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Támop-Humboldt Colleg for Environment and Climate Protection

2009. December 3rd
&
2010. October 21st

in Sopron
University of West Hungary

Unterstützt von / Supported by

Alexander von Humboldt
Stiftung/Foundation

NIH
Nemzeti Innovációs Hivatal

Befektetés a jövőbe
Új Magyarország
FEJLESZTÉSI TERV

Michael Palocz-Andresen

&

Róbert Németh

&

Dóra Szalay

editors

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Befektetés a jövőbe

Új Magyarország FEJLESZTÉSI TERV

This book will be used in the education of environment and climate protection at the University of West Hungary

A Nyugat-magyarországi Egyetem ezt a könyvet felhasználja a környezet- és klímavédelmi oktatásban

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Prof. Dr. Hartmut Grassl	Max-Planck Institut für Meteorologie Hamburg
Dr. Franz-Josef Kirschfink	Lufthansa Technik AG Hamburg
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Foreword

Dear readers,

The first five chapters of the book deal with specific lessons of the Támop - Humboldt Colleg on the 21st October 2010. The last chapter contains several preparation lessons for the common Hungarian-German education and research at the field of environmental and climate protection reported in the last years.

The individual lessons are divided into six selected groups:

Section 1: Reason and Impacts of the Climate Change
Section 2: Landscape and Environment
Section 3: Environment, Climate and Energy
Section 4: Technology and the Future
Section 5: Red Sludge Catastrophy in Hungary
Section 6: Topics for Environment and Climate Protection

Especially thanks belong to the leaders of the sections.

Section 1

Dr. Hartmut Graβl, professor of the University of Hamburg, former director of the Max-Planck Institute of Meteorology Hamburg and honoris causa of the University of West Hungary chaired the Section 1 with the topic “Reason and Impacts of the Climate Change”.

Section 1
Section chair: Prof. Dr. Hartmut Graßl

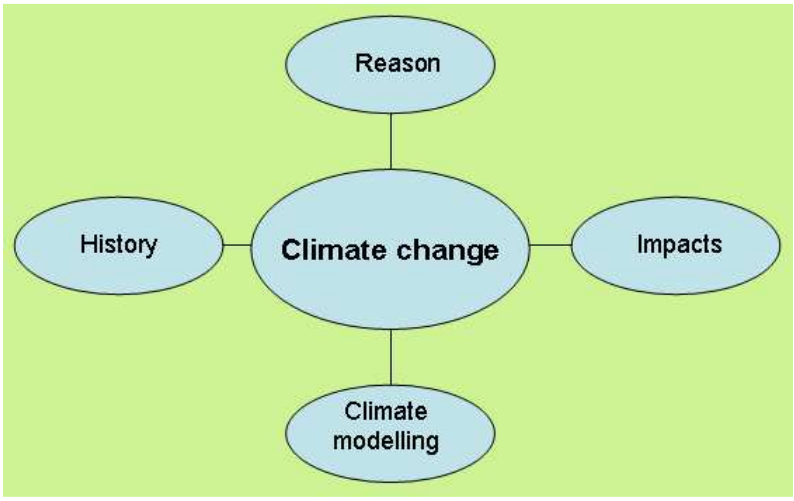

Figure 1: Topics of the Section 1

Section 2

Dr. Uwe A. Schneider is associated professor of the Climate Campus of the University Hamburg and is leader of the Workgroup for Research Unit Sustainability and Global Change, Department of Geosciences, Centre for Marine and Atmospheric Sciences. His special field is research of the land use and the adaptation sciences. He chaired the Section 2 with the topic "Land use and Ecology".

Section 2
Section chair: Dr. Uwe A. Schneider

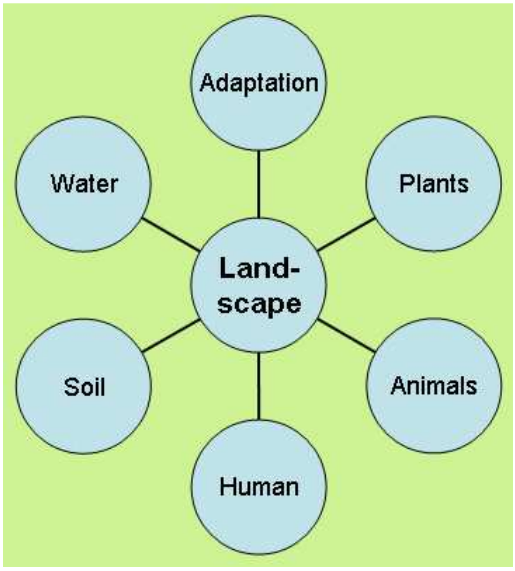

Figure 2: Topics of the Section 2

Section 3

The Section 3 was chaired by Dr. Stefan Bringezu, head of department of Material Flows and Resource Management of the Wuppertal Institute. The section applied questions of "The Problems and Perspectives of integrated management of Environment, Energy and Climate".

Section 3
Section chair: Dr. Stefan Bringezu

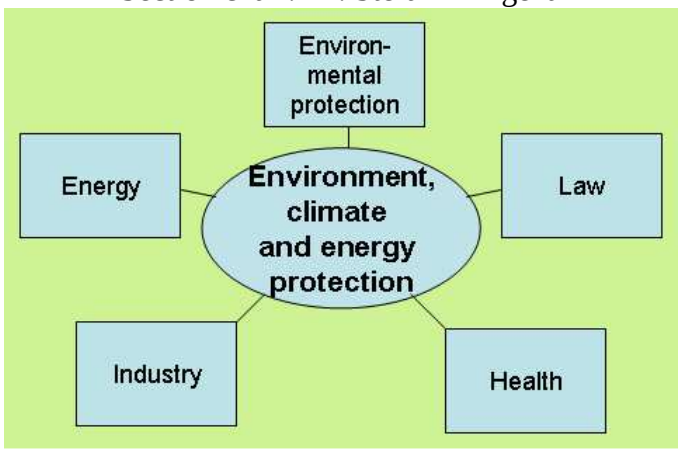

Figure 3: Topics of the Section 3

Section 4

The Section 4 with the topic "Biomass Production, Fuel Consumption, Engineering and Building Technology" was chaired by Dr. Franz-Josef Kirschfink, leader of Department of Lufthansa Technik joint stock-company in Hamburg.

Section 4
Section chair: Dr. Franz-Josef Kirschfink

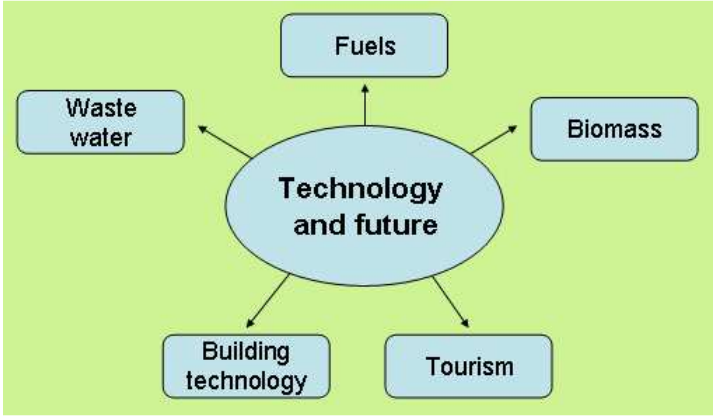

Figure 4: Topics of the Section 4

The Section 5 led by Dr. Michael Palocz-Andresen, professor of the University of West Hungary presents reports about "The Connection of Red Sludge Catastrophe and Climate Change" in Hungary.

Section 5
Section chair: Dr. Michael Palocz-Andresen

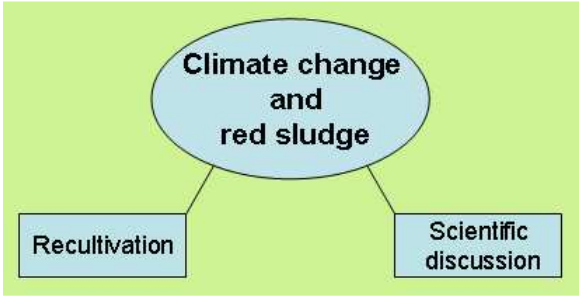

Figure 5: Topics of the Section 5

Section 6

Aim of the Section 6 directed by Dr. Manfred Fischedick, professor of the University Wuppertal and deputy director of the Wuppertal Institute for Climate, Environment and Energy Protection is "The Searching and Analysing of Common Research and Teaching Activities" at the field of environmental and climate protection.

The last chapter summarizes the reports for a common environmental and climate protection activity in the last two years, protected by the Hungarian National Innovation Office NIH. There is no section for these lessons.

Section 6
Section chair: Prof. Dr. Manfred Fischedick

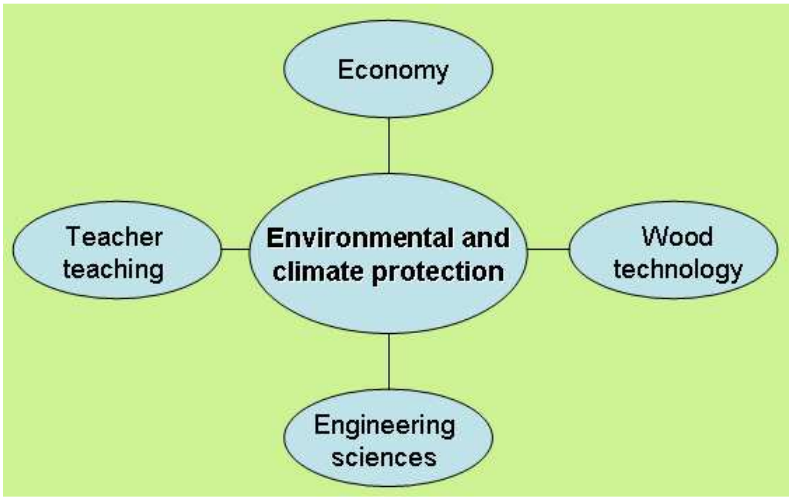

Figure 6: Topics of the Last Section

The colleg 2010 was supported by the Alexander von Humboldt Foundation Bonn. The Faculty of Forestry of the University of West Hungary also contributed to the success of the conference by the project TÁMOP. The common activity conducted to the possibility, to organize the meeting with nearby 200 participants.

Prof. Dr. Michael Palocz-Andresen
Organizer of the Humboldt-Kolleg
and the planned Common Climate Research Centre

Welcoming Speech
of the Dean of the Faculty of Forestry of the University West Hungary

Dear Mr Mayor,
Dear Employees in the TÁMOP project,
Dear Mr President Kengyel of the Humboldt Society Hungary
Dear Ladies and Gentlemen!

I am specially honoured to introduce this book with a welcoming speech as a collection of many lectures which have resulted at the University of West Hungary within the last few years.

I am particularly pleased that four German scientists have taken the management of the individual Sections. With their work the success of the lecture stands or falls.

What can the University of West Hungary contribute to the success of the lecture? The university has 10 faculties with approx. 3600 employees. It offers a high-quality research and teaching for almost 16 000 students. Containing the branches

- Forest sciences
- Wood sciences
- Economic sciences
- Art and the sport sciences
- Nature sciences
- Farming and food sciences as well as
- Teaching education beginning with bringing up little children, the basic and secondary school teacher-training up to the university teaching.

The University of West Hungary is located at the western border of the Republic of Hungary. Therefore we work naturally together in teaching and in researching several topics with scientists living in the German-speaking region west of Hungary. The cooperation brings advantages for both sides.

We can bring in an extraordinary value in the common work. The processes of the environmental and climate change happen considerably faster in the Carpathians basin than in western or northern regions of the Alps. One can look so into "a green time watch" and study events which will appear in Germany and in Western Europe within 20 or 30 years.

A second quite important advantage is our function as a bridgehead. If we think only on the coming Hungarian advice presidency, it should be clear that Hungary can form an important connecting role to the south-eastern European regions. The states situated in this region partly strive for joining the EU, the reception in the Schengen agreement and joining the euro zone. Who could represent the interests of these countries better than Hungary whose people historically and geographically are closely connected to these regions?

The conference can play an important role in this process. It reviews the concrete application cases for the climate and environmental protection, the adaptation of the landscape to the challenges permanently growing by the climate change, the rise of the efficiency from technological processes and the role of the technological progress for the reduction of the greenhouse gas emissions in these regions. She defines also tasks and aims and makes suggestions for common solution trials.

I would like to thank the Alexander of Humboldt foundation and therefore the German government for the support of the reports.

Furthermore I owe the Hungarian project sponsor TÁMOP.

This conference proves the close relationship of the two countries and the two nations.

So I wish the participants a valuable scientific work and much fun and joy for the readers lecture.

Good luck!

Prof. Dr. András Náhlik
Dean
TÁMOP project manager
nahlik@emk.nyme.hu

Welcoming Speech
of the President of the Humboldt Society Hungary

Dear Ladies and Gentlemen,
Dear Humboldt Fellows,
Dear Scientists!

Let me to welcome all participants at the event quite cordially. It is a great honor for me that I can take part in this international meeting of high rank and that I can give you some welcoming words on behalf of the Humboldt organization in Hungary. I am very pleased that this interdisciplinary conference on the protection of the environment and the climate in Sopron takes place at the University of West Hungary.

We, former Humboldt scholars could already learn a long time ago that Humboldtscientists are not only researchers who spent one or two years in Germany at a university or a research institute, it is a state for the whole life. “Once a Humboldtscientists – always a Humboldtscientists” was from the beginning the trademark of the Alexander von Humboldt foundation. The foundation does not settle to make single research stays in Germany possible for foreign scientists. Their support is sustainable: as a lifelong partner it holds the connection with its alumni promotional programs in a long run upright.

You will soon get a detailed information lecture on the promotional program therefore this speech now only covers the so-called Humboldt lectures.

A quotation from the 2008 annual report of the foundation: "The Humboldt foundation supports financially the Humboldt-society as well as single Humboldtscientists at the event of regional and specialist conferences. These Humboldt-lectures are one of the most popular instruments to be fortifying around the regional and technical networks.

The responsibility regarding the content lies with the respective organizers. The frame topic shall be interdisciplinary. “Besides taking care of the network the Humboldt lecture aims to wake up the interest of the scientific talent for the programs of the Humboldt foundation and at the research location in Germany."

The Humboldt foundation supports about fifty events for Humboldt-lectures all over the World annually. After the annual report of 2007 three specialist conferences were held in Hungary:

- June 2007, Andrássy University of Budapest: "The influence of the European civil proceedings on the national systems of laws"
- September 2007, University of Szeged: "Beautiful but incomprehensible? Georg Trakl and the literary modern age"
- October 2007, Hungarian Academy of Sciences: "Militia et litterae, international Zrinyi conference"
- September 2009, University of Debrecen: "Where goes historical language science?"

I am therefore very pleased that the laudable tradition of the Hungarian scientific conferences does not stop and the row of meetings will be continued with the support of the Humboldt foundation in 2010.

In this year Hungary organizes two meetings.

- today in Sopron and

at the end of November in Szeged under the title

- "Freedom - Security – (criminal) Law ".

I may talk about 2011 last. The Humboldt organization in Hungary plans a regional meeting with the support of the Embassy of the Federal Republic of Germany. We inform soon all Humboldtians about the time and the program.

As a closing remark:

Many thanks to everyone who has played a part in the organization of this meeting. Quite special gratitude is for Prof. Dr. Michael Palócz-Andresen. In the name of the Hungarian Humboldt family which consists at the moment of three hundred Humboldtians.

I wish you a very successful meeting and a nice time here in Sopron.

Prof. Dr. Miklós Kengyel
President of Humboldt Society Hungary
kengyel@ajk.pte.hu

Welcoming speech of Dr. Andor Nagy vice-chairman of the Parliamentary Committee on Sustainable Development

It is my great pleasure to welcome you to this book and share with you some of my thoughts about the importance of the here presented works. Environment and climate protection are key tasks if we want to preserve our ecosystem intact for future generations.

In the quest for liveable conditions on our planet, Hungary seems to be a rather small country, maybe even too small to matter. Nevertheless, due to geographic conditions as well as scientific relations, we are a great source of innovative new directions and ideas. Especially through bilateral and international co-operations we have our impact in shaping environmental protection. We use our position to be the often mentioned bridge of the region.

My expertise as a member of the Hungarian National Assembly lies in environmental policy and sustainable development. In my function a vice-chairman of the Parliamentary Committee on Sustainable Development I deal with the issues presented in this volume on a day-to-day political basis. It was formerly known as the Committee on Environmental Protection and I believe the name change is more than verbal transformation: it means the necessity to think ahead, to do more than just the preservation of the present environmental conditions. Thinking ahead and combining expertise in transnational seminars and workshops is also what made the following compilation possible.

Worldwide we are facing natural, but also man-made environmental disasters. Hungarians do not have to think as far as Fukushima to know the impact of ecological catastrophes. The unfortunate red mud disaster of October 2010 raised many political questions along the technical difficulties it posed to the region's ecosystem. We all live in a delicate balance with our environment; therefore changes, let alone disasters, have significant economical and societal impacts. As politicians and responsible citizens we all have to be cautious and alert. Keeping the example of the red mud as my illustration, I can show how information leads to action. We were able to mobilize experts soon after the event and drew various important conclusions that were important in innovative restructuring programs. Politically such events are wake-up calls as well as catalysts to find partners for already present political projects to protect the environment and promote sustainable development.

The success of this course of lectures depends on our willingness to be creative and co-operative. Environmental protection and sustainable development is a process that begins in our minds. This College unites researchers from Hungary and Germany drawing up possible ways, new technologies and frameworks how we can achieve common objectives. For politics these are more than welcome sources for policy inspirations.

As a last point let me give you a little thought provoking impulse which is often overlooked but an ever-present premise in the following articles: environmental fairness. It is hardly a principle we can presuppose, but we have to make it one of our guiding motifs if we want to reach a sustainable environmental development.

Let me congratulate the contributors to this book for their excellent work. We need ready and up-to-date research and knowledge which supports all actors in their commitment to environmental and climate protection. The Támop-Humboldt College is coming up with solution models and assembling an insightful bouquet of articles that will help us form a better picture of risks and chances of current environmental and climate issues.

Section 1
Reason and Impacts of the Climate Change

Natural and Anthropogenic Climate Change

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Keywords: climate change, anthropogenic, 2℃ goal, sea leve l rise

ABSTRACT

Climate was always changing naturally and is now changing rapidly due to mankind's global activities. The key element cycle, the carbon cycle, is strongly disturbed by emissions of carbon dioxide and methane, having already led to a mean global warming of about 0.8°C since 1900, a stronger warming in parts offset by rising air turbidity. This warming leads to changed precipitation patterns cloudiness etc. Depending on mankind's behaviour a further warming (unprecedented at least over the last million years) is projected by climate models for this century unless a stringent climate protection policy is implemented, trying to reach the goal of a mean warming at the surface of below 2°C, as set by nearly all parties of the United Nations Framework Convention on Climate Change.

INTRODUCTION

Global climate change must occur all the time because external and internal influencing factors change with strongly differing time scales of decades to million years. The following list names the most important natural climate change factors for the recent millions of years with a rough implicit ranking:

- Changes of the Earth's orbit around the Sun caused by neighbouring planets
- Variability and/or change of solar irradiance at the top of the atmosphere
- Changed atmospheric chemical composition both with respect to gases and particles
- Drift of continents caused by convection in the Earth's interior
- Impact of large celestial bodies

All these influencing factors have continuously caused global climate change in the recent few hundred million years, but the globally averaged mean annual temperatures was according to palaeo-climatic reconstructions never more than about 6°C lower or higher in comparison to the present interglacial, called the Holocene.

When major industrialization began with the growing use of coal around 1750 also humankind became an important factor for global climate change. The accumulated effect of land use changes since the beginning of industrialization has reached a radiative forcing[1] of about -0.2 ± 0.2 W/m², hence is not negligible but its absolute value is by more than a factor of 10 less than the combined radiative forcing of all anthropogenic greenhouse gases, which amounted already to $+3 \pm 0.5$ W/m² in 2005 (IPCC, 2007) and is still increasing nearly

unabated. A bit more than half of it is due to the carbon dioxide increase from 280 to 385 part per million by volume (ppmv) since 1750, but also methane, tropospheric ozone, nitrous oxide and stratospheric water vapour are non-negligible contributors. As IPCC has put it: The understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to very high confidence that the global average net effect of human activities since 1750 has been one of warming with a radiative forcing of +1.6 [+0.6 to +2.4] W/m².

[1]Radiative forcing is a measure of the influence that a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism. Positive forcing tends to warm the surface while negative forcing tends to cool it.

MAJOR NATURAL CLIMATE CHANGE IN THE RECENT PAST

It took a long time until the major cause for glacials and interglacials has been understood in principle. As shown in Figure 1 for two parameters in the atmosphere over the Antarctic, namely carbon dioxide concentration and temperature at precipitation formation over the Antarctic, there is a very high correlation over eight glacial/interglacial cycles between these two parameters. Whenever a glacial occurred the carbon dioxide concentration decreased to very low values of about 190 ppmv and went up more rapidly to values of about 280 ppmv in the interglacials, as in the Holocene, our present geological period. The different processes leading to a reduced or enhanced carbon dioxide content in the atmosphere when it becomes colder or warmer are not yet fully understood, but there is agreement that the Earth orbit changes are the pace-makers of the quasi-periodic sequence of glacial and interglacials.

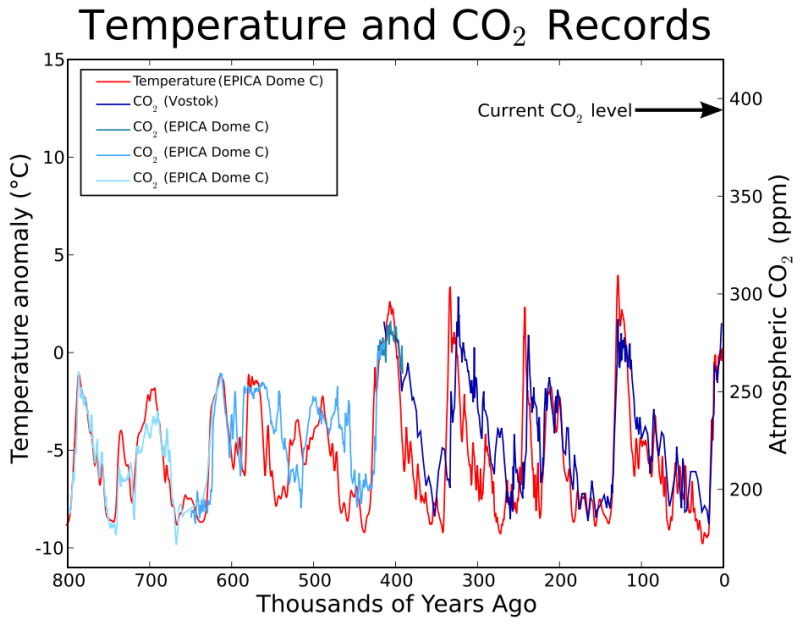

Figure 1: Temperature anomaly at snow formation and carbon dioxide concentration during the last 800 000 years as derived from air bubbles in Antarctic ice and from the ice core itself. Data Sources: (red) EPICA Dome C temperature data: doi:10.1594/pangaea.683655; (dark blue) Vostok CO2 data: doi:10.1594/panaea.55501; (steel blue) EPICA Dome C temperature data: doi:10.1594/pangaea.472482;(pale blue) EPICA Dome C CO2 data: doi:10.1594/pangaea.472481

ANTHROPOGENIC CLIMATE CHANGE

There are many anthropogenic factors influencing global climate. Some stimulate, because of the negative radiative forcing, a cooling and several with positive radiative forcing a warming of the lower atmosphere and the surface. The negative forcing factors are dominated by aerosol particles in the lower atmosphere (the troposphere), i.e. tiny particle suspended in air with a diameter mostly below a micrometer. These indirect aerosol effects are far from being fully understood. Therefore, they have a strong impact on the uncertainty of climate system sensitivity to the combined action of all the negative and positive radiative forcings.

The positive forcing factors are dominated by the concentration increases of all naturally occurring long-lived greenhouse gases (carbon dioxide, methane, nitrous oxide; if ranked according to their radiative forcing) and new long-lived anthropogenic ones like chloro-fluoro-carbons (CFCs) and other halocarbons. But also the short-lived greenhouse gas ozone, the third in the ranking of natural greenhouse gases of the atmosphere, has increased strongly in the troposphere and its contribution to radiative forcing is at present more important than the one by nitrous oxide. As IPCC (2007) has stated: the understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to very high confidence that the global average net effect of human activities since 1750 has been one of warming with a radiative forcing of +1.6 [+0.6 to +2.4] W/m².

HAS SOLAR RADIATION INCREASED IN RECENT DECADES?

The energy from the Sun is the fundamental input for circulation in atmosphere and ocean on our planet and thus for nearly all life. Since 1979 we do have a continuous record of the output of the Sun from different earth orbiting satellites. The two major findings of these observations are: The 11-year cycle has on average an amplitude slightly below 0.1 percent and there was no significant trend in the recent three minima of the cycles (Figure 2). The major global warming at the Earth's surface occurring during this period must have had other causes than solar irradiance change.

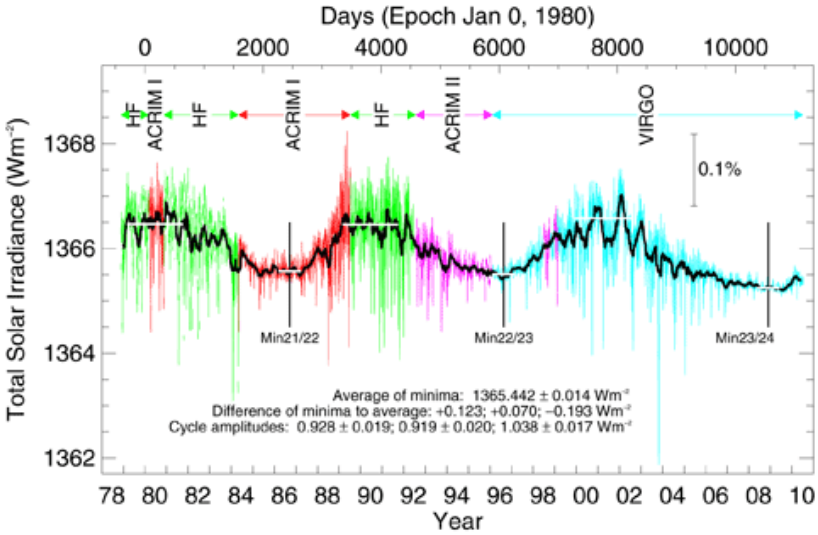

Figure 2: Daily total solar irradiance of the PMOD composite (updated until end of March 2010, Version 41 62 1003a). The amplitudes of the three cycles decrease first and then increase again. The two horizontal lines indicate the value of the minima in 1986 and 2008, respectively. Note the low value of the 2008/9 minimum, which is 0.22W/m2 lower than the previous one, or 25% in terms of the mean cycle amplitude. Source: Fröhlich (2010)

HOW STRONG IS THE DISTURBANCE OF THE CARBON CYCLE?

The carbon cycle is key for life. Many billion tons of carbon are exchanged every year between the different reservoirs, mainly between the atmosphere, the ocean and the terrestrial biosphere to sustain life. The yearly net carbon flux at the Earth's surface was close to be balanced between input and output as long as fossil fuels, reservoirs in the Earth's crust with high carbon content, were not used by mankind. At present the global carbon budget is disturbed by rapid burning of fossil fuels (acceleration by a factor of about one million compared to the formation rate of fossil fuels), destruction of vegetation and unsustainable agriculture. As figure 3 clearly demonstrates the main reason for concern is the continuous accumulation of 3.2 billion tons (Gigatons) of carbon per year in the atmosphere (to be multiplied by 3.67 to get the mass of carbon dioxide).

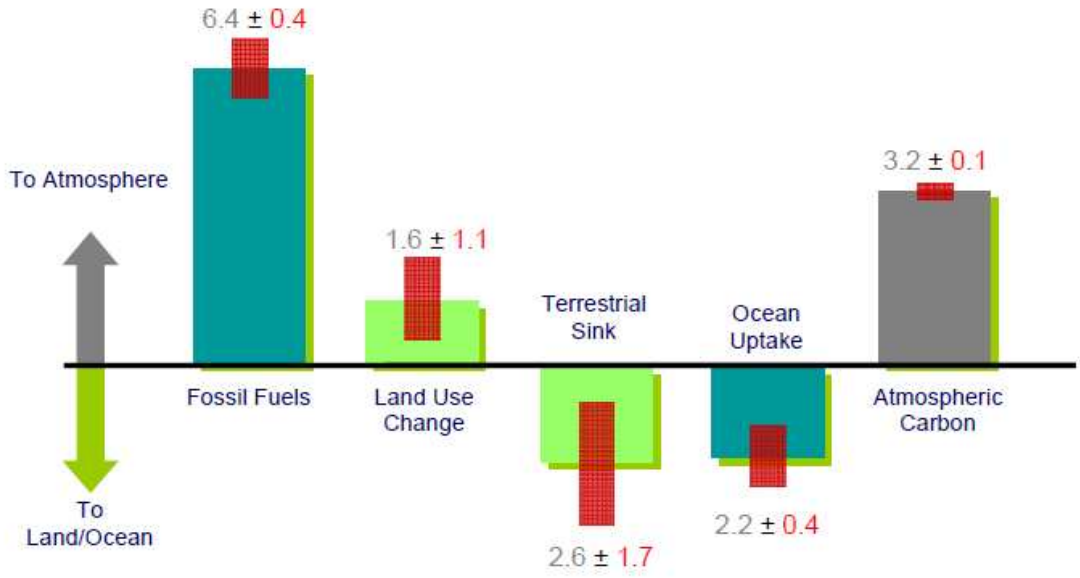

Figure 3: Global Carbon budget with the main fluxes into the atmosphere and out of the atmosphere in Gigatons of carbon per year. The fluxes caused by changes in the biosphere are in green. Uncertainties are given by the red error bars; redrawn after IPCC (2007).

THE RESULTING CHANGED PLANETARY ENERGY BUDGET

Absorbed solar radiation must be equal to emitted heat radiation in a multi-year average for a planet without major internal heat sources, because otherwise a continuous warming or cooling of the entire planet would take place. The greenhouse gases act like a thick blanket keeping the warmth at the Earth's surface. In the present situation with a growing greenhouse effect this also leads to a continuous net heat flux into the ocean by 0.9 W/m², which warms the ocean interior.

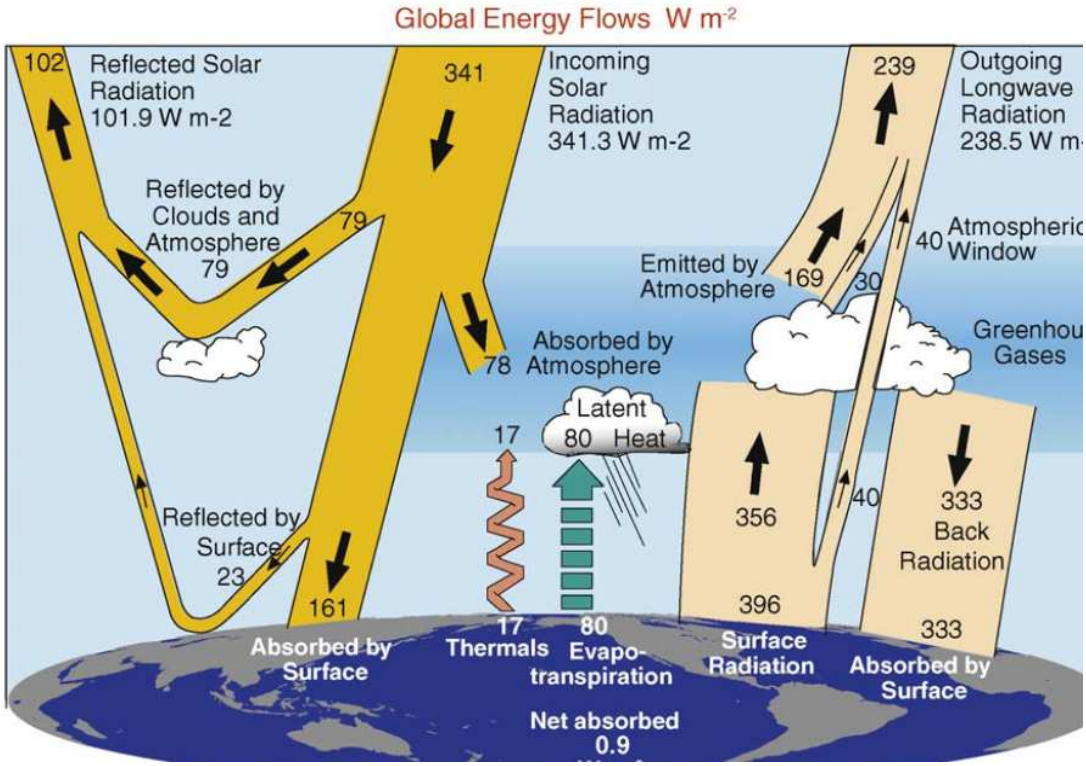

Figure 4: The global annual mean Earth's energy budget for the Mar 2000 toMay 2004 period (W/m²). The broad arrows indicate the schematic flow of energy in proportion to their importance; Source: Trenberth et al.(2009)

OBSERVED CLIMATE CHANGE

The full theory of anthropogenic climate change was already discussed by Callendar (1938, 1939). His claim was refuted by the scientific colleagues and only in the 1950s did the debate start again. Present knowledge is well represented in the long measured time series of Figure 5 (IPCC, 2007), which combines changes of global mean temperature, sea level and northern hemisphere snow cover in early spring. Are the trends already mainly human induced? A partial answer for temperature is: "Palaeo-climatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1,300 years. The last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6 m of sea level rise." IPCC (2007).

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

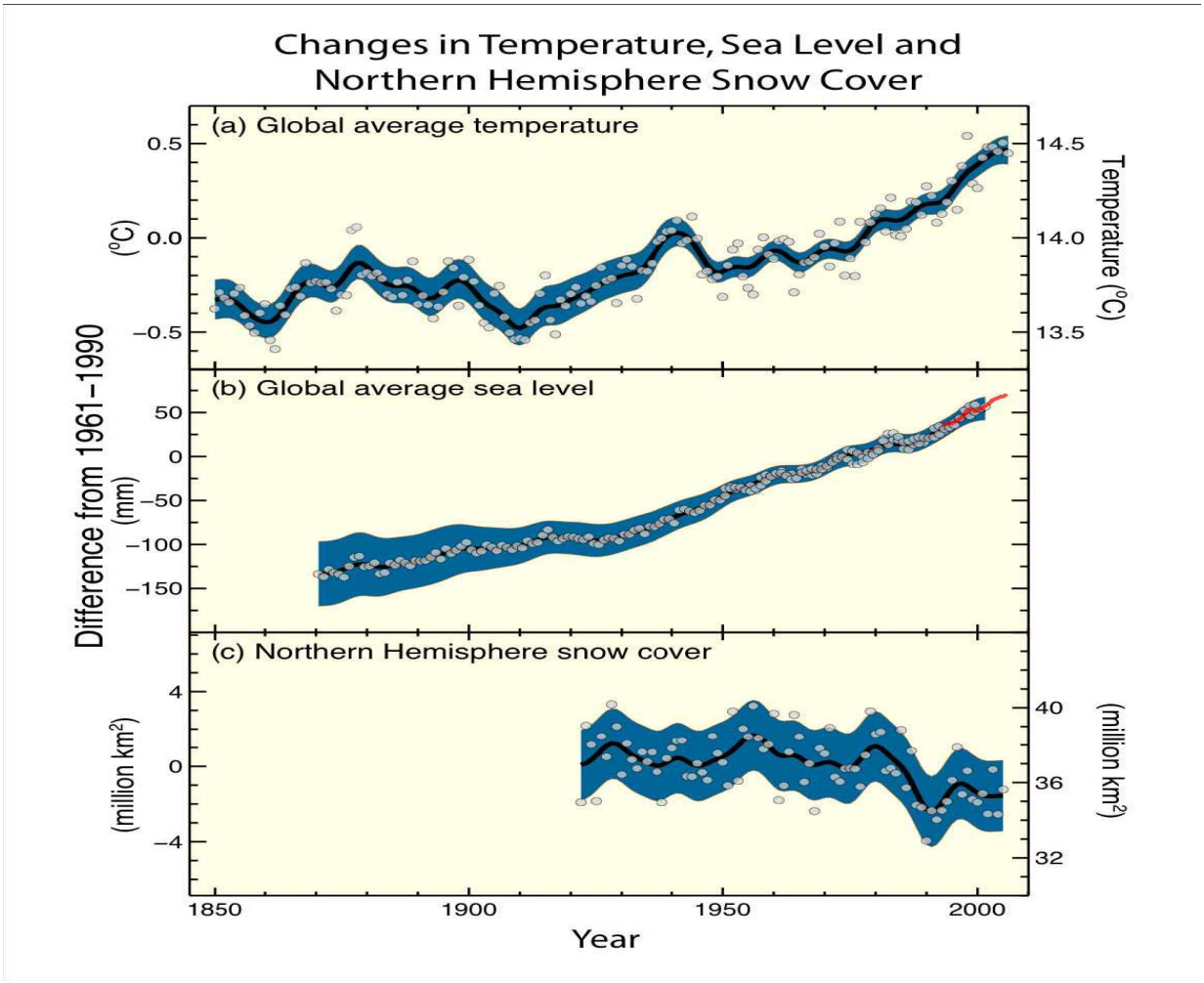

Figure 5: Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c).

