will shortly introduce time-frequency analysis, before we apply it to the three variables.

C. Single spectra of the NDVI growth rate

Figure 5 shows the time-varying spectrum of the NDVI. The regression is based on all seasons rather than just the spring seasons as shown above. For this reason we should not necessarily expect the same cyclical behaviour as in figures 3 and 4.
If the NDVI growth rate was a white noise process then the spectrum would be completely flat. The spectrum shows peaks at the following frequencies: 0.5, 1, 2.1 and 2.5. Of these, the most important cycles are at the frequencies of 0.5 and 2.1. This corresponds to 12 seasons and 3 seasons respectively. The frequency of 1 corresponds to 6 seasons and the frequency of 2.5 corresponds to 2.5 seasons.

In other words vegetation growth rate mainly follows a 12 and 3 season cycle (Fig. 6).
In the figure 6, the 12 seasons represent 3 years and is the main cycle whilst the 3 season cycle (or 0.75 years) fluctuates around the main cycle.

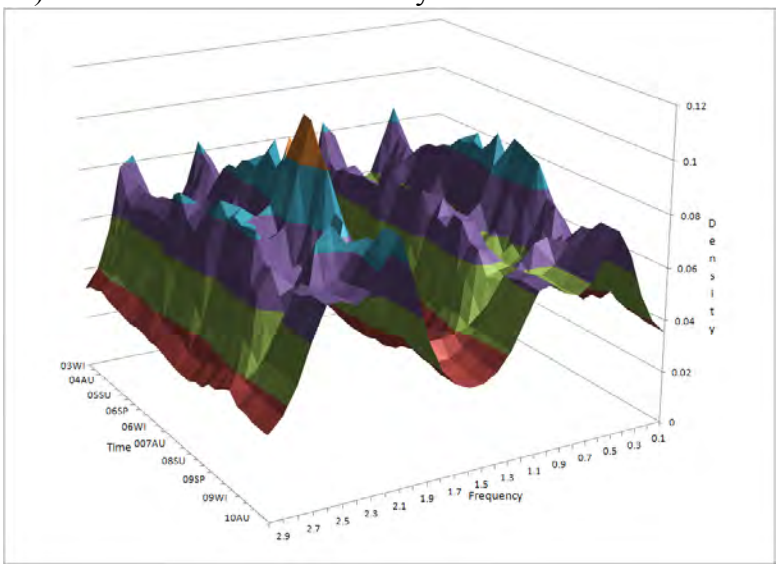

Figure 5. Spectrum of the NDVI growth rate

Table 1 shows the regression results for the series dlNDVI. This AR(8) model is the basis for the spectrum shown in figure 6. As one can see the regression is robust as there is no autocorrelation. For the chosen model, this was in fact, the lowest AIC value we could achieve. The R-square is relatively high with 99%, but there is also unexplained variance. Although the first four lags are statistically not significant at the end of the sample, they were at other sample points in time, which is why we kept them in the regression (Table 1). Hence, this table only shows the final regression for the last observation for reason of restricted space.

Table 1. Regression results for dlNDVI

Estimation by Kalman Filter			
Dependent Variable	dlNDVI		
Usable Observations	48	Degrees of Freedom	45
R2	0.99308		
Mean of Dependent Variable	0.00356	Std Error of depend variable	0.054619
Standard Error of Estimate	0.051779	SS Residuals	0.093837
Akaike Information Criterion:	0.06117	Ljung-Box Test: Q*(9) =	13.3008
Variable	Coeff	Std Error	T-Stat
Constant	-0.0113	0.0441	-0.2559
dlNDVI [3][3]	0.1260	0.0330	3.8128
dlNDVI [3][3]	-0.4198	0.0641	-6.5492
dlNDVI	-0.2358	0.0706	-3.3410

Annual growth rate of NDVI (dlNDVI)

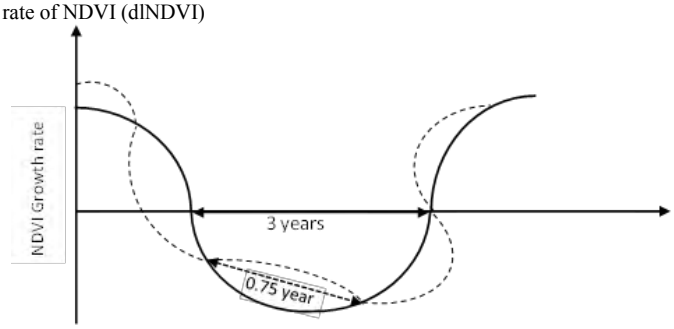

Figure 6. Graphical interpretation of NDVI Growth Cycles. There are two fluctuations of equal strengths: one has a length of 3 years (solid line) and there is a shorter one of 0.75 year (dashed line)

D. Cross-Spectra and simulation results

In the next step, we estimated the dependence of the NDVI growth rate on temperature and ASW rates according to equations 4 and 5. We used a bi-variable approach in order to avoid potential multicollinearity. In other words, in the first regression, we estimated the dependence of the growth rate of the NDVI on the growth rate of temperature and in the second step we estimated the dependence of the growth rate of NDVI on the growth rate of ASW. We start off with the temperature results.

Table 2. Regression results between dlNDVI and temperature

Estimation by Kalman Filter			
Dependent Variable	dlNDVI		
Usable Observations	48	Degrees of Freedom	42
R2	0.97282		
Mean of Dependent Variable	0.0036	Std Error of Dependent Variable	0.0546
Standard Error of Estimate	0.0779	Sum of Squared Residuals	0.1943
Akaike Information Criterion:	0.1043	Ljung-Box Test: Q*(9) =	16.4616.
Variable	Coeff	Std Error	T-Stat
Constant	-0.0116	0.0352	-0.3305
dlNDVI [3][3]	-0.7842	0.0925	-8.4767
dlNDVI	-0.1021	0.0400	-2.5526
dlTmed	0.0863	0.0182	4.7353
dlTmed [3][3]	0.0978	0.0210	4.6718
dtTmed [3][3]	-0.1112	0.0305	-3.6415
dlTmed	-0.0823	0.0228	-3.6076

Annual growth rate of: NDVI (dlNDVI) and mean temperature (dlTmed)

Table 2 shows the regression results. As in the previous section we only show the final observation results. The resulting coherence is shown in figure 7. There are two cycles at which the link between the growth rate of the NDVI and the temperature is biggest, namely at a frequency of 0.8 and 2.4. These frequencies are very close to the original frequencies in figure 6. They correspond to cycles of 7.8 seasons (or 2 years) and 2.6 seasons (or three quarters of a year). The coherence close to these two cycles is very high as well. So we can conclude that the temperature explains a lot of the spectrum apart from the short term (frequency of "π"), the long run growth (frequency of "0") and the cycle at a frequency of 1.6 (or 4 seasons, i.e. 1 year).