PROJECTIONS OF CLIMATE CHANGE IN THE 21ST CENTURY

All major research centres participated in the global coupled climate model calculations using scenarios of greenhouse gas and sulphur dioxide emissions, originating from the IPCC scenarios that were developed under the assumption of a world without stringent climate change policies. Therefore, we have ensemble projections of mean global warming in the 21st century including standard deviations among the climate models for several of the scenarios published by IPCC in 2000. Figure 6 from IPCC (2007) has the following main message: Mean global warming will be unprecedented in the 21st century if no stringent climate policy in global co-ordination will be decided.

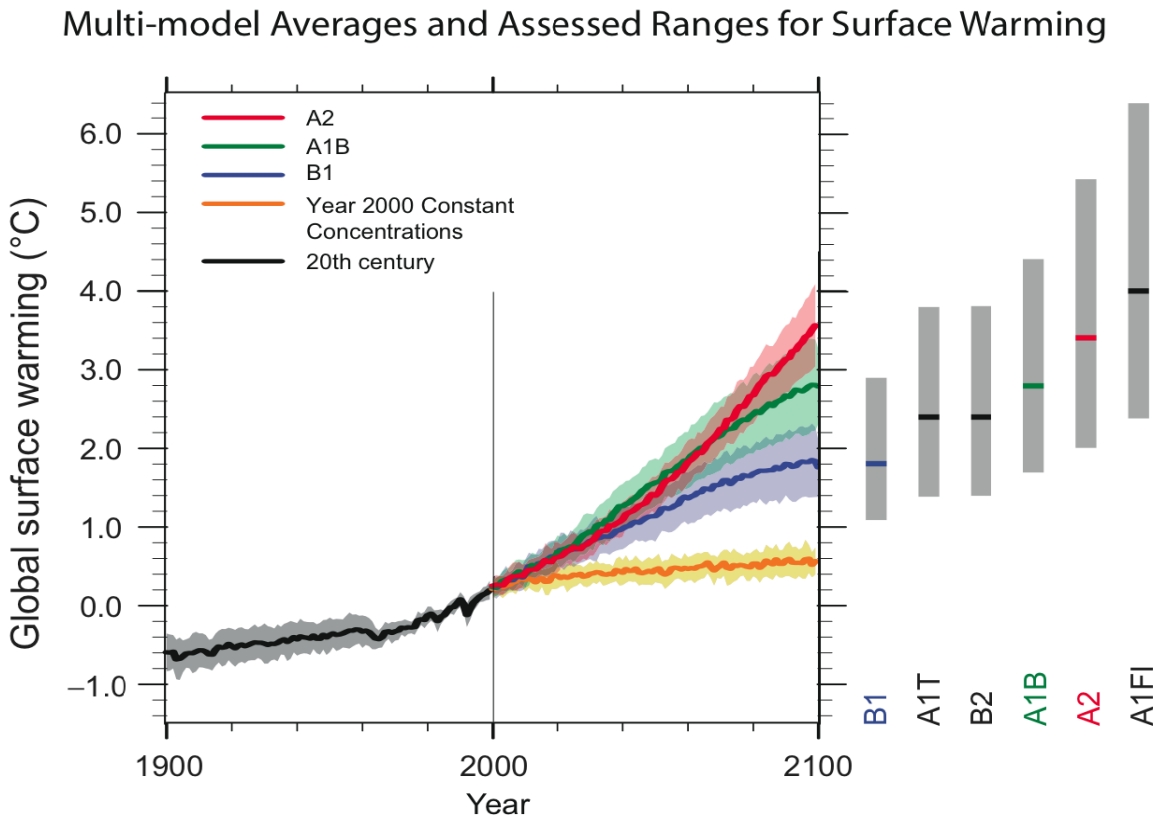

Figure 6: Multi-model averages and assessed ranges for surface warming for different scenarios of human behaviour and a hypothetical emission stabilization in the year 2000 (orange line.)Source: IPCC (2007). For scenarios see IPCC (2000)

Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios. The assessment of the best estimate and likely ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints.

For most people the changes of precipitation accompanying the warming shown in Figure 6 is more or at least as important as a temperature change. The projected regionalized precipitation changes in Figure 7 give - despite the large uncertainties still present for precipitation estimates in climate models - a clear message: people in semi-arid climates already suffering from water scarcity will often get less and those with already enough water in high latitudes and parts of the inner tropics can expect more. Because most developing countries in the semi-arid areas have not caused the larger part of the enhanced greenhouse effect, this figure points to a growing injustice as a consequence of anthropogenic climate change.

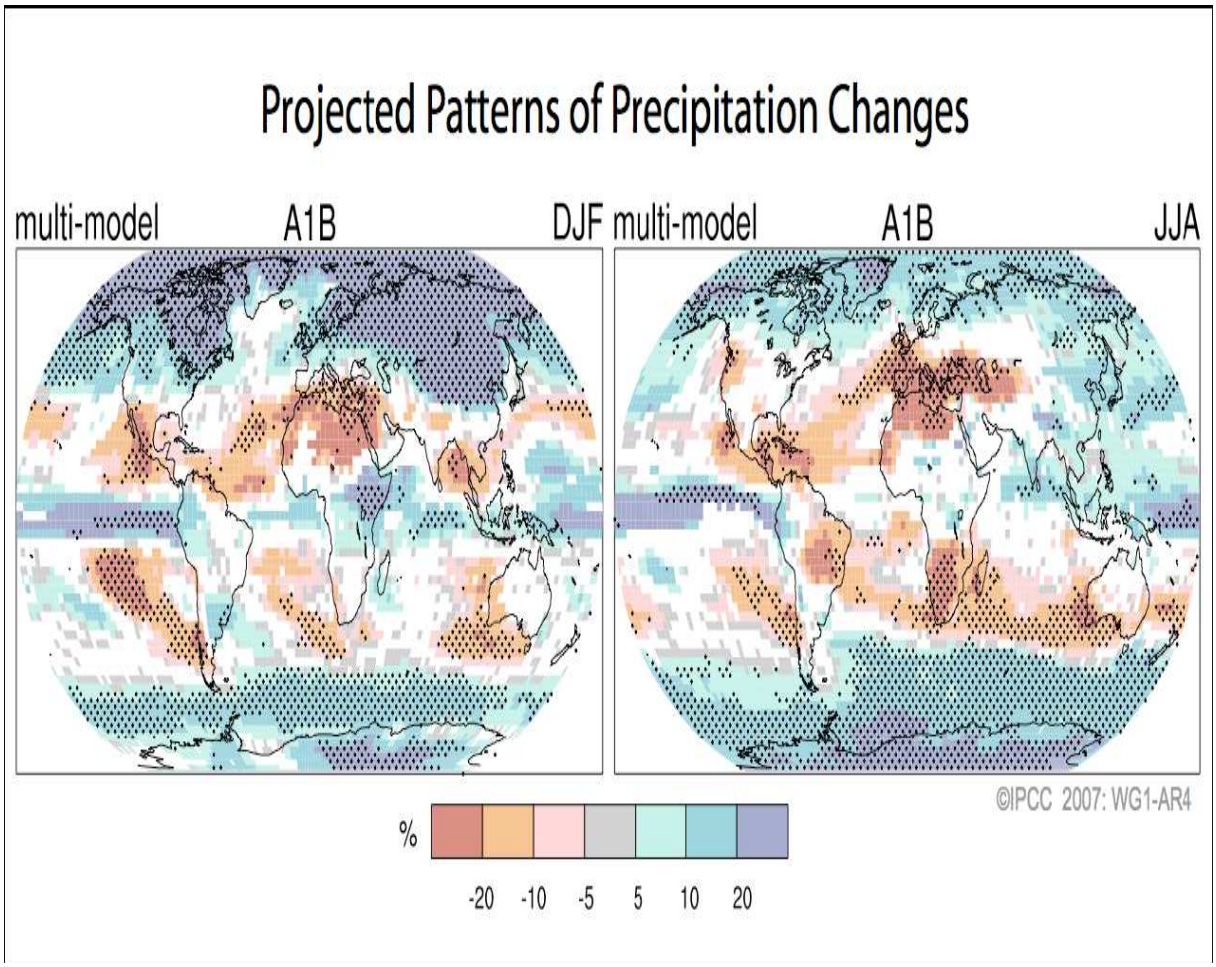

Figure7: Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are show where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change

GREENHOUSE GAS EMISSIONS ALLOWED UNDER THE 2°C GOAL

Many decision makers may not know how demanding the 2°C goal is, because it is not less than the comparably fast end of the use of fossil fuels, long before these are exhausted. The challenge has been shown in several publications within the recent decade (e.g. WBGU (2003) and Meinshausen et al. (2009). The main message of the Figure 9 is: The probability to surmount the 2°C goal even under the remaining total sum of a worldwide emission of 1000 Gt CO_2 is still 25 percent.

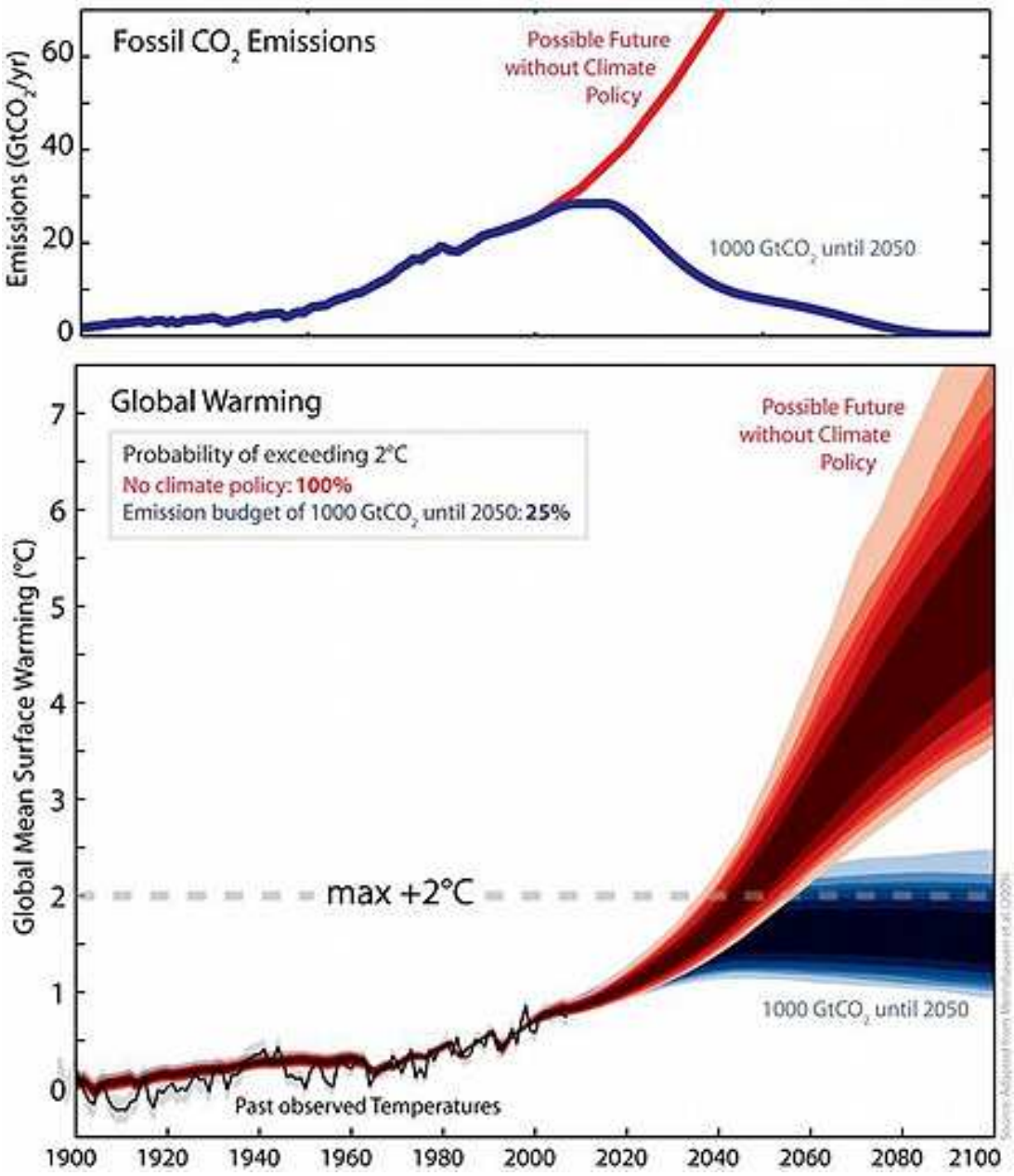

Figure 8: Observed and projected global mean near surface air temperature from 1900 to 2100, (lower part) and accompanying global carbon dioxide emissions in Gt CO□. The projections for the fossil fuel intensive scenario (A1FI in IPCC (2000))and the 2°C scenario contain uncertainties originating from the incomplete knowledge of climate system sensitivity; taken from Meinshausen et al. (2009).

WHICH RENEWABLE ENERGY SOURCES?

The 2°C goal forces humankind to become a solar society again soon, deriving its energy to a very large extent from renewable energy resources, originating all, except deep geothermal heat, from the Sun. Which ones will these be? As Table 1 shows, mainly direct solar radiation and wind, because the others do not have the technical potential needed for a supply without disturbing the environment. In some countries also hydropower could remain or become a major or a considerable renewable energy source, however, far below the potential of wind energy and orders of magnitude below incoming solar radiation.

Table 1: Technical potentials of renewable energy sources and present energy flux density on global scale and in Germany

Energy source	Global mean	Germany	Type of energy offer
Sun	~ 165	~ 110	strongly varying, daytime only
Wind	~ 3	~ 3	variable, day and night
Biomass	~ 0.1	< 0.3 Fertilized maize <0.5 Sugar cane	manageable, but low energy flux density, competition with food production
Deep Geothermal Energy	~ 0.1	~ 0.08	continuous, risky exploration
Tides	<< 0.1		regularly alternating, only few coastal areas
Ocean waves	< 0.1		variable, nearly as wind, but less
Energy flux density today	< 0.03	~ 1.5	
Energy flux density in 2050	< 0,06	< 1.5	

FINAL REMARKS

Anthropogenic climate change in the 21st century is maybe the most demanding challenge we face. Only a globally co-ordinated action, i.e. a binding protocol to the UNFCCC, will change the boundaries for development of all countries in such a way that climate change mitigation policy can reverse the presently still growing greenhouse gas emission trend. At the same time adaptation to the unavoidable climate change has to become a major policy arena in all countries as well, thereby accounting in both cases for the differentiated capabilities of different regions and parts of societies.

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History of Climatic Change during Pliocene and Lower Quaternary according to the Study of Fossil Soils

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Keywords: red clays, X-ray diffraction, rain forest, steppe, Pliocene, Pleistocene

ABSTRACT

The mineralogical composition of red clays derived from fossil soils is interpreted in terms of palaeo-environmental and palaeo-climatic conditions in SE Transdanubia, Hungary. The time span considered is Middle Pliocene to Lower Pleistocene (about 3.5 to 0.8 million years). The results are compared with those obtained in the same localities by palaeontology of Vertebrates and Molluscs. The environment gradually changed from warm, humid forest and swamp to dry and warm savannah and later to dry and temperate steppe and forest steppe. Accordingly the mineralogy changed from associations containing dominantly disordered kaolinite, kaolinite/smectite interstratifications and gibbsite to associations of smectite (or vermiculite) with illite, chlorite and various amounts of relatively ordered kaolinite. Slight increase of kaolinite at the expense of chlorite may indicate more humid, forested periods.

INTRODUCTION

GEOLOGICAL BACKGROUND

Red clays and other related fine-grained sediments were studied in SE Transdanubia. These sediments are derived from fossil soils of various ages from Middle Pliocene to Lower Pleistocene, representing a time span of about 3.5 to 0.8 million years (Figure 1). Red clays occur on the surface and in fissures of karstified limestone in the Villány Mts. and in the hilly areas of the broader surrounding where they are usually covered by Quaternary loess.

Even in the karst areas the red clays came from the soil layers of the surface and cannot be derived from the insoluble residue of the underlying limestone.

It is advantageous that many fissures filled with clays in the Villány Mts. contain fossils of Vertebrates or less frequently terrestrial snakes. Their study enables us to determine the age and the environmental conditions prevailing during the accumulation of the sediment. The age of the fossil fauna is nearly identical or may be somewhat younger than the age of formation of the soil which the animals were living on. The difference in the age cannot be too large because with the changing environmental conditions the composition of the soil is evolving as well. Results of the mineralogical and palaeontological studies are summarised in Figure 2. From the minerals present in the soils only the clay minerals of the <2 µm fraction will be considered in the present summary.

We can arrange the localities studied in this paper according to the age and environmental information obtained from Vertebrate palaeontology in the scheme of Figure 2. In each case the name of the locality, the rock, the age, the name of the formation and finally the typical clay mineral association in the <2 µm fraction is given. When considering the palaeo-environmental relations in the given time period we relied on the comprehensive characterisation of the stratigraphic units made by Schweitzer (1993) and on the systematic summary of the environmental significance of the faunas made by Pazonyi (2006).

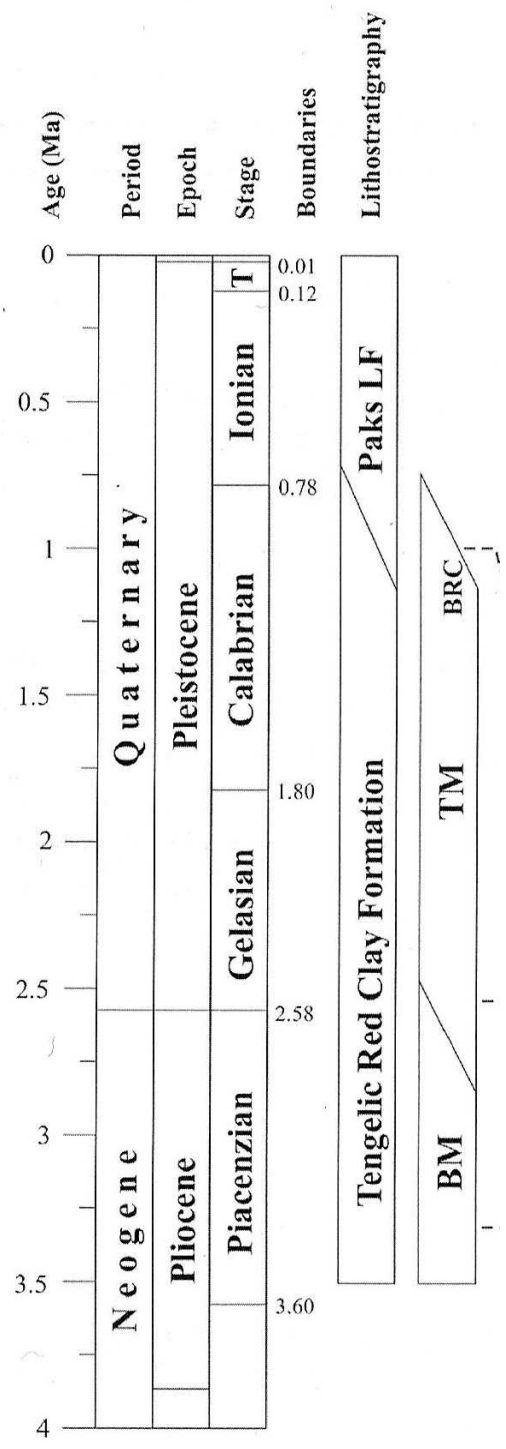

Figure 1: Geochronological and stratigraphical framework of the Hungarian red clays and loess-palaeosol sequences (compiled by RAUCSIK ET AL. 2010). Legend: T: Tarantian, Paks LF: Paks Loess Formation, BM: Beremend Member, TM: Tengelic Member, BRC: basal red clay. Ma: million years

RESULTS

On the basis of quantitative XRD analyses made on 181 samples correlation was found between the mineralogical composition and environmental relations of Pliocene and Pleistocene terrestrial red clays in SE Transdanubia (for detailed discussion see Dezső et al. 2007 and Viczián 2006-2007). These clays belong to the stratigraphic units *Tengelic Formation* and *basal beds of the Paks Loess Formation*.

TENGELIC RED CLAY FORMATION

On limestone surface of the Villány Mts. red clays covering the surface or filling fissures and recently existing caves can be regarded as *terra rossa* in the same sense as similar red clay deposits in the Dinaric range and in N Hungary. The formation can be divided into two units: *Beremend Member* and *Tengelic Member*. Both members occur in the Villány Mts. In the broader surrounding of the mountains, in basin areas of SE Transdanubia the *Tengelic Member* is the most widespread.

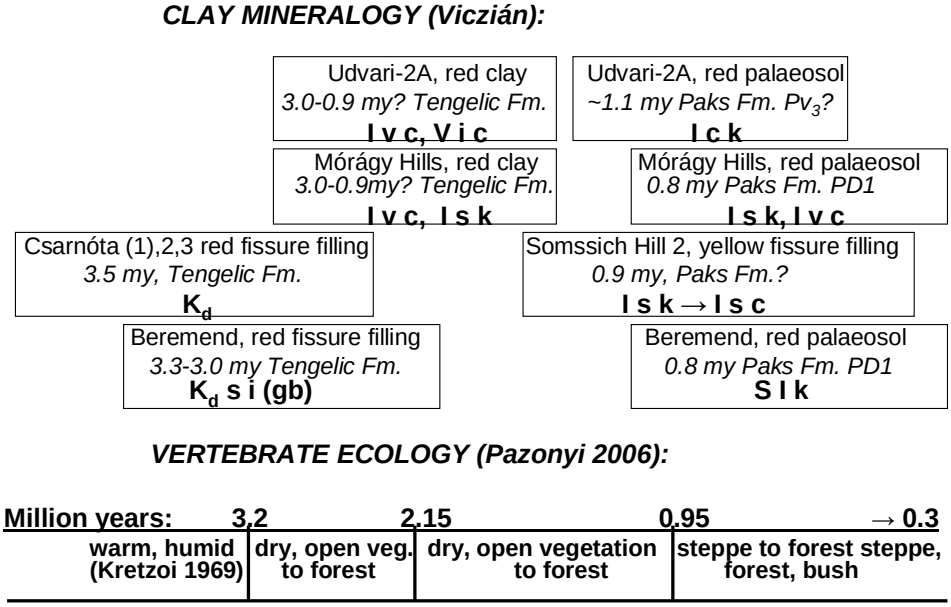

Figure 2: Typical clay mineral associations of various red clay occurrences in SE Transdanubia. In each locality the approximate age and the name of the stratigraphic formation are given. The clay mineral data are compared with the results of the palaeo-ecological evaluation of the Vertebrate fossil record (KRETZOI 1969 and PAZONYI 2006). Legend: v: vermiculite, s: smectite, i: illite, k: kaolinite, kd: disordered kaolinite, c: chlorite, gb: gibbsite. Capital letters indicate amounts >25 % of the total clay mineral content of the <2 µm fraction

1a. The older type is called *Beremend Member of the Tengelic Formation* is red kaolinitic clay. It contains typically disordered kaolinite, mixed-layer smectite/kaolinite, smectite and little gibbsite. It was formed in the local subaerial weathering crust in warm, humid, subtropical or monsoon climate. Products of similar weathering, mineralogy and age can be found on Mt. Esztramos, N Hungary and in the Poltár Formation, near Lučenec, S Slovakia.

Low amounts of gibbsite are typical together with kaolinite in the Beremend Member which may be related to an older generation of fissures, i.e. to an older period of weathering on the surface (3.5-3.0 million years).

1b. The younger type of the *Tengelic Fm.* called *Tengelic Member* contains red (or "reddish") clay beds. It can be found in the Villány Mts. as well but it is especially widespread in the hilly areas of SE Transdanubia comprising a time span of approx. 3.0 to 0.9 million years. It contains relatively fresh material in which the weathering products are predominantly smectite and goethite. The weathering took place under generally warm and dry climate in environmental conditions of savannah and steppe which temporarily became forested in relatively more humid periods. These periods may be reflected by somewhat higher smectite, vermiculite and kaolinite contents.

BASAL BEDS OF THE PAKS LOESS FORMATION

2a. Yellow fissure filling clays in the Villány Mts. (e.g. at Somssich Hill, site No. 2) correspond to the cooling period of *Lower Pleistocene* period (about 0.9 million years), as it was shown also by the malacological studies of Krolopp (2000). They are even less altered and less oxidised than the relatively fresh material of the reddish clays of the *Tengelic Member*. (These clays have uncertain stratigraphic position between the *Tengelic* and *Paks* Formations.)

2b. The *basal red palaeosol layers of the Middle Pleistocene Paks Loess Formation* (about 0.8 million years) contain remarkably similar material as the underlying red clays belonging to the *Tengelic Member.* Like in the *Tengelic Member*, they contain relatively much quartz and other detrital minerals. In both formations typical clay minerals are well-crystallised detrital illite and mixed-layer illite/smectite. Less frequent clay minerals are smectite+kaolinite or vermiculite+chlorite, depending probably on slight climatic fluctuations during this period. There are, however, slight but clear differences in the quantitative composition of the Tengelic member and the Basal Red Palaeosol which indicate somewhat lesser degree of weathering in the palaeosols. This is the consequence of the further cooling of the temperature.

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The Main Global Environmental Problems: an Earth-Science Perspective

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Keywords: energy, water, soil, raw material, climate, IYPE

ABSTRACT

Most people and many decision makers think that the number one challenge for humanity is the fight against global warming. At the same time, on basis of the overview provided by the International Year of Planet Earth, it is evident that the principal environmental problem is not the global warming. Instead, the principal problem of the coming decades is the ever-increasing demand for Earth resources such as energy, freshwater, soil and rare earth materials. An infinite growth (both in population and living standard) cannot be continued in a finite system, the Earth. If the tendencies will not change, a catastrophe will be simply unavoidable, independently on the actual warming or cooling phase of the global temperature. Instead of global warming, it would be advisable to turn our attention towards these global warnings.

INTRODUCTION

UNESCO proclaimed 2007-2009 as the International Year of Planet Earth (IYPE), with 2008 the central year. The original goal was to build a safer, healthier and wealthier society around the globe with focus on key issues in ten chosen themes aimed at drawing greater human awareness. The themes included groundwater, hazards, Earth and Health, climate change, Earth resources, megacities, deep Earth, soils, oceans, and Earth and life (IYPE Booklets 2008, Szarka et al. 2010. The panoramic picture about the Earth in these ten themes compiled by the author reveals that the principal environmental problem is not the global warming. Instead, the principal problem in the coming decades is the ever-increasing demand for Earth resources such as energy, drinking water, soil and rare earth materials. In a finite domain, the Earth, it is impossible to have an infinite growth. I provide a summary about the main findings in the ten IYPE themes, then I confront the main IYPE conclusions with the fashionable view of environmentalists.

THE TEN IYPE THEMES

GROUNDWATER

Groundwater represents nearly all the potentially drinkable water on Earth. Because of increasing consumption and pollution, it is already shrinking as a resource. The freshwater consumption is much larger than the natural refilling of the groundwater reservoirs. It should be realised that human action has drastically modified the ‘natural’ water cycle. Unfortunately this is not well recognized as a major cause of climate change when compared to the emission of greenhouse gases through human action (Yim 2008). Since water is a limited resource, its over-use is a global problem, which is complicated by trans-boundary issues.

EARTH AND HEALTH

Direct links between geology and health are provided by the food chain and by inhalation of atmospheric aerosols, dusts and gases. A better co-operation between geologists and medical doctors would lead to improvement of health of about three billion people.

GEOHAZARDS

The Earth, due to its dynamics, is a dangerous place, and is often made more dangerous by human intervention. The frequency and size of losses to natural disasters are increasing dramatically over the world. Its reasons, according to the Munich Re-Issurance Co. (Smolka and Hollnack 2008) are as follows: (1) rise in population, (2) better standard of living, (3) concentration of people and values in large conurbations, (4) settlement in and industrialization of extremely exposed regions, (5) susceptibility of modern societies and technologies to natural hazards, (6) increasing insurance density, and finally (7) change in environmental conditions. It means not less than the increase of number of natural catastrophes is dominantly of anthropogeneous origin.

CLIMATE CHANGES

The Earth's climate has been varying throughout the Earth's history. It is a complex physical system involving a number of different scientific disciplines, spatial regimes, and feedback mechanisms including among others the oceans, the whole hydrological cycle, the land vegetation (biosphere), the atmosphere, the cryosphere, the solar variability, the human activity, etc. In spite of claims by the Intergovernmental Panel on Climate Change (IPCC) that there would be consensus amongst scientists in terms of answering the key questions, the science has not been able to provide the answers, particularly on the assertion that anthropogenic greenhouse gases would be mainly responsible for human-induced climate change. Consecutively, Earth scientists do not have an overwhelming consensus on whether carbon trading alone is an effective measure in mitigating climate change. The rise in mean annual temperature of about 0.6-0.8 °C found in the increase of the global annual mean temperature in the 20th century could be explained by the thermal heat island effects alone. No evidence has been found for an increase in frequency and intensity of extreme meteorological events as typhoons and hurricanes.

DEEP EARTH

The deep-Earth processes and their long-period changes make the Earth 'alive'. We need a better understanding of the evolution of continents and their role in the dynamics of the Earth's lithosphere and mantle. Vulnerability is increasing because of the pressure exerted by humans upon the environment.

MEGACITIES

Megacities are defined as urban areas with more than five million inhabitants. By 2015 the world may contain as many as sixty megacities, housing altogether more than 600 million people. For attaining a greater degree of sustainable development, the wise use of human and natural resources are essential. It is necessary to reduce the risk posed by megacities and to enhance the quality of life for those who live in, or are impacted by, megacities.

EARTH'S RESOURCES: ENERGY AND EARTH MATERIALS

Modern society is increasingly dependent on energy and mineral resources. Humans are guzzling away the fossil energy (i.e. the conserved solar energy of past times); the renewables (i.e. the usable parts of the present natural processes) are not able to satisfy the actual demands. At the same time it seems that there will be enough earth material for a long time, with the exception of rare earth metals, which could be shortly (within a few years) exhausted. A future scarcity of the special materials is constraining the modern technology.

SOIL

An important question to address is whether there is an ultimate limit on agricultural production from soils to support the Earth's growing population. According some numerical modelling, the Earth is hardly able to feed 9 billion people predicted for 2040, but on the price of ecosystems and biodiversity, and there is no room for biomass production. All agricultural products should preferably be local or regional in their origin in order to reduce, among others, transport-related anthropogenic greenhouse gases.

OCEANS

Humans began to scientifically explore the oceans only two hundred years ago. The knowledge gained has revolutionized our understanding of planet Earth as a whole but much more remains to be discovered particularly on the use of oceans to the benefit of humankind and also in preventing disruptions around the continental margins where so much of the human population is concentrated. The future research is full of surprises, all from biological-, resource- and environmental points of view.

EARTH AND LIFE

One of society's most pressing problems is to sustain a functioning global ecology. The global ecological system is at risk. We are all at risk, as confirmed by the International Year of Biodiversity (2010).

ORDER OF PROBLEMS

Richard Smalley, the 1996 Nobel Laureate in chemistry, presented a list entitled "Top Ten Problems of Humanity for Next 50 Years". His list in order of priority is: (1) Energy, (2) Water, (3) Food, (4) Environment, (5) Poverty, (6) Terrorism & war, (7) Disease, (8) Education, (9) Democracy, (10) Population. This order of priority reflects the point of view Energy is at the top, because it is the key to solving all of the rest of the problems − from water to population. Without cheap energy, there is no acceptable solution for water supply. Without abundant fresh water, how are we going to provide the food for the worldwide population? Without cheap energy, it is impossible to produce the fertilizer, till the soil, harvest the crops, process them, package them, and deliver them to markets. Some details in the order of importance can be of course discussed, but it is remarkable that the first three problems identified by Smalley are the same as have been identified by International Year of Planet Earth, too. Problem No 4 is the environment (with its geo-, hydro-, atom- and biospheres), which is a much broader issue than the climate change. Depletion of rare earth metals (the earth materials are not mentioned by Smalley) might cause serious constraints in technology. The first four problems are natural conditions and mean altogether the basis of any societal issue.

CRITICS OF SOME FASHIONABLE VIEWS OF ENVIRONMENTALISTS

THE "GLOBAL WARMING" CONCEPT

As GHIL (2010) has stated: "the components of the climate system − the atmosphere, oceans and cryosphere − are active across a wide range of space and time scales. The physical and chemical processes within each of these components are nonlinear and quite complex, and the interactions among these components are even more so. Moreover, the whole system is open to external fluxes of energy and momentum". We do not know much about these factors. Nevertheless, in terms of the deterioration of the Earth's environment, climate change through global warming is on top of the list of most nations.

Through the work various green groups and the IPCC, anthropogenic greenhouse gases through fossil fuel consumption has been identified as the main culprit. Without the need for evidence, droughts, floods, malaria, hurricanes/typhoons and even cooling, even depletion of groundwater can all be blamed on global warming. The climate change is true, but there are several alternative possible causes for the present global warming. At the same time, all statements narrowing all environmental problems to the CO_2 emission and ignoring all anthropogenic changes in the geo- hydro-, atom- and biospheres and on the surface of the Earth, can be easily falsified (Szarka 2010).

OLLIER (2009) went even further. He made a direct comparison between global warming and lysenkoism. He found the following common points: (1) Work first through political organizations; (2) Claim that the science is settled. There is nothing to debate; (3) Disregard or deny all the accumulating evidence that the predictions are wrong; (4) Demonise the opposition (Mendelian geneticist versus global warming 'deniers'); (5) Victimise the opposition (execution or exile; loss of jobs or research funds); (6) Relate to a current ideology (Stalinism; Environmentalism); (7) Support a vast propaganda machine; (8) Create a huge bureaucracy where many people have careers dependent upon 'the ruling concept'. (OLLER 2009, Yim and OLLIER 2009). The present events of climate research are unfortunately full of such features both international (MONTFORD 2010) and national level. For example in Hungary the rebuttal of MISKOLCZI (2010) theory by van DORLAND (2010) and the re-rebuttal by ZÁGONI (2010) needs further clarification. At the same time, the Royal Society (2010) has published an exceptionally correct scientific summary about climate change.

It is a rough over-simplification that the climate change would be caused exclusively by one single parameter, namely the greenhouse effect due to an enhanced CO_2 emission of anthropogeneous origin. However, it is realistic to assume that the present change is partly due to the human activity: either via CO_2 emission or other human activities, or both.

THE "SUSTAINABLE DEVELOPMENT" CONCEPT

Sustainability requires Earth's natural systems to be in overall long-term balance. To restore that balance we should (1) stop using non-renewable resources, (2) stop using renewable resources at rates that exceed replenishment, (3) recycle all manufactured materials, and (4) stop polluting at rates too great for natural systems to cope with. Since neither the zero population growth, nor the zero growth in global demand for higher living standard, nor zero waste, nor zero fossil energy is a realistic alternative, the sustainability remains really, as described by Wright (2001), an "unsustainable myth".

DISCUSSION: GLOBAL WARNING, INSTEAD OF "GLOBAL WARMING"

We observe a lot of fully human-induced changes in the atmo-, hydro, geo- and biospheres on a global scale. E.g., nearly the half of the ice-free land surface on the Earth have been transformed by humans, and an order of magnitude more sediment is moved by humans than by the sum of all other natural processes operating on the surface of the planet. It evidently has multiple consequences, not only climatic ones. The International Year of Planet Earth (2008) focussed on the future scarcity of the fossil energy, groundwater, soil and some raw materials, the International Year of Biodiversity (2009) concentrates on the loss of biodiversity.

In the light of the all these facts, I think, the environmental consequences of the human activity cannot be expressed in one single parameter, namely the CO_2 emission. I think, the main environmental challenge is due the fact, that while the Earth and its resources are limited, the human demands are still continuously increasing. The human demands are continuously heightened by the increasing population and the expanding economies. We are approaching the threshold of the source- and as well of the sink capacities of the Earth. The growth will inevitably lead to a catastrophic collapse, independently of the actual climate tendency, and this catastrophe might take place much sooner than that due to the global warming, feared by all of us.

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Results of Regional Climate Models for the Carpathian Basin

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Keywords: Regional climate model, temperature, precipitation, Carpathian Basin, downscaling

ABSTRACT

Global climate model (GCM) results are not able to provide detailed regional estimations of future climate conditions. The 10-25 km horizontal resolution of the regional climate models (RCMs) nested into GCMs is anticipated to improve the results of the global climate models. Expected regional climate change in the Carpathian Basin is simulated by four different RCMs, namely, ALADIN-Climate, PRECIS, RegCM, and REMO. First, the control experiments are validated and inter-compared for the 1961-1990 period applying lateral boundary conditions from the European Centre for Medium-range Weather Forecast (ECMWF) re-analysis dataset (ERA-40). Then, future climate of the Carpathian Basin have been simulated using A1B emission scenario for the 21st century. Simulations agree in increasing mean and extreme temperatures, however, precipitation results are rather uncertain, they fully agree only in the decrease of summer precipitation for the future.