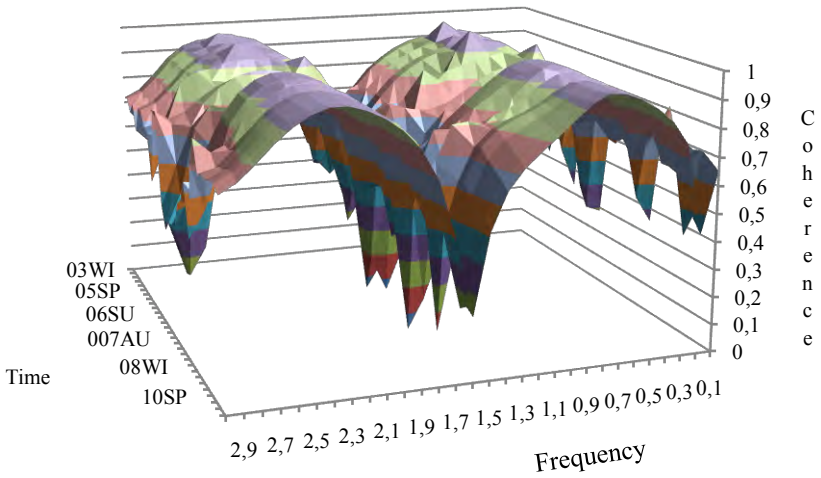

Figure 7. Coherence between the growth rate of NDVI and the temperature

In order to analyse the NDVI-based growth rate sensitivity of the model, a number of simulations about changes in temperature and ASW were computed.
The regression result also allows us to look at the impact of a 10% change of the temperature on NDVI, if everything else remains constant. Figure 8 assumes a 10% one-off increase in temperature.

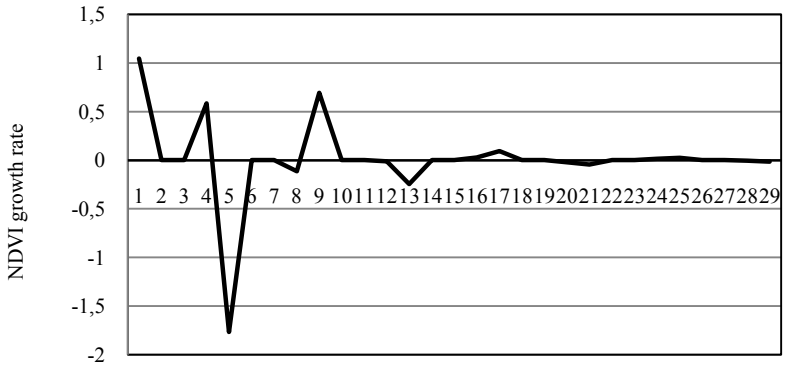

Figure 8. Impulse – Response Function for Temperature.

Figure 8 shows that most of the shock has been absorbed after 10 quarters, where the system returns to the steady state. From a time series point of view, this indicates a stationary process, i.e. after a shock, the system returns to a steady state value. It is worth noting that stationarity has not been imposed by the regression. It is the outcome of the regression which could have been non-stationary as well.

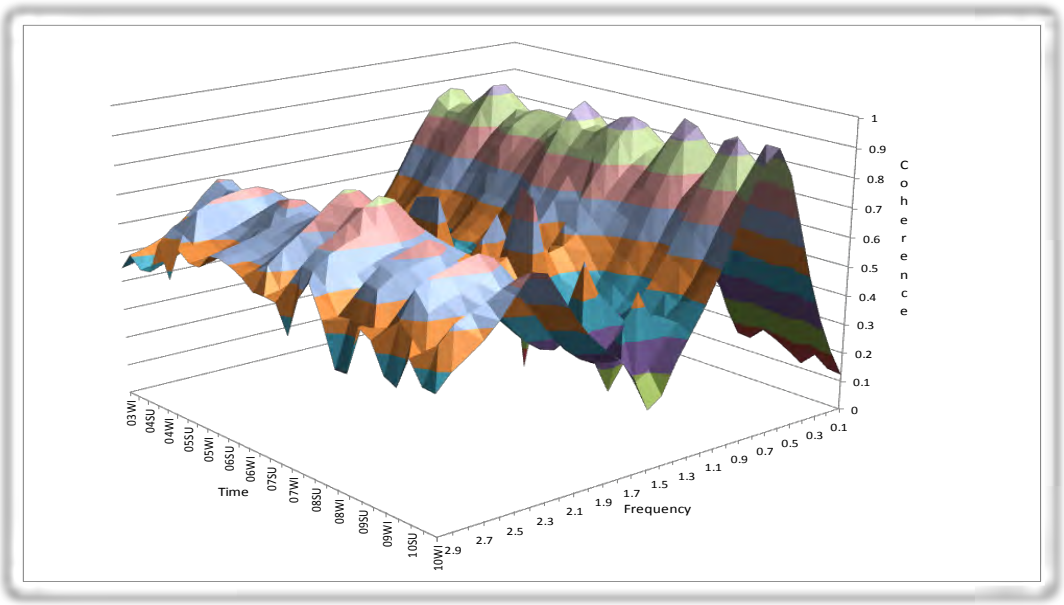

Figure 9. Coherence between the growth rate of NDVI and growth rate of available soil water

It is interesting to note that the dynamics which are caused by an one-off increase in temperature by 10% imply positive NDVI growth rates as well as negative ones. The immediate effect of the increase of temperature is a 1% increase of the NDVI, which is followed by a 0.5% increase 4 seasons later. This increase is then completely removed the following season where the NDVI growth is reduced by 1.5%. These two year cycles are in line with our observations made earlier in this paper. It is also important to note that the reaction of the NDVI growth rate to a change in temperature is under-proportional to the change in temperature (about 10%).

Finally, we also analyse the impact of ASW on vegetation. We ask what NDVI growth cycles are determined by ASW. The figure 9 gives the answer.
The coherence shown in figure 9 is based on the regression results from table 3. The coherence shows that the growth rate of the absorbed soil water explains 95% of the NDVI cycle at a frequency of 0.7, i.e. 9 seasons or 4.5 years. The second cycle the growth rate of the ASW is explaining is at a frequency of 2.4 or 2.6 seasons. ASW explains about 50% of this cycle. This cycle corresponds closely to the cycle shown in figure 6, the spectrum of the NDVI growth rate. There is also a coherence at a cycle of 1.3 of 0.5 years, but this coherence diminishes over time. The two main coherences stay important throughout the sample though the long run cycle coherence has slightly increased towards the end of the sample.
Overall, the mass of the spectrum, which the growth rate of the ASW is explaining is less than the temperature. Given an R^2 of 0.95, this highlights that time series results alone may sometimes be misleading: One may not capture the crucial cycles if one only takes into account time series properties. This is not to say that time series results are wrong, one just has to be careful on interpreting them.
Like in the case of the temperature, we can also investigate the effects of a 10% increased of the ASW (Fig. 10).