INTRODUCTION

Results from coarse resolution global climate models (GCMs) can only be considered as a first-guess of regional scale climate change. Regional climate models (RCMs) nested in GCMs may lead to better estimations of future climate conditions since their horizontal resolution is much finer than the GCMs' (IPCC, 2007). Future regional climate change focusing on Central and Eastern Europe, particularly the Carpathian Basin is assessed by the following four different RCMs (SZÉPSZÓ ET AL., 2008):

(1) The ALADIN-Climate model was developed by Météo France (SPIRIDONOV ET AL., 2005) on the basis of the internationally developed ALADIN modelling system.

(2) The PRECIS model was developed at the UK Meteorological Office, Hadley Centre (WILSON ET AL., 2005).

(3) RegCM model was originally developed at the U.S. National Center for Atmospheric Research (GIORGI ET AL., 1993a, 1993b), and currently it is improved at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste (e.g., GIORGI AND MEARNS, 1999; PAL ET AL., 2000).

(4) The REMO model was developed by the Max Planck Institute for Meteorology, Hamburg (JACOB AND PODZUN, 1997).

The horizontal resolution of the model experiments is 10 km in the case of ALADIN-Climate and RegCM, and 25 km in the case of PRECIS and REMO. RegCM and PRECIS are used by the Department of Meteorology, Eötvös Loránd University, ELU (BARTHOLY ET AL., 2006; TORMA ET AL., 2008). ALADIN-Climate and REMO are run by the Hungarian Meteorological Service, HMS (CSIMA AND HORÁNYI, 2008, SZÉPSZÓ AND HORÁNYI, 2008). The target regions of the four RCMs are presented in Figure 1.

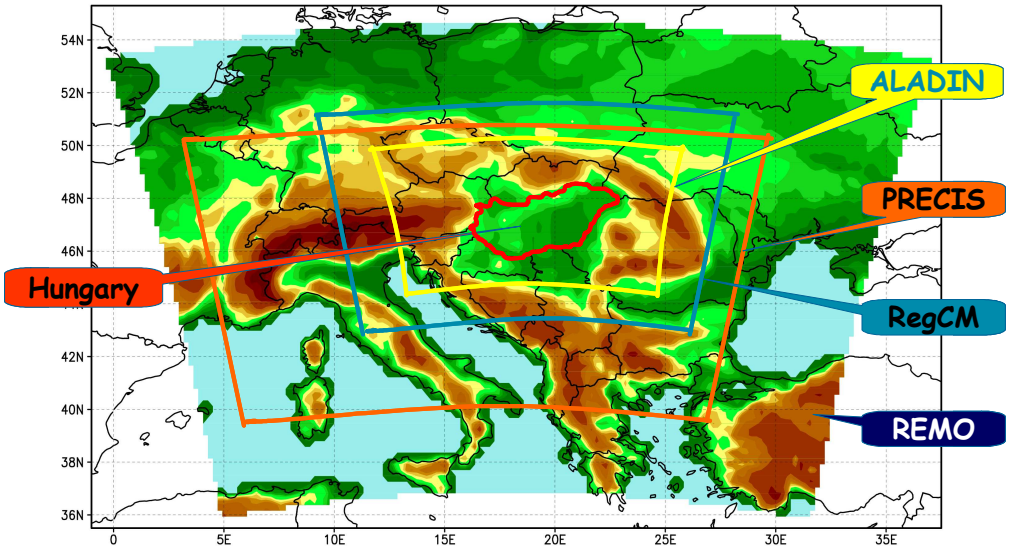

Figure 1: Model domains of the different regional climate models

Most of the RCM experiments consider A1B scenario, which projects the global population to reach 9 billion within a few decades, and then, to decrease to about 7 billion by the end of the 21st century (NAKICENOVIC AND SWART, 2000). Furthermore, fast economic and technological growths are projected, and the increase of CO_2 concentration will be slowing down by 2100 (exceeding 715 ppm according to the estimations). In the experiments of model PRECIS scenarios A2 and B2 were taken into account, for which the projected CO_2 concentration for 2100 is 856 ppm and 621 ppm, respectively (NAKICENOVIC AND SWART, 2000).

Table 1: Main characteristics of the adapted RCM experiments for the Carpathian Basin

RCM	ALADIN-Climate	PRECIS	RegCM	REMO
Developer -- Institute that adapted	Météo France -- HMS	UKMO Hadley Centre -- ELU	ICTP, Trieste -- ELU	MPI-M, Hamburg -- HMS
Horizontal resolution	10 km	25 km	10 km	25 km
Vertical levels	31 hybrid atmosphere + 4 soil layers	19 hybrid atmosphere + 4 soil layers	28 sigma atmosphere + 3 soil layers	20 hybrid atmosphere + 5 soil layers
Completed model experiments and corresponding lateral boundary conditions	CTL: 1961-2000 ERA-40 CTL: 1961-1990 ARPEGE A1B: 2021-2050 ARPEGE A1B: 2071-2100 ARPEGE	CTL: 1961-1990 ERA-40 CTL: 1961-1990 HadCM3 B2: 2071-2100 HadCM3	CTL: 1961-2000 ERA-40 CTL: 1961-2000 ECHAM5/MPI-OM A1B: 2021-2050 ECHAM5/MPI-OM A1B: 2071-2100 ECHAM5/MPI-OM	CTL: 1961-2000ERA-40 CTL: 1951-2000 ECHAM5/MPI-OM A1B: 2001-2100 ECHAM5/MPI-OM

The present paper discusses the results of the four regional climate models (in case of PRECIS experiment using B2 scenario is included in the current analysis). First, after a brief summary of the models, validation runs are evaluated. Then, simulated temperature and precipitation changes for the target periods 2021-2050 and 2071-2100 are analyzed for Hungary. Besides the evaluation of mean climate characteristics, future extreme conditions are also discussed. Finally, the main conclusions are summarized.

REGIONAL CLIMATE MODEL SIMULATIONS

In our first experiments, the applied initial and lateral boundary conditions (LBC) are compiled from the European Centre for Medium-range Weather Forecasts (ECMWF) ERA-40 re-analysis database (UPPALA ET AL., 2005) using 1.125° horizontal resolution. The simulations cover 1961-1990 as a reference period. Furthermore, GCM-driven experiments were accomplished in order to analyze the future climate tendencies. In these climate change simulations ALADIN-Climate was driven by ARPEGE-Climat GCM (GIBELIN AND DÉQUÉ, 2003), and the experiments were carried out for 3 time slices: 1961-1990, 2021-2050, and 2071-2100 (Table 1). In the case of the RegCM simulations, for the same time slices ECHAM5/MPI-OM coupled atmosphere-ocean AOGCM outputs (ROECKNER ET AL., 2006; JUNGCLAUS ET AL., 2006) with 1,875° horizontal resolution provided the atmospheric forcings. LBCs for PRECIS for 1961-1990 and 2071-2100 are taken from HadCM3 AOGCM using ~150 km horizontal resolution (GORDON ET AL., 2000). Finally, REMO was run in transient mode for the entire 1951-2100 period using ECHAM5/MPI-OM AOGCM (using 1,875° resolution) driving data.

VALIDATION

First, the control runs of ALADIN-Climate, PRECIS, RegCM, and REMO are validated and inter-compared for the 1961-1990 period using lateral boundary conditions from the ECMWF ERA-40 re-analysis dataset. For the validation, monthly data sets of the 10-minute resolution Climate Research Unit (CRU) of the University of East Anglia (MITCHELL AND JONES, 2005) are used as reference.

Figure 2 summarizes the annual and the seasonal temperature bias fields for the model domains. For Hungary, temperature is most realistically simulated by RegCM with a slight positive annual bias (with minor underestimation in most seasons except winter). ALADIN-Climate simulation underestimates the past temperature conditions (with the largest seasonal departure values in MAM and SON), while PRECIS and REMO overestimate the past climate in all seasons (with the largest bias values in summer).

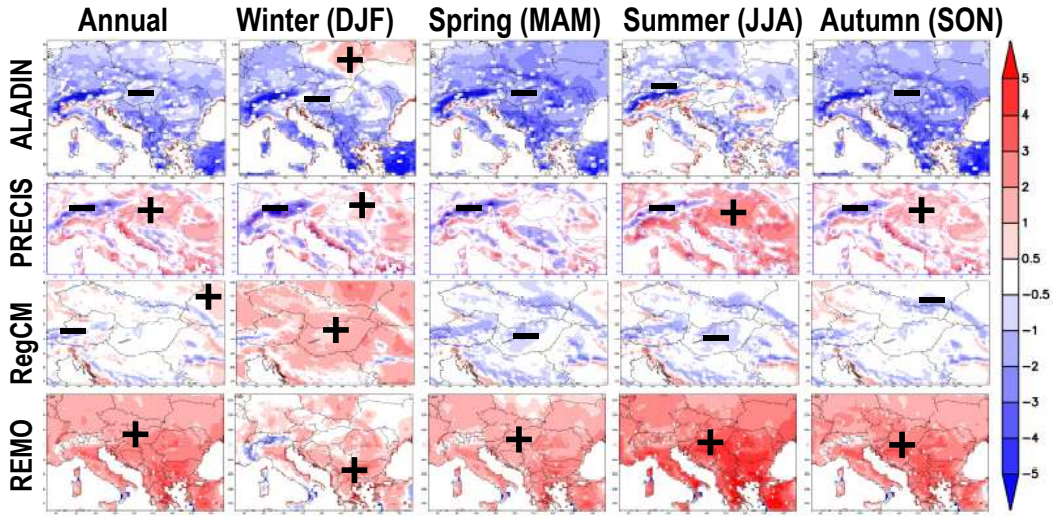

Figure 2: Validation of simulated annual and seasonal mean temperature (°C) for 1961-1990 against the CRU data sets. Lateral boundary conditions were provided by the ERA-40 dataset

Figure 3 summarizes the annual and the seasonal precipitation bias maps. In case of Hungary, the best annual performance has been achieved by REMO and PRECIS (partly due to positive seasonal departure values in winter and spring, and negative values in summer and autumn). ALADIN-Climate and RegCM are too humid in all seasons (with the smallest seasonal values in autumn).

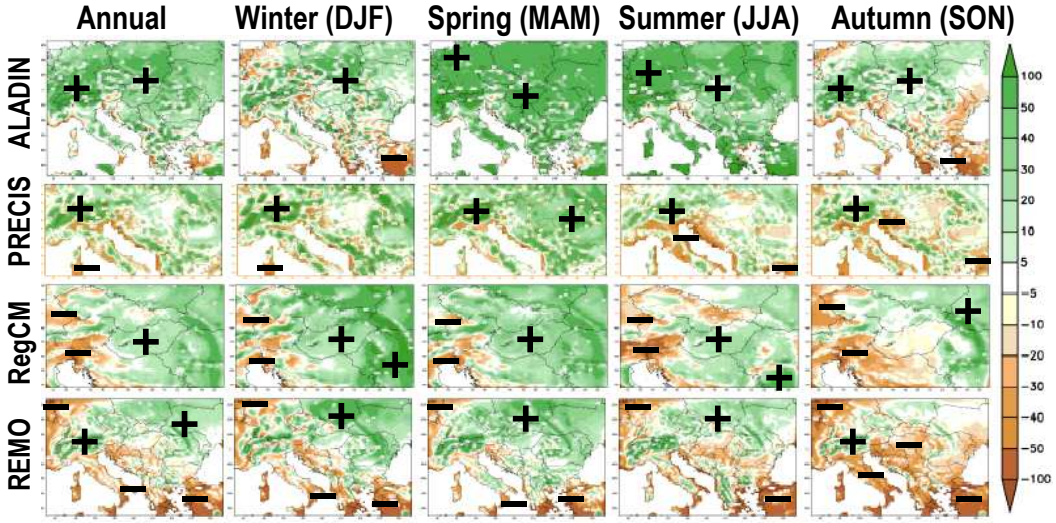

Figure 3: Validation of simulated annual and seasonal mean precipitation amount (%) for 1961-1990 against the CRU data sets. Lateral boundary conditions were provided by the ERA-40 dataset

More details on the individual model validation results are found in the following papers: CSIMA AND HORÁNYI (2008), TORMA ET AL. (2008), SZÉPSZÓ AND HORÁNYI (2008), BARTHOLY ET AL. (2009).

ANALYSIS OF FUTURE REGIONAL TEMPERATURE TRENDS

The projected annual and seasonal temperature changes over Hungary for 2021-2050 and 2071-2100 are summarized in Figure 4.

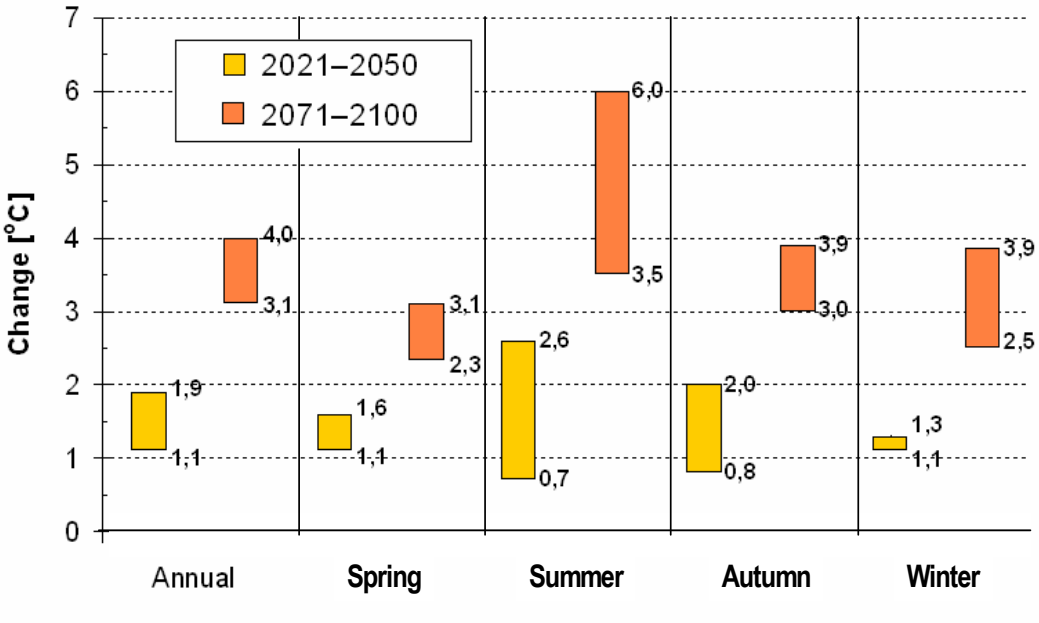

Figure 4: Summary of the projected annual and seasonal mean temperature change (°C) for 2021-2050 and 2071-2100 for Hungary (reference period: 1961-1990)

The intervals are formed by the individual model simulations, the smallest and the largest estimated changes are indicated on the right side of the bars. The warming is significant on both annual and seasonal scales. Evidently, projected changes are smaller for 2021-2050 than for 2071-2100. The spatial average of the estimated annual temperature change is 1.1 1.9 °C, and 3.1-4.0 °C, respectively. Both the largest warming signal and the largest variability of the model estimations are projected for summer.

For the last three decades of the 21st century Figure 5 shows the spatial distribution of the projected seasonal temperature changes for all the four RCMs. The maps emphasize that the estimated increase is largest in summer and the smallest in spring/winter. Furthermore, the projected warming tendency in summer is larger in the southern part of the country than in the northern parts.

Warming tendency is manifesting not only in the mean temperature but also in extreme temperature characteristics. Extreme climate indices were calculated using daily maximum, minimum, and mean temperature values (Tx, Tn, and Tg, respectively). The extreme temperature indices can be defined as number of days exceeding several different threshold values (e.g., 25 °C for summer days, 30 °C for hot days, 35 °C for extremely hot days) or as number of days with temperatures less than the threshold values (e.g., 0 °C for frost days). Figure 6 summarizes the estimated annual changes of six temperature indices. Indices associated with negative extremes (e.g., frost days) are likely to decrease by 20-40 days on average. Indices associated with positive extremes are likely to increase by 9-27 days (2021-2050), and by 23-51 days (2071-2100) on average. Overall, both estimated changes imply warmer future climate conditions in Hungary.

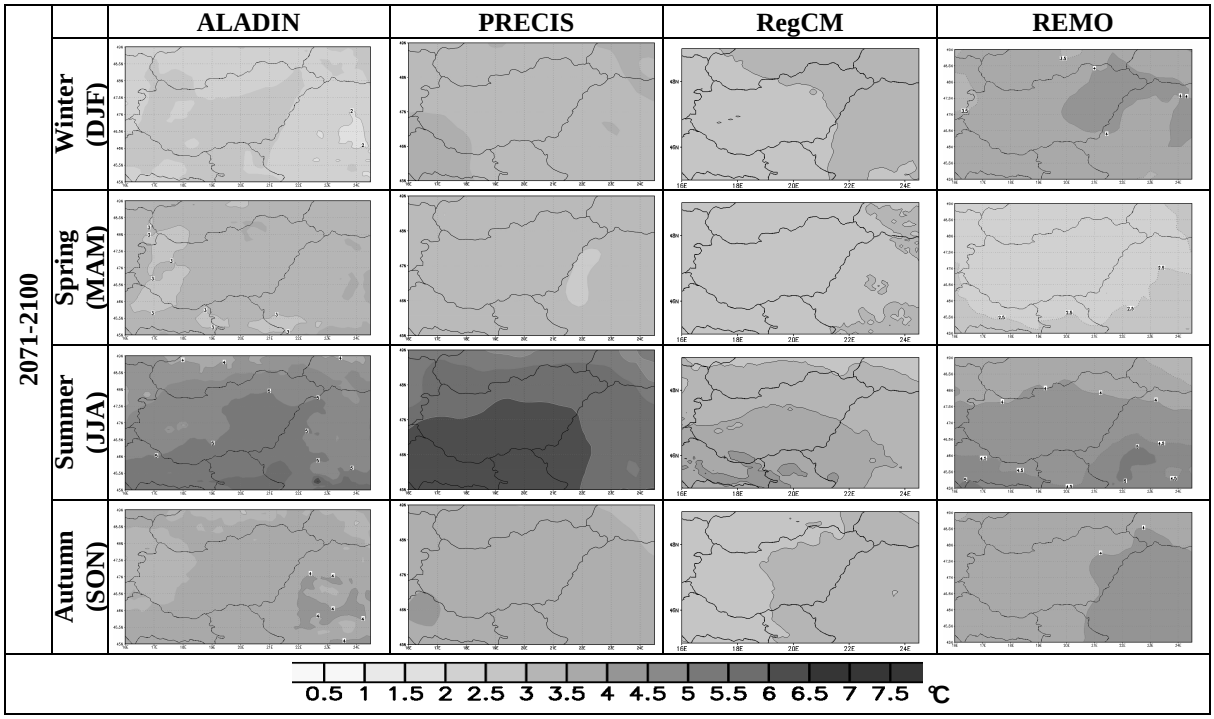

Figure 5: Projected seasonal temperature change (°C) for 2071-2100 using 4 RCMs (reference period: 1961-1990)

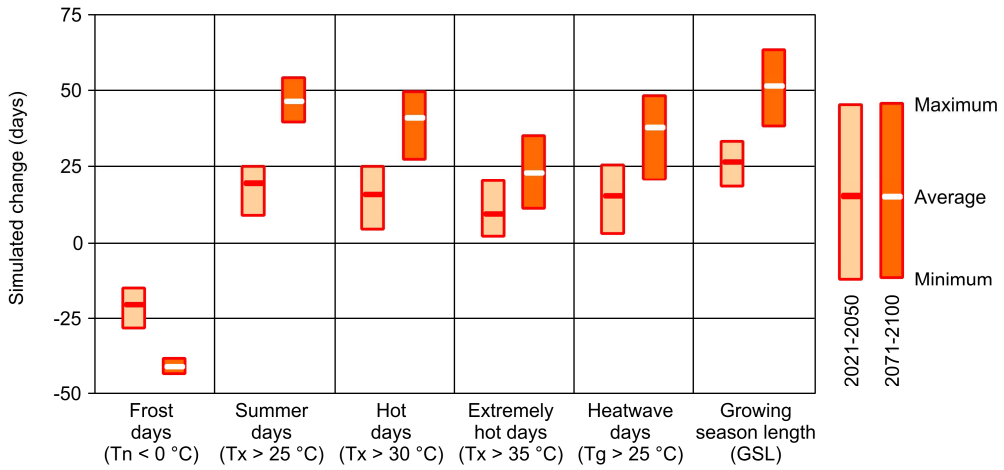

Figure 6: Summary of the projected mean change of extreme temperature indices for 2021-2050 and 2071-2100 for Hungary (reference period: 1961-1990)

As an example, the spatial distributions of the estimated change in the annual number of hot days (when the daily maximum temperature exceeds 30 °C) are illustrated in Figure 7 using composite maps. Strong zonality can be found for both the 2021-2050 and 2071-2100 periods. The estimated average change in Hungary is 10-18 days, and 30-46 days, respectively.

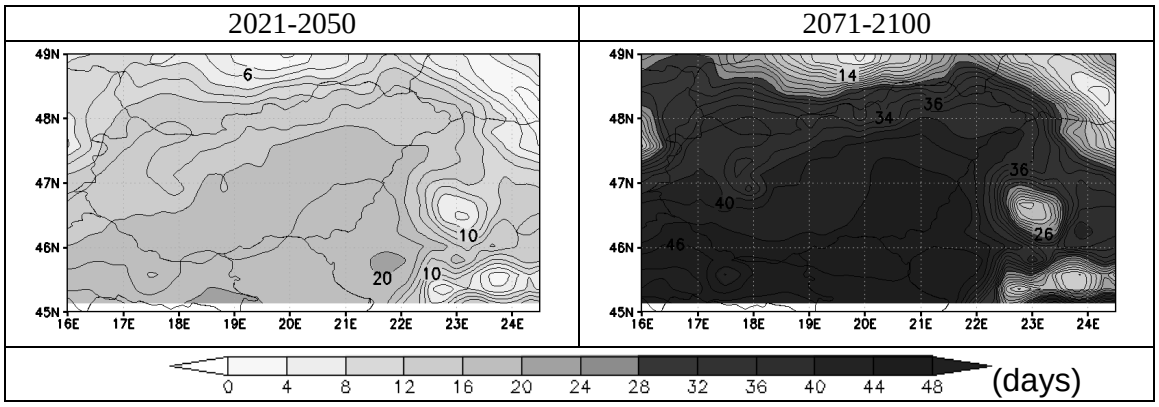

Figure 7: Projected mean change of annual number of hot days (Tx > 30 °C) for 2021-2050 and 2071-2100 (reference period: 1961-1990)

ANALYSIS OF FUTURE REGIONAL PRECIPITATION TRENDS

Unlike temperature, simulated precipitation changes are much more uncertain. Different models project different changes for the same season (i.e., some of them estimate precipitation increase, some of them decrease). Moreover, due to great variability, most of the projected changes are not statistically significant. Figure 8 summarizes the projected annual and seasonal changes for 2021-2050 and 2071-2100, the values are spatial averages for Hungary. Overall, the annual precipitation is likely to decrease slightly, the estimated changes are 0–(7)% for 2021-2050, and (+3)–(21)% for 2071-2100. All the RCMs agree in the sign of the projected summer precipitation change (in the other seasons even the sign of the change is uncertain). The estimated decreases are 2-5% and 18-43% by the middle and the end of the 21st century, respectively. Basically, increase could only occur during autumn and winter.

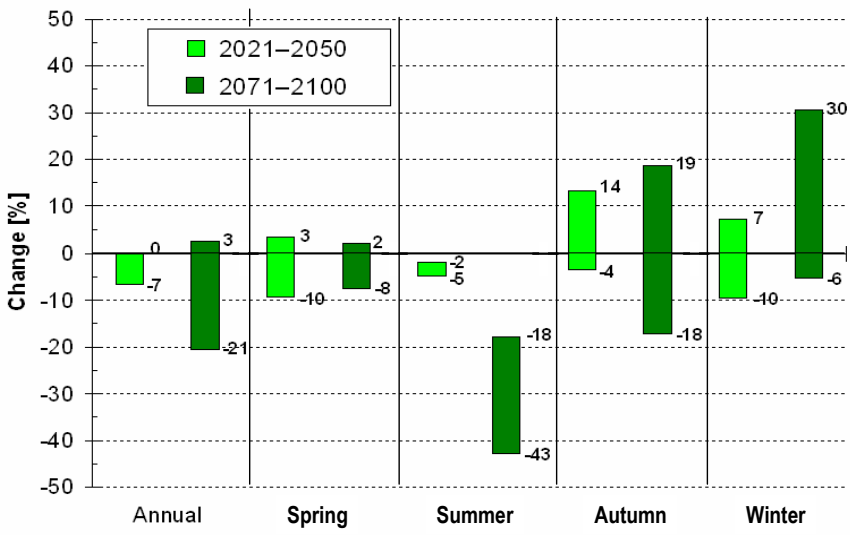

Figure 8: Summary of the projected annual and seasonal mean precipitation change (%) for 2021-2050 and 2071-2100 for Hungary (reference period: 1961-1990)

The spatial structure of the projected seasonal mean precipitation changes by 2071-2100 relative to 1961-1990 is mapped in Figure 9. All the four RCMs project precipitation decrease for the entire area of Hungary during summer. This summer drying is likely to be larger in the southern regions of the country than in the northern part. Overall, model PRECIS predicts the largest decrease for all the four seasons. Seasonal predictions of model REMO imply the largest increase for autumn and winter.

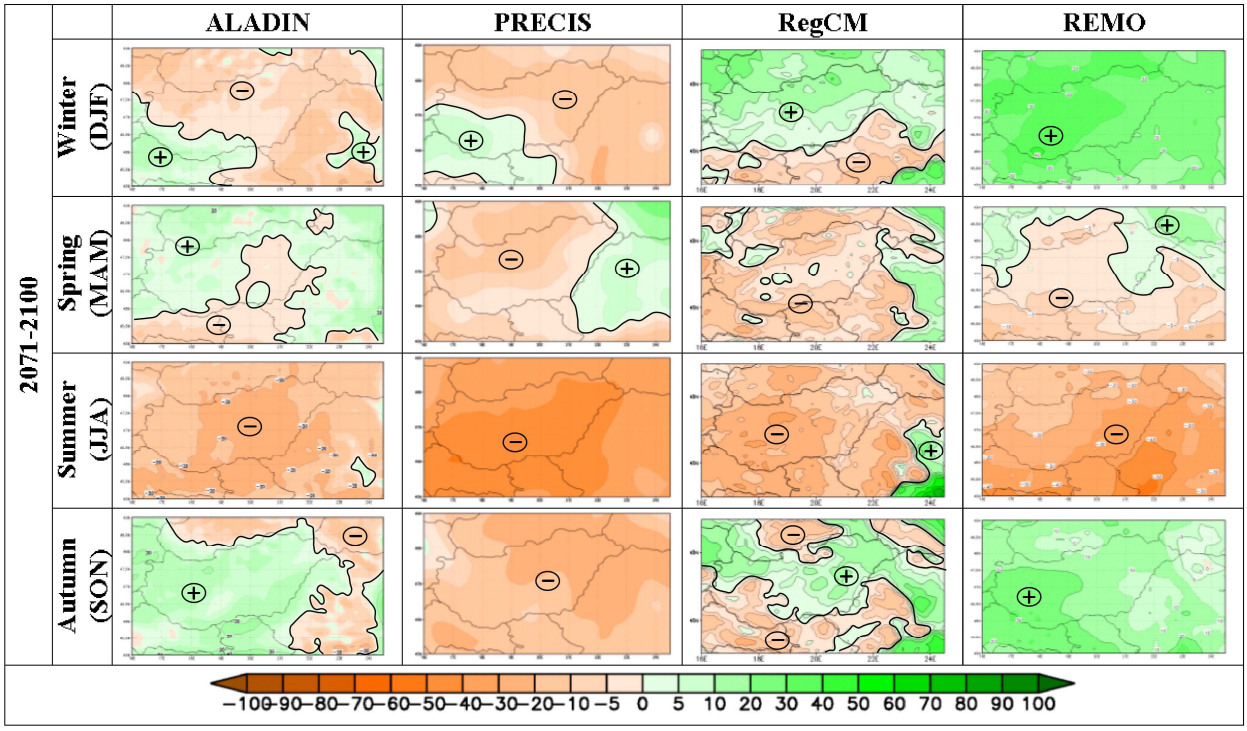

Figure 9: Projected seasonal precipitation change (%) for 2071-2100 (reference period: 1961-1990)

Changes in the 30-year mean annual distribution of monthly precipitation can be seen in Figure 10. Present conditions are represented by the CRU data (Mitchell and Jones, 2005), and the simulated changes for 2021-2050 and 2071-2100 are added to these reference values. Largest changes are projected for July and August, for which the estimated decrease is larger by the mid-century than by the end of the century. In May, June, and September the monthly precipitation is likely to increase slightly for 2021-2050, however, it is projected to decrease in the second half of the 21st century. In the winter half-year (from October to February) the precipitation might increase in the future slightly.

Precipitation related climate indices has been also analyzed: five of them are shown in Figure 11. RR1, RR5, RR10, RR20 indicate the seasonal numbers of days with precipitation exceeding different thresholds (1 mm, 5 mm, 10 mm, 20 mm, respectively).

Evidently, due to the distribution characteristics (less events with higher thresholds) of daily precipitation values, the smaller the threshold is, the larger the index values will be. CDD refers to the dry periods, namely, the consecutive dry days are the longest period without significant precipitation (more than 1 mm).

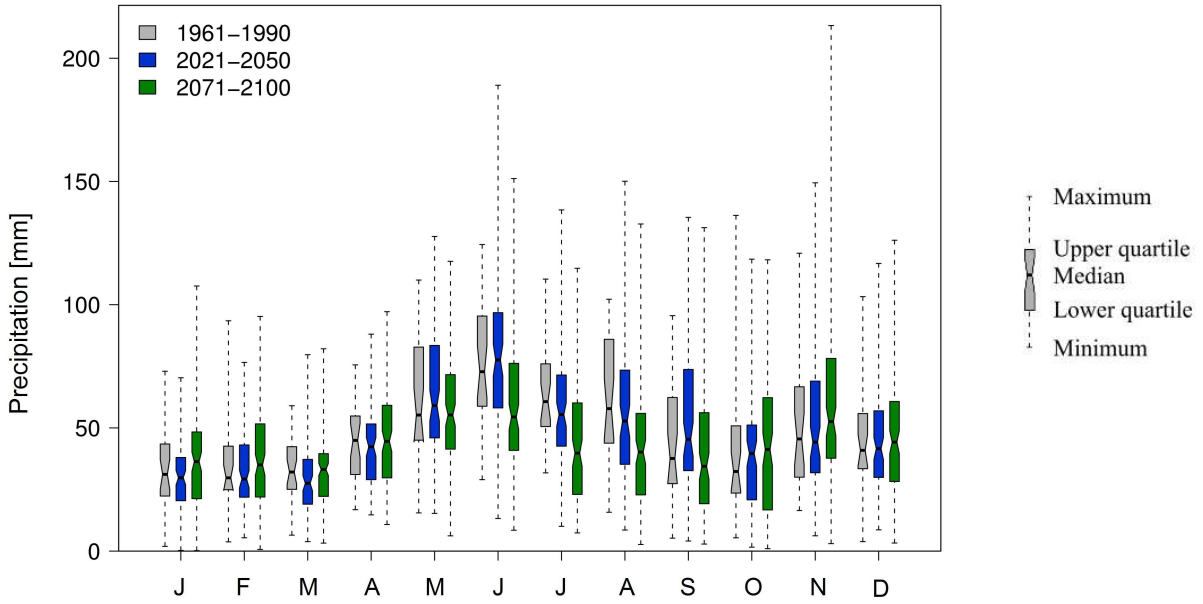

Figure 10: Monthly 30-year precipitation means (mm) over Hungary (simulated changes are added to the observed CRU mean values)

In winter, the precipitation index values using larger thresholds (RR10, RR20) are projected to increase, especially by the end of the 21st century. It indicates that precipitation will be more intense in winter. In summer, the precipitation index values using smaller thresholds (RR1, RR5, RR10) are projected to decrease, which means less precipitation events and it is larger for 2071-2100 than for 2021-2050. In the case of the only index considering dry conditions (CDD), much larger changes are simulated for summer than for winter. During summer CDD in Hungary is likely to increase, which is larger by the late-century than the mid-century.

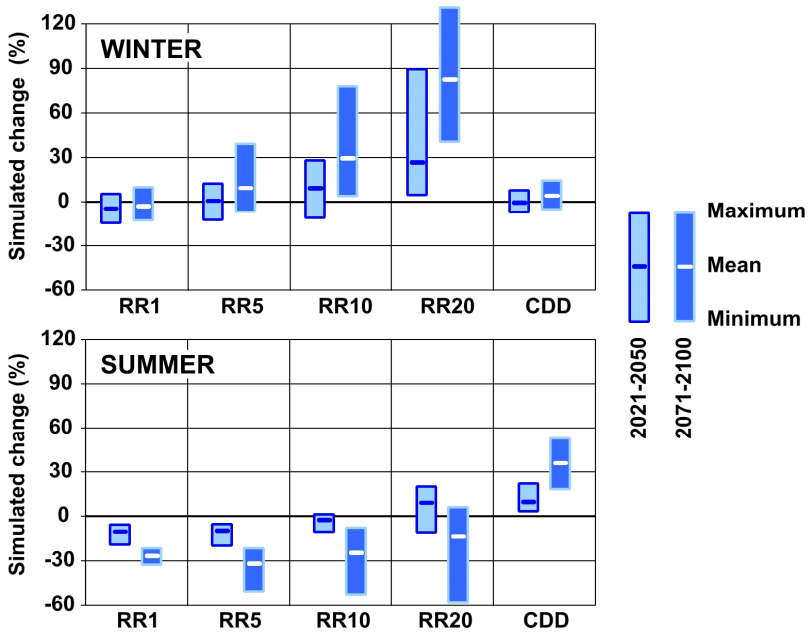

Figure 11: Summary of the projected mean change of extreme precipitation indices for 2021-2050 and 2071-2100 for Hungary (reference period: 1961-1990)

CONCLUSIONS

Regional climate projections provide state-of-the-art estimations regarding the details of future climate conditions. Scenario experiments for the Carpathian Basin (using four different RCMs adapted in Hungary) suggest that (i) the largest temperature increase in Hungary is projected for summer, and (ii) the summer precipitation in Hungary is projected to decrease for 2071-2100. Since regional temperature increase exceeds the global mean changes and summer drying may affect local agriculture, it is essential that decision makers act as soon as possible (e.g., forming adaptation and mitigation strategies). The RCM projections are still uncertain in several aspects of the regional climate change therefore further analysis should address these issues.

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Regional Changes in Central Europe Based on Global Climate Models, Re-scaled by the MAGICC/SCENGEN 5.3 Diagnostic Software

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Keywords: climate change, OAGCM, MAGICC/SCENGEN, temperature, precipitation.

ABSTRACT

The aim of the study is to present how global climate models of the IPCC AR4 (2007) project the regional features of climate change for the future. Computed changes in 21 coupled ocean-atmosphere general circulation models (OAGCM) are first presented for periods 2080-2099 and 1980-1999, for a few parameters such as cloud cover, sea-level pressure, runoff, and soil moisture. Precipitation and temperature results, projected by the same global models, are presented just for Europe. Besides the better visual indication, this Figure is an interface towards the second part of the study where the MAGICC/SCENGEN 5.3 diagnostic model (WIGLEY, 2008) is used to re-scale the results for the closer, 2030-2049 time slices. Its results are presented also for Europe. All the projections are based on the moderately rapid A1B emission scenario. Spatial resolution of these OAGCM-based scenarios is 2.5 x 2.5 deg.

INTRODUCTION

The IPCC Fourth Assessment Report (IPCC, 2007) suggests that similarly to many regions of the World, eastern and central European countries could become vulnerable to the global warming. Many investigations support these findings e.g. in the Carpathian Basin: next to rising temperature means, severe shortage of precipitation occurred in the last few decades, therefore, ecosystems is facing to high risk of ecological changes, as well. Parallel to the changes of precipitation, that are not unequivocal in space even within a water catchment (e.g. MIKA AND BALINT, 2000), frequent extreme events (e.g. floods or persistent droughts) may occur, result in unstable climate conditions and increased vulnerability of water management in the region. These facts highlight the importance of detailed climate research of the region.

RESULTS FROM THE GENERAL CIRCULATION MODEL OUTPUTS (2080-2099)

In the recent IPCC Report (2007) Chapter 10 displays maps of changes of several climate variables. The model simulations are based on the mid-range (A1B) SRES scenario (NAKICENOVIC AND SWART, 2000). The forecasted and control periods are 2071-2100 vs. 1980-1999.

In Figure 1 the average changes in cloudiness, sea-level pressure, runoff and soil-moisture content are presented for 2080-2099 compared to 1980-1999 according to the A1B scenario. The model-mean global mean projected warming is between these periods is 2.7 K.

Except the pressure changes, all fields are annual averages. The original figures are presented in colour. The signs in the figure are added by the authors for better understanding.

The projected changes in cloudiness exhibit rather simple structure: With the exclusion of a few smaller low latitude areas, the cloudiness is decreasing between the ca. 60th latitudes of both Hemispheres with increasing cloudiness in the rest of the Globe. The less clouds at the low and intermediate latitudes mainly contribute to the greenhouse warming since majority of these sectors are of positive radiation balance (both at the surface and at the upper boundary of the atmosphere).

In these sectors the lower cloudiness supports the short-wave radiation income to larger extent than the also increased outgoing long-wave radiation. At the polar latitudes the more cloudiness also contributes to the warming allowing smaller part of the energy in the long-wave part of the spectrum than the blocked the short-wave component.

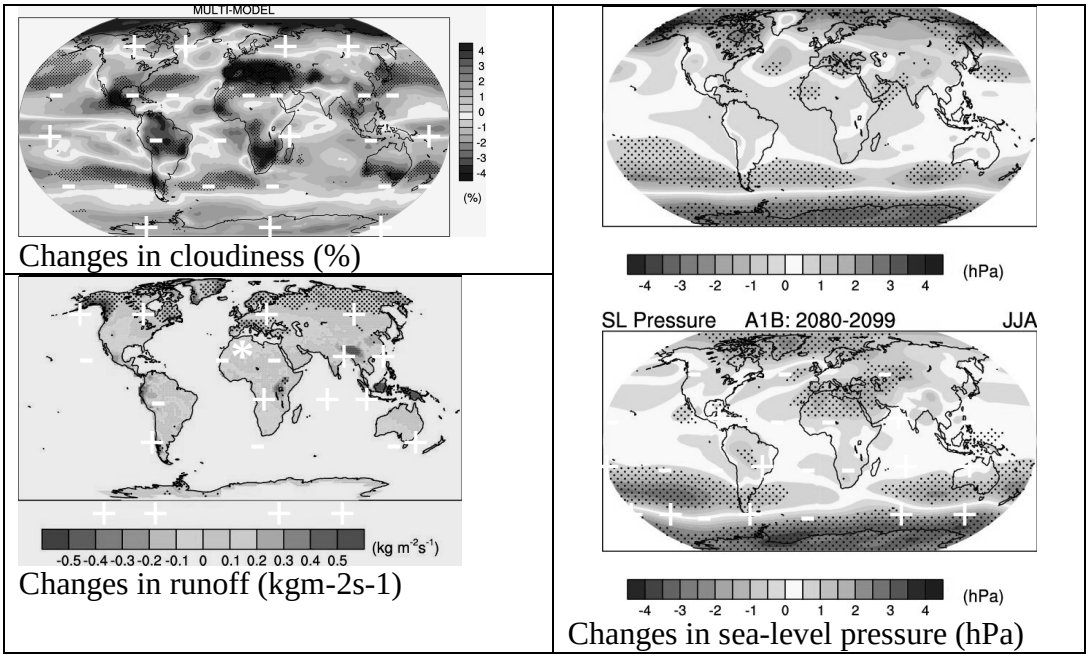

Figure 1: Averages of the projected changes in the selected indicators derived from the 19-19 available results. In a part of the figures area of significant changes are marked by points (source: IPCC WG-I, 2007: Chapter 10, Supplement)

Patterns of changes in the sea-level pressure do not show so simple structure. As expected from the law of mass conservation, there is a territorial balance between increasing and decreasing sectors of sea-level pressure. For majority of Europe significant increase of the pressure indicate more frequent anticyclones in winter. At the same time, in summer the pressure is decreasing over almost the whole continent.

Patterns of changes in runoff are also patchy. Decrease of runoff is projected at the lower temperate latitudes with definite continentality, expressed in decrease in the western and increase in the eastern parts of both Eurasia and Northern America. This feature is hardly explainable with hydrological causes since the zonal differences are the opposite to the availability of moisture sources! Particularly in Europe a clear zonal structure with increase in the northern and decrease in the southern parts of the continent is also distinguishable.

The large characteristic sizes of the changes with identical signs in both hydrological patterns may be partly caused by the coarse resolution of the models and the averaging among the individual model outputs, as well.

Next, in Figure 2 one can find the average modelled changes of temperature and precipitation for Europe in the extreme seasons, winter and summer. The warming has different patterns in winter and in summer with more similarity to the first one in annual mean. Strongest warming is expected in North-East Europe in winter and in the wide Mediterranean in summer. The latter peak is likely connected with the extra heat gained from the decreasing cloudiness (vs. with Figure 1). For Hungary the annual mean warming is over 3 K which is slightly higher than the global mean change of temperature. The change in winter is similar to the annual one but in summer the expected warming is close to the 4 K.

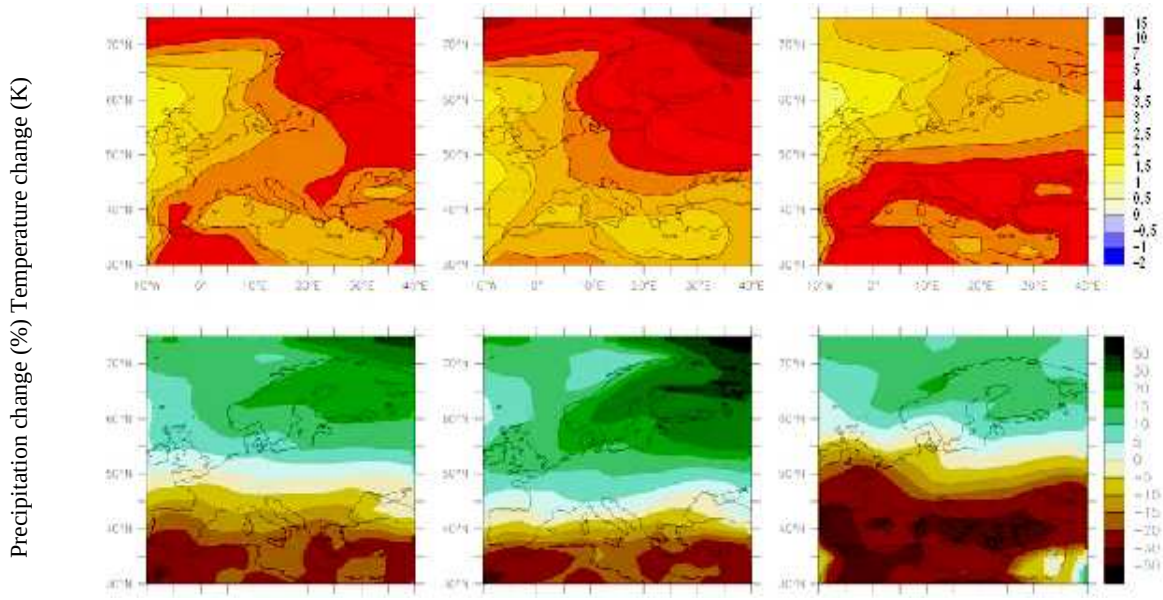

Figure 2: Model average changes of temperature and precipitation in Europe from the GCMs. Note the seasonal differences in the distribution of the changes. (IPCC, 2007, from Figure 11.5)

Precipitation has a clear zero-line with a surplus in the northern and decrease in the southern part of the continent. The line is rather southward in winter parallel to precipitation increase in most of the continent. In summer, however, the zero-line is situated more north-ward with a slight dominance of areas with decreasing precipitation over Europe. The position of this line in the annual mean precipitation is closer to the winter position than to the summer one.

For Hungary, the annual men precipitation change is close to zero according to the model mean. More problematic is the intra-annual distribution with increase of the input side of water balance in winter but strong (ca. -15 %) decrease in summer. This inequality of the distribution, together with the (also asymmetrically) increasing temperature, as a key factor of evapotranspiration, may also contribute to the projected decrease of soil moisture in Hungary (see in Figure 1).

DIAGNOSTIC RESULTS FROM THE MAGICC/SCENGEN V.5.3

In order to generate climate scenario on local and regional scales, a relatively simple tool, namely, the MAGICC/SCENGEN 5.3 software package (Wigley et al., 2003, 2008) was applied. All these newest GCMs were evaluated by the Fourth Assessment Report (IPCC, 2007).

Figures 3 and 4 demonstrate the seasonal changes in temperature and in precipitation for the European sector, respectively. The maps are rather patchy, intentionally not smoothed, though the MAGICC/SCENGEN software provides this alternative, in order to document the real resolution of the whole GCM-based approach. (Here, the patchy structure of the fields does not really allow marking the signs of changes in the black and white maps.) One should also note that these maps are derived from the above GCM-outputs, but linearly scaled to a more practical time period, closer (still from above) to the scope of any adaptation and planning.

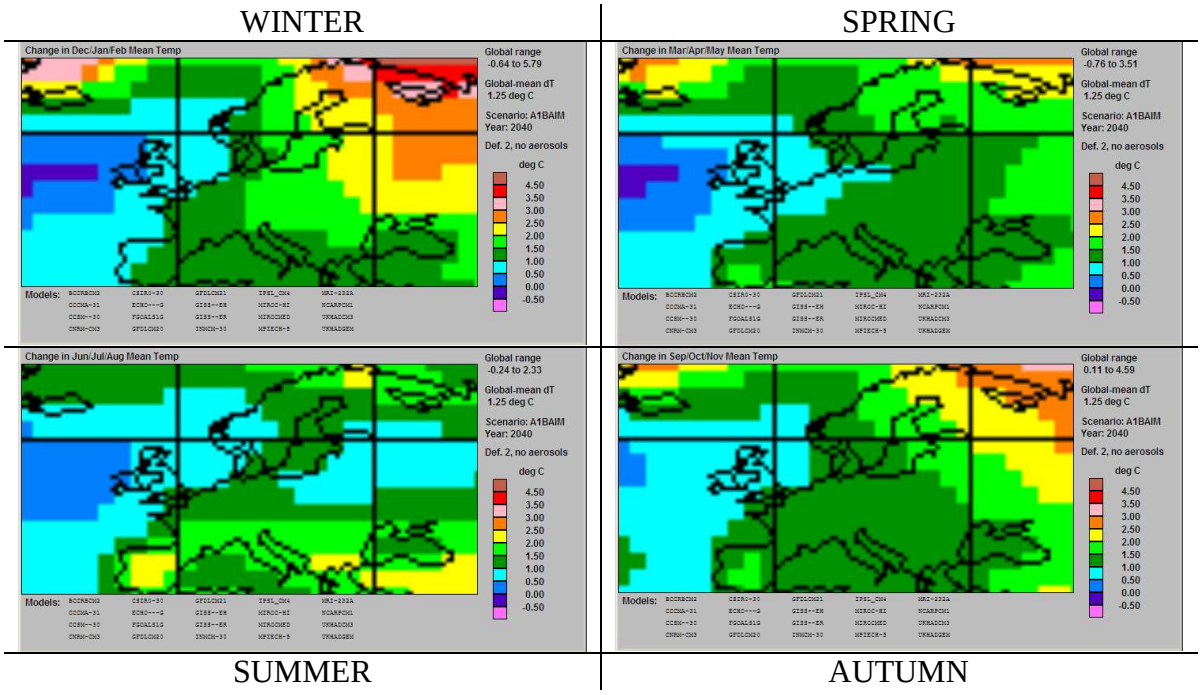

Figure 3: Model-mean changes of temperature computed by the MAGICC/SCENGEN for 2030-2049 compared to 1980-1999. The projected global change is 1.25 K. The strongest warming areas are found in the north-east and north-west sectors of the European region. The less warming is seen in the Atlantic with almost no change

Having a look at the temperature changes the three seasons except summer show the strongest warming over the north-eastern part of the continent with slight decrease toward south-west. In summer, however the Mediterranean region shows the strongest warming. The warming over Hungary is 1-1.5 K in the transition seasons, i.e. equal to the global annual mean warming. In winter and in summer the warming is slightly higher, 1.5-2 K in Hungary.

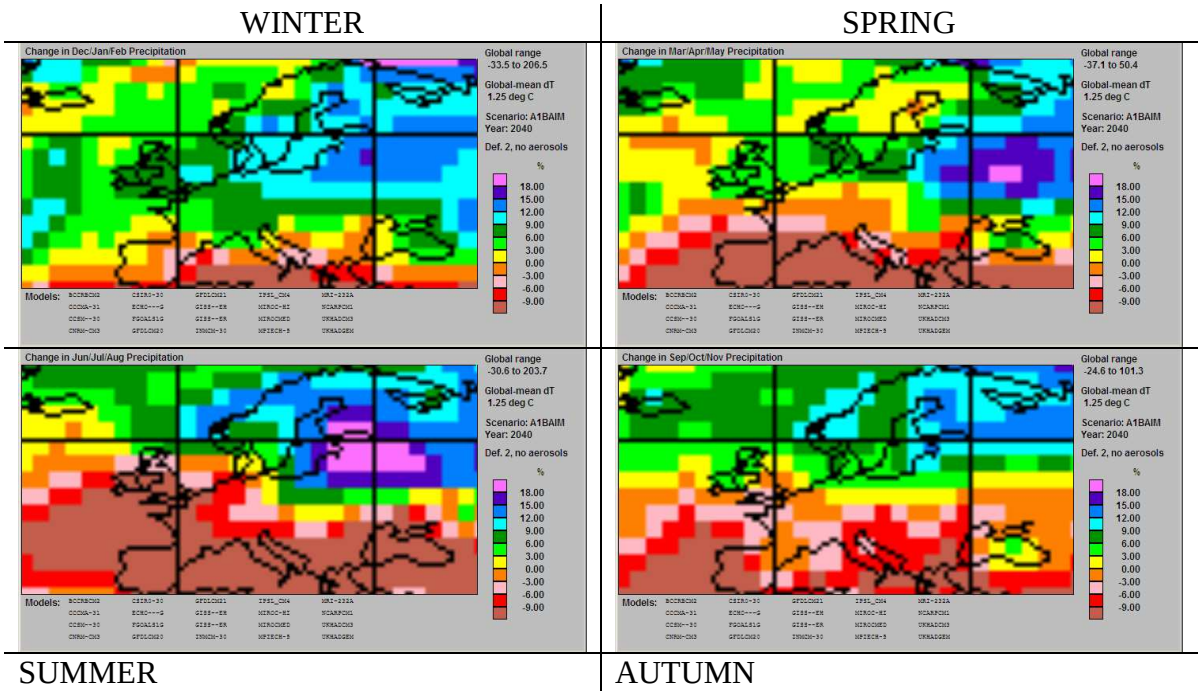

Figure 4: Model-mean changes of precipitation computed by the MAGICC/SCENGEN for 2030-2049 compared to 1980-1999. The projected global change is 1.25 K. The southern areas of Europe become drier, the north-eastern sectors get wetter. The borderlines between these sectors vary with the season

Precipitation changes in Europe exhibit the well known split between the wetting north and drying south with fluctuating borderline along the seasons (see also in Figure 2). The presence of mountains however disturb this simple structure to some extent e.g. in the Alpine Carpathian region.

The relatively small changes if global mean temperature lead to slight relative changes in Hungary, only. The summer decrease is -3 − -6 % which is partly balanced by +3 − 6 % increase in winter. (In absolute value this is an annual decrease because of the differences in the 100 %!). Similar dichotomy is present in the transition seasons in Hungary with +3 change in spring and -3 % in autumn.

DISCUSSION

Nowadays the regional features of climate change are mainly based on finer resolution models imbedded into the mainframe GCM results of which were presented above. However, diversity of these results sometimes even in signs, e.g. for precipitation is several seasons (Christensen et al., 2007; van der Linden, P. and J.F.B. Mitchell, 2009) is a challenge to solve before finally neglecting the other sources of information applied in the impact and adaptation studies. One reason of the diversity of regional model results may be the difference between boundary conditions taken from the mainframe models. This problem is presented by Figure 11.6 of the IPCC (2007) Report, where two different mainframe models led to different responses in the same regional model, even in the sign of precipitation change in many sectors of Europe.

Hence, (i) no single GCM output can be applied for adaptation-related consequences, and (ii) the embedded regional climate models aimed to overcome the differences between the GCM-resolution and the significant scales, are strongly influenced by the boundary conditions. This means that, though coupling the GCMs with regional models really promise better results, we should not forget about this uncertainty of the mainframe GCMs.

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International Relations of the Hungarian Meteorological Service

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Keywords: WMO, ECMWF, EUMETSAT, EUMETNET

ABSTRACT

Meteorological observations have a great tradition in Hungary. Earliest records go back to the 11th century. Buda was member of the first world network called Societas Meteorologica Palatina. The Hungarian Meteorological Service (OMSZ) was established 140 years ago. Its predecessor was supported by the Austrian partner institute (ZAMG). Hungary was one of the twenty founding countries of the International Meteorological Organization. Since then International co-operation plays an essential role in all activities of the OMSZ. Experts represent our country and the national meteorological service in twenty organizations. The lecture presented the main activities of the four most important international meteorological organizations in a nutshell.

WMO (WORLD METEOROLOGICAL ORGANIZATION)

WMO is a special agency of the United Nations to ensure the co-ordination of the meteorological, hydrological and geophysical activities on global level. WMO is called the UN's voice on weather, climate and water. It has a membership of 189 Member States and Territories. The Hungarian State has been a member of WMO since the establishment of the organization in 1950.

The WMO connects and coordinates international data collection and data exchange, organizing data transmission lines, promoting the establishment of data collecting centres and coordinating the respective endeavours. It provides the members continuously with information about the developments in meteorology. The organization maintains training centres and finances the participation at some of its events or supports the expenses of organization. It organizes support special programmes for member states and especially for the least developed countries.

WMO organized three Congresses on climate change. All of them had fundamental effects on the establishment of other international organizations. Figure 1 summarizes the main Events, Programmes, Forums and outcomes. The five major scientific, technological and geopolitical developments inspire UN General Assembly (UNGA) Resolution 1721 (XVI) which triggered the establishment of the WMO World Weather Watch (WWW) and the WMO-ICSU Global Atmospheric Research Programme (GARP) and, later the convening of the 1972 United Nations Conference on the Human Environment (UNCHE).

WMO EC (Executive Committee) triggered the convening of the 1979 World Climate Conference (WCC-1) and the establishment of the four-component World Climate

Programme (WCP), including the WMO-ICSU World Climate Research Programme (WCRP). The 1987 report of the World Commission on Environment and Development (WCED), the 1988 Toronto Conference and the First Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

The Second World Climate Conference (WCC-2) in 1990 led to the establishment of the Global Climate Observing System (GCOS) and the negotiation of the UN Framework Convention on Climate Change (UNFCCC). WMO sponsors and hosts four of their Secretariats. The chart also depicts the proposed evolution of the service-oriented components of the WCP into a more integrated World Climate Services System (WCSS), built on GCOS and WCRP.

The contemporary third World Climate Conference (WCC-3) held in Geneva 2009 aimed to produce a new Global Framework for Climate Services. (http://www.wmo.int/pages/gfcs/gfcs_en.html)

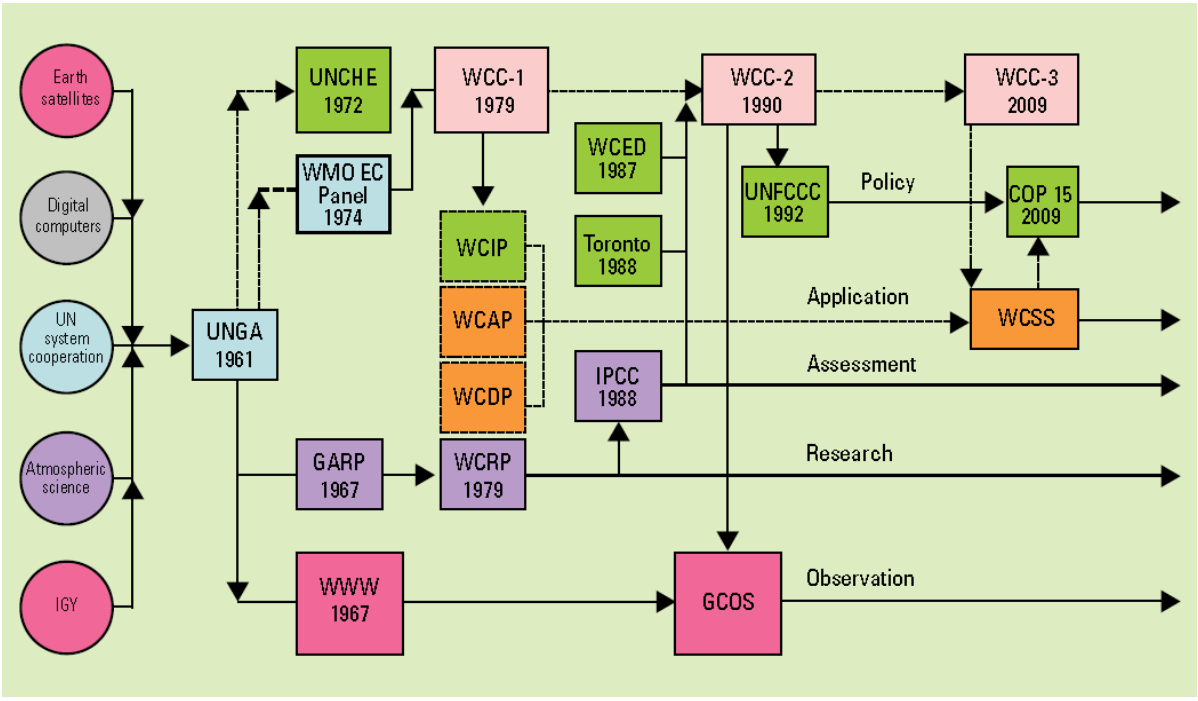

Figure 1:
Emergence of climate as an international scientific and political issue resulted in the establishment of the main international organizations.
Source: WMO Bulletin

ECMWF (EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS)

One of the basic tasks of meteorology is to prepare weather forecasts for different time ranges. Western European countries established a joint forecasting centre in 1974 in order to prepare forecasts applying mathematics and computer technology requiring super computers. ECMWF leads the world in global Numerical Weather Prediction, the advanced computer observation-analysis modelling techniques used for predicting the weather.

Hungary joined this centre as a co-operating state in 1994. OMSZ receives all the results of the global model of the centre in Reading, we can participate in the developments, obtain the scientific and technological results of the centre and our colleagues may compete for the vacant jobs there.

ECMWF is contributing significantly to climate change studies. One of the most valuable innovative approach known as re-analyses. Observations collected over decades are fed into modern Numerical Weather System to recreate the past weather circumstances. The latest ECMWF re-analysis products provide increasingly accurate representations of climate variability and trends (e.g. ERA-40 goes back to 1957). A second important contribution is emerging with the concept of seamless systems unifying weather and climate predictions. There are important synergies between Numerical Weather Prediction and Climate Prediction. Thirdly ECMWF's core activities will contribute to the adaptation of societies to climate change. As severe weather events are likely to increase in frequency or magnitude with climate change, early warnings will become even more crucial for mitigating the consequences of these events. The ECMWF strategy prioritizes the improvement the early warning of severe weather and improving forecasts from days out to seasons.

EUMETSAT (EUROPEAN ORGANIZATION FOR THE EXPLOITATION OF METEOROLOGICAL SATELLITES)

Western European countries established an organization for launching, operating meteorological satellites and utilizing satellite information. Hungary joined the organization as a co-operating state in 1999. Since then we have been receiving all the transmissions of the METEOSAT satellite via a special coded line. This means data measured in visible, infrared and other thermal channels and different vertical soundings. The Organization provides opportunity to participate in its developments and trainings. Beyond data supply it finances the participation in its numerous meetings. As a full member since 9th October 2009 we have the right to vote in the Council, take part in the decisions and participate as consultants in the SAF (Satellite Application Facilities) programmes, and even take part at industrial competitions.

EUMETSAT contribute to the operational monitoring of the climate and the detection of global climate changes. In order to effectively monitor climate change a list of 45 essential variables (ECVs) has been developed by international organizations. Satellite data providers have central role to play in the generation of ECVs. Most of these data require continuous, stable, independent and long-term (at least 30 years long) records of satellite observation data.

The EUMETSAT network offers this range of data, products and infrastructure in support of climate monitoring, such like data and products from Meteosat, the EUMETSAT Polar System and Jason/OSTM. Unique archive of historical satellite data dates back to 1981. Satellite Application Facilities (SAFs) provide application specific processed data, software tools and services. Recently 8 SAFs provide useful products for climate studies.

EUMETNET-EIG (NETWORK OF EUROPEAN METEOROLOGICAL SERVICES - ECONOMIC INTEREST GROUP

Western European National Meteorological Services (18 institutes) established a professional co-operating organization in 1995. The co-operation refers first of all to realization of professional projects. There are professional programmes for the maintenance of a joint radar network, harmonized climate research, maintaining and improving the part of the WMO's uniform observation network due to the member states and organizing the data exchange within it, harmonized development of new observation instruments, unification of meteorological trainings and for environmental utilization of meteorological information. Our efforts to join EUMETNET were successful in 2003. Since then 22 programmes have been established, at present 15 is active. OMSZ participates in 10 specific programmes.

Recently ECSN (European Climate Support Network) is one of the programmes, which is co-operative project of EUMETNET in the fields of climatic data bases, climate research and applications. The objective of ECSN is to organize improved co-operation of its Members in the field of climate and related activities in order to expand their capabilities to support the European user community through enhanced provision of high quality climate data and products, services and advice based on the climate expertise of the members. Basically EUMETNET activities on climate focus on integration, standardization and coordination between members in order to support them for the provision of advanced climate information services.

SUMMARY

Because weather knows no country borders, the international relations are the backbone of the activity of any national meteorological service. All work including observation, weather forecasts, alerts and climate related services need daily routine between organizations. OMSZ as representative of Hungary actively participate in WMO, EUMETSAT, ECMWF and take part of many programmes of EUMETNET. The long-term plans of these organizations determine the future of meteorology.

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Relationship between climate change and insects

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ABSTRACT

Climatic factors can have significant influence on insects directly (e.g. via the various development states) and indirectly (e.g. via their host plants) as well. Change in each of the climatic elements (e.g. temperature, moisture, etc.) may results in a wide range of reactions.

Some typical examples in the case of a forest insect community:

- Change in the distribution area: more preferable environmental conditions (for insects) enable the extension of the distribution area of the species (mainly towards the north or higher elevations). Example: thuja bark beetles.
- Change in swarming time and generation cycle: earlier or later swarming than usual; possibility of the development of more generations due to the warmer climate; more frequent and longer outbreaks. Example: leaf beetles.
- Occurrence and damage from species that cause no economic damage before. Example: beech splendour beetle.

All these changes are generally accompanied by the reduction of the vitality of the host-tree species and they contribute significantly to the development of various damage chains as well.

INTRODUCTION

Effects of climate change are so wide ranged that only listing them would fill a book. This short summary discusses only one relation and even in this respect not in all respect. The aim of this paper is to analyse briefly the relationship between various elements of the climate (temperature, precipitation, air moisture, extremities, …) and insects. Special emphasis is on the direct and indirect effects on insects living in forest biocenoses.

Climate of Central Europe experienced significant changes at several occasions during its geological development. Ace ages and warmer periods replaced each other causing changes and migration in the flora and fauna time-to-time (HEWITT, 2000). Of course, not all plant and animal species could accommodate to these changes, many of them perished. Climate changes even today. In contrast to changes in the past, however, this change is faster and probably man could play a role in the speeding up of the process. The change is likely to put forward a challenge to the biosphere. It is very hard to predict the way and speed of response from animals. Even if we study the climate changes of the geological past we cannot tell which species will shade away. Maybe we have a better chance in predicting which species will start to migrate in great mass shifting not only the border of their territory but the region of their occurrence as well.

Fauna usually respond strikingly to the change of climate (BOTH ET AL., 2006). Effects on the flora are also significant, their limited mobility, however, impedes spectacular reactions though there is no lack of response at all. The effect of changing carbon dioxide concentration in the atmosphere on the composition and quantity of chemical compounds in plants can be measured accurately. Buffer capacity of certain plant species can be significant 'hiding' the effect until the change exceeds the buffer capacity.

Effects on animal species differ significantly as well. There are animal species of wide tolerance, occurring in areas with extreme climate and animals with narrow tolerance can also be found. The former include for example rats that occur everywhere from tropic regions to arctic areas. The latter involve corals for example that response with mass extinction to a few tenth of °C change of sea temperature. Of course, changes and effects can be studied not only from temperature point of view. Role of the amount of precipitation and related to this the moisture content is just as important.

In the case of insects their enormous species number has to be emphasized. Half (!) of the animals known at present (around 700 thousand species) are classified into this group and it is likely that the number of unidentified species is high. Insects show reactions similar to the above mentioned ones. In the case of herbivorous insects indirect effects are also significant, i.e. effects induced by changes in the host-plant. A fine example for this is shifted shooting time and the changed chemical composition of the texture of the plant as a nutritive material. Further interrelationships cannot be ignored either as there are close connections among the plants as food, the insects living on them and the animals eating them, the breaking of which may induce unexpected events (e.g. mass reproduction, damage-chain).

EFFECTS OF CLIMATE CHANGE ON INSECTS

Analysing effects on (vector) insects hosting various diseases would worth a separate chapter. Man frequently has a bitter experience of these effects (e.g. occurrence of new blood-sucking mosquitoes) and they have significant human and animal health effects as well. The chikungonya fever appearing in North Italy can be mentioned as an example. The special about it is not the fact that a European man imported an illness from a tropical area but that the disease is able to spread in European conditions and by European transmitters (mosquitoes) causing mass maladies.

Forest biocenoses – at least in the case of natural or close-to-natural woodlands – are based on very complicated relationships. Each element in the food-chain (e.g. span-worm eating the leaves of an oak, tit eating the worm, beech-marten easting the tit, …) is associated to climate elements by a thousand threads (SEPPÄLÄ ET AL., 2009).
The changes of what elements influence significantly insects of a woodland? Apparently the most significant is the effect of temperature. Change in the absolute value as in the case of appropriate nutrient supply only this determines the development of insects. The possible number of generations of one species to develop in a given time period can be calculated from the annual heat-sum. Absence of winter colds can be classified into this group as well resulting in increasing number of certain pestiferous species. A general example is the wood-borer species, *Dendroctonus ponderosae* destroying in British Columbia (KURZ ET AL, 2008) pine woodlands over an area bigger than the size of Hungary. Warmer winter time periods however, cause break in the resting state. Insects 'woken' from this winter resting state may die due to the lack of food, or pupas wintering in the soil can be drowned in the occurring groundwater.

Changes in the development and generation cycle of insects due to rising mean temperature were proved in several cases for Hungary (CSÓKA ET AL., 2007). Caterpillars of certain defoliator moths (primarily geometrids) hatch out from the eggs and reach the pupa and adult state much earlier than before. Beetles developed for two years earlier can reach adult state within one year as a result of increased temperature and deteriorated host-plants and they might even turn to harmful from a former neutral (or at least not causing damage) state. As an example the jewel beetle (*Phaenops cyanea*) occurring on pine trees or the beech splendour beetle (*Agrilus viridis*) causing mortality to beech trees could be mentioned (MOLNÁR & LAKATOS, 2008). Number of generations developing within one year also changes. One generation of spruce bark beetle (*Ips typographus*) characteristic in high mountains and the two generations characteristic in lower mountains and hills increase to two and three generations respectively (LAKATOS, 2006). Occurrence of extremities can have significant effects as well. Early or late frost weakens host-plants on which insects can become abundant. Even the behaviour of the insects can change. Larvae of puss moth (*Cerura vinula*) used to eat the upper levels of the tree crown but now they move to the lower parts.

Changing climatic conditions often change the distribution areas of insects as well. In general, the distribution area of several insects is shifting towards the north parallel to the host-plants (JUMP ET AL., 2009). This may mean that new species occur in Hungary coming from the south and also that other species leave the Carpathian Basin towards the north. Changes can appear in a wide range of forms. Species moving towards the north from the Mediterranean include for example oleander scale (*Aspidiotus nerii*) and cypress bark beetle and thuja bark beetle (*Phloeosinus* species). Ithomiola butterfly species that do not die during winter because of the warmer climate are also significant as they lay eggs now in spring and the next generation occurs now in spring. Such species are the cotton ballworm (*Helicoverpa armigera*) and the silver Y moth (*Autographa gamma*).

Increase in the damage area was detected in the case of the following insects in Hungary: brown-tail moth (*Euproctis chrysorrhoea*); totrix moths (*Tortrix viridana, Archips xylosteana,* …), acorn weevils and other weevils (*Curculio spp*.) and various bark beetles (*Ips typographus, Ips sexdentatus*) (HIRKA, 2009). Damage also occurred in the case of species that lived in woodlands but caused no economic damage earlier: beech splendour beetle (*Agrilus viridis*), oak philloxera (*Phylloxera quercina*) and oak processionary moth (*Thaumetopoea processionea*).

Invasive species that get into a new environment by man and able to establish there have to be discussed separately. Their presence is not always associated with changing climatic factors although their effects might be significant.

SUMMARY

Climatic factors have significant effects on insects in both direct and indirect ways. Changing of given climate elements (e.g. temperature, precipitation, moisture content) may result in a wide range of reactions.

A few typical examples for forest insects are the following:

- Changes in swarming time, generation cycle: swarming earlier or later than usual; development of more generations due to warmer climate; more frequent and longer periods of mass reproduction. Example: wood-worms and greenflies.
- Changes in distribution areas: favourable environmental conditions enable the expansion of the distribution area of certain species (mainly extension towards the north). Example: cypress bark beetle and thuja bark beetle, cotton ballworm, silver Y moth.
- Damage of species that were not considered as pests earlier. Example: beech splendour beetle

All these changes frequently accompany the reduction in the vitality of the host-plant and contribute significantly to the development of various damage-chains.

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Section 2
Landscape and Environment

Challenges for Land Use in the 21st Century

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Keywords: Sustainable development, land use externality, governmental regulation

ABSTRACT

The turn of the last century marked a new calendar era as it coincided with the turn of the millennium. The beginning of a new calendar era is often accompanied by propositions and promises. In this spirit, 192 member states of the United Nations assembled at the Millennium Summit in 2000 and agreed on eight international development goals. These goals included many land use related objectives such as mitigation of malnutrition, poverty, and water deficiencies; preservation of biodiversity, and assurance of environmental sustainability. Here, I will address some implications of societal development goals for land use in this century. I will start with a review of sustainability. I will then proceed with a brief discussion of land use services, opportunities, and challenges. Finally, I will draw some conclusions for the role of government in promoting optimal land use.

SUSTAINABLE DEVELOPMENT

The terms sustainability and sustainable development are frequently used by politicians, scientists, company representatives, and the general public. While most users may have an intuitive understanding of these terms, many may be unable to provide an exact and adequate definition. Others may choose particular descriptions distinctly different from one another.

The Brundtland definition of sustainability (Brundtland 1987) refers to human needs and human ability. Human needs relate to the consumption of goods and the utilization of services. Needs may contain virtual goods such as satisfaction from the perceived state of human societies and the environment. There is little theoretical foundation for the determination of sustainable needs. Clearly, a lower bound exists which reflects the biological minimum requirements for long-term survival. Biological requirements include minimum food and water intake levels and protection against life threatening environments. However, the majority of people including many political leaders would argue that assurance of survival would be an insufficient sustainability criterion. Many would relate sustainability to conditions that permit every person to live a sufficiently happy life in dignity and with a certain degree of freedom to pursue ideas and visions.

Sustainability is linked to efficiency, equity, happiness, and freedom (Figure 1). A high degree of efficiency facilitates the satisfaction of human needs. Inefficient allocations of resources, goods, and services, which result from market failures, decrease sustainable consumption trajectories. On the other hand, fully efficient resource allocations (from the current generation's perspective) may lead to unsustainably high consumption patterns. Thus, sustainability and efficiency are related but they are not equivalent.

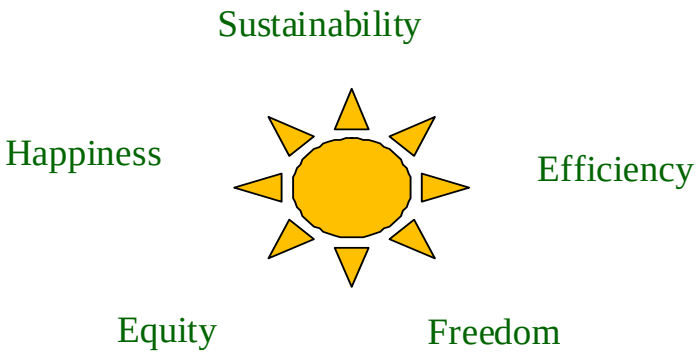

Figure 1: Basic development objectives

Equity concerns the treatment of inequality i) within a generation (spatial equity) and ii) between generations (intertemporal equity). In the context of sustainability, equity translates the aggregate needs of the human population to the needs of individual persons. A society in which at least some people die of malnutrition and poverty does not meet the above definition of sustainability. Inequality within a generation can be corrected through governmental redistribution of wealth. Theoretically, this inequality correction could range from zero (free market economy) to full redistribution of wealth with the latter leading to total equality.

Freedom is another aspect of human life that is strongly related to efficiency, equity, and sustainability. The absolute freedom of an individual person is restricted by property endowments, biological and technical ability, societal rules and laws including other people's rights and duties, and the environment. Civil liberties constitute basic needs for a happy life in dignity and thus are essential for sustainability. Economic freedom defined as a free market system with protected private property rights can promote sustainability through efficiency in the allocation of resources, goods and services through exchange markets.

LAND USE – SERVICES, OPPORTUNITIES, AND CHALLENGES

The land surface is a fundamental resource of our planet. It serves as foundation for terrestrial ecosystems and - since the emergence of modern humans – as foundation for managed agricultural and forest systems, and residential and industrial complexes. Modern human beings emerged about 50 thousand years ago. Within the last ten thousand years, deforestation slowly increased and about 150 years ago it accelerated substantially. An exponentially growing population needed more and more land for agriculture and settlements. It is estimated that about half of all natural forests have been converted. Agriculture occupied about 38 percent of the global land area in 2005 (FAOSTAT, 2007). If agriculture would expand at the current rate of population growth, it would use an area equivalent to one half of the current terrestrial land area by 2030 and an area equivalent to two third by 2070 (SCHNEIDER ET AL., 2011).