Table 3. Regression results between dlNDVI and Available Soil Water

Estimation by Kalman Filter			
Dependent Variable	dlNDVI		
Usable Observations	48	Degrees of Freedom	44
R2	0.9467		
Mean of Dependent Variable	0.0036	Std Error of Depend Variable	0.0546
Standard Error of Estimate	0.0572	Sum of Squared Residuals	0.1111
Akaike Information Criterion:	0.0734	Ljung-Box Test: Q*(9) =	17.8760
Variable	Coeff	Std Error	T-Stat
Constant	0.0006	0.0350	0.0172
dlNDVI[3][3]	-0.5953	0.0741	-8.0353
dlASW	0.0325	0.0116	2.8076
dlASW[3][3]	-0.0421	0.0093	-4.5369
dlASW	0.0006	0.0152	0.03885

Annual growth rate of: NDVI (dlNDVI) and Available Soil Water (dlASW)

From figure 10 we can see that a 10% change in the growth rate of ASW leads to a 0.4% change in the growth rate of the NDVI. Like in the case of the temperature most adjustments have been finished after 10 seasons. Given that the behaviour of the system is very similar to the temperature shock, this supports the hypothesis that a particular area can only support a certain vegetation level. From this point of view, it is certainly no coincidence that like in the case of temperature, after 5 seasons there is a negative effect on NDVI by about 0.6% which is balanced four seasons later. Over all the impact of a 10% on the NDVI growth rate is close to zero after the system returns to the steady state.

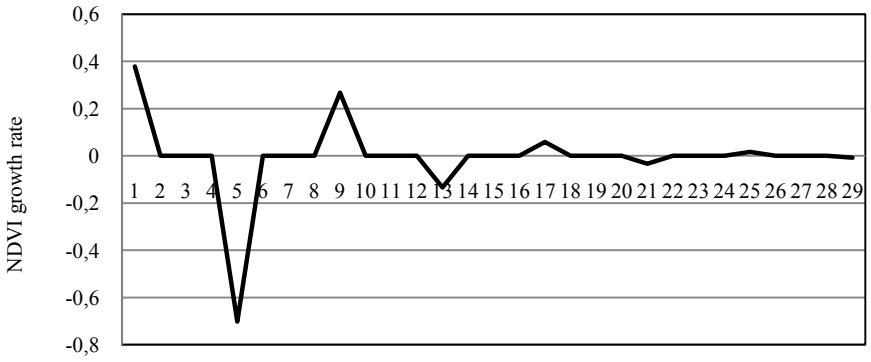

Figure 10. Effects of a 10% change of the Growth Rate of Available SoilWater (ASW) on the NDVI Growth Rate.

5 DISCUSSION

The increased importance of satellite data in support of research in impact of climate on the vegetation dynamics leads to a strong need for a more comprehensive understanding of time-series changes. We apply a time-frequency approach, which not only gives us the cyclical properties, but also how they changed over time. This alternative approach was partially presented in previous work by Cunha and Richter[25] and Hughes Hallett and Richter[26,27] .
We achieved all of the results by estimating a dynamic time series model. The time series model is characterised by its lag polynomials and the time-varying weights. The lag polynomial allows us to describe the dynamic properties of the estimated relationships. As the lag polynomial is time-varying itself the Fourier transform becomes time-varying. As a result, we have a time-varying spectrum and a time-varying coherence. In traditional frequency domain analysis, a time series has to be stationary for the frequency estimators to be unbiased. By using a time-varying estimator, the series does not have to be stationary anymore as long as the non-stationarity was caused by structural breaks of which the Kalman filter is able to take care of. Therefore, with this approach we gain many more insights in the dynamic properties of a system than with the more "common" approaches (see section1).
The results of the satellite based grassland growth rate clearly show the existence of two-year spring cycles, but also longer term cycles.
Our results also stated that temperature and ASW are important drivers of vegetation growth rate cycles. The variability of the three variables under consideration differs and so does their relationships. However, the link between satellite derived vegetation growth rate and temperature is positive as well as the link between and ASW.
We can also recognise a relative increase of importance of soil water at constant importance of temperature. Despite soil water explaining about 50% of short term cycles, temperature still explains about 90% of those cycles. Because evapotranspiration rates are positively related to temperature, increased temperatures are likely to be associated with increased rates of soil water loss. Therefore, if temperature warms without a compensating increased in precipitation, plants may become increasingly water-stressed, which could lead to decreases in growth rate where the irrigation were not possible.
The individual shocks of the temperature and ASW to the system have similar dynamic effects/consequences (Fig. 8 and 10).
The question is what drives this behaviour? Why is the growth rate of the NDVI stationary? It seems that a particular area can only support a certain vegetation level. A shock to this system can therefore only have a temporary effect, but not a permanent one; unless all other determinants of vegetation growth will support an increased vegetation, which in this scenario/regression they do not do (all other variables stayed the same). As a result, an increase in vegetation has to be off-set later. The estimation results show that this off-setting starts a year later. This was not imposed in the regression and is purely a regression result. It also indicates that a shock to the system causes a two-year cycle: in the first year, vegetation increases; in the second year it decreases.
The results support the hypothesis that vegetation dynamics are physiologically dependent in several ways on the previous years. Therefore, a time-varying spectral approach, capable of separating out changes at different cyclical frequencies and points in time with respect to grassland growth, will need to provide the flexibility to capture these features and the important ecophysiological information contained therein.

[25] Cunha and Richter, s.
[26] Hughes and Richter, 2006, s.
[27] Hughes and Richter, s.

6 CONCLUSION

We modelled cyclical satellite based grassland growth rate with a time-frequency approach. It provides the cyclical properties of the satellite based growth rate and what cycles in particular are explained by the climate variables.
The cyclical analysis revealed that there are more than just seasonal cycles working for the NDVI based vegetation growth. We could show that the cyclical properties of NDVI are not constant over time.
While this time-frequency approach of satellite based vegetation growth cycles can only give indications of causal relationships on potential climatic growth impact, they provide the catalyst for causal hypothesis generation, namely for the plant soil-interactions, which could be tested where other data-sources are available. The quantification of the relative impact of these myriad factors on the grassland dynamics, is still a huge challenge for developing strategies for the sustainable use of grassland resources in northeast Portugal, as well as other extensively managed grassland systems worldwide.

7 ACKNOWLEDGMENTS

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HOW MICRO-CLIMATE HAVE AN IMPACT ON SOCIAL INTERACTION?

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Abstract

As an architect and designer, I have come to understand that successful architecture benefits society by helping to fulfill its functional, social and emotional needs. Although over the past three decades much progress has been made in developing architecture's functional potential, both materially and structurally but less progress has been made in developing architecture's potential as an emotional or social tool. One that brings people together, one that lifts the spirit and boost human health.

This research paper aims to look at various weather conditions on a small scale urban area and to explore how built environment can create an undesirable micro-climate and consequently diminish social interaction between people and weakening human mental health and his social skills.

There is a large body of literature devoted to the impact of variable human activities on climate which reminded us the phenomenon of Climate Change and Global Warming whereas a minor amount of work has been done on the impact of climate on human social interaction.