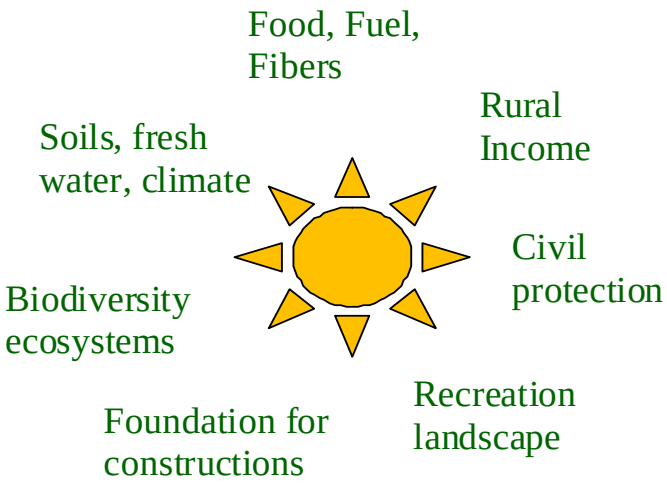

Figure 2: Land use impacts on society

The land resource and its goods and services are essential for the security of food, water, energy, climate, and ecosystems (Figure 2). While the quantitative targets of these sustainability objectives may be debated and may change over time, they are intrinsically linked to land use and land management. The optimal development of land from the society's perspective faces several principal challenges. First, some of the land use related objectives compete with one another. Particularly, food production, dedicated bioenergy plantations, and dedicated nature reserves are mutually exclusive.

Second, several major land use impacts are external to decision makers. Water pollution, greenhouse gas emissions, and habitat degradation are often not or at least not fully internalized. As a result, many current land management systems do not yield the societal optimal balance between conflicting objectives but respond mainly to selected market-driven demands. Unfortunately, full regulation of all land use externalities is difficult because a) many external impacts arise from heterogeneous non-point sources and thus are costly to monitor and regulate, b) the societal costs of resource degradation (soil, water, atmosphere) are diverse, complex, and uncertain and thus are difficult to value, c) full regulation would pose heavy restrictions on the freedom of choice, and d) external impacts often cross national borders and require international policy agreements.

The incomplete internalization of social impacts from land use has also affected the technological development of land management systems. Most current systems aim at efficiency in producing food or bioenergy. Relatively little attention is given to the development of management systems which maximize joint benefits over the entire suite of economic, societal, and environmental impacts. Such systems include multi-functional agro-forestry systems or extensive animal grazing systems both of which may combine food and bioenergy production as well as wildlife, soil, and landscape preservation.

GOVERNMENTAL REGULATION OF LAND USE

In this section, I focus on two essential policy questions. First, what can policymakers do to promote sustainability in light of the above discussed limitations and uncertainties? Second, what should policymakers not do? In attempting to answer these questions, I begin with

addressing the problem of resource competition which especially concerns land. Competition only leads to efficient resource allocation, if there are no market failures. Unfortunately, land use impacts include several unregulated externalities and private decision-making is therefore inefficient for society. For example, lack of penalties for ecosystem destruction, soil degradation, and greenhouse gas emissions is likely to lead to relatively high deforestation rates. Since ecosystem services and greenhouse gas emission damages are difficult to value and uncertain, a first best internalization is not feasible at present. Nevertheless, there are some policy actions which may be justified by the following arguments. i) Greenhouse gas emission damages from deforestation can hardly be compensated through greenhouse gas emission savings from subsequent bioenergy plantations. ii) Ecological losses from destroyed ecosystems are substantially higher than ecological benefits from restored ecosystems. iii) The size of remaining undisturbed ecosystems has declined below critical levels in many regions and for many types. Thus, from a society's point of view, it may hardly be desirable to convert more functional ecosystems into agricultural lands or intensively managed forests. Instead of working out overcomplicated certification systems to avoid so-called indirect land use changes from food and bioenergy production systems, a much more efficient policy option would be to protect all remaining valuable ecosystems at global level. Market forces, however, may be left to decide on the allocation of all managed lands between alternative uses. From a greenhouse gas emission perspective, forest and ecosystem protection would have more external benefits.

To achieve an optimal allocation of managed lands, all major externalities on these lands must be internalized. The problem of non-point sources could be remedied in two alternative ways. One solution would be to use a second best policy where the externality is indirectly regulated through a policy on a correlated, easier to monitor activity. For example, nitrous oxide emissions from fertilization might be approximated based on information about fertilizer applications. Another solution would be to develop cost-efficient monitoring technologies which would allow a proper internalization. It should be considered that the advancement of these technologies is a dynamic process which often accelerates after policy introduction.

The problem of large uncertainties about external damages from managed agricultural and forest lands remains difficult to solve. These estimates on damage functions are necessary for adequate internalization of externalities. Given potentially large savings from better information, governments should carefully examine investments in suitable research and data collection technologies which include land use monitoring systems. Only if we have adequate understanding of the complex and heterogeneous impacts of land use, we are able to steer them in the most beneficial way for current and future generations.

SUMMARY

Sustainable development is closely linked to land-use. Because of many environmental externalities, market forces alone are highly unlikely to promote an efficient and sustainable land-use development both at local and global scales. Governmental interference may improve the overall land-use efficiency from a societal perspective. However, governmental regulations must be carefully designed and scientifically supported to avoid excessive policy transaction costs in a sector characterised by diffuse non-point impacts. A certain level of biodiversity hotspots and old growth forests should simply be preserved through a globally negotiated network of protected areas. The optimal balance between food and non-food production should be largely left to market forces on existing and degraded arable lands.

Water and air pollution impacts require more cost-efficient monitoring technology. Until this technology is available alternative regulations may be used. Different environmental standards in different countries need to be compensated through border taxes or producer compensation in regulated countries. Finally, governments need to make a forward-looking decision on spending for research and development related to land use systems.

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Climate change impacts on crop production

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ABSTRACT

Agriculture in general and crop production in particular are highly affected by climate change impacts. Results of recent climate change researches have highlighted, that climate change impacts may influence production efficiency, quantitative and qualitative deterioration of crop yields produced for alimentary purposes, and determine post harvest manifestation of agricultural products inducing hazard in the field of food safety, transport, storage and distribution.

The problems of any of these fields are many fold:

- High variability of yield performance in accordance with weather extremities.
- Economic losses in agricultural and food production.
- Quantitative and qualitative deterioration of food and feed products.
- Lack of sustainable long term vertical and horizontal technology structures.
- Limited chances for forecast and prevention, as well as for technological implementation.
- Environmental hazards affecting agro-ecology as a whole.

ADAPTATION TO CLIMATE CHANGE IMPACTS

The main tasks of science, practice and policies regarding adaptation to climate change impacts are as follows:

- To develop agrotechnology and apply to novel biological bases in favour of higher economic turnover in agricultural food production,
- To maintain ecological equilibrium of production sites regarding organic matter, soil fertility and biodiversity,
- To secure food production while establishing energy cropping structures,
- To create new job possibilities and challenges in the rural sector,
- To establish sustainable cropping and landscape preserving systems in favour of environmental protection and nature conservation,
- To provide a quality management system to cover all technological aspects in the food production chain from soil tillage to post harvest stage,
- To provide a technological basis that may serve future assurance and hazard management systems.

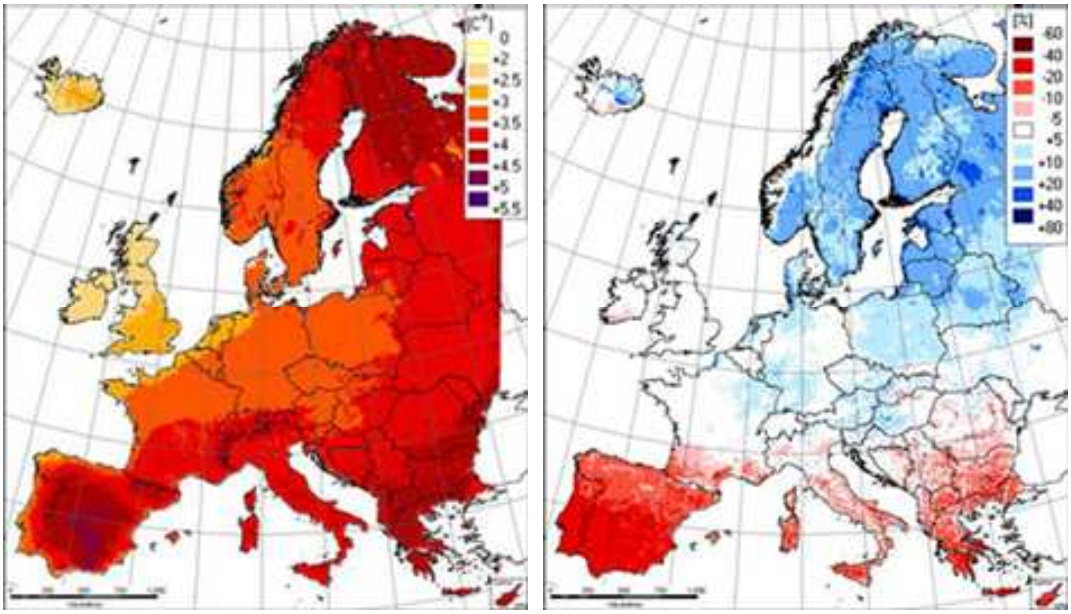

Figure 1: IPCC A2 scenarios for temperature and precipitation
Source: EU DG Environment „Green book" 2007

"Green book" statements and directives are based on the IPCC A2 scenario. 3-3,5°C temperature rise and -5 - +5 %rainfall change compared to 1961-1990 years mean is scheduled for Hungary by the end of the century

MAIN CLIMATE CHARACTERISTICS IN HUNGARY

In case of Hungary two facts can be observed in the Carpathian basin. In first place the ascending levels of temperature rise, with a magnitude of 1 °C. The other is the decreasing trend-line of annual precipitation according to what, during one century 83 mm rainfall has disappeared. Hungary is a country in the centre of Europe with a most peculiar geographic location regarding the possible impacts of any sort of climatic changes. The climate of the region has always been highly variable.

Table 1: Main climatic characteristics

Annual precipitation	580 mm
Annual mean temperature	11°C
Altitude	78-1014 m
Heat amount in vegetation period	1280-1465°C
Dry matter production	8.3-17.6 t/ha/year
Photosynthetic active radiation	1518-1612 MJ/m^2
Annual snow coverage	41 days/year

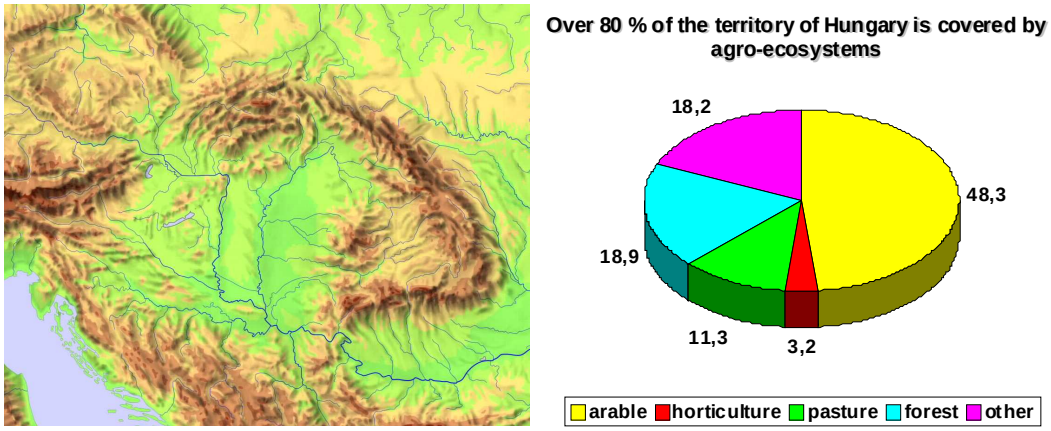

Figure 2: Ggeographic location and land use distribution of Hungary

VAHAVA PROJECT

Expert teams of various fields of agriculture have been working within the framework of the national VAHAVA project. The main task of this work was to study climate change impacts and possible responses in the respective fields. The working hypotheses of the project were as follows:

- The warming of the climate will be stronger in the Carpathian Basin;
- We may expect the decreasing of annual average precipitation;
- The number and intensity of extreme weather events will be increasing.

RESULTS OF RESEARCH

The report of the project was edited in 2007. The results of expert teams were summarized in that. The following passages present a digest of the report's crop production postulates.

- Climate change impacts in crop production can be prevented or reduced by the following measures. Water preserving soil tillage that may contribute to storage of higher amounts of annual precipitation. Increment of irrigation. Novel crop production technologies, breeding and use of drought tolerant crop varieties. Establishment of appropriate cropping structures and crop rotations.
- Water supply of crop production involves three major sources; annual precipitation in rainfed cropping depending on the amount and distribution as well as the preservation and storage of that; irrigated cropping where rainfall is considered as additional or modifying means of water supply only; and flood irrigation systems that are mainly independent from precipitation impacts. In favour of preventing harmful climate change impacts the two latter cropping systems should be given priority in the future.
- Climate change impacts may have an influence on the trends of temperature as well as on the vegetation period of various field crops. Ascending levels of temperature induce alterations in the physiological requirements of heat amount. This may result in a change of duration of crop variety vegetation periods, and also, there is a chance for alterations in yielding ability, winter hardiness, phenological phases etc.
- Warming and drying may have an effect on plant nutrition. In general there is a scientific evidence that high levels of mineral fertilization may counteract the harmful effects of drought. In particular there are several crop species that may respond with yield declines in case of permanent drought. Abundant nutrient supply may result in higher concentrations that may be less beneficial to crop performance. Optimal soil conditions are required for better crop plant development.

- Abiotic stress resistance of wheat varieties is a major issue in Hungary. The major task of plant breeding is to provide high yielding wheat varieties of marketable quality, that are less susceptible to climate change impacts. Any variety has to meet a threefold demand: grain quality, quantity and yield stability.
- Seed production is a field where climate change impacts may have both positive and negative effects. Arid conditions and weather extremities may risk the results of seed production and processing. On the other hand climate change may contribute to favourable conditions that is essential for producing seed of new species and varieties.
- Agricultural mechanization is also facing new challenges induced by climate change. Such are: Technology improvements (water preserving tillage technologies); combined or reduced number of field operations (to prevent or lessen unfavourable soil conditions); more quick, flexible and efficient machinery; security equipments (installation of special machinery for emergency uses only); propagation of tram line production systems; use of adapted machinery.
- Agricultural mechanization may have a major role in mitigation processes, like CO_2 emission control and carbon sequestration. Specific tillage technologies, mulching and appropriate stubble operations may contribute to a better soil water budget.
- Plant protection is highly affected by climate change. There is an invasion of new plant diseases, insect pests and weed species. To counteract the harmful effects improved methods of prevention, defence and remediation are needed. The major fields of that are as follows: comprehensive and efficient forecasting systems, extension services, integrated pest management, application of high tech implements, site specific precision methods. Genetic resistance and/or tolerance of crop plants has to be improved by breeding. Means of biological control has to be studied and applied.
- A most peculiar field of agriculture is the grassland and pasture management. In Hungary over 1.1 million hectares of grasslands are exposed to climate change impacts, but on the other hand provide new adaptation chances for agriculture and for the country as a whole.

SUMMARY

Recent results of climate change research revealed, that climate change impacts may influence production efficiency, quantitative and qualitative deterioration of crop yields produced for alimentary purposes, and determine post harvest manifestation of agricultural products inducing hazard in the field of food safety, transport, storage and distribution. Agriculture as a whole, and within that crop production as a specific field are highly affected by climate change impacts. The present study summarizes the possible fields of adaptation processes in Hungary.

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AtCRK5, a CDPK-related Serine/threonine Protein Kinase may Participate in Regulation of Salt Tolerance in Arabidopsis Thaliana

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Keywords: CDPK-related kinases, *Arabidopsis thaliana*, primary root, salt tolerance

ABSTRACT

Plant growth and development are seriously affected by several abiotic stress factors like drought and high salt concentration of soil. Adaptation of plants to constantly changing environmental conditions requires significant molecular and physiological responses from these sessile organisms, which makes sustained growth and survival possible for them. Salinification of soil is one of the most important problems of the modern agriculture since different crops can tolerate different levels of salinity. The tolerance of plants to salinity is mainly influenced by the climate, but other factors, e.g. soil types, plant rootstock or stage of plant growth are also determinative. Due to the global warming of overall climate, it is an increasing demand to breed plant cultivars tolerant to high salt concentration in order to improve their chance to survive deleterious effects of hyperosmotic conditions.

Here we describe a preliminary characterization of a CDPK (Calcium Dependent Protein Kinase)-related protein kinase, CRK5 found in the higher plant model, *Arabidopsis thaliana*. Comparison of the primary root lengths of the wild type and a mutant of CRK5 shows that mutant roots display significantly greater lengths than the control seedlings under severe salinic conditions. Among the higher plant serine/threonine protein kinases, only the SnRK2/SnRK3 subfamilies are known to play a basic role in responses to hyperosmotic stress. Our conclusion is that in addition to the SnRK2/SnRK3 subfamilies, the CDPK-related CRK5 protein kinase is also involved in the regulation of osmotic tolerance. Exploitation of the data obtained from the model plant *Arabidopsis thaliana* may promote the improvement of crop plants against abiotic stress tolerance triggered by uninterrupted climate changes.

INTRODUCTION

Agro-ecosystems are very forcefully influenced with climate variability. Climate change scenarios forecast significant decrease in plant productivity for considerable part of Europe which decline in yield may get up to 20%. This may result also in drop of the stability of agricultural ecosystems, concerning the Carpathian Basin too. Therefore, to increase abiotic stress adaptability of plants has a great importance. For plant breeding and crop production new approaches are needed to reach this. Among the most critical environmental factors is the high salinity which has an unfavourable effect on large areas of cultivated land (Figure 1).

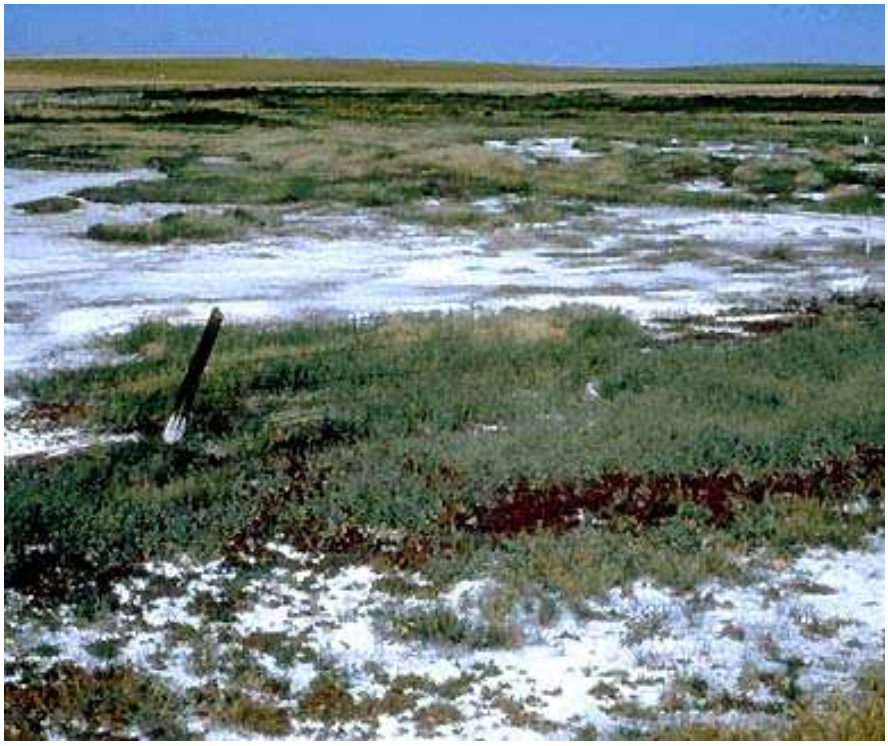

Figure 1: Salinity of soil is a great problem for agriculture areas between the Rivers Danube and Tisza in Hungary but this problem also exists all over the world

Uptake and over accumulation of Na^+ ions during salt stress induces ionic and osmotic stress in plants. The lipid and protein composition of plant cell plasma membranes are severely modified by salt accumulation leading to ion imbalance and hyperosmotic stress. This finally disturbs normal plant growth and development. Plant molecular adaptations to salt stress include among others, the salt induction of certain serine-threonine protein kinases (AHUJA ET AL. 2010).

The serine/threonine protein kinase CDPK superfamily including e.g. CRK (CDPK-related) and SnRK (sucrose nonfermenting1-related) protein kinases are members only of plant kingdom. The most studied members of this superfamily are the CDPKs and the SnRKs. Genome analysis of *Arabidopsis thaliana* revealed 34 CDPKs, 8 CRKs and 38 SnRKs (THE ARABIDOPSIS GENOME INITIATIVE 2000, HRABAK ET AL. 2003). The plant SnRKs have three subfamilies (SnRK1, SnRK2 and SnRK3). The SnRK1 kinases are involved in regulation of energy metabolism (HARDIE ET AL. 1998). The SnRK2/SnRK3 subfamily members are strongly involved in environmental stress reactions (e.g. SOS2 is involved in salt tolerance regulation, GONG ET AL. 2002). Many SnRK2 members from several plants are activated by hyperosmotic and salinity stresses. Unlike SnRKs, there is only very few information about *in vivo* function of plant CRKs.

Up to now, data concerning mainly their biochemical characterization, e.g. predicting plasma membrane localization of these proteins, have only been published (PODELL AND GRIBSKOV 2004, RIGO ET AL. 2008). With the exception of AtCRK3, information about physiological substrates of individual CRK isoforms is scarce (HARPER AND HARMON 2005). The glutamine synthetase enzyme (AtGLN1;1) involved in leaf senescence was found to be a substrate of AtCRK3 (LI ET AL. 2006).

In this study, a CRK member from *Arabidopsis thaliana*, CRK5, was investigated and its response to high salinity was determined. Primary root morphological assay revealed that an insertional mutant of AtCRK5 showed significantly longer root length on high salt concentration than the wild type allele.

EXPERIMENTAL METHODS

PLANT MATERIAL AND GROWTH CONDITIONS

Seeds of wild type (Col-0) and a homozygous mutant of *Arabidopsis thaliana* (SALK INSTITUTE, LAJOLLA, USA) were surface sterilized in 70% ethanol and Na-hypochlorite for 1 minute and 15 minutes, respectively. Then seeds were washed in sterile water five times. Seeds were stratificated at 4 °C for 48h in darkness, than were transferred into a growth chamber. They were kept at vertical position under condition for short day (8h light/16h dark cycle) at 23 °C.

PRIMARY ROOT SALT TEST

The primary root salt test was basically done according to SUN ET AL. (2008). Vernalized seeds were put individually on half-strength MURASHIGE AND SKOOG (½ MS) medium (MURASHIGE AND SKOOG 1962) supplemented with 0.5% saccharose and 0, 175 and 200 mM NaCl concentrations. Each petri dish contained two layers of media. The upper half of petri dish included normal ½ AR medium without salt, and the lower half of the petri dish contained individual salt concentrations (0, 175 and 200 mM NaCl, respectively).

The seeds were put 1.0 cm above the interface of the two media, so during the first five days, the seedling roots had grown about 10-15 mm in length straight down in normal ½ MS medium. As a control, salt less ½ MS medium was used for each genotype. The total primary root lengths were measured in every ten days (0, 10, 20 and 30 days after germination). Experiments were carried out two times. In each case, the primary root lengths of 25 seedlings were measured. Statistical analysis was carried out using Student's two-tailed *t* test.

RESULTS AND DISCUSSION

In order to compare the sensitivity of primary roots of wild type (Col-0) and a CRK5 mutant of *Arabidopsis thaliana*, seeds were transferred to medium containing different NaCl concentrations using two-layer media. Measuring the total primary root length revealed that the mutant showed longer primary root length in comparison with that of the control seedlings at each NaCl concentration in all time points (Figure 2).

This difference in root lengths proved to be significant at $P<0.05$. The difference in total root lengths between salt treated and untreated roots were more pronounced during a prolonged period of treatments (at 30th day). At this time point, 200 mM NaCl drastically decreased the wild-type primary root length (by 90%) representing that this salt concentration is already lethal for wild type seedlings. 30 days after germination at the same NaCl concentration, the mutant seedlings still have twice as long primary roots as the wild-type indicating their ability for salt tolerance.

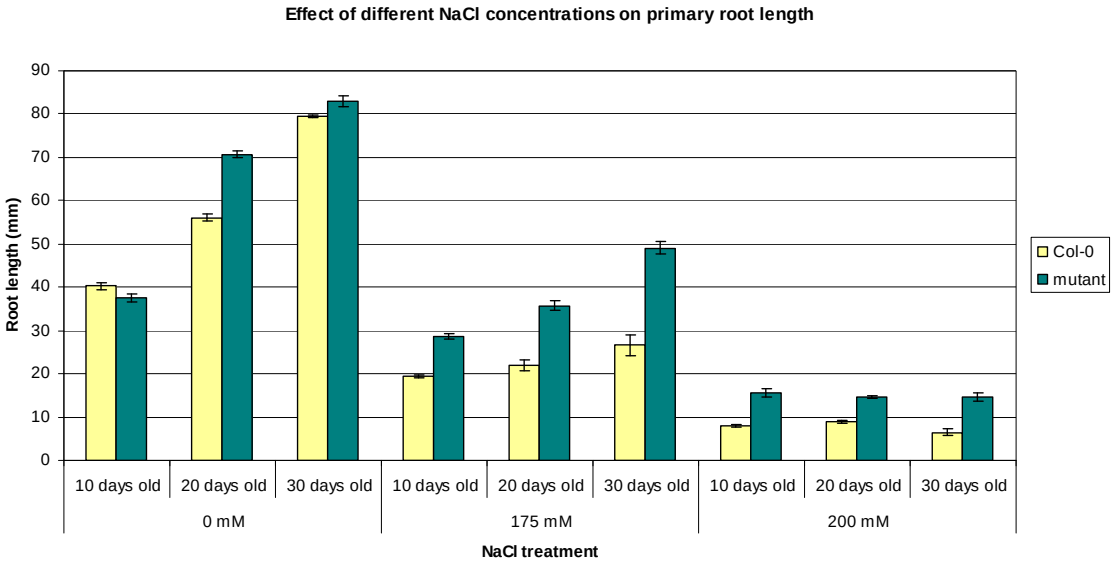

Figure 2: Test of different salt concentrations on wild type (Col-0) and a CRK5 mutant primary root lengths in Arabidopsis thaliana. The values are means ± SE, from two independent experiments where n = 50

The same difference in primary root lengths between wild type and mutant was also observed at sublethal concentration (175 mM NaCl) after 30 days treatment. Among plant serine/threonine protein kinases, only SnRK2/SnRK3 subfamilies are known to play a basic role in responses to osmotic stress.

Maize, rice and *Arabidopsis* have ten SnRKs, respectively, which are all involved in regulation of salt tolerance (BOUDSOCQ ET AL. 2004, 2007, KOBAYASHI ET AL. 2004). Overexpression of certain SnRK2s increased the expression of stress-related genes resulting in elevated drought tolerance in *Arabidopsis* (UMEZAWA ET AL. 2004), in rice (DIEDHIOU ET AL. 2008) and in wheat (MAO ET AL. 2010). Contrary to SnRK subfamilies, there is no information about the possible participation of CRK protein kinases in regulation of molecular and physiological responses to osmotic stress.

CONCLUSIONS

In present study, a preliminary investigation was performed with seedlings of wild type and a mutant CRK5 which were exposed to severe salt stress. Since the mutant primary roots display significantly greater lengths than the control seedlings at every salt concentration tested, we may conclude from these results that CRK5 protein kinase may be involved in regulation of salt tolerance. However, further investigations concerning physiological (e.g. stomatal conductance, osmotic potential, proline determination) or molecular (e.g. gene expression level, protein abundance) parameters are necessary to carry out to clarify the precise role of this protein kinase in hyperosmotic stress.

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Climatic and Ecological Challenges for Continental SE Europe

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Keywords: forest damage, forest ecology, ecotone, succession

ABSTRACT

Climatic forecasts for Southeast Europe show higher uncertainties, and processes are displaying trends different or even opposite to western or north European forecasts. There are extensive plains in the region which are situated in a broad climatic and ecological transition zone (ecotone) towards steppes and arid lands. The vulnerability of this region to climatic changes is high. The decline of vitality and stability of vegetation zones, especially forests, in this region may generate ecologically harmful processes (degradation, aridification, oxidation of organic carbon stored in ecosystems etc.).

INTRODUCTION

Changes in climate conditions in Hungary in the 20th century with respect to forest ecology. Annual precipitation sum decreased in the last 50 years in most part of Hungary. Temperatures have increased at the same time. From point of view of forest ecosystems, the changes in the frequency of droughts are the most decisive for the stability, health and growth of forest tree populations and for the floristic, faunistic and genetic diversity of communities.
From among simple indices describing climate suitability for forest vegetation, Ellenberg's climate quotient (EQ) is one of the most illustrative. For Hungary, the EQ value was calculated for climates at the beginning and the end of the 20th century. Value 24 of EQ represents the long-term optimum limit for beech in Central Europe (higher values are unfavourable). Figure 1 shows a remarkable shift which hits first of all the climatically more favourable Southwest of the country.

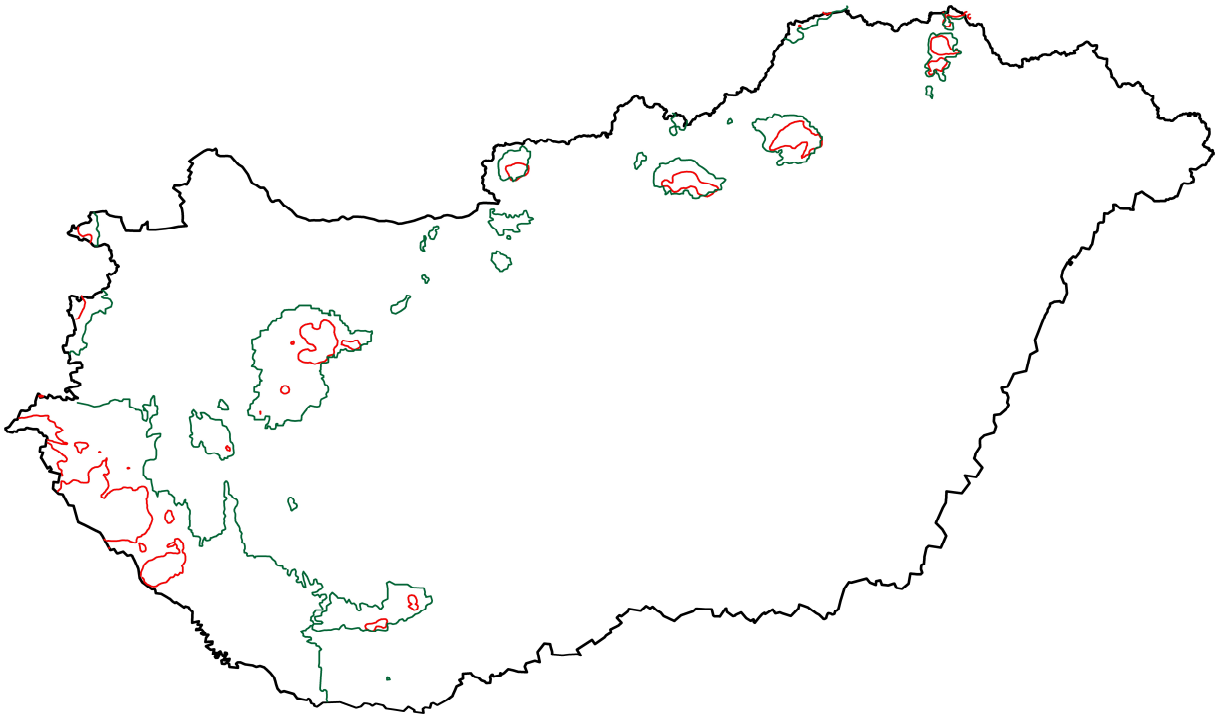

Figure 1: Change of climate favourable for beech in course of a century: shift of contour line 24 of Ellenberg's climate quotient (= long-term minimum for beech) for Hungary, in the average of the years 1901-1930 (green) and 1975-2004 (red) (design: Rasztovits, Móricz, 2009)

FOREST DAMAGE TRENDS

The recent decades have shown an increasing tendency of both biotic and abiotic forest damages. (Source: National Forest Service, Figures 2.)

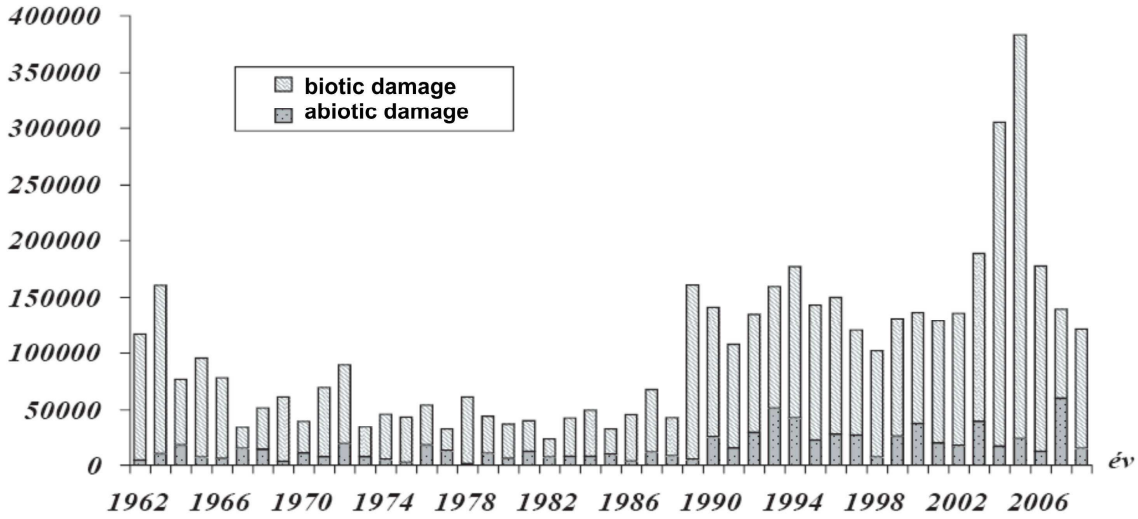

Figure 2: Reported biotic and abiotic forest damages (in hectares) in Hungary between 1962 and 2008

DISEASES AND PESTS LEADING TO MASS MORTALITY

Very likely more frequent and more severe insect outbreaks will occur if the frequency and severity of droughty years will increase in the future. Outbreaks of some well known species will likely spread vertically, heavily influencing forest types not damaged earlier (i.e. gypsy moth in beech stands at higher altitudes). (CSÓKA ET AL, 2007).

Out of the manifold impacts observed in the past, the oak decline syndrome of the 1970s and 80s has to be highlighted. Originally identified as a disease caused by fungi earlier mainly saprophytic, and turning now virulent, it was later admitted that the primary reason triggering the pandemy was climatic. The total extent and damage of the dieback hitting sessile oak stands in the Northern Mountain Range and in Transdanubia may be assessed to damaging ca. 35% of all stands above the age of 40 years, amounting to a total damage of 2.5 million cu. m. (the total annual cut being 7 million cu. m.).

As typical examples for mass mortality following climatic extremes, beech (*Fagus silvatica*) and Norway spruce (*Picea abies*) should be mentioned.

The mass mortality of beech in Hungary is the result of a typical damage-chain. The symptoms appear first on marginal sites, isolated stand margins and in opened-up stands. In mass mortality events observed in West Hungary, both insect species, such as the green jewel beetle (*Agrilus viridis*) or the beech bark beetle (*Taphrorychus bicolor*) and also some fungi (e.g. *Biscogniauxia nummularia*) play an important role. Further pest and pathogen species causing damages on beech are expected (MOLNÁR & LAKATOS 2008, CZUCZ, GALHIDY, MÁTYÁS 2009).

Mass mortality of Norway spruce (man-made) stands started in the early ’90s. The hot and dry summers, the decrease on winter precipitation were favourable for the main pests (bark beetles), which had up to three generations per year. The outbreak of *Ips typographus* and *Pityogenes chalcographus* resulted in a strong decrease of this tree species and a high volume of sanitary cuttings (approx. 800.000 cu. m. 1990-2008). Bark beetles (especially *Ips typographus*) attacked not only their main host (*Picea abies*), but also many other coniferous species of the genera *Picea, Pinus, Larix, Abies, Pseudotsuga* or even *Taxodium* and *Thujopsis* (LAKATOS 2006, LAKATOS & KOVÁCS 2006).

GROWTH AND INCREMENT

The climate change and the tree growth addresses two related issues. One is whether, and how, growth patterns of stand mean height have changed in Hungary in the last few decades, the other is whether this change could be attributed to increases in mean annual temperature. Changes in tree growth were investigated for beech (*Fagus silvatica*), sessile oak (*Quercus petraea*) and Turkey oak (*Quercus cerris*) by comparing stand mean height over age using data from the forest inventories of 1981 and 2001 (Figure 3). Tree growth was found to have accelerated for each species, with Turkey oak showing the largest acceleration (SOMOGYI 2007). General inventory data therefore do not detect growth decline yet.

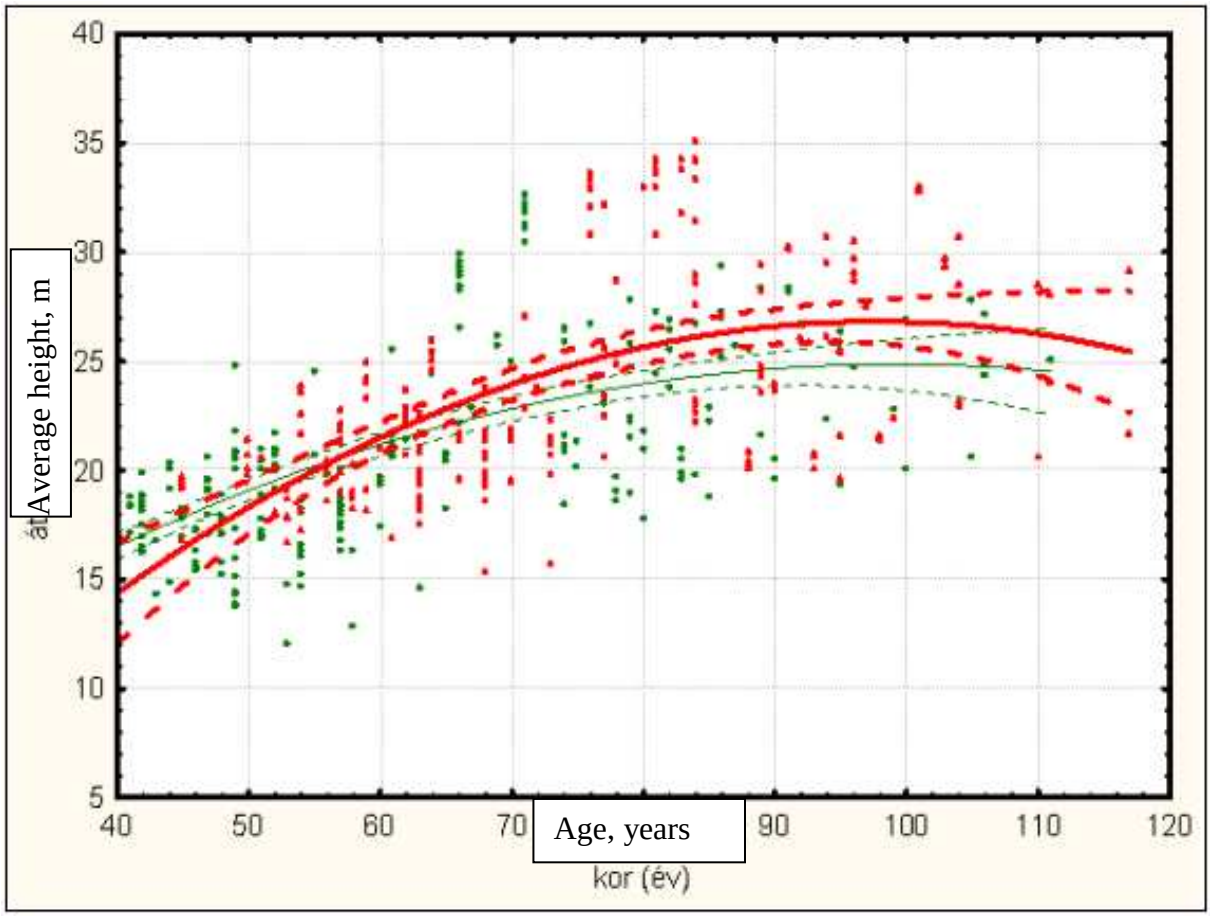

Figure 3: Mean height of sessile oak over age after 1990 (red, thick continuous line) and before 1990 (green, thin continuous line), together with confidence bands of 95% probability (dashed lines) (data of permanent yield plots, from Somogyi 2007)

SUCCESSION

Species-dependent responses to climatic extremes trigger changes in both structure and composition of forest stands, i.e. succession (or rather degradation) is ongoing. This effect is often compensated by human (silvicultural) intervention and can be properly observed in undisturbed reserves only (Figure 4).

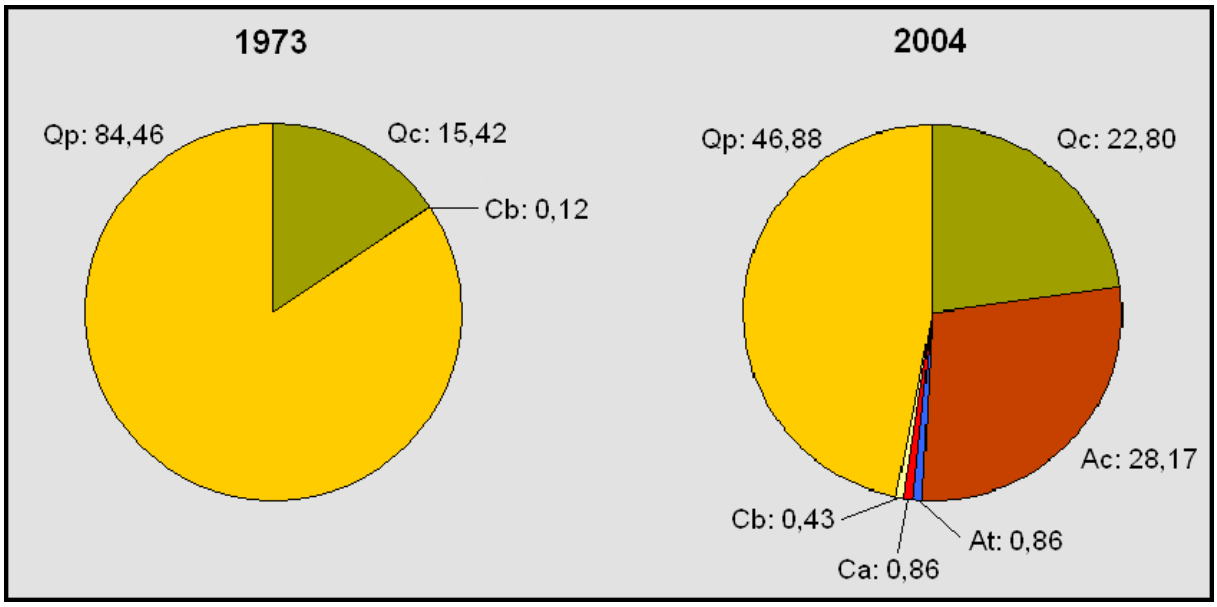

Figure 4: Effect of severity of climatic change on the species composition in the MAB reserve Síkfőkút, a Turkey and sessile oak mixed forest, indicating ongoing succession (Kotroczó et al. 2007)
Qp = Quercus petraea, Qc = Quercus cerris, Ac = Acer campestre
At = Acer tataricum, Ca = Cerasus avium, Cb = Carpinus betulus

The forest gaps formed due to tree mortality, respectively the fallows are colonised by *Robinia pseudoacacia* and *Ailanthus altissima* etc. These adventive alien species have a wide tolerance to drought and are strongly competitive, so they can form very dense stands reducing the biodiversity of the forest community (Figure 5).

Figure 5: Young Ailanthus altissima stand in uncultivated pasture

SUMMARY

Southeast Europe situated in a broad climatic and ecological transition zone (ecotone) towards steppes. The vulnerability of the forest to climatic changes is high. Annual precipitation sum decreased in the last 50 years in most part of Hungary. Temperatures have increased at the same time. The recent decades have shown an increasing tendency of both biotic and abiotic forest damages. Very likely more frequent and more severe insect outbreaks will occur if the frequency and severity of droughty years will increase in the future. Out of the manifold impacts observed in the past, the oak decline syndrome of the 1970s and 80s has to be highlighted.

Mass mortality of Norway spruce (man-made) stands started in the early '90s. In mass mortality events of beech of 2000-s observed in West Hungary, both insect species, such as the green jewel beetle or the beech bark beetle and also some fungi play an important role. Tree growth was found to have accelerated for each species, with Turkey oak showing the largest acceleration. General inventory data therefore do not detect growth decline yet. Species-dependent responses to climatic extremes trigger changes in both structure and composition of forest stands, i.e. succession (or rather degradation) is ongoing. The forest gaps formed due to mortality, respectively the fallows are colonised by adventive alien species reducing the biodiversity of the forest community.

CONTACT FIELDS TO THE GERMAN-HUNGARIAN EDUCATION

climate change and landscape ecology, forest genetic, air pollution and eutrophisation, forest growth, forest decline, forest protection, biodiversity, area biology, biological invasion succession.

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Correlations between garden design plant applications and climate change

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Keywords: garden design, landscape design, green roof, ornamental plant

ABSTRACT

Possible effects of climate change means great challenges to landscape design professionals in Hungary. Our climate will shift towards the Mediterranean and we have to prepare for this with among others, choosing correctly the plants to be planted. Teaching garden design dendrology has not recognized yet the necessity and urgency of this matter. Quick measures are required due to the long life-time and slow development of woody taxons. This paper presents the double relationship between landscape design and climate change emphasizing the outdoor architectural methods of adjustment. Such techniques recognized abroad are presented like precipitation drainage by vegetation and extensive green roof. Finally the effects of climate change on ornamental plants application are presented together with the associated project started at the Corvinus University of Budapest in 2010.

LANDSCAPE DESIGN AND CLIMATE CHANGE

Relationship between landscape design as an engineering scientific field and climate change is double: on the one hand landscape design methods can help the protection of climate and on the other hand we have to adjust to the climate change. Regarding climate protection it is highly important to increase the spreading of CO_2 bonding vegetation by various landscape design methods: regulation plans can help changes among cultivation types, it can prescribe particular plantation of vegetation in outdoor architectural plans, it can improve the living conditions of the vegetation, for example by establishing water surfaces, landscaping. Garden design, garden planning are parts of landscape design. It is thinking in small steps therefore its role in climate protection is limited, its effects on the micro-climate and the urban meso-climate are more significant.

Today's tendency – from landscape architectural university training point of view – preference of intensive garden maintenance methods the essence of which is to maintain the state of the garden regardless of resources, time and costs even in the case of plans regarding no environmental conditions. Automatic irrigation systems using the public network or fertilizing are classified into intensive garden maintenance. It gave such a tool by today with which we could think we do not need to accommodate to climate change. This view is dangerous from several points of view: on the one hand we will have to accommodate to climate change sooner-or-later as intensive garden maintenance only delays and not solves the problem; on the other hand it is doubtless opposite to the climate protection efforts (energy wasting).

Intensive garden maintenance – mainly due to increasing energy prices – may get into crisis in future decades. In order to avoid it ecologic efforts supporting the effectiveness of natural processes, like permaculture should be incorporated into the Hungarian professional knowledge. This method pointing beyond eco-management hardly known in Hungary yet can be characterized so that it sets every element of management – including the flora and fauna, landscape conditions and buildings – into such a united ecological system in which productivity and applicability increase with the help of a connection network planned beforehand while necessary expenses decrease (BAJI, 2009).

OUTDOOR ARCHITECTURAL MEASURES OF ACCOMMODATION

From landscape architecture point of view the primary consequence of climate change are the rising of temperature, drying of the growing season, increasing frequency of heavy rains and decreasing frost risk. These are – except for the latter one – regarded to be negative changes, however, the changing of these factors mean purely new landscape architectural challenges to be solved that have to be not assessed but accommodated to. From settlement and outdoor design points of view important tasks are presented by the frequency of extreme precipitation (and in a smaller part the rising of temperature as well) the rest of the changes rather influence the applied plant species. In the following the outdoor architectural measures are presented that help accommodation to climate change.

In urban environment greatest problem is caused by the prevailing view that we would like to get rid of the precipitation falling suddenly thus it is drained into the public drainage network – generally managed in a joined system with the sewage – as soon as possible. Heavy rainstorms in recent years like in Budapest July 2006 and June 2009 revealed that the drainage network cannot drain precipitation water in every case. Therefore the target has to be set to leave as less precipitation water as possible and as slow as possible into the drainage network.

This can be achieved by establishing green roofs on the flat tops of buildings. Green roofs are planted by vegetation where insulation and gardening layers form a unit reducing the runoff velocity of precipitation and the water quantity entering the drainage network by the precipitation retaining capacity of the substrate, the vegetation and by evapotranspiration (evaporation and transpiration).

Further ecological advantages of green roofs apart from retaining the precipitation water are the moderation of the urban meso-climate (so called heat island effect), cleaning of the air and increasing biodiversity. It also has aesthetic values and secondary social effects (recreation function, job establishing power). Most important arguments, however, are economic ones: it improves the energy balance of buildings with its shading and heat insulating effects, protects the roof cover, filters the noise and the ultra violet radiation, as a whole it increases the value of the property. Two main types of green roofs are the extensive (shallow productive layer with small maintenance costs) and the intensive (deeper productive layer with greater maintenance costs) ones. The latter one is also called as roof garden if it is accessible and may function as a garden. Considering these, plantation of extensive green roofs can be recommended as it has less establishment cost, smaller maintenance expenses with significant power in improving the life standard in the settlement (SZABÓ, 2009).

Figure 1: Good example of a facade overgrown by woodbine in Budapest. (Photo: Ákos Bede-Fazekas 2010)

Establishing green facades is not widespread in Hungary in contrast to green roofs. They include greening outdoor walls by vegetation, wood species or mounted green facade elements planted into special wall holes. In a wider sense creepers climbing up the walls – with the help of a support network or not – are classified into green façade category as well. This latter seem to be the most sustainable system and in the drier climate of Hungary plantation of creepers is recommended to be supported instead of mounted green facades.

In a private garden we have to aim for retaining and infiltrating the total precipitation water quantity. This can be achieved by appropriate landscaping and plantations complemented by sedimentation and reservoir basins. Retaining precipitation water presents a larger challenge in an urban environment mainly due to the great ratio of covered surfaces. The aim in this case as well is to retain and infiltrate into the soil as much of the precipitation water as possible or to improve the micro-climate by evaporating the accumulated rainwater. Released precipitation shall be delayed from the public drainage network as long as possible and shall be drained separately from the sewage!

There are several ways to retain precipitation on the surface. One method is to form pervious cover that can be spread (rubble stone, pea gravel), composed of several smaller elements (dressing stone, cobblestone, pervious concrete mould) or continuous (drain asphalt, stabilized rubble stone, grass strengthen by turf grid). It is important to lay these covers on flexible bases to leave precipitation to infiltrate down to the subsoil. We also have to consider the danger presented by movements due to frost effect! A further solution is to accumulate and infiltrate surface precipitation by a drainage layer (subsurface drain well, desiccating ditch) that can be combined by vegetation as well. Drainage helped by vegetation is not widespread in Hungary yet, however, it is effective and aesthetic measure against precipitation runoff both in urban and in private garden environments. Several types of infiltration helped by vegetation are identified including filtering belt, grassy hollows, water retaining area, infiltrating plantation basin, rain garden (CSILLAG, 2009).

There are further landscape architectural measures to accommodate to the climate change that can be applied easily in both private garden an public area contexts. One of these is to establish multi-levelled, structured plantations. Combining perennial herbaceous plants, bushes and trees help the development of a more vaporous, cooler and more balanced micro-climate. The role of which is expected to rise significantly in our parks the following decades. Further aim is – again to improve the micro-climate – to increase surface and leafage cover. Covering the surface protects against greater precipitation falling suddenly and against associated erosion as well. Furthermore extended areas with vegetation cover mean greater evapotranspiration as well. Increasing foliage cover – that is the most apparent measure of protection against climate change – is accompanied by the change of view that urges the retaining of woody plants found in the area of outdoor design as much as possible – independent from their dendrological value.

Utilizing existing relief forms and changing them by landscaping can improve not only the rate of retaining precipitation water but micro-climatic conditions as well influencing at the same time wind movement and surface exposure moderating as a consequence the unwanted effects of climate change. A further measure to accommodate to climate change beyond the above mentioned is to apply appropriate plants as in the future plants of warmer climate will appear in our gardens as ornamental plants. Selecting the species, breeds recommended for plantation will be the great challenge for future decades demanding a conscious seeing into the future from landscape designer professionals. Relationships between climate change and application of ornamental plants are investigated in the followings.

APPLYING PLANTS AT THE TIME OF CLIMATE CHANGE

Hungarian climate is formed by dry continental, wet oceanic and Mediterranean climate effects from which the Mediterranean effects will advance in the forthcoming century this is why plants applied in our gardens and parks have to be changed. Due to the long lifetime of woody plants landscape designers have to think in advance thus the plants that will be in their peak thirty years later – planted today – have to be selected from species enduring drought, preferring warmth and enduring Mediterranean climatic effects. A part of these plants survives difficultly the current severe winters (winter cover and frost protection help) but the risk of freezing will decrease gradually in the forthcoming decades. Ornamental plants originated from southern areas are termed frequently as frost sensitive that is used generally parallel to warmth demand, however, using the terms as synonyms is misleading and may deter people from planting them. Therefore, frost sensitivity is recommended to be regarded as a temporary problem solved easily in good garden conditions.

It is necessary to identify species and breeds that cope well with today's climate conditions as well (enduring frost and winter). Unfortunately there are only a few example on selection of taxa originated from areas of warmer climate regarding frost endurance, on multiplication, presentation and spreading of selected species and breeds in Hungary. Botanic gardens (and arboretums) where older plants of these warmth demanding exotic species can be found and plant keeping experience is present may have special role. Such collections in Hungary are in Pécs, Sopron, Badacsonyörs, Csákvár, Budakeszi and Somogyvámos. Most warmth demanding species are from the Mediterranean, western shores of North America and the Far East.

Figure 2: The Folly Arboretum in Badacsonyörs is the home of old plants of several rare warmth demanding species. In the foreground a Chinese juvenile cone can be seen. (Photo: Ákos Bede-Fazekas 2010)

Domestic garden design dendrological literature deals with very few warmth demanding taxa, although the list could be extended significantly on the basis of species and breeds found in Hungarian botanic gardens. Several cypress, pines and evergreen oaks could be applied in the changed climatic conditions, however, numerous other species would worth trying them like *Abies bracteata, Abies cilicica, Abies lowiana, Abies pardei, Acer kawakami, Aesculus californica, Berberis morrisonensis, Carpinus turczaninowii, Celtis bungeana, Cephalanthus occidentalis, × Chitalpa tashkentensis, Cupressus bakeri, Cupressus gigantea, Cupressus goveniana, Cupressus pigmaea, Cupressus torulosa, Elaeagnus bockii, Ephedra equisetina, Fontanesia fortunei, Helwingia chinensis, Ilex latifolia, Juniperus deppeana, Juniperus pseudosabina, Kalopanax pictus, Ligustrum lucidum, Mahonia fremontii, Melia chinensis, Phillyrea angustifolia, Picea koyamai, Pinus bungeana, Pinus gerardiana, Pinus palustris, Pinus pinaster, Pinus sabiniana, Prunus lusitanica, Quercus faginea, Quercus libani, Quercus trojana, Rhamnus alaternus, Sequoia sempervirens, Tilia maximowicziana, Torreya jackii, Viburnum wrightii, Yucca baileyi, Zanthoxylum alatum* (BEDE-FAZEKAS 2009).

Figure 3: Himalayan real cypress in the Arboretum in Buda (photo: Ákos Bede-Fazekas 2010)

It is not enough, however, to give lists of new species as such lists are subjective based on only a few domestic individuals. It is important therefore to predict in objective ways based on controllable scientific methods what taxa (maybe limited to species due to the lack of data) are expected to advance in our gardens in the future. In contrast to botanists for the landscape designer not the future distribution area of the given plant is interesting but rather whether the plant founds good life conditions in good garden conditions or not. Thus in contrast to area shift it is much easier and more accurate to estimate and model which areas will meet the climate demands of the selected species in the future. Demand of the plant can be determined accurately based on its current distribution area and the meteorological data sets of past centuries. Considering this, research has been initiated in the Corvinus University of Budapest to model the shifting towards the north of areas appropriate for species demanding warmth, mainly Mediterranean pines. Predictions to the period between 2011 and 2100 were prepared based on various climate scenarios.

As an example the preliminary map showing the maritime pine is given. Dark grey indicates the continuous distribution areas found in the Euforgen database (Atlantic and Mediterranean shores) based on which the climatic demands of the species are estimated using the monthly average temperature and monthly average precipitation of meteorological data sets from 1960–1990. Light grey colouring indicates areas that would have been suitable for the plant in the last decades (Greece, Italy, Spain and extended areas in France beyond those mentioned above) while middle grey indicates areas where the species will be possible to be planted securely between 2011 and 2040 according to the climate model. Most significant advancement of the studied taxon is expected in the northern areas under the effect of the Gulf stream, however, results interesting for Hungary are also presented in the preliminary research. As can be seen the southern Transdanubia will be suitable for maritime pine to be planted in forthcoming decades a few of which can already be found in Hungarian botanic gardens but unfortunately only a few steps have been taken for its multiplication, distribution, presentation and securing its acceptance by professionals. The presented model species is only one of numerous taxa the names of which were left out of Hungarian dendrological textbooks and tree nursery price lists!

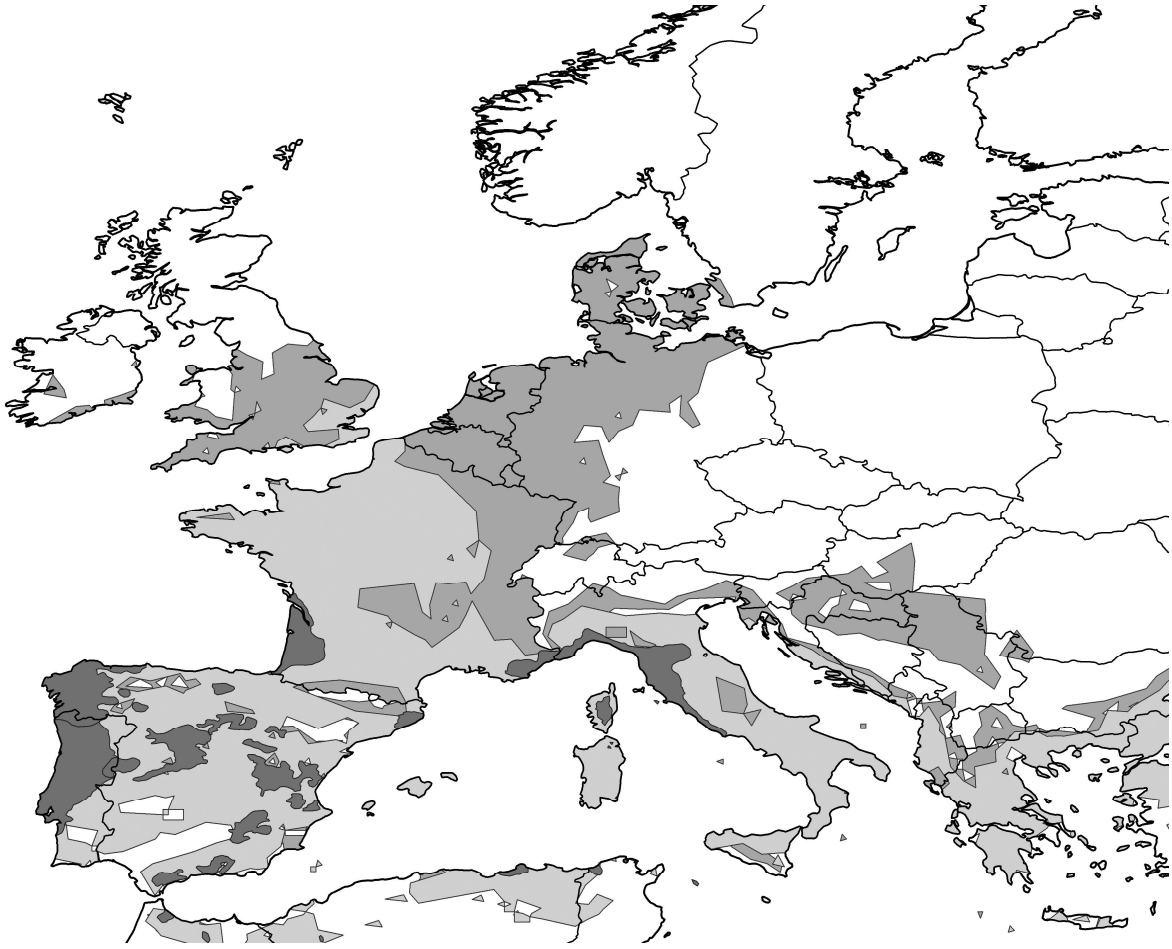

Figure 4: Distribution area and climate demand of maritime pine reflecting the climate change (the map was constructed by the author based on the Euforgen area database)

The research described above is suitable for tracing not only species advancing into the area of Hungary but those leaving it as well as some of the indigenous taxa (or planted regularly nowadays) are expected to find not even the minimum conditions of plantation in Hungary due to the effects of climate change. The last few centuries brought continuous extension of plant offer for garden design dendrology, however, climate change may reverse this tendency. Further development of the research – the aim of which is to predict the changes in the real distribution area – could be achieved by searching functions approaching well the current area, however, this requires significant mathematical and programming backgrounds.

SUMMARY

In its report the Climate Change Intergovernmental Board urges for preliminary plans for the changed climatic conditions based on the scenarios modelling climate change. Considering garden dendrology this means the finding of taxa that could be applied successfully by garden design in Hungary in future decades. Woody plants originated from warmer climate proved themselves several times in Hungary: more-and-more species in increasing number of locations prove their warmth and drought endurance.

My highest aim with my presentations, research and publications is to call the attention of landscape designers to the importance of accommodating to climate change and to help to take the initial steps to reduce the apparent backlog of the profession to climate change.

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Consequences of Climate Change: Land Degradation and Desertification

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ABSTRACT

Soil degradation and desertification can be attributed to both natural and artificial effects. Significant increase of anthropogenic effects since the occurrence of man in nature is well known. One of the most important effects caused by man is the intensifying global warming that has significant role in triggering and accelerating soil degradation and desertification. Degradation is considered not only soil degradation but includes also the degradation of the landscape. Present article analyses the process in both global and Hungarian contexts. Desertification is a problem in Hungary as well. The most exposed area is the Danube-Tisza Interfluve. Drought is influenced most by the dynamism of the groundwater table. Research of drought is one of the most significant challenges for Hungarian geography.

INTRODUCTION

It is impossible to give a precise definition of land degradation. It may be defined "as the loss of utility or the reduction, loss or change of features or organisms which cannot be replaced" (BARROW 1991). The land is degraded when "it suffers a loss of intrinsic qualities or a decline in its capabilities" (BLAIKIE AND BROOKFIELD 1987). The UNEP (1992) definition emphasized the reduction of the potential of natural resources as a result of processes acting on the landscape. JOHNSON AND LEWIS (1995) underlined the role of human interventions in land degradation and focused on the reduction of biological production and/or utility of an area. Distilling the essence of these cited definitions, it is evident that there are common elements in them. Hence, even though it is difficult to give a precise definition acceptable to all disciplines, the concept of land degradation is fairly clear. It means the reduction or loss of biological productivity and negative effects on the functioning of the land and related ecosystems (HUDSON AND ALCÁNTARA-AYALA 2006). Functioning of the land involves the interaction of environmental factors and connections between landscape components, such as hill slopes and floodplains.

The concept of land degradation originates from soil degradation and it is often used as a synonym for soil degradation. It is evident that if soil is degraded, it has huge impacts on both the land and landscape, because soil degradation prevents or impedes plant growth. Land and soil are not identical notions, but they are often used interchangeably. To avoid this confusion it is suggested to use the term 'landscape degradation.' Landscape degradation means much more than just the degradation of the uppermost layer of the Earth's crust. It means the

decline of all landscape forming factors and of their synthesis, which is called landscape in physical geography and landscape ecology. Landscape ecology and physical geography deal with various aspects of landscape development (TÓTH AND SZALAI 2007). However, despite its importance, few scientific papers in Hungary report degradation processes.

The concept of desertification dates back to the 1920s (BOVILL 1921, CITED BY HERRMANN AND HUTCHINSON 2005) when the extension of the West African Sahara into the Sahel zone was first observed. The term 'desertification' was first used by AUBREVILLE (1949) to describe the change of productive land into a desert (HERRMANN AND HUTCHINSON 2005). According to this first definition, the term desertification is always connected with human activities (i.e. with land mismanagement). The Nairobi UNCOD Conference (United Nations Conference on Desertification) in 1977 came about following extremely arid periods in Sahelian Africa.

Desertification is a special and very important group of land degradation processes. According to the United Nations Intergovernmental Convention to Combat Desertification "Desertification means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climate variation and human activities" (UNCOD 1977). There are examples where drought did not lead to desertification under arid climatic conditions, because of proper land management. Desertification is the result of a combination of drought with land mismanagement (LE HOUÉROU 1996). Desertification processes affect 42 million km^2 (33% of the Earth's land surface, ESWARAN AND REICH 1998), effecting some 1 billion people.

Desertification and land degradation are not only the problems of the developing countries. Hungary is also threatened by desertification, especially the central part of the country, i.e. the Danube-Tisza Interfluve where drought has always been a major problem. Shorter or longer dry periods in the past have led to serious water deficit and water imbalances affecting natural systems and land resource production systems. The term aridification was introduced to characterise the increasing dryness (aridity) of the climate as a result of global climate change and its environmental consequences.

Climate change is a major global process. As it is the main factor influencing desertification processes, the global importance of desertification will increase and it is and it will be the most important group of land degradation processes in those regions of the world where the climate is arid, semi-arid or dry sub-humid.

Some 38% of the agricultural area of the Earth can be considered as degraded (Figure 1). Most of the areas in question are in the Third World (the share of degraded territories in Africa is 65%, in Central America 74% and in South America 45%). The proportion of degraded pasture and forests is much smaller (21 and 18%, respectively). Considering only used land (agricultural area, permanent pasture and forests), the proportion of degraded area is 23% and that of strongly degraded land is 14%.

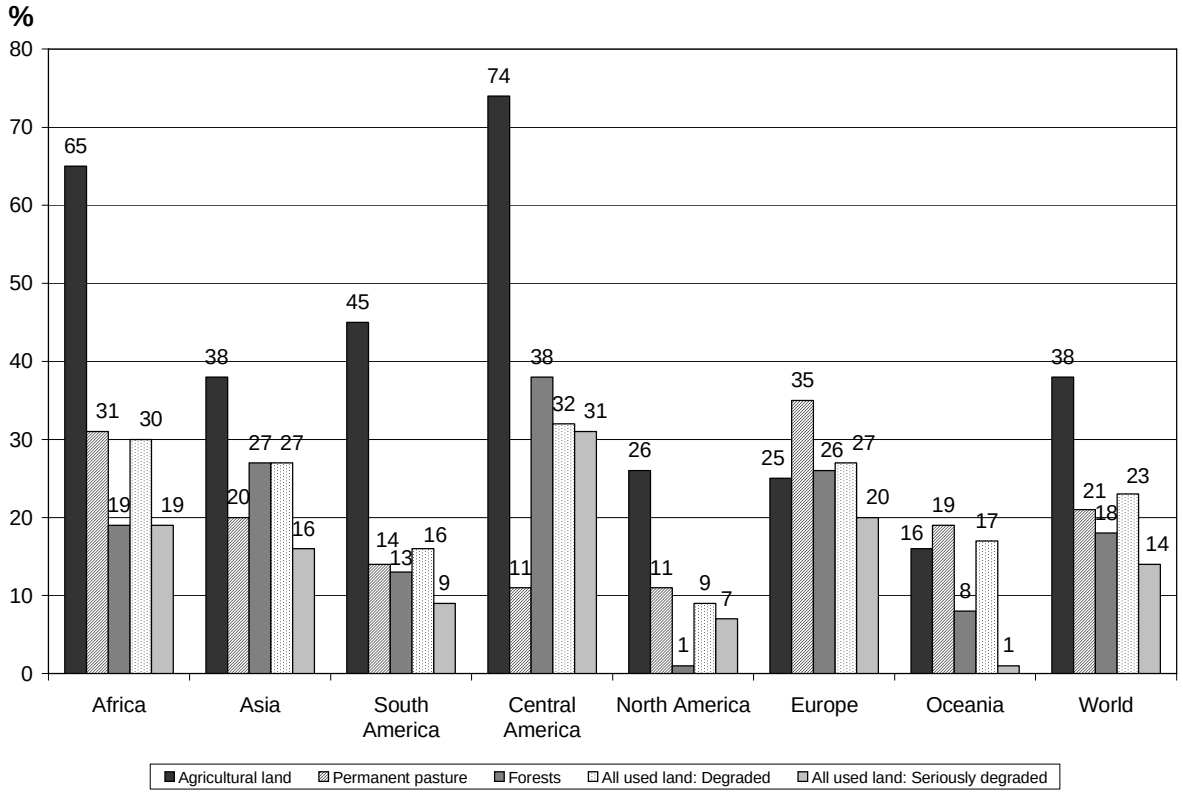

Figure 1: Estimates of soil degradation in the world by region and land use (after FAO 1990, Oldeman et al. 1991 and Scherr 1999)

LAND DEGRADATION IN HUNGARY

Soil erosion by water and wind, extreme soil reaction, compaction, structure destruction and surface sealing are the most significant land degradation processes in Hungary. Though land degradation processes are induced both by natural and human factors, the role of the human impact is definitely more important at the beginning of the twenty first century, especially in those countries where agriculture still has a considerable contribution to the national economy like in Hungary.

Water erosion endangers 25 %, wind erosion 16 % of the country area. Agricultural activities on hill slopes and soil parent material (loose sediment, mainly loess) favour soil erosion. Wind erosion is promoted by sand and peat soils on unvegetated surfaces in spring and summer.

Acidification is the consequence of acidic parent material, leaching, plant residues as well as air pollution and improper fertilizer application. As it is well known, Hungary is one of the most important countries of the world concerning salinity and alkalinity. Besides natural factors (quality of surface and subsurface waters, weathering, migration of soil solution), human impact (e.g. improper irrigation, application of fertilizers) can also lead to salinization. Highly saline groundwater (Na+, HCO_3^-, CO_3^{2-}, SO_4^{2-}) promotes the development of various forms of salinization. Compaction, structure destruction and surface sealing are caused by improper human activities, like overtillage, the application of heavy machines etc.

DESERTIFICATION IN HUNGARY

Desertification is already present in the central part of Hungary, i.e. on the Danube-Tisza Interfluve, as mentioned above. As desertification processes affect also Hungary the desertification convention was signed also by Hungary. Aridification is mainly due to climate change therefore desertification research and legislation are very much connected with climate change issues. Temperature increase and precipitation decrease as well as the increase of the frequency and amplitude of extreme events contribute to the acceleration of desertification risk.

A major impact of changes toward a drier climate is the depletion of groundwater reserves. The most serious aspect of the aridification trend here is extremely reduced infiltration into the soils and reduced recharge of groundwater. According to hydrologists, a combined effect of several factors is responsible for falling groundwater levels: lower precipitation and increased evaporation explain about 50% of the drop, but the extraction of confined groundwater for drinking water supply (25%), afforestation and other land use changes (10%), drainage regulation (7%), direct extraction of free groundwater as well as reduced recharge from the neighbouring hills and from the Danube (6%) are also significant factors.

Legislation activities concerning land degradation and desertification in Hungary concentrate mainly on climate change at the moment, however, climate change is also the main influencing factor of desertification processes and therefore any action taken against climate change is also an action against desertification. The National Climate Change Strategy 2008-2025 (NCCS, Act No. LX/2007, V. 28.) is the implementation of the UN Framework Convention on Climate Change and of the Kyoto Protocol. The objectives of the National Climate Change Strategy will be implemented by National Climate Change Programs to be prepared on a biannual basis. The National Strategy foresees measures in compliance with the EU and international requirements in order to reduce the emissions of greenhouse gases and to prevent their increase. It should be underlined that the National Strategy includes the key elements of the fight against the unfavourable ecological and socio-economic effects of climate change and of the improvement of the adaptability to the consequences of climate change including the raising of social awareness about it. Desertification processes belong undoubtedly to the unfavourable consequences of climate change.

CONCLUSIONS

Global climate change increases land degradation and desertification risk all over the world. Although land degradation and desertification processes have evolved because of natural processes throughout the history of the Earth, today the role of human society is equally important and in some cases it is even more important than natural factors.

Soil science played a leading role in the identification of the degradation processes. Geographers prefer the use of the concept of landscape degradation as degraded land is also a degraded landscape. The methodologies of physical and social geography are the best tools for the investigation of land degradation processes due to the complex nature of these processes.

The possibilities of agricultural use on degraded land are restricted or prevented because of soil degradation. If the degraded area is not used for agricultural production, then the degradation of natural vegetation takes place.

In spite of the fact that desertification processes threaten first of all the poorest regions of the Earth, they are also present in the more developed parts of the world. Hungary is also one of them therefore she signed the Convention on Desertification as increasing aridity is a real national danger, especially on the Danube-Tisza Interfluve. Thus, desertification research is an important challenge for Hungarian geography.