This topic is significant in a way that if architecture has the potential to promote creative interaction between individuals or groups of individuals, and if this interaction can aid the conception of new ideas, those new ideas which society needs to progress, then architecture becomes much more than a functional decorated shed, it becomes a powerful tool for social change and increase human health, well-being and will lead to a better quality of life style.

Key Words: Sociological Dimension, Human Health, Social Interaction, Built environment, Micro-Climate

Introduction

1.1 Understanding The Climate

"Climate" is a very general term that has a variety of closely related meanings. Usually, "climate" refers to the average, or typical, weather conditions observed over a long period of time for a given area. ''The Climate refers to the average weather experienced over a long period, typically 30 years.''[1]

There is still a lot of uncertainty about what causes climate variations, with some of the factors being:[2]

- Variations in the sun
- Changes in ocean circulation
- Changes in land cover types
- The production of greenhouse gases by mankind's burning of fossil fuels
- The role of man-made aerosols on cloud formation

However it is worth mentioning that man is capable of influencing climate through human activities of many different kinds for example increasing urbanisation and industrialisation has caused the climate of urban environment to change quicker and creating Micro-climate for a small environment such as a town, forest or garden.

1.2 What Is Micro-Climate?[3]

It is believed that a Micro-climate is a small but distinctly different climate within a larger area. For example, it could be as small as a back garden, a spot which is sunny and protected from the wind could be considered a Micro-climate, as it will be significantly warmer than the rest of the garden for most of the year. Micro- climate is mostly affected by microtopography (little hills, buildings, etc.) But Micro-climates can also get much larger, the shape of the land, including large features like mountains, Water - Lakes, ponds, rivers, etc.

The consequences of Micro-climate would then affecting human attitude and behavior on small and large places and people unintentionally change their behavior.

1.2.1 Factors Affecting Microclimate

These are some of many factors which could have an affect on Micro-climate of any area:

- Dark surfaces
- Buildings form
- Shelters
- Natural Physical features

1.3 Social Imprint

The Physical well-being and attitudes of people are directly affected by climate, and these in turn prescribe the planning needs. It is well , therefore, in the study of climatic

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[1] www.ukcip.org.uk/, January 2010.

[2] Dr W. Spencer, 2010, s. 58.

[3] Erell, 2011, s. 43.

regions to note behavioral reactions and patterns of community organisation that are unique and attributable to the climate or the weather. The special foods an dishes, the manner of dress, and the traditional customs are indicative. But how planning and building design could affecting climate and as consequence creating the Micro-climate which could have an impact on human behavior.
Jan Gehl in his book ''Life Between Buildings'' exploring outdoor activates and ''quality of life'', He divided outdoor activities into three categories.

1. Necessary activities
2. Optional activities
3. Resultant activities

The interesting argument in here is the way that these activities occur each of which has got different demands on the physical environment and lack of one parameter could drawn the space into different category or from active/divorce/civic/vibrant place to a dead/negative/doll/poor quality place.
In order to obtain and achieve a healthy and good quality outdoor space the importance of climate and weather condition has to considered and designed building with conscious and care. With this in mind we could create a better outdoor spaces and provide a platform for people to interact and socialised.

''The more residents are outdoors, the more often they meet-and the more greetings are exchanged and conversation develop''.[4]

Well designed outdoor spaces could invite people to stop, sit, eat, play, and so on. In poor quality spaces, only the minimum of activity takes place. People hurry home, no place to have a chat with each other, no place to relax, no interaction,...

It could be now stated that Micro-climate and having a good quality outdoor space have a direct relationship with each other. On next Chapters extensive investigation have taken place in order to justifying this phenomenon.

2.1 Introduction to The Case Study

Site Location

Bermondsey Square is located on Tower Bridge Road in Bermondsey, part of the London Borough of Southwark (figure 1), in south London, England. The location was formerly the site of the 11th century Bermondsey Abbey.

2.2 Historical Significance

For nearly 60 years Bermondsey Square has hosted the New Caledonian Antiques Market every Friday morning. There is also Farmer market on Saturdays which is organised by London Farmers' Markets and established 10 years ago which considered as main characteristic of the Bermondsey square and the London Borough of Southwark hoping this

[4] Gehl, 1987, s. 112.

feature could attract tourists to the place.

2.3 Bermondsey Square After Regeneration Plan

The old medieval square, formerly a clunic abbey, has been overhauled entirely and now boasts the standard modern mix of cutting-edge restaurants, luxury flats, bars, a pricey hotel and, an age-old antiques market and Farmers' Market. In a very glance view on the site it is understood that Bermondsey square designed to provide a place for people to stay, sit, eat, enjoy and interact with each other and give them a relaxing moment. With combination of residential, commercial and office (mixed-use) buildings around the Bermondsey Square it is assumed that Square should use in any time of the day and night. Since there is no permanent structure available on the square, Stall holder has to set up their own structure every week around 4 am and pack up again on following evening. It is somewhat disappointing that despite of high quality redeveloped area, still the square is under used. It is also noted that the market stalls themselves are in poor condition and present a detrimental image for the market. According to the council's draft markets strategy, "Bermondsey Antiques Market has 40 to 50 stalls with another 120 pitches available; however in a reality these numbers are far too unrealistic.

3.1 Methodology

Measuring Micro-climate[5] and social behavior are the two which needed various and different method to record, it is also worth to mentioning that social aspect is none quantifiable and it is very delicate issue, therefore it has to be studied with cautious and concise. Few possible measuring methods have been chosen and to ensure that the correct method is chosen for this report, there will be a brief discussion of their advantages/disadvantages.

3.2 Observation (Primary Data)

Any assumption will follow by specific observation and recording data in order to revealing/justifying useful data. There is also limitation on this option which most of the time one set of data alone cannot given insight and it doesn't useful as a evidence to make stance based on it. In any case these data has to compare with another set of similar observation on other environment/time scale/climate/... (case study), to spot any differences and then critically analyse this.

3.3 Secondary Data

Data from material previously published by academics or commercial & industrial interests that the data which has been found is matched with the specific study location. In addition to this there is always limitation on this and that would be sometimes lack of data on smaller scale caused surveyor to use some general data

from larger scale.

3.4 Virtual Simulation

[5] Brown, 1995, s. 26.

This is an advanced 3D modeling and visualization software solution. It empowers users to quickly predict, understand and convey complex climate phenomena in urban, suburban and rural environments. The output result of this software is accurate since it is widely used in architectural and engineering practices. However it could be argued that using distrusted climatic data as its input would definitely given incorrect output, therefore the data has to be accurate and scientifically/academically proven to get the best result on modeling.

3.5 Interview

Interview with inhabitants of the building/people passing by/shop owners (if possible) to establish usability and other social concerns. it is important in order to get reliable and usable feedback asking the right question from the right person.

3.6 Summery Of Various Methodology

All options listed have characteristics in their favor, one could use to gather specific data and one could fill in the gap between other options or could test the outcome of other options, therefore in order to get a complete and accurate result all options taken into account with careful consideration of their limitation.

3.7 Measuring Micro-Climate

It is important to note how the various categories of outdoor activities are influenced by the Micro-climate of that space. In this section factors that creating various weather conditions on any region is subject of study in addition on that to see how, when and what is affecting Micro-climate on Bermondsey Square and only then certain social behaviors are examined in relation to response to Micro-climatic conditions and to see opportunities for diminishing the impact.

It would be so many parameters involved in creating Micro-climate of any places but considering time limitation, in this report four main parameters chosen which its likely believed to have an determining impact on human behavior and their social interaction. A brief explanation provided too in order to justifying and understanding their importance for such a study. List of possible investigation on site

- Solar access
- Rainfall
- Wind flow
- Temperature

4.1 Initial Mapping

In order to explore and observe the usage of Bermondsey Square, initial mapping carried out. The main aim was to see how people use the square, it is believed that such a study would led to reveal the quality of the Bermondsey Square. And only then can stated that either the square and its surrounding buildings were well designed and provided a good quality space for its users or it considered as a poor space and doesn't really work that way. It is worth to mentioning that this study occurred at three occasions and the weather condition was a sunny and cloudy on all of them. The total sample taken was 92 and their outdoor activities recorded for one hour. (figure 1 & 2)

Since Square surrounded by mixed use building It is assumed that on the below chosen

times, different types of activities would take a place. In total 92 samples taken from which 69 male and 23 female.

Monday 10 am
Thursday 4 pm
Thursday 8 pm

Outdoor activities (figure 2)
a. Interacting
b. Sitting
c. Staying
d. Playing
e. Passing Through (on foot)

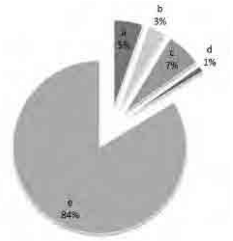


Fig 1 - Although come and go activities accounted for more than 80 percent of the total number of activities occurring on Bermobsedy Square , stationary activities are the ones that brings life to the street.

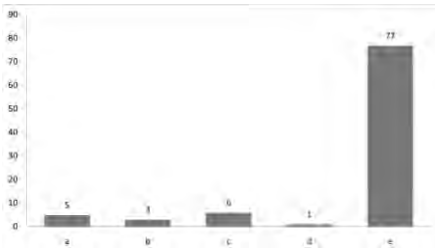


Fig 2 – Graph showing all types of outdoor activities on Bermondsey Square

4.2 Lesson Learnt From Initial Observation

Fig.3 – Outdoor activities on Bermondsey Square.

It is now understood from the initial mapping that not much social activities happening within the square and nearly every one cross the square follows the shortest route as their pass way across the square. The square merely uses as a shortcut from tower bridge road to the other street (Bermondsey street/Long Ln) or vice versa. As discussed before when optional activities like standing around enjoying life, or sitting, talking with friends while walking reduced dramatically it pushes the space to poor quality zone. Shops, cinema, cafes, restaurants, hotel, gallery,... all gathered in one place to attract people and make the place active and a good place to enjoy but based on initial mapping this has not happened. The big question here is Why is this? Is there any clear answer for this!? Is this somehow related to Micro- climate of place!? These are the question which has to be answer by more in depth research and exploration on site. However, it could also be argued that to get hold of accurate result on such a study, observation (mapping) has to carry out for a longer period and in a various weather conditions. Which this would be the aim for later exploration on this report.

5.1 Solar Access

Human being have, quite understandably, a special love affair with the sun, This is actually a scientific fact ‘’In Sweden, at the beginning of every dark winter, more and more people start to make a daily trip to the local medical center to sit for 30 minutes dressed entirely in white in a bright room flooded with 10,000 lux of daylight spectrum light. These individuals are sufferers from Seasonally Affective Disorder(SAD).’’[6] This happens when people haven’t got enough of sunlight/daylight this could led sufferers become depressed, secluded and unsocialised. Since most of the

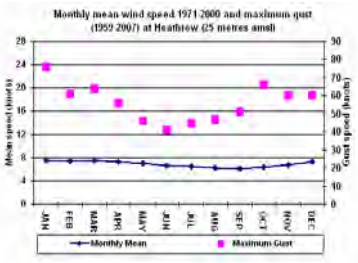


Fig.4 – The number of hours of bright sunshine is controlled by the length of day and by cloudiness. In general, December is the dullest month and June the sunniest.

[6] Battle & McCarthy, 2001, s.56.

year England covered with fogs and clouds ,almost four hours sunlight a day (figure 5), therefore when the sun is shining, young and old sunbathe in large number, no matter where they are!, in the middle of square or park, public or privet spaces, Summer or winter. Sunlight and daylight on outdoor spaces itself could attract people to stay longer in space and enjoy their life plus there is a possibility to interact with each other since they spending more time outdoor. In a very general term we could say sunshine has that magical power to alter people moods and cheers them up, thereby preventing anxiety and depression so if it is possible to provide sunlight to the space even only for a brief period, the urge to do so is very great. All these discussions increasing the importance of having sunlight on public spaces to elevate activities and improve quality of life therefore creating a moment for people to interact with each other.

5.2 Solar Access and Daylight On Bermondsey Square

Solar access studied on Bermondsey Square to estimate the amount of sunlight/daylight we could get within the square. The result shows that good sunlight across most of the site. Early morning, most of the square and west boundary in shade, but improves throughout the day. At noon, onwards site gain most of the sunlight because of lower height of the building on south side plus a gap between newly built building and Victorian houses. (figure 5) The low winter sun means that the site is overshadowed throughout the day. Shorter days, high level of overshadowing, and the typical weather at this time of year means that a very limited amount of sunlight. (figure 7)

Fig.6&7 − Bermondsey sq, March and November Solar Access. 08.00am and 14.00pm

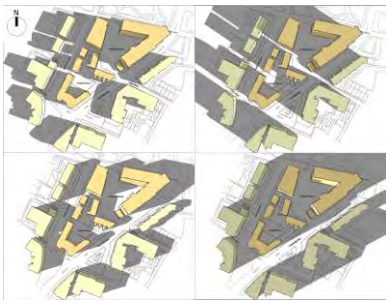


Fig.8 − Previous layout of Bermondsey Square (2005), November Solar Access. Good sunlight from early morning till noon and there after blocked with Victorian houses on south side of the square

5.3 Interview with Inhabitants

In addition to above study, couple of interviews carried out in order to see how much people(Resident, Stall owners, Passerby) are satisfied with solar access on Bermondsey Square? Total number of sample 28

Responds (figure 9)

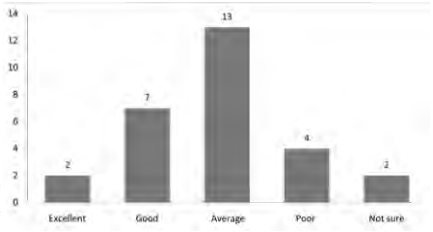


Fig.9 − More than half of the sample were happy about the solar access and rated the Square above average

5.4 As A Summary

It is somehow shows that people are quite satisfied with the sunlight and there is no urge to redefining the building arrangement to get more sunlight into the square. In this case transformation based on solar access would position at the bottom of the proposal list.