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About the Link between Climate Change, the Food Industry and Animal Agriculture

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ABSTRACT

While almost everybody automatically thinks that global warming is caused by the burning of fossil fuels, an increasing amount of evidence suggests the extraordinary role of animal agriculture, and meat consumption in this process. Although it might be surprising to many people at first, this is actually good news, because individual people so far might have felt absolutely helpless in terms of shaping their own future, while these data now finally give a really efficient tool to individual people and communities, as we all decide ourselves what gets onto our plates.

LIVESTOCK ON THE ENVIRONMENT

The problem was first highlighted relatively late, in the autumn of 2006 in a 388 pages long report called „Livestock's Long Shadow", written by the Animal Agriculture Department of the UN Food and Agriculture Organization (FAO). This report discusses in detail the multifaceted, harmful effect of livestock on the environment, including its greenhouse gas (GHG) emissions: with its 18% contribution, animal agriculture globally plays a more important role in climate change than all forms of transportation combined (13%), and only the energy sector surpasses it.

Figure 1: Cows at an industrial pasture

This picture got even worse with the publication of a new study, „Livestock and Climate Change", in the November-December 2009 issue of World Watch Magazine. The authors, Robert Goodland and Jeff Anhang, former and present environmental researchers of the World Bank, started their study using the data of the FAO report, but

- they took into account as yet unaccounted greenhouse gas emissions;
- they found some emissions to be greater than the data in the FAO report; and
- some emissions were previously assigned to wrong sectors, so they reassigned them to animal agriculture. Their overall analysis shows that „livestock and their byproducts actually account for at least 32,564 million tons of CO_2 per year, or 51 percent of annual worldwide GHG emissions."

DECLINING PHOTOSYNTHETIC CAPACITY

A basic tenet of their study is that – in contrast to the equilibrium state assumed by the FAO – there is no equilibrium state between the CO_2 absorbing and CO_2 emitting sides of the biosphere. „Today, tens of billions more livestock are exhaling CO_2 than in preindustrial days, while Earth's photosynthetic capacity has declined sharply as forest has been cleared." A convincing evidence for this is presented actually by the FAO report itself: while around the year 1770 50% of the land was covered by forest, and 5% by pasture, by 2002 the rate of the forests – which are the most efficient CO_2 absorbers on land – decreased to 30%, and pastures cover now 27%!

Because of this, the authors of the study take into account both sides of the unequilibrium: on one hand the CO_2 released during the breathing of livestock, since „livestock (like automobiles) are a human invention and convenience, not part of pre-human times, and a molecule of CO_2 exhaled by livestock is no more natural than one from an auto tailpipe." On the other hand, in addition to the yearly greenhouse gas emissions due to fresh forest clearing, they also take into account the decreased CO_2 binding capacity due to previous forest clearing, because the non-absorbed CO_2 has the exact same effect as the emitted one.

ROLE OF METHANE

They also consider the role of methane to be far greater than the FAO report: in contrast to the global warming potential (GWP) of 23 for methane for a 100-year timeframe, as used by FAO, they use the more appropriate GWP of 72 for a 20-year timeframe, as it is also supported by the IPCC. Therefore „livestock methane is responsible for 7,416 million tons of CO_2 or 11.6 percent of worldwide GHGs". They also consider other factors, like the increased number of livestock, fisheries, GHG emissions accountable to the waste and byproducts of animal agriculture, etc.

GHG EMISSIONS

In December 2009, in his presentation in front of FAO decision makers Dr. Goodland remarked: „GHG emissions from deforestation and forest fires are now reported to exceed those from transportation across the world. Tropical forest occupying land the size of New York State is now lost each year, and the carbon thereby released into the atmosphere accounts for roughly 17% of all global GHG emissions. It will be a long time before the world's transportation fleet becomes emission-free. But right now, 17% of global GHG emissions could be eliminated by halting the cutting and burning of tropical forests."

The other, severely harmful environmental effects of animal agriculture are also already mentioned by the FAO report. Henning Steinfeld, senior author of the report said: „Livestock are one of the most significant contributors to today's most serious environmental problems. Urgent action is required to remedy the situation."

A fresh, major UN Environmental Programme report entitled „Assessing the Environmental Impacts of Consumption and Production", timed to be released to coincide with UN World Environment Day on June 5, 2010 found agriculture, and within it predominantly animal agriculture to be on a par with fossil fuel consumption in terms of environmental impact. It says: „Unlike fossil fuels, it is difficult to look for alternatives: people have to eat. A substantial reduction of impacts would only be possible with a substantial worldwide diet change, away from animal products."

According to Dr. Goodland „Livestock products and feed are global commodities, so they get flown, shipped and trucked all over the world; and climate change is transboundary. So policymakers must look beyond their own borders in considering the impacts of livestock on climate."

PROPORTION OF HUNGARY IN EMISSIONS

Obviously, our country is also no exception from this. For example, the role of Europe was highlighted by „Killing fields" (Gyilkos szójamezők), a recent documentary made also by the contribution of Friends of the Earth Hungary. According to this film, a major cause of deforestation in South America is industrial scale soybean production, destroying also many small farms, and thus leading to increasing local food prices. (An unfortunate observation is that most of today's more than 1 billion hungry people live in food or feed exporting countries!) The major buyer of the cheap, protein-rich animal feed, made of actually gene modified soy, is indeed Europe, where most of it gets used by the poultry and pig industries.

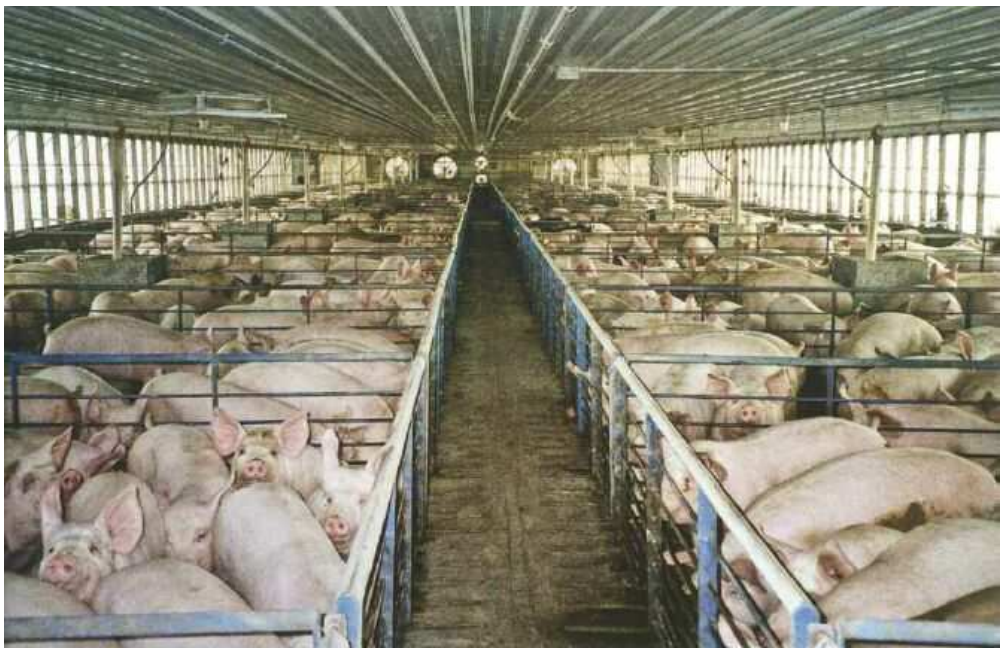

Figure: Industrial peag production

DECREASING MEAT CONSUMPTION

Fortunately, the notion that decreasing meat consumption is the fastest, and one of the most efficient remedies for many of our era's problems is getting ever more popular in scientific and political circles. It is enough to think about the statements of Dr. Rajendra Pachauri, chairman of the Nobel-prize winning IPCC, or the recent editorial of Nature GeoScience, the most prestigious scientific magazine of the Earth sciences. It is also emphasized by Lord Stein, England's leading climate expert, and even Al Gore has decreased his meat consumption! In December 2009 the EU Parliament had a special hearing on the subject, with a title, „Global warming: less meat = less heat".

SUMMARY

Earth's photosynthetic capacity has declined sharply last years. Livestock are one of the most significant contibutors to today's environmental problems. However, decreasing meat consumption does not solve the problem.

Individuals and local communities luckily don't have to wait until all of this is manifested in political decisions. A perfect example of local initiatives comes from the Belgian city of Ghent, where „every Thursday is veggie day". The „Meatless Monday" movement, launched by Sir Paul McCartney has also spread to cities like San Francisco or Washington DC, and even appeared in Hungary!

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Evapotranspiration Estimation from High Frequent Measurement of Groundwater and Stream Baseflow

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Keywords: high frequent streamflow measurements, groundwater evapotranspiration, riparian zone

ABSTRACT

In shallow groundwater environment vegetation has a great influence on groundwater level and groundwater-sustained stream baseflow. A new technique was developed to calculate evapotranspiration rates in the riparian zone from high frequent groundwater-level readings (on a local scale) or from high frequent stream baseflow rates (on a catchment scale). The new method takes into account diurnally change replenishment rate therefore gives higher ET values than former estimations. The method was successfully tested with hydro-meteorological data from the Hidegvíz Valley experimental catchment, located in the Sopron Hills at the western border of Hungary.

INTRODUCTION

A typically observable diurnal pattern in groundwater level and streamflow rate is displayed in Figure 1b. The maxima occur in the morning hours, between 6 and 8 a.m., and the minima in the afternoon, between 4 and 5 p.m.. Both signals are characterized by sharp lower extrema, but the peak regions of the streamflow signal are more rounded.

In drought periods the groundwater of the riparian zone used by evapotranspiration is typically replenished via groundwater flow from areas farther away from the stream (Figs. 1a,c). Around the timing of the groundwater level extrema, supply, *Qnet* [LT^{-1}], and demand, *ET* [LT^{-1}], are in an equilibrium in Eq. 1

$$\frac{dS}{dt} = S_y \cdot \frac{dh}{dt} = Q_{net} - ET \qquad (1)$$

where, S [L] is the stored water volume per unit area and Sy [-] is specific yield.

WHITE (1932) published a method of estimating riparian ET rates based on fluctuations in the groundwater level. He assumed that during the predawn/dawn hours when ET is negligible,

the rate of the observed groundwater-level increase is directly proportional to the rate groundwater is supplied to the riparian zone from the neighbouring areas (Figure 1a). The slope, r [LT^{-1}], of the tangential line drawn to the groundwater level curve in these sections (from midnight to 4 a.m.), multiplied by the specific yield value, Sy [-], of the riparian zone, therefore, represents the rate of water supply to a unit area. By extending the tangential line over a 24-h period and taking the difference in groundwater levels, one would obtain an estimate of the total water supply to the unit area over a day. The so-obtained daily rate of water supply must typically be modified by s [L], the difference in the observed groundwater level over the 24-h period. The daily ET rate this way is obtained as

$$ET = S_y \cdot (24 \cdot r \pm s) \qquad (2)$$

Although this approach might provide a fairly good estimate, it is subject to a certain error. This error is based on the assumption that the rate of replenishment remains constant throughout the 24 hours (TROXELL 1936). Late at night or early in the morning, when transpiration is practically nothing, the height of the groundwater table and the static hydraulic head are nearly the same. The increase of the transpiration drain on the groundwater supply causes a depression in the riparian zone. As the water table drops, the spatial difference in head increases. This increase in the head gradient causes an increase in the rate of replenishment r, so that in the afternoon this rate will reach its maximum (Figure 1c).

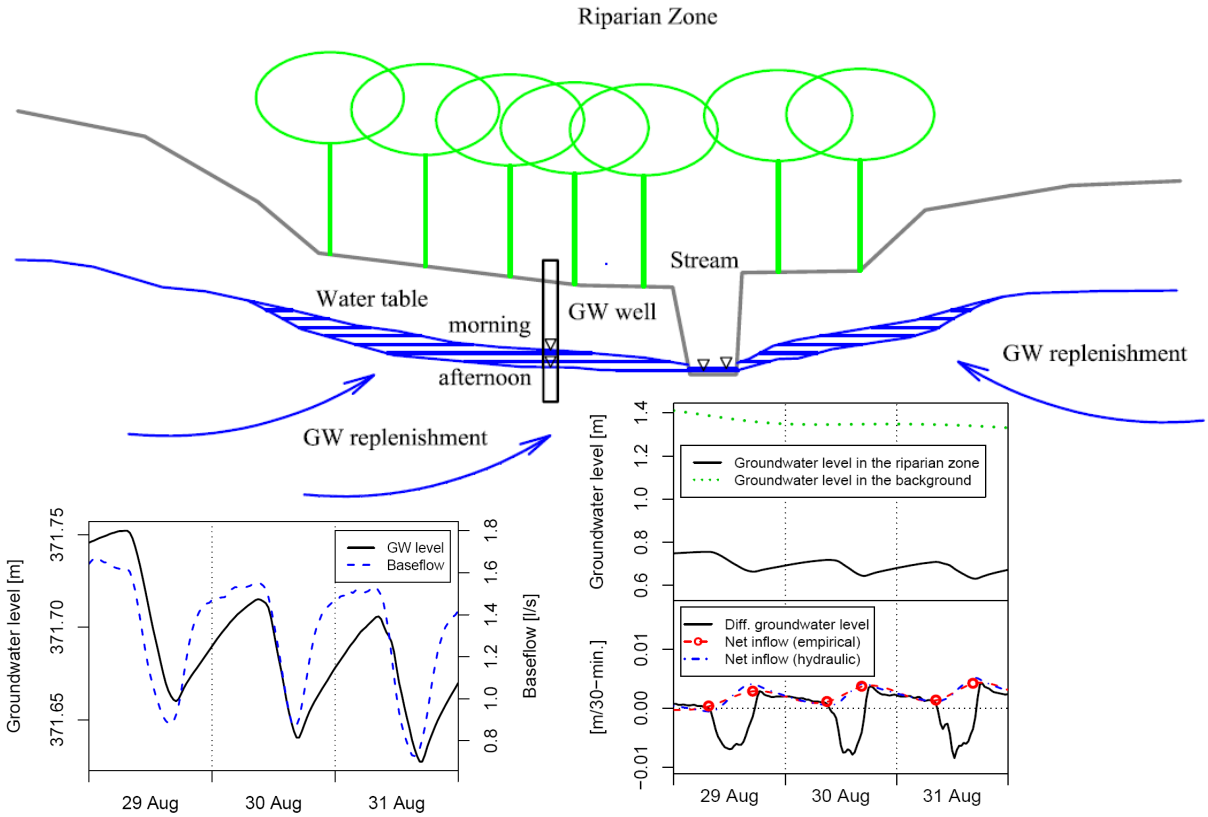

Figure 1: (a) Schematic model of the riparian zone (upper), (b) diurnal signal in streamflow and in groundwater level (lower left) and (c) the main principle of the upgraded White method (lower right)

EXPERIMENTAL METHODS

ET ESTIMATION FROM THE GROUNDWATER SIGNAL

By modifying the White method (WHITE 1932), an empirical as well as a hydraulic version of a new technique were developed (GRIBOVSZKI ET AL. 2008) to calculate evapotranspiration (ET) from groundwater level readings (Figure 1) in the riparian zone.
The method has the following steps (Figure 1):
In the empirical method once the time rate of change, dh/dt, (30-min rates were used) in groundwater level has been calculated, the daily maximum and minimum values of Qnet are obtained from the corresponding minima and maxima in dh/dt as $Q_{net} = S_y \cdot dh/dt$. In the hydraulic method, however, Darcy's law was employed to calculate Qnet at late night hours. In both versions, to obtain intermediate values of Qnet, a spline interpolation was employed.
Finally, the ET rates, characteristic of the riparian zone, can be obtained by rearranging Eq. 1 as

$$ET = Q_{net} - S_y \cdot \frac{dh}{dt} \tag{3}$$

The half-hourly ET rates of the proposed method lag behind those of the Penman-Monteith method (as reference method) but otherwise the two estimates compare favourably. On a daily basis the newly-derived ET rates are typically 50% higher than the ones obtainable with the original White method.
More detailed description of this method can be found in GRIBOVSZKI ET AL. (2008).

ET ESTIMATION FROM THE STREAMFLOW SIGNAL

Evapotranspiration rates can be calculated by two different methods (Figure 2a) from the diurnal cycle of the streamflow:

The original diurnal streamflow method employs the daily maximum streamflow rate, qmax [L^2T^{-1}], as an upper envelope of the specific streamflow rate, q [L^2T^{-1}] (MEYBOOM 1964, REIGNER 1966). ET (L^2T^{-1}) along a unit length of the stream follows as:

$$ET = q_{\max} - q \tag{4}$$

In our second method the hydraulic approach of upgraded White technique (GRIBOVSZKI ET AL. 2008) was utilized for determining the riparian zone ET (LT^{-1}). ET calculation has the following steps:

First, a groundwater flow rate is calculated on the basis of the water balance equation of the streambed:

$$q_{gw} = \frac{dA}{dt} + \frac{dQ}{ds} \tag{5}$$

where qgw [L^2T^{-1}] is the groundwater inflow to the stream channel, A [L^2] is the wetted cross sectional area and dQ/ds [L^2T^{-1}], the change of stream discharge along the section of the stream.

From q_{gw} the groundwater level in the riparian zone was back calculated on the basis of Darcy's equation. Some groundwater level measurements along the stream in the riparian zone were used for calibration of the hydraulic conductivities.

With the calculated groundwater levels the upgraded White method (GRIBOVSZKI ET AL. 2008) was applied for determining the ET rates.

RESULTS AND DISCUSSION

The proposed ET estimation methods were tested in a small (drainage area is 6 km^2) experimental watershed dataset in the Sopron Hills of western Hungary

The upgraded White method ET have a significant lag (150-210 min.) in comparison with the original diurnal method, and a 30-60 min. lag behind the Penman Monteith ET rates (Figs. 2b and 3).

Daily mean ET values (valid only for rainless periods) from the upgraded White method are close to the Penman-Monteith ET rates and a magnitude higher than those of the original diurnal method.

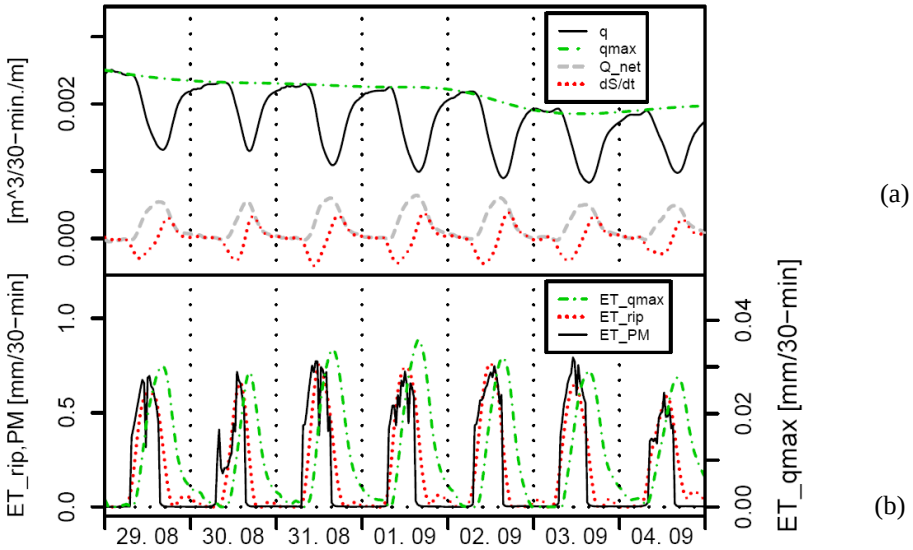

Figure 2: Basic principle (a, upper) and results (b lower) of ET calculation from streamflow diel signal: (a) q, streamflow, qmax, daily maximum streamflow rate as upper envelope; Q_net water supply estimates divided by S_y (specific yield), dS/dt, temporal differences of the calculated groundwater levels, (b) ET_qmax, original diurnal method ET, ET_rip, upgraded White method ET, ET_PM, Penman-Monteith reference ET

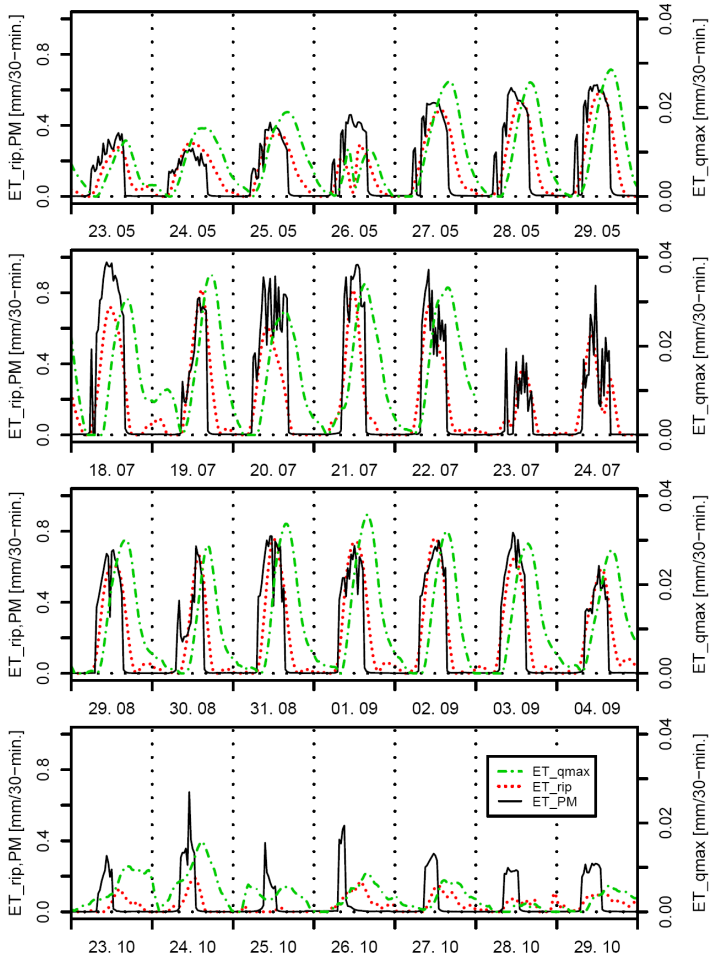

Figure 3: Comparison of the 30-min ET rate estimates of the original diurnal method (ET_qmax) and the upgraded White method (ET_rip) with those of the Penman–Monteith method for some selected growing season periods in 2005

CONCLUSIONS

The new methods described in this paper based on the former White method (WHITE 1932), but took into account diurnally change groundwater replenishment from the background. The new technique uses water balance equation to calculate ET rate and has high frequency groundwater level or stremflow rate data demand, but there are no need any other meteorological data for the proper working of the method. ET rates calculated by the new method are generally higher (sometimes more than a magnitude) than former outworked water balance based ET estimation method and have a fairly good agreement with more sophisticated ET calculation method like Penman-Monteith equation, which is a very "parameter rich" model.

ACKNOWLEDGEMENT
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Section 3
Environment, Climate and Energy

Sustainable Resource Management - Challenges for Policy and Science

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Keywords: socio-industrial metabolism, physical economy, strategies for the future

ABSTRACT

Trends of global resource use are provided together with data showing the growing net import of resources by the EU. Before the background of the total socio-industrial metabolism key conditions for sustaining the physical basis of economy and society are described and long-term targets are suggested. Both cross-resources and resource specific policy challenges are described with a focus on "The Big Three" issues: GHG mitigation, halt of global cropland expansion and a reduction of global abiotic resource extraction. Four key strategies for sustainability are described and exemplified, and tasks for research are depicted.

INTRODUCTION

Member states of the European Union are challenged to develop programmes for economy-wide sustainable resource management. This is requested by the Thematic Strategy for the Sustainable Use of Natural Resources (CEC 2005). As European countries are increasingly sourcing from other world regions, such programmes need to consider the use of both domestic and imported resources and their environmental and socio-economic implications. Designing a robust and effective policy framework for sustainable use of natural resources also requires knowledge on the long-term dynamics of the socio-industrial metabolism and the key strategies, technologies and institutions to develop the physical basis of the economy sustainably.

At the national and European level, programmes for sustainable resource management need to be developed which act economy-wide, and integrate climate and resource conservation, and supply security; consider biomass and mineral use for all purposes; build the bridge between economy and ecology; use comprehensive indicators and targets for long-term orientation; account for domestic and foreign resource use (materials, land); and minimize problem shifting (between regions, different pressures, or over time).

TRENDS OF GLOBAL RESOURCE USE

There are "Three Big" environmental pressures worldwide which are going to increase:

- The emissions of green house gases inducing climate change,
- The extraction of abiotic resources leading to landscape change and ending up in waste disposal,
- The change of land use, in particular expansion of built-up and agricultural land at the expense of natural ecosystems.

Land use change, mineral extraction and GHG emissions are interconnected and also linked with other environmental pressures like water consumption and pollution which vary within regional contexts. Whereas the climate issue has been well described and is widely acknowledged (IPCC 2007), the relevance of resource extraction and land use change has received less attention so far.
The extraction and harvest of abiotic and biotic resources is expected to nearly double between 2000 and 2030 under business-as-usual conditions, from 52 billion tonnes to over 100 billion tonnes (FoEE 2009). This comprises the used extraction of fossil fuels, metals, minerals and biomass, but does not entail the unused extraction. The latter constitutes, for example, the earth excavation for infrastructures, extraction waste of mining and quarrying and the erosion linked to agriculture. The unused extraction adds double to triple amount to the used extraction. The extraction and refining waste is particularly high for metals. Because the concentration of metals in ores is declining in many cases, the consequence will be growing amounts of primary extraction, higher volumes of mining waste, water discharge and landscape change (MUDD 2007, NORGATE 2010, MCLEAN ET AL. 2010).

The total material requirement (TMR) is an indicator measuring the domestic and foreign resource extraction which is directly and indirectly linked to all production and consumption activities of a country. The TMR of the EU has been increasing in between 2000 and 2007, from 43 to 46 tonnes per capita. Whereas the domestic extraction and harvest remained rather constant, the resource requirements of the imports increased, even to a higher level than those of the exports (Figure 1). Fossil fuel and mineral resources made up the highest portion of the domestic TMR, whereas metal resources dominated the resource requirements of imports and exports (Figure 2).

Global land use change is characterized by two key developments: the expansion of built-up land and the extension of agriculture land, both at the expense of shrinking forests worldwide.
In 2005, the "built environment" was accounted for with 306 Mha worldwide. Without policy intervention it is expected to grow by up to nearly 250 Mha (or 81%) by 2050 (ELECTRIS ET AL. 2009). According to Seto et al. (2010) urban area alone might expand altogether between 40 and 143 Mha from 2007 to 2050. Holmgren (2006) assumes that 80% of urban expansion occurs on agricultural land.

Whereas forest area in Europe is even growing slightly, forests in particular in tropical regions are increasingly being degraded and deforested. This is not only a result of growing demand for forestry products, but also a consequence of growing demand for agricultural commodities.

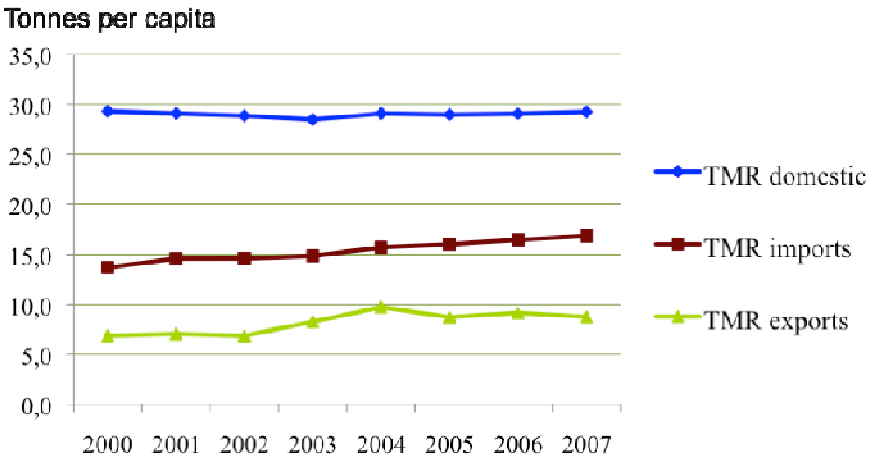

Figure 1: Total material requirement (TMR) of the European Union (EU27) from domestic sources, and TMR of imports and exports. Source: data base of the Wuppertal Institute, compilation by H. Schütz

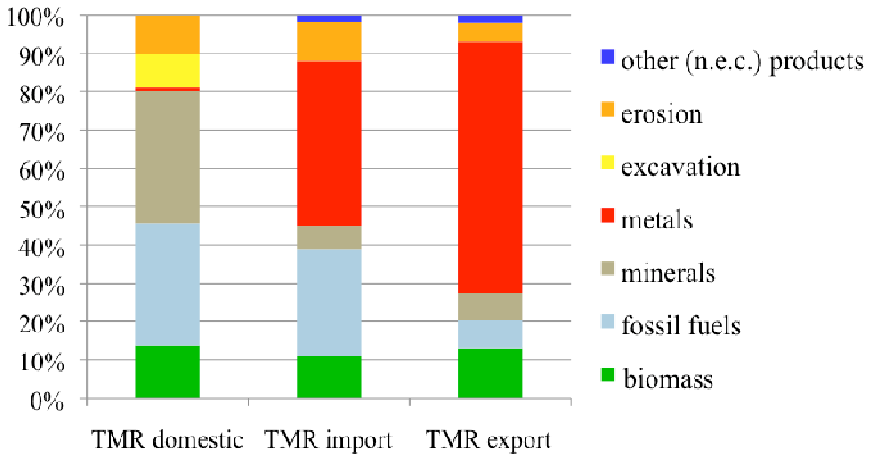

Figure 2: Composition of the EU´s TMR in 2005. Source: data base of the Wuppertal Institute, compilation by H. Schütz

Until 2030, global cropland will probably be expanded only to feed a growing world population with changing diet pattern (BRINGEZU ET AL. 2009A). Any prognosis towards this end is based on rather uncertain development of agricultural yield increases. If one assumes a rather conservative global average increase of about 1% p.a., this equals about the rate of population growth. At the same time, however, developing countries will significantly increase their consumption of protein rich food, i.e. meat and dairy products. And in order to feed the required animals, more cropland will be needed. Global cropland may then be expanded by 10-20% from 2004 to 2030, i.e. between about 150 to 300 million hectare.

Global land use accounts (GLUA) measure the global land use of equivalent land use categories associated with the domestic consumption of goods and services (Bringezu et al. 2009b, 2009c). GLUagriculture accounts for the global land use for domestic consumption of agricultural goods, for food, materials and energy. Analogously, GLUcropland and GLUforest can be determined. In each case, imports and exports are calculated based on real land use for the production of their feed-stocks.

GLUagriculture is about 30 mill. ha larger than the domestic agricultural area of the EU27, clearly indicating that the EU is a net importer of land (Figure 3). While the domestically used agricultural land is slightly declining, the land used in foreign countries has been growing.

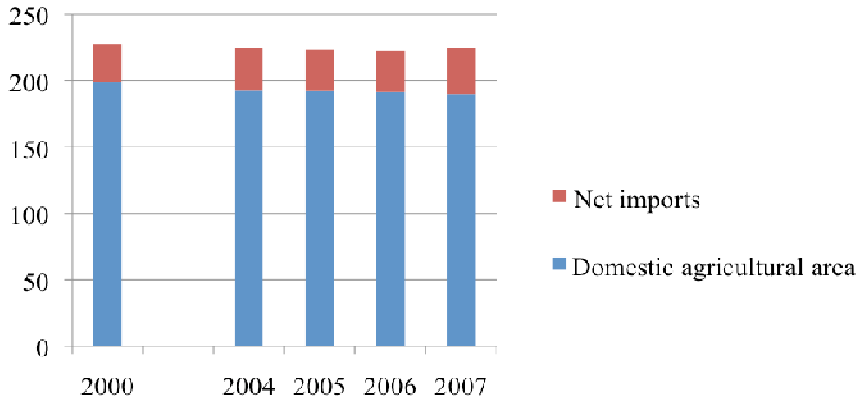

Figure 3: The EU is a net importer of land: Global land use for domestic consumption of agricultural goods of EU-27 (in mill. ha). Source: data base of the Wuppertal Institute, compilation by H. Schütz

Following a strategy which aims at halting biodiversity loss due to land use changes and calls for ending expansion of agricultural land from 2020 (VAN VUUREN AND FABER 2009, challenge scenario), and keeping the relations of pastures and cropland, one would arrive at 0.19 ha cropland per capita in 2030. In any case, the current EU consumption of about 0.31 ha per capita would clearly exceed the globally available cropland for each world citizen. Even a further yield increase of 1% p.a. on average would not suffice to keep EU´s consumption below global mean use of cropland. A further increase of non-biomass demand, for instance for biofuels or biomaterials would increase the disparity of EU´s demand and global availability and probably lead to increased pressure on land use change, in particular in tropical regions.

LONG-TERM DYNAMICS AND FUTURE OPTIONS OF THE SOCIO-INDUSTRIAL METABOLISM

When developing the physical basis of society and economy towards sustainability, not only carbon flows need to be considered but the whole socio-industrial metabolism, i.e. the extraction, use, recycling and final disposal of all material resources.
In order to outline how that metabolism may develop in future under sustainability conditions, the following aspects should be considered (details are given in BRINGEZU 2009):

- The net addition to stock (NAS), measuring the amount of buildings and infrastructures added each year to the existing ones, must become zero. Otherwise, the EU would become totally covered by buildings, roads etc., which would compromise the supply from agriculture and forestry. Zero NAS means that there will be a dynamic equilibrium between the construction of new houses and roads and the deconstruction of old ones.
- Domestic biomass harvest from agriculture and forestry may probably be kept constant or increased by up to 25% under conditions of sustainable cultivation, in particular by mobilising unused potentials from forestry. Imported biomass should be reduced with regard to a balanced global land use.

- The use of abiotic resources (naturally non-renewable) should be significantly reduced in order to mitigate the domestic and foreign environmental pressure of resource extraction and waste disposal, and to contribute to a more equitable pattern of global resource consumption. The indicative target of 80% reduction had been derived from the assumption that global abiotic resource extraction should be halved and equally used by 9 billion people in 2050, and that the TMR would be developed in constant relation to TMC (political targets for absolute resource consumption should be based on TMC rather than TMR which should be used in relation to GDP, see below). Recent data, however, indicate that since 2000 global extraction has grown further, and moreover, also less developed countries which still need to develop their infrastructures are already above 6 t/cap TMCabiot. Therefore, it seems more realistic to pursue a global target of returning to global abiotic resource extraction as of year 2000 and use this for 9 billion persons (see below).
- Erosion on agriculture fields within the EU should be reduced by a factor of 10 in order to approach the level of soil regeneration, although the data indicate large variation between member states and crops, and data availability also needs improvement.
- Fossil fuel use for combustion needs to be phased out. Total carbon dioxide emissions, however, will be reduced only by one quarter to one third, as the remaining input from carbon from biomass will be oxidised and emitted from respiration, fermentation or incineration under conditions of a dynamic flow equilibrium.

POLICY CHALLENGES

There are some cross-resources strategies on the one hand, and some theme and resource specific challenges on the other hand, both of which requiring cross-sectoral action between different policy departments.

CROSS-RESOURCES POLICY TASKS

Monitoring and control of the Big Three global environmental pressures is key to progress on sustainable resource management on the national and European level. Indicators should measure national and EU consumption of global resources.

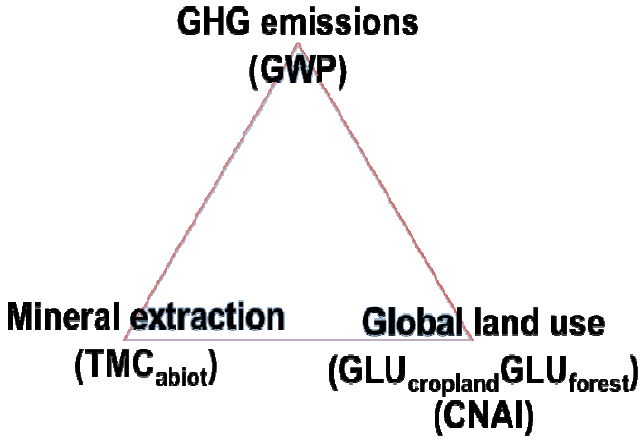

Figure 4: The "Big Three" global environmental pressures and related indicators

Consumption based accounting refers to domestic production plus imports minus exports of products and services, according to conventions of economic statistics. The environmental pressures linked to these product flows, either emission or resource or land use oriented can be quantified.

With regard to the extraction of mineral resources it is more difficult to determine a global target of sustainable use. Those resources cannot be regenerated by and within the speed of natural processes. While mining and refining tend to extract these non-regrowing resources with increasing efficiency, near surface deposits become more and more depleted, ore concentrations decline or deeper depths need to be explored, which tends to lead towards higher energy, water and waste intensity (NORGATE 2010, MCLEAN ET AL. 2010). The impacts are local to regional, albeit ubiquitous, and there will probably be no tipping point of global extraction which can be determined to lead to forecastable consequences. Instead, these flows contribute to a continuous, and currently growing rate of a changing environment. The extraction volume of minerals determines the scope of landscape change, and in addition, determines the overall generation of waste disposal along the production and consumption chain, from mining to final waste deposition. If a global target aims to return to extraction levels of the year 2000 globally, and use these resources equally amongst 9 billion people around 2050, then the reference level could be around 10 t/cap TMCabiot (in 2000, the EU-15 consumed 33 t/cap TMCabiot).