6.1 Prevailing Wind

Based on met office climate data, London has got high strength wind flow specially during autumn and winter period with prevailing south-westerly wind direction through the year (figure 10)

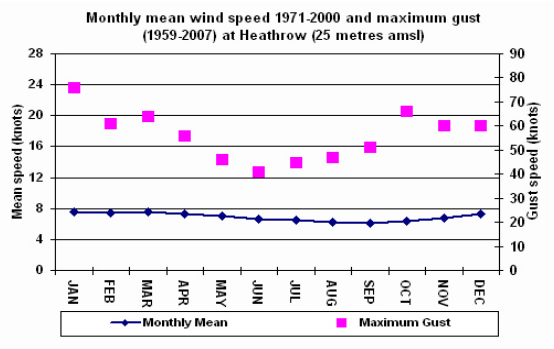


Fig.10 − Monthly mean wind speed 1971-2000 and maximum gust (1959-2007) at Heathrow (25 meters amsl), When the wind reaches a mean speed of 24 knots or more over any ten consecutive minutes, then that day is classed as having a gale. Source: Met Office

6.2 Prevailing Wind On Bermondsey Square

The wind can vary in a number of ways – both in terms of its speed and direction. As a result, different pieces of equipment are needed to measure these different characteristics where in this study two appropriate method have been chosen. Interview Inhabitant (Shop owners, Stall Holders, Resident of Bermondsey Building).

6.3 Virtual Wind Simulation Software. Current Resident Concerns

the current users of Bermondsey Square may have proved a useful source of information for evaluating the current condition of the square, although they may not have had any professional expertise, they should have been able to give a good indication of how well the square functions. It became clear that the time frame of the report would not allow for an extensive survey of opinion. In this case variety of samples such as shop owners, stall holders, residents taken for interview and based on their opinion and respond, a diagram has been drawn by author.(figure 11)

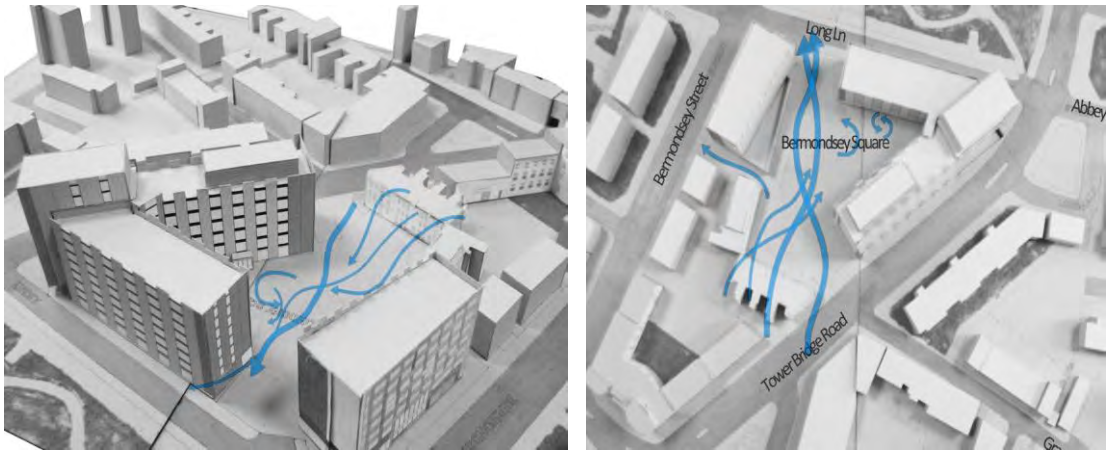


Fig.11 − Wind characteristic drawn based on interviews and author assumption. Before using virtual simulation

6.4 As A Summary Of Interviews

- There have been sever issues with wind flow and its velocity.
- Temporary canopy(Parasol is no use since wind would blown them away and smashed the window displays of restaurant and Ground floor
- Unpleasant Space to stay.
- Customer of restaurant won't sit outside since debris and dust blown to air.
- Experiencing wind tunnel on the north side of the square.
- Calm condition on the south side of Square.
- It is assumed that windblown to square from south west and over pass the Victorian houses and make its way to square.
- Love to sit inside cafe but not outside.

The issues raised by the resident and users of the square, although, will become much more useful when combined with data from other sources such as virtual wind simulation. it is worth to mentioning that the comfort level of the interviewee is personal, and may be of a higher or lower tolerance than the Actual condition. However when combined with information carried out during virtual simulation it could helped to build up an accurate picture of the condition and concerns.

Extensive exploration carried out with help from engineering softwares for modeling the square and study wind movement and its characteristic on a much more scientific manner and then from that point if it possible setting up improvement(s) as form of options.

On first attempt the existing situation modelled and it is confirmed and justified the true representation of opinion from users of the square.(figure 12)

So no wonder that all interviewee were annoyed by windsuck on north side of the square plus on North east of the square wind turned to vortex form and funnel shape which it was the main concern for the shop owners

The main reason for this is that the high rise building on north and east side of the square catch the wind above ground and direct them downward toward the square and surface, where they chill everything and everybody plus blow sand, dust out to the air.

6.5 Development Options

Further simulation carried out to identify the main factors that affecting Micro-climate of square.

Shows the Bermondsey square before development of Bermondsey Buildings. Comparing this output with the one after development(figure 15) clearly justifying that Micro-climate of the square heavily affect by the way new buildings arranged.
Few options and modifications carried out to reduce wind tunnel and vortex in order to make Square pleasant and comfortable place to stay and increase its usability to occur more social interaction.

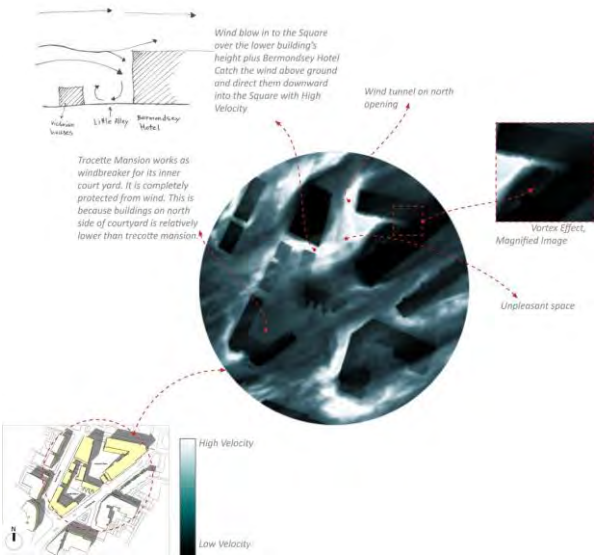
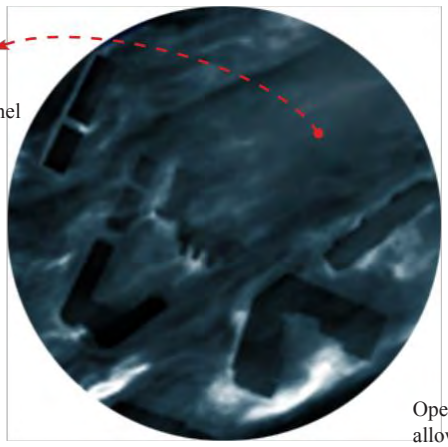