RESOURCE SPECIFIC CHALLENGES

Biomass and land use

The key challenge here is to halt the loss of global biodiversity, and thus the expansion of global cropland as important driver of that loss. For that purpose, two complementary strategies need to be pursued:

a) fostering the sustainable cultivation of each hectare through standards of good agricultural practise;

b) controlling the demand for the number of hectares not to surpass levels which cannot be supplied sustainably.

For (a) agricultural policies need to be complemented by product policies; certification of biomass based products (food and non-food) can help to ensure that the required feed-stocks are derived from sustainable cultivation.

For (b) a comprehensive biomass strategy needs to be developed which considers the use for food, materials and energy, and the land altogether needed for the provision of feed-stocks for domestic consumption both in foreign countries and domestically. If GLUA reference indicators show an undue use of global cropland, then policies influencing demand for biomass based products need to be adjusted; in the case of the EU, that could mean to revisit the targets for biofuel quota again and to check biomaterials and timber product enhancement programmes not to widen the disparity between sustainable supply and growing demand.

Metals

The key challenge for metals is to foster recycling also beyond country borders and enhance a more efficient use along the production chain. Europe drains metals with export of new products and end-of-life products and waste like scrap cars, while the supply of metals is largely based on ores and concentrates imported from outside (for structure metals like steel and auxiliary metals like platinum group metals). High-level recycling needs to build up within Europe and beyond, and producer responsibility should be fostered to establish also collection and recovery systems abroad, in cooperation also with developing countries such as in Africa.

Construction minerals

Construction minerals are mainly sourced from within Europe. The key challenge here is to enhance efficient use in production and consumption which could be facilitated by a balanced combination of:

a) increased pricing of raw material extractions, e.g. by an aggregated tax,
b) education and training of engineers and architects as well as R&D on dematerialized construction,

c) demonstration projects, e.g. public buildings, to show how material and energy efficiency can be combined.

Certainly, there are other challenges as well, however, those roughly outlined here seem to be paramount when trying to moderate the magnitude of resource flows towards more sustainable levels.

KEY STRATEGIES

There are four key strategies which may be deemed essential for implementing an economy-wide SRM:

RESOURCE EFFICIENT AND RECYCLING BASED INDUSTRY

The search for a smart combination of dematerialization and rematerialization will drive innovation. Resource light product design is an essential prerequisite to reach factor 4 to 10 resource savings and to combine both resource and climate protection with cost savings in manufacturing. Product-service systems will help to orientate production towards consumers needs while offering functions rather than hardware. The multitude of anorganic elements used in the era of rare metals may on the long run be superseded by a limited number of structure building organic elements, in particular carbon as basis for chemicals and materials with multiple properties. Carbon recycling will then regenerate feed-stocks from organic waste, in the long-run by means of renewable energies. The stocks of materials in buildings and infrastructures as well as long-lived products will be the mines of the future ("urban mining").

THE STEADY STOCKS SOCIETY

The maturation of the socio-industrial metabolism will lead to a dynamic flow equilibrium between inflows and outflows of the materials stocked in buildings and infrastructures. Construction of new houses and roads will be associated with deconstruction of old ones, either at the same or other places. Recycling will be the dominant source of material input, in contrast to the current phase of physical growth. In Western Europe, the levelling off of the increase in living space and road length per capita indicates that that stadium may not be so far ahead as it might be in Eastern Europe and the developing world. Investment patterns will have to shift from new additional buildings to maintenance, refurbishment and quality up-grade of existing ones.

SOLARIZED INFRASTRUCTURES

The surface of buildings and infrastructures still remains a largely unused resource of energy supply. Roofs, facades, and windows, but also side walls of highways and train tracks, even the roads and tracks, may be equipped with either solar thermal or solar power generating functions. Integrating these functions will save land and improve energy security. In developing these technologies further it seems important to (a) avoid the use of hazardous substances (like Cd in photovoltaic's) which may be dispersed later by improper waste disposal, in particular in developing countries; and (b) to minimize the resource requirements (TMR), and pressures such as GHG emissions per unit of energy supplied and per hectare.

BALANCED BIOECONOMY AND BIONICONOMY

The reduction of mineral resource use can lead to a relative increase of biomass input, which in itself should not increased significantly due to limited land resources. In devising policies for efficient use of biomass, priority should be given to food production, and the non-food use should prefer material purposes against energy which might better be recovered at the end of a cascade. Carbon recycling technologies should be further developed to use organic waste for the regeneration of material feed-stocks such as polymers. In the long run, the absorption and use of atmospheric carbon dioxide by means of renewable energies will provide the basis for a "bioniconomy" which uses bionic principles from nature. Industrial photosynthesis will then allow regenerating the material basis of the economy, largely based on carbon (hydrocarbons, carbohydrates, graphen etc.).

RESEARCH TASKS AND OUTLOOK

Applied sustainability science is challenged to inform policy and society on the problems and perspectives of global resource use for activities in industry and households, and provide strategic knowledge on key leverages to sustain our supply. Stakeholders in science, industry, society and policy need to interact, improve the knowledge base and discuss the features of a desirable and acceptable future.

The transition towards an economy-wide sustainable resource management will especially depend on:

- Discussion and agreement on long-term goals, objectives and targets; for that purpose, science will have to describe the safe operating space of global resource use more extensively;
- Indicator based information on current performance, business-as-usual outcomes and alternative scenarios at various levels of decision making;
- Analysis of systems technologies such as solar energy systems and carbon recycling regarding their resource efficiency;
- Economic incentives motivating market actors to develop eco-innovations for resource efficient products and services; research is reqired on the preconditions of successful innovations, and how innovations can be steered into "the right direction";
- Experiments and societal learning, including the analysis of experiences from different countries by international comparison of policies related to both resource supply and consumption.

Various puzzle pieces within the framework of economy-wide SRM already exist. For instance, indicators are gradually enhanced, resource efficiency agencies effectively advise companies how to save materials, energy, water, waste, and costs. Some countries have even introduced taxes on mineral aggregates, others are considering reductions of subsidies for resource intensive industries, and to invest more into R&D, education and training for efficient and sustainable resource use. It is the science complex which should make sure not to stay behind industry and policy, but to take the lead for a better informed way forward.

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Mitigation Tasks of the Hydrocarbon Industry

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ABSTRACT

The article delivers a sort of diagnosis and public elements of self-therapy of the hydrocarbon industry (HCI) concerning the greenhouse gas (GHG) emissions.

First, it provides a brief introduction to the GHG emissions by HCI in the USA and the EU-27 as well as in Germany and Hungary on the basis of the available statistics and estimations.

After having an outlook to the future, it points out the early reactive and the prevailing pro-active approaches and gives an overview of the public mitigation actions by a group of leading Fortune Global 500 oil and gas companies. It lists mitigation actions with regard to direct and indirect emissions by the worldwide HCI. Among direct mitigation measures energy efficiency improvement, loss prevention, switch to low-carbon sources, carbon capture and storage, investment is flexible mechanisms and other additional elements (carbon cost assessment, advocacy and outreach and research programmes' funding) are mentioned. Indirect mitigation measures include facilitation of fuel switch to low-carbon energy (e.g. substitution with conventional and unconventional natural gas, investments in nuclear and alternative energies like biomass, wind, solar and hydrogen) and carbon capture and storage. All these actions are demonstrated by examples taken from the leading HCI companies.

HCI is both a source of problems (of global warming) and solutions (to mitigate climate change). It is a significant indirect source of global warming. At the same time it is a (in some areas outstanding) solution-provider for the whole economy, being a developer or investor of cogeneration technology, next energy sources (algae) and new generation of biofuels, wind, solar and hydrogen economies and carbon capture and storage. All these technologies are also listed in IEA Blue Map scenario among key technologies to cut carbon dioxide emissions.

GREENHOUSE GAS EMISSIONS BY THE HYDROCARBON INDUSTRY

The first question would be what are the greenhouse gas (GHG) sources in the hydrocarbon industry (HCI).

There is a recognized source classification provided by the American Petroleum Institute (API) in its recently updated over 800 pages compendium (AMERICAN PETROLEUM INSTITUTE 2009). Direct (on-site) emissions of the HCI come from combustion, process emissions and vented as well as fugitive sources. The second category of emissions, 'Off-site emissions' (or according to API indirect emissions) are originated from the operation of the auxiliary facilities (such as electricity, steam production) necessary for the operation of the hydrocarbon industry.

Use (mainly combustion) of hydrocarbons produced by the HCI causes indirect GHG emissions beyond the HCI.

The emitted hydrocarbons consist predominantly of carbon dioxide, additionally methane and dinitrogen oxide.

The next question would be what is the quantity of the HCI's direct and indirect GHG emissions.

Unfortunately, only some elements of the hydrocarbon industry's direct emissions are available in UNFCCC data interface (UNFCCC 2010) such as petroleum refining emissions and fugitive emissions from oil and gas. Petroleum refining, and fugitive oil and gas emissions represent a very small ratio both in the baseline year and in 2008. Presently, more than 90% of the transport fuel demand is covered by the HCI, therefore the largest part of the transport emissions can be regarded as HCI' indirect emissions. Fuel combustion and fugitive from fuels of the other energy industries (e.g. manufacturing, residential) are the largest contributors to the GHG emissions, although share of the HCI depends on the energy structure of the given area.

Direct GHG emissions of the HCI represented 2.5 and 3.9% of the total emissions in the USA and the EU-27 in 2008. The corresponding values are for Germany 3.2% and for Hungary 4.8%. Shall be noted that this figures do not take into account GHG emissions of other HCI installations e.g. of the separation units of hydrocarbon production, compressor stations (fuelled by natural gas), and petchem units. Therefore they should be regarded as minimum values.

Indirect emissions from oil and gas combustion and fugitive oil and gas emissions were calculated on the basis of the national reports for 2007 (there were not found USA petroleum refining and fugitive oil and gas emissions for 2007 and national reports for 2008). Again, the summarized values do not cover all the emissions (e.g. dinitrogen oxide is missing). Indirect GHG emissions of the HCI account for more than 53–55% for the USA and the EU-27 in 2007.

Consequently, HCI is a small direct but a big indirect contributor to the GHG emissions.

THE CHALLENGE

According to the recent IEA Energy Technology Perspectives (ETP) 2010 study (IEA 2010) 'our current path is not sustainable', current global CO_2 emissions should be halved by 2050. If governments around the world continue with policies in place to date – the underlying premise in the ETP Baseline scenario to 2050 – CO_2 emissions will raise by 130% and oil demand will rise by 70%. The required emissions halving can be achieved via the IEA Blue map scenario. All its listed elements (carbon capture and storage, renewables, nuclear, power generation efficiency and fuel switch, end-use fuel switching and end-use fuel and electricity efficiency) have impact on the HCI. Oil demand by 2050 would be 27% below the level of 2005.
HCI would contribute to the implementation of the required tasks.

MEASURES TO REDUCE DIRECT GHG EMISSIONS

Place of birth of the HCI's climate change mitigation actions – similarly to the birth of the chemical industry's responsible care 25 years ago – is North America.

Speaking at Stanford University in California in April 1997, eight months before adoption of Kyoto Protocol, John Browne, CEO of British Petrol was the first senior executive of an oil company to acknowledge that carbon dioxide and other greenhouse gases probably caused global warming, and to recommend that action (control of own emissions, funding of research, initiatives for joint implementation, developing alternative fuels, etc.) be taken (BROWNE 1997). Following BP's announcement, Shell in September 1997 revealed a similar action plan.

BP and Shell followed a proactive strategy to tackle the climate change challenge.

At the same period Exxon (with its CEO, Lee Raymond), the biggest oil company of that time disputed the notion that fossil fuels are the main cause of global warming. That time Exxon pursued a reactive strategy, however, later ExxonMobil's approach to climate change mitigation has changed (WSJ 2005).

Today, most of the HCI companies' strategies cover proactive elements targeted at the climate change mitigation.

HCI companies improve their energy efficiency since such a measure would cut both operational costs and GHG emissions. This action is a typical reactive strategy's element and would cover heat exchanger networks' optimisation, heat recovery solutions, etc. in early applications. E.g. ExxonMobil's Global Energy Management System launched in 2000 identified opportunities of 15–20% energy efficiency improvement. Since 2004 ExxonMobil invested USD19 billion in cogeneration technology and now it is a world leader in this technology (EXXON 2010).

Typically, energy efficiency improvement in a given installation results at the beginning in successes (shorter payback periods) but later in diminishing returns. Furthermore, in some sectors stricter regulations, specifications lead to higher energy consumption and, consequently to higher GHG emissions.

HCI companies would cut losses, typically via flaring reduction. It can be regarded as a reactive strategy's element. Flares allow a quick and controlled combustion when hydrocarbon gas needs to be released from pipes in an emergency and for maintenance. Very small volumes of hydrocarbon gases may be released without being burnt (emergency venting). Following the World Summit on Sustainable Development in 2002, some gas flaring countries (incl. Russia), large HCI groups and intergovernmental organizations launched a Global Gas Flaring Reduction (GGFR) initiative in 2003. The endorsed standards and facilitated projects of this World Bank-led organization would help to reduce total global flaring by 12 bcmpa from 147 bcm in 2007 (OGP 2010). Some companies set up sharp flaring reduction targets, like Total (-50% by 2014 vs. 2005) and ENI (-7% by 2012 vs. 2007) (TOTAL 2010; ENI 2010).

HCI companies would switch to low-carbon energy sources. It is also a reactive strategy's element. Fuel switch to low-carbon traditionally means substitution of liquid fuel (oil) with natural or process gases, resulting in a 37–55% reduction in CO_2 emissions (calculated on equal heat values). Fuel switch would provide flexibility for HCI companies to control their GHG emissions.

All the EU oil companies invest in biofuels in connection with the related EU legislation. It is a proactive strategy's element. Most companies work on new generation biofuels from biomass, biogas, or algae (e.g. Shell tries to find new enzymes to break down the cellulose in plants as straw (SHELL 2010)). Own use of biofuels for transport or in combustion facilities would help to reduce own GHG emissions.

Carbon Capture and Storage (CCS) is a favourite measure for companies. This is also a proactive strategy's element. The EU is to finance up to 12 demonstration projects for CCS through the use of ETS (emissions trading scheme) allowances, MEPs voted for giving up to 500 million ETS allowances to CCS projects in the EU or even in third countries. Depending on the price of CO_2, these revenues could exceed ten billion Euros.

BP have taken steps to re-inject naturally occurring carbon dioxide produced with methane in In Salah in Algeria with local Sonatrach and Statoil, thus improving hydrocarbon recovery rate. This project is one of the largest carbon capture and storage systems in the world. It have reduced the burning of natural gas which has no market – so called flaring – across operations (WRIGHT 2006). Shell's demonstration plant in Mongstad (Norway) would capture the refinery's CO_2 and storage it from 2011 in quantity of 100,000 tpa (SHELL 2010).

HCI companies may invest in flexible mechanisms (in the form of joint implementation and clean development mechanism in developed and developing countries respectively) under governmental aegis, i.e. invest in GHG emissions reduction in other countries and benefit from the reduction. This option represents a proactive strategy element. GHG emissions reduction investment in a less developed installation of the other country, even in the frame of the same company may allow avoiding the diminishing returns phenomena.

Additional elements of the pacesetters' climate change mitigation strategy include carbon cost assessment (they regard carbon dioxide emissions as an economic factor of their operation), advocacy and outreach, and research programmes' funding.

Only few HCI companies reveal commitments to reduce own GHG emissions, e.g. BP (-10% by 2010 vs. 1990) and Total (-15% in 2015 vs. 2008) (BP 2010; TOTAL 2010).

MEASURES TO REDUCE INDIRECT GHG EMISSIONS

HCI companies facilitate fuel switch to low-carbon energy. This traditionally means substitution of liquid or solid fuel with natural gas, resulting in carbon dioxide emissions reduction. Natural gas is quoted as an ideal bridging fuel to the low-carbon energy future. Natural gas reserves would be sufficient for an around 17 years longer time period than of crude oil at present consumption (62.6 vs. 45.7) (BP 2010). Supermajors invest in natural gas reserves. From 2012 Shell would produce more natural gas than oil (SHELL 2010).

Furthermore significant unconventional gas reserves exist. One of their form is subsea methane hydrates made up of a lattice of frozen water which forms a cage around methane molecules. (Others are tight gas, deep gas, gas-containing shales, coalbed methane, geo-pressurized zones). Methane molecules of hydrides can be substituted with CO_2 molecules. According to a source Black Sea represents an important gas source of 30 trillions m^3 and liquid CO_2 would substitute methane at a cost of 20 - 40 USD/1,000 m^3 (CEIBC 2010).

TOTAL INVESTS IN NUCLEAR ENERGY (TOTAL 2010)

Major HCI companies invest in renewables, especially in biofuels in connection with the related legislations in the USA or the EU. Most companies work on new generation biofuels from biomass, biogas, or algae. The Finnish Neste, a non-major company has developed a very successful NexBTL process for the production of biodiesel (NESTE 2010).
Shell started to invest in wind energy in 2008 (SHELL 2010).

Today Shell owns the world's largest grid-connected PV-powerplant with an output of 5 MW (Shell Solar GmbH). BP Solar is one of the world's largest solar companies with manufacturing facilities. It invested into an over 700 MW California solar power plant (SHELL 2010).

Production, handling and treating of hydrogen require special knowledge that oil companies, especially the integrated ones have already accumulated. Oil companies can benefit from this knowledge in the future transport. Shell owns commercial hydrogen filling station (SHELL 2010), Chevron invests in fuel cell plant (CHEVRON 2010).

Presently the oil companies are the determinant suppliers of fuels for transport vehicles, having the possibility to play the same role in the future. They have the capital advantage, to invest into the future technological developments. This advantage enables them, to be technology drivers and future suppliers, regardless of the type of future powertrains.

CCS is a favourite measure for companies like Shell, BP, Chevron and ENI. CCS projects are under implementation in Australia, Canada, and the Netherlands.

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Legal Aspects of Climate Protection

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ABSTRACT

It is the social function of the law to orientate the human behaviour, in the case of the nonobservance of mandatory legal provisions to sanction.

The Hungarian law regulations concern also the climate change in the following legal acts: Act on protection of the environment, decree on air-pollution control, decree on the meteorological service, decree on disaster management, decree on defence of high water damages and so on. The most important regulations under international law are the Frame Convention about climate change (Rio de Janeiro 1992) and the Kyoto protocol (1997). The EU has followed the Kyoto protocol (2002), Directive 2003/87 via greenhouse gases together with the change Directive 2004/101 are the most important European legal provisions in the fight against climate change.

INTRODUCTION

It is the function of the law to orientate the human behaviour with legal norms, regarding questions that are particularly important to the society with mandatory legal norms. If such mandatory legal norms are not followed, a second function of the law emerges: the sanction, the possibility to punish.

I report on 3 categories of legal norms:

- the Hungarian law
- the International law
- the European law.

HUNGARIAN LAW

The Act 1995/LIII on the protection of the environment also mentions the one on the climate in § 22 next to the protection of the air. According to the wording of the law this regulation contains the commandment, that the air must be protected from every artificial influence, or endanger or load with arrangement of other environmental elements with radiant, liquid, air like character or solid materials.

In this meaning I report on the Decree No 21/2001 that also mention air-pollution control in § 15, regulations about extraordinary measures. Regarding this, smog situations and necessary measures are discussed.

Another topic to be mentioned regarding this should be the meteorological service. Decree No. 277/2005 (wording of 2009) provides this service as a mediator which takes many different international meteorological base data, meteorological data of their own analyses and analyses of companies. Using these data the service gives weather forecasts and climatological activity investigations exchanging the results with international organizations (see § 2 d).

According to the general conviction, great floods of recent years can be associated with the climate change and the exaggerated tree-felling in the neighbouring countries. Because of this Decree No. 232/1996 (wording of 2009) on defence of high water damages has a great importance.

Another administration and economy task is the elimination of the consequences of natural disasters, catastrophes with biological origin that are the result of the climate change. According to § 26 of the Act set on disaster management No. 1999/LXXIV the international remedy is also part of the tasks of the headquarters of disaster management. For the latter cooperation is provided with international charitable organizations and with the Red Cross.
The cited legal regulations, as all Hungarian regulations and decrees (such as § 280 of the Criminal Code on causing environmental damages) are naturally apply only in Hungary. Regarding environmental damage originating from neighbouring countries, like e.g. water contamination from either Romania or Austria Hungarian laws can fight against them only with little success as shown by experience. Regarding this, compare § 339 of the Civil Code on causing damages.

INTERNATIONAL LAW

In my opinion all countries should in this respect be interested in preventing measures at an international level the acceptance of which is prepared in a diplomatic way. Norms under international law are the results.

Measures which were set from the United Nations have a global character. At the Conference in Stockholm, 1972 it was decided to set up an environmental protection programme (UNEO2), including an atmosphere research program (GARP). A particularly important measure under international law is the United Nations Framework Convention on Climate Change accepted in Rio de Janeiro in 1992 aiming ultimately the stabilization of the greenhouse gas concentrations in the atmosphere in a state that obtains in the end, which prevents the dangerous influencing of the climate system caused by man. The Frame Convention was put in concrete terms with the Kyoto protocol in 1997. Last, the sad result of UN conference in Copenhagen 2009 still should be mentioned, is the restraint of the USA and China from the Kyoto protocol.

EUROPEAN LAW

On third place I mention a smaller international unit, namely the European Union (EU) which is admittedly particularly important from our point of view. The ordinances of the EU yield the European law.
The treaty establishing the European Economic Community (wording of 1986), means in article 130 (new article 174) about the ecological policy of the community that it aims "to preserve the environment". This principle also applies to: "Impede environmental impairments and fight if possible against at their origin".

With the Green Paper for the trade with greenhouse gas emissions in the EU a Europe-wide discussion about adequacy and the possible functioning of the trade was brought about to walk with greenhouse gas emissions within the EU. Political concepts and measures of the Community in the context of a process which was based on the inclusion of many pressure groups as well as a system for the trade with greenhouse issue certificates in the community were object to the European program for the climate change (ECCP) according to the model of the Green Paper.

This EC Program for Action was established with the Decision No. 1600/2002, the climate change as prior-ranking measure area defined and the facilities of a community far system for the issue trade is encouraged by 2005 in the sixth Program for Action for the environment. In this program of the Community it is confirmed that it would reduce its greenhouse gas emissions by 8 % in the time period 2008-2010 compared to the level of 1990 and in the long-term the global greenhouse gas emissions must be lowered by about 70% regarding the value of 1990.

The Kyoto protocol of 1997 has become effective with the Decision 2002/358/EC for the community.

The community and its member states had correspondingly agreed to meet the obligations to the reduction of the anthropogenic greenhouse gas emissions in the context of the Kyoto protocol together. This obligation shall be accompanied by impairment as low as possible to the economic development and to the employment situation.

The member states have to control their emission according to Directive 2003/87 EC and provide that the operators of certain (definite) activities have an approval for the emission of greenhouse gases and supervise the emission of the greenhouse gases specified for these activities and report on it.

This amending Directive of 2004 determines the trade with greenhouse gas emission certificates in the community (according to the project-related mechanisms of the Kyoto protocol).

In the considerations of the amending Directive it is emphasized that any member state that allows private or public participation in the measures of the project remains responsible for the fulfilment of the obligations from the UNFCCC and the Kyoto protocol and therefore the state shall take care of that the participation is carried out in agreement to the appropriate guidelines, modalities and methods of UNFCCC and the Kyoto protocol.

The European law is obligatory for all member countries of the EU. In this respect we can consider (since 2004) the European law as Hungarian law as well.

The EC has decided to establish a European Environmental Agency and the introduction of a European net for environmental information and observation 1990 (revised Decree no. 401/2009 EC)The recording, composition and assessment of data about the condition of the environment, preparation of expert reports on the quality, the sensitiveness and the loads of the environment is part of the tasks of the agency among others in the area of the community ... (Art 2 e).

Furthermore the promotion of the consideration of European environmental information in international environmental supervision programs, like the ones that get into the context of the United Nations and its special organizations (Art 2 g).

Finally the European Court of Justice shall be mentioned that has to make judgements not seldom related to environmental protection issues on situations that can also have climate consequences. Nevertheless, about 30% environmental issues were in the business sales volume in the year 2005. Of this 30% was related to conservation, 18% waste management, 16% environmental compatibility, 11% concerned the water, 8% considered the air.

In particularly urgent cases the European Court of Justice has also taken interim injunctions. So for example relating to the motorway construction in Poland where woods under special protection in the community or containing special sites of aquatic animals could have been destroyed. In the decision Poland was called not to start or suspend the construction of the motorway.
In a similar case a limited ban of hunting was ordered for Malta on quail and wild pigeons when they were returning in spring.

CONCLUSIONS

So Europe and the EC is important also for us, however, we have to remind that Europe does not belong to the large continents. Therefore I would consider it sensible that the EU parallel to its own regulations and their execution would be active worldwide towards on the one hand the major economic competitors and on the other hand to open towards the developing countries who apparently drift aimless towards their uncertain future. Informing about the dangers and suggestion for technical and legal measures, mine also would be an important task of the EU for me.

Finally, I would like to quote from the talk of the former President of Hungary, Prof. Sólyom at the climate conference in Copenhagen (2009): "The greenhouse gas emissions can be reduced. With a strong political will we still could evade the most serious results of the climate change. The technological and economic means required to this are available ... Why then this awkwardness? Why don't we have still burst capably? ..."

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Fighting against Catastrophes in the European Union

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ABSTRACT

Consequences of catastrophes in recent years made clear that cooperation at community level according to the principle of solidarity is important even today and experienced a clear development since the middle of the 1980s. After six commission decisions the first program for action was approved in 1997. The community mechanism for disaster management was then imported into 2000 as a milestone. The members of the European Union, the joining candidates and the EFTA states of Norway, Iceland and Switzerland took part in the mechanism at that time.

In the present work I would like to give a short summary of the European disaster management – when I mention European disaster management I always use the official German terminology for European Civil Protection – the result of which the Prestige-Disaster should be given as an example of practice which functions after the principles of solidarity and subsidiarity.

BRIEF SUMMARY OF RIGHTFUL REGULATIONS

THE EUROPEAN CONSTITUTION

Disaster management was not an important part of the European constitution which came into force. Articles I 43 and III 329 dealt with the tasks to prevent and combat the consequences of terrorist attacks and catastrophes of natural or human origin according to the solidarity clause. According to article I 43 (1) the Union and its member states act together in spirit of the solidarity, if a member state is concerned of a terrorist attack, a natural disaster or a catastrophe caused by man. The Union mobilizes all means available including the military means provided by the member states to eliminate terrorist threats from the sovereign territory of member states, to protect democratic institutions and the civil population from terrorist attacks and to support a member state in the case of a natural disaster or a catastrophe caused by man on requests.

However, not only the Union and member states operate together based on article III 329 (1) if a member state is concerned of a terrorist attack, a natural disaster or a catastrophe caused by man, member states help it mutually on requests according to the principle of solidarity.
The constitution text was unfortunately after the failed referendums -- already signed in Rome on 29th October 2004 -- in France and in Holland in 2005 the ratification procedures have been set in the other member states and the treaty did not attain any legal validity as a constitution for Europe.

The reform contract was signed by the state presidents and prime ministers as a compromise instead.

THE CONTRACT OF LISBON

The Lisbon contract finally became effective after prolonged negotiations on 1st December 2009. It had all functions in the area of disaster management and Humanitarian help were established in the contract text.

The Union promotes the co-operation between member states to make the systems of preventing catastrophes and natural disasters more effective.

The Union supports and completes the activity of member states involved at a national, regional and municipal level regarding risk prevention and education disaster management in the case of catastrophes and promotes a fast and efficient co-operation.

Why is such a co-operation so important? It is important because (as I have already mentioned in the introduction) the measures of single member states may not always be sufficient for extreme catastrophes.

SECONDARY SOURCES OF RIGHT

Secondary legislation is named on the basis of the primary law of the organs of the European Union or the European Atomic Energy Community act.

The secondary right should not contravene the primary right. In this case the European court of justice can declare the secondary right case as trivial. These secondary legal acts are regulations, policies, decisions and recommendations

For these legislation norms certain methods of regulations are fixed.

Considering the facts mentioned above, different legal actions for fighting against natural disasters operate within the Union or in other countries. The most important secondary legal instruments of the cooperation are the followings: community methods for disaster management, financing disaster management, executing regulations for transportation, financing regulations for disaster management and executing regulations for community procedures for disaster management.

The general purpose of the community procedures is providing support in case of emergency based on a corresponding request supporting a better coordination of help using the member states and the community.

The commission administers the Brussels-based night and day attainable and immediately responsive Monitoring and Information Centre (MIC). Communication between the MIC and the contact points of the member states is carried out by the Common Emergency Communication and Information System (CECIS.)

Protection ensured by the method considers primarily the people but also the environment and real values including cultural possessions in case of natural and artificial catastrophes, terrorist attacks and technology catastrophes, radiation and environmental accidents, including accidental sea pollution happening within or outside the community.

Participant states can apply financial support from the community for delivering its help to the countries concerned.

Costs of transporting to and back the teams and their equipment including costs of all services, charges, costs of logistics and handling, costs of fuel and possible accommodation, as well as other indirect costs like taxes and transition costs can also be supported. However, it is very important that all costs are covered duly.

The execution regulations contain the most important features of disaster management modules like tasks, capacities, subassemblies and duration.

A disaster management module is fixed, independent and autonomous requiring oriented combination of the capacities of the member states or a mobile operative team of the member states as a combination of human and material resources which is marked by its ability to use or to perform tasks as mentioned above.

After the coming into force of the first execution regulation of 2004, the last six years made it clear that the thirteen disaster management modules must be extended with four new types of modules.

Therefore the previously existing modules have been completed with the modules "forest fires on the ground", "forest fire fighting on the ground with the use of vehicles", "control of floods" and "search and rescue missions using boats during floods".

In major disasters the community showed solidarity with the population in affected the regions and provided a solidarity fund to contribute to the restoration of normal living conditions in the damaged regions.

The state may immediately, however, no later than within ten weeks after the commission received a request for assistance from the fund considering the first damage caused by the disaster.

The grant has to be used within one year from the date on which the commission has disbursed. The portion of the grant that was not used within that deadline is recovered from the recipient state by the commission.

THE PRESTIGE ACCIDENT

A good example for the functioning of community methods for disaster management and the Solidarity Fund of the European Union is the accident of the oil tanker Prestige. The extend of the tanker accident – valued at 94% of the "Oilspills" caused worldwide had an influence back on the account of the prestige accident in 2002 – pointed that this size of a disaster requires use of funds and a coordinated action at EU level when the national help capacity is not sufficient. The Monitoring and Information Centre (MIC) has asked for help in eight cases with the result that different countries involved have provided the Spanish, Portuguese and French authorities with ships, airplanes, equipment and experts.

Figure 1: Enhanced radar image of Prestige oil tanker spill, taken from a Canadian satellite Nov. 18, the day after the tanker sank http://www.albionmonitor.com/0211a/prestigeoilspill1.html

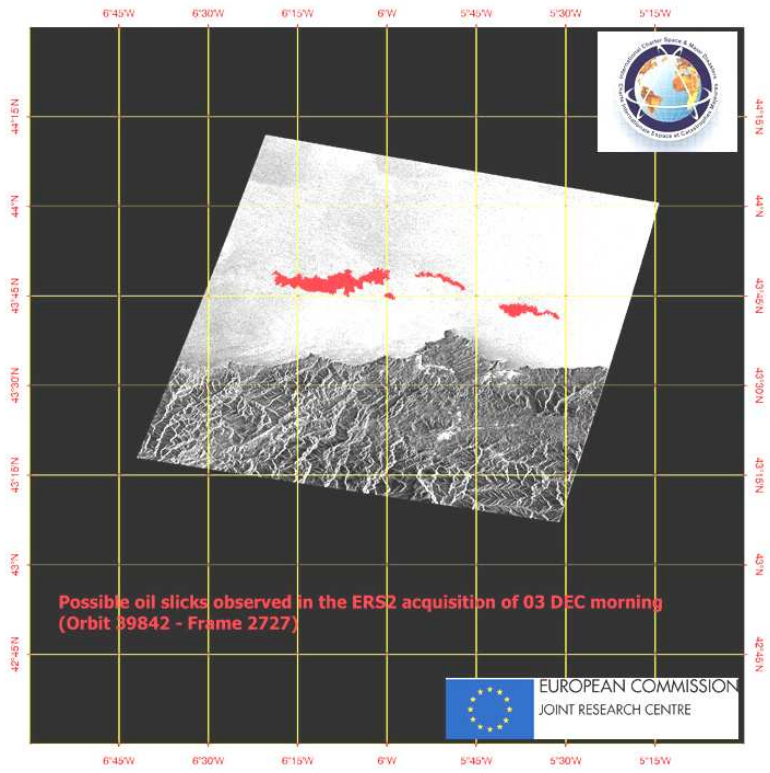

Figure 2: Satellite image http://www.disasterscharter.org/image/journal/article.jpg?img_id=35273&t=1239883666331Summary

The Monitoring and Information Centre and the Joint Research Institute in coordination with the Spanish authorities under the charter "Space & Major Disasters" obtained satellite photos of the area concerned. The Joint Research Institute assessed all photos. After the prestige accident the commission suggested to extend the remit of the European Maritime Safety Agency, which is to support the community method. In addition, the commission organized a "lessons learned" one year after the accident Catania, Sicily. On request of the Spanish

authorities 8.626 million € were paid from the EU solidarity fund for the costs of the immediate measures. In addition, two EIB loans amounting to a total of 500 million € were approved for the recovery of the economy in the area.

SUMMARY

Action against disasters like natural and artificial catastrophes, terrorist attacks, technological radiological or environmental accidents and accidental marine pollutions is taken seriously not only at the level of member states, but also at Union level. By the Prestige accident we could understand the functioning of the European disaster management on the basis of an accidental marine pollution in which member states and the Union acted together according to the principles of subsidiarity and solidarity.

It is also important that the legal regulations are regularly overviewed by different EU organizations. Thus, the practice gained in the exercises and experiences can be discussed and new solutions will be found. Based on the new information, for example previous disaster management modules were checked and the decision 2010/481/EU, Euratom on the execution regulations of the community methods for disaster management module was completed by four new ones.

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Displacement in Climate Change and the International Migration Regime

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Keywords: international legal protection, displacement, migration law, UNHCR, recognition of climate displaced persons

ABSTRACT

The author proves the necessity of minimum rules on displacement management and legal status of displaced persons due to the climate change and environment degradation because the existing human rights standards are not sufficient to them. Taking into account the binding legal as well as soft law instruments at international level, certain further law making efforts are required in order to manage the forced migration of individuals and mass movements in the context of environment displacement including the temporary entry, reception and resettlement of displaced persons unless they remain under the ambit of national rules in great extent pending on full discretion power of authorities. This process would be built on the regional norms of solidarity, human rights' protection and financial, social and administrative co-operation in burden-sharing. However, the UN Framework Convention on Climate Change or its Protocol shall be supplemented on binding provisions on a comprehensive international regime on the protection of environmentally displaced persons and effective management in case of mass displacement providing the human needs for all inhabitants shall be established sooner or later.

THE SIZE AND NOTION OF DISPLACEMENT

Regardless the absence of generally accepted definition on direct or indirect (possible) victims of climate change, experts are calculating the scale of displacement in the context of ecological catastrophes, environment degradation, warming and devastation, or stopped conveyor belt in the oceans. For instance, up to 2060 the number of displaced persons due to climate change would be 1 billion according to the estimation by the Intergovernmental Panel on Climate Change, (VIDAL, 2007). The United Nations High Commissioner for Refugees (UNHCR) predicts up to 2050 the number of forced migrants and displaced persons at least 250 million only due to climate change (JOHNSTONE, 2008A). In fact, only in 2008 the number of victims for natural disasters relating to climate change was 20 million as displaced persons (NRC 2008).

Instead of miscalculation, it shall be taken into account the actual number of displaced persons based on the registration of UN (UNHCR, 2008a). It meant 55 million persons, and from them there were 15.2 million refugees, 839 000 asylum seekers (rather in Pakistan, South-Africa, Syria and Iran), 26 million internally displaced person (56% females and minors), 12 million stateless persons, 600 000 repatriated migrants and 88 000 replaced persons (mainly into USA). This simple list from the statistics on forced migrants may illustrate how difficult to find a precise and fair term on migrating people beyond endurance environment. The gathering term of displacement is properly neutral and flexible and perhaps refers on external, supra-individual forces in decision on leaving the home (land).

Summing up, the term of *environment displacement/displaced persons* can reflect the best way the multi-causality of forced migration due to overlapping reasons without over-used, misused the existing legal phrases or stigmatisation the communities/individuals in need. The task of governance and legislative power at national and international level is to determine who are responsible for reception of environment displacement persons, who has to care for environment displaced persons, how can the costs of their reception financed.

EXISTING LEGAL INSTRUMENTS ON DISPLACEMENT MANAGEMENT

What are the main principles of applicable and at least partly relevant legal sources on environment displacement and of legal status of victims?

PREVENTION

It is a leading aim of numerous international norms of mass migration, refugee waves, forced displacement relating to environment and human rights crisis. The UN Framework Convention on Climate Change (1992) urges comprehensive response strategies at the global, national and, where agreed, regional levels that take into account all greenhouse gases. Giving a simple definition of climate change the Convention intends to protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities; so parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. (Art 3) These preventive measures are inserted into the each party's national mitigation policies