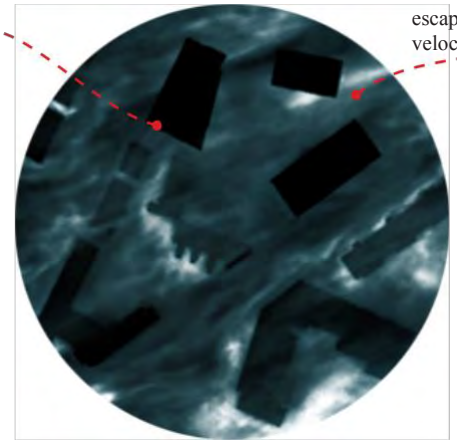
Fig.12 − Combination of low height building on south side of the square and high rise building on north and both sides of Bermondsey square made the square perfect condition for wind tunnel. There is no way that wind to escape from the square other than north opening.

Fig.13 − Bermondsey Square, 2005, Simulation shows low wind flow through out the Square, this is because wind spread out in large open space and this reduced its impact.



Steady condition, No vortex, No wind Tunnel Wind flown over the Square with an equal velocity

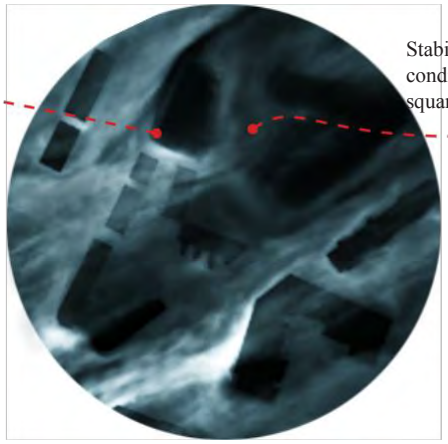
Rather interesting that the wind velocity dramatically dropped on little alley, it shows that the open spaces on Square corner gives enough room for wind to escape with out rushing between buildings.



Opened- up corner allowed wind to escape with low velocity

Fig.14 − Option a. This option would help to reduce wind speed and dissolve vortex on the corner of Bermondsey Square but its not a rational option since this need to demolish a part of newly built apartment.

Trees pushed back wind and redirected it to Bermondsey Street through little alley.



Stabilized condition in the square

7.1 Rainfall

Fig.15 − Option b. By planting trees on south side of Bermondsey Square we could create natural windbreaker which this help both to reduce and break the wind plus being beneficial to environment plus good shelter against Rain and Sun

In City of London Rain can fall at any time of the year, but mainly from late September onwards. Figure 16 shows London's monthly rainfall, It is worth to mentioning that in London, there are also significant amounts in the summer associated with showery, convective rainfall. Rain has an immediate reaction on human behavior and therefore their interaction. People on a rainy day tend to find a shelter as soon as they can as matter of fact their pace would be quite faster than a sunny condition however rain without wind is not major problem A canopy or umbrella provides perfect protection. On this climate condition activities such as standing around, enjoying life, or sitting, talking with friends while walking reduced dramatically.

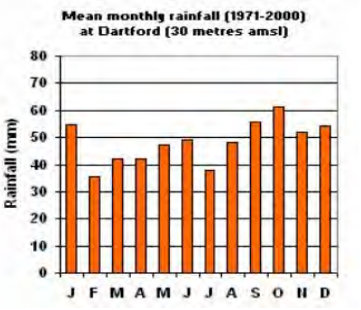


Fig. 16− Mean monthly rainfall(1971-2000) at Dartford (30 metres amsl) Source: Met Office

7.2 Impact of Rainfall On Bermondsey Square

Two methods used on this section to identify any changes on human interaction while its raining on Bermondsey Square.

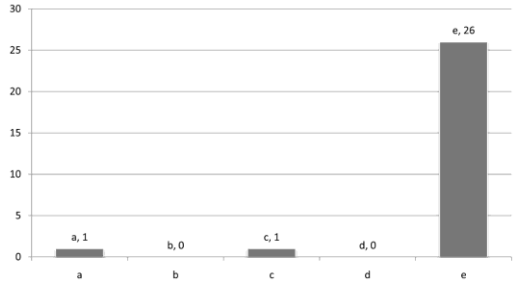
7.2.1 Methodology

Mapping pedestrian

Interview stall and shop owners on market days plus their customers.
Mapping taken on a rainy day on Bermondsey Square for duration of one hour and People's activities on Square have been recorded. Total samples taken 28 from which 22 male and 6 female.

Outdoor activities (figure 17)
Interacting
Sitting
Staying
Playing
Passing Through (on foot)

Comparing this map with the very first mapping shows substantial reduction of users on square, at the same study on sunny condition this number of users is far more than this, plus noticeable changes on route used by passer.



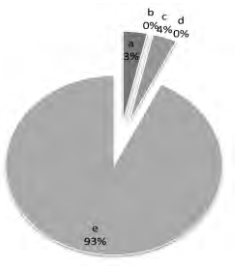


Fig 18 − Graph showing all types of outdoor activities on Bermondsey Square, Since there is no shelter on the Square so most people quickly crossed the Square

7.3 Analysis Of Mapping And Interviews

It could now be stated that Beromdsey Square function highly affected by rain, The main reasons on this matter are in one hand undesirable weather condition and on the other hand unprotected space against rain. The best example would be benches on the Square (figure 19 left image) which their presence with no shelter highly questionable. This condition also affecting Market, since the market take a place in uncovered outdoor space it is very difficult for stall owners to cope with different weather condition specially rain. Based on the interviews most of them are not happy with the condition and concerning substantial loss on number of their customers. Since stall holders using any available structure to erect their stall plus lack of shelters on benches, possible transformation on this condition would be providing shelters and protected spaces for both market days and other days of the week, this could happen in form of canopies or flat/sloped roofs. Providing shelters for benches would give two functions one protecting Benches and increasing their usability throughout the year (rain/shine) plus will turned into stalls when the market is around. It is much easier, faster, practical and efficient. Another matter to look at is, Bermondsey Buildings, It is somewhat disappointing that they didn't provide any shelters for pedestrian.(figure 19 Centre image) Since ground floor on Bermondsey Square given to the commercial, adding a meter or so over hanged shelter shouldn't be a problem plus it is an perfect advantages for restaurant and cafes to serve their customer outdoor.(figure 19 Right image) Needless to say that by protecting square from rain people could stay longer on the square and more interaction would happened.

Fig. 19– Left Image: No body use them during rainy days, even they are wet for hours after the rain. Centre Image: Current situation. Right Image: Added shelter, From earlier mapping it is understood that people walking close to these buildings when it is raining so locating shelters on this place would be perfect match with people's behavior. This might be very simple but effective.

8.1 Temperature

London temperate, with modest daily high temperatures during summer and winter lows that seldom fall below freezing(figure 20)

The temperature is obviously not uniform across the city, and there can be big differences in just a short distance. By building large cities in what once was a rural setting, we can disturb the weather and give the location its own Micro-climate. This is called an urban heat island.[7]

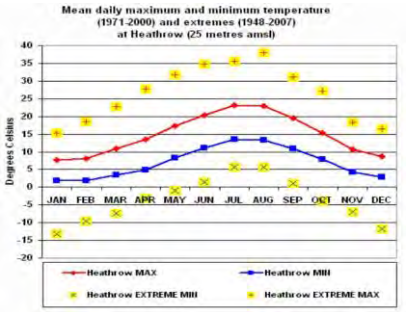


Fig. 20 – The variation of mean daily maximum and minimum temperatures month by month, together with the highest and lowest temperatures recorded, is shown for Heathrow, Temperature shows both a seasonal and a diurnal variation. January is the coldest month July is the warmest month Source: Met Office

[7] Givoni, B., 1998, s.168.

8.2 Temperature On Bermondsey Square

It is believed that the temperature which could have an impact on people's behavior is when it drops or increases extremely in a short period of time which this phenomenon happened very rarely, however on worst case scenario urban heat island could reduce or increase temperature by two or three degree which it is not noticeable and not so considerable on this study.

But to identify factors affecting temperate in a Micro-climatic scale on Bermondsey Square few studies carried out and resulted on following factors:

The dark surface of the building. (figure 21) The storage of solar energy Anthropogenic heat sources[8]. (e.g. transportation (figure 22) , heating and air conditioning, cooking and other industrial processes) Minor contributing factor, air pollution. This is because a heavily polluted atmosphere may act to produce a local greenhouse effect.

As a result of such a study in order to reduce these effects we have to looking at much larger scale and alteration has to be done on much larger area, moreover this phenomenon hasn't got immediate impact on human behavior however a list of effective strategies that can be implemented within the context of the existing urban structure and have impacts at the local and near local scale is provided here:

Cool roofs
Green roofs
Planting trees and vegetation
Cool pavements

Fig. 21 – The storage of solar energy during the day by building materials, particularly those with dark surfaces. This is release at night.

Fig. 22 – Traffic counts (turning) vehicular movement survey analysis. (By author) All the possible movements allowed in these junctions are shown here. It is worth noting that junction A presented the highest amount of traffic. According to the survey, 130 vehicles implement this movement on the junction during 10 minutes of mapping .It is now could stated that junction A would also has highest Noise level plus air pollution comparing to other junction.

9.1 Summarising of Finding and Conclusion

After a very extensive exploration on Solar access, Rainfall, Wind flow, Temperature, it is now revealed that how various weather condition could affect Bermondsey Square and therefore creating a unique Micro-climate on this particular place. Comparing the four parameters shows that the most affective parameters are Rainfall and Wind flow which both has an immediate impact on human behavior and therefore the way they interact with each other in Bermondsey Square likewise this is true on any other outdoor

[8] Birks, 1989, s. 73.

spaces around the world. Considering the argument, it could now be stated that the best and most effective transformation for Bermondsey Square is to combining proposed transformation on each two parameters. This then means to providing trees on south side of the Square plus providing shelters.

- Benefits of planting trees would be:
- Trees cool air and provide shade
- Natural Windbreaker
- Shelter when it is drizzling

Rationalising benches on Bermondsey Square by sheltering and relocating them again could led to increase square usability plus being permanent structure for Stalls on Market days, in addition to this, with a conscious design we could also help to breaking down the wind velocity by dispersing them. As it was presented before this could implemented in a form of one or few tensile canopies, however in order to dispersing wind the structure have to be aerodynamically stable and flexible yet watertight and translucent to allow light penetrate inside.

In addition on these transformations there is also an urge to establishing a good quality market on Bermondsey Square and giving back the true historical and cultural identity to the space.

It is believed that by having a good quality Market would attract more people from close and far neighborhood and would boost up the activities on space.

Hereby few improvements provided to increase usability of Square:

- Re-launch and re-brand the Market
- Upgrade the stalls used by traders
- Improve promotion of the Market to attract more customers
- Recruit more traders
- Establish other Markets on the square (7 days a week)

It is expected that after intervention, Users on Bermondsey Square would increase, and will stay longer in the space; therefore more and more activities would occur in the Square which it most definitely led to dramatic improvement on human social life and their interaction. The study also shows us that architectures' potential to affect us socially and emotionally is great and has yet to be fully realised. High quality design can greatly improve the environmental performance of urban buildings and outdoor spaces, However the critical question in here, is, how we could create high quality spaces, is it just considering worst climate conditions enough!? What about Cultural and Historical significance!? or political issues or most importantly financial and economical feasibility. These are questions to be answered by developers even before planning stages to make sure that their future architecture would gather people around in one comfortable place and providing a platform to emerge social interaction.

At the end, despite all the problems, and their significant it is worth to mentioning that it is fine to be protected from the worst climatic, but it is also desirable to have the opportunity to experience good and bad weather, to feel seasonal changes. In any case it is nice to experience the pleasant weather when it is provided by architecture and this is the minimum achievement towards increasing quality of life.

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PROF. DR. SEMRA ATABAY

CURRICULUM VITAE

Prof. Atabay graduated from Stuttgart University in 1968 as an Dipl. ing. Architect. She worked first at the Ministry of Planning and Construction in Ankara. Subsequently she started her academic career at the Faculty of Architecture of Yıldız Technical University in 1970. Since then she has been lecturering at the Urban and Regional Planning Department of YTU. She had been a visiting lecturer at Stuttgart, Hannover, Kassel and Berlin Technical Universities. She was the Dean of Akdeniz University, Faculty of Tourism Management between the years 1996-1997. She also held the position of the Head of City and Regional Planning Department of Yıldız Technical University between 1997-2001. Prof. Atabay directed post-graduate programmes in Landscape Planning since 1988. She has many publications in the fields of Urban, Regional and Landscape Planning and Architecture. She received many Academic Achievement awards since 1990 and she was also given a Gratitude Plaque by the Rector of the Yıldız Technical University in 2002 for her academic contributions to Environmental Science.

Currently she is lecturing on diverse subjects ranging from Landscape Planning to Environmental Impact Analysis and Threshold Analysis Methods. Furthermore, she continues to supervise post-graduate dissertations and doctoral theses.

She organized many international symposia on environmental planning in cooperation with Istanbul Goethe Institute, Yıldız Technical, İstanbul Technical and Istanbul Universities. She was also the editor of many symposium books.

BOOKS

- Environment Friendly Planning Instruments and Policies – 1992
- The Re-cultivation of the Old Raw Material Quarries – 1993
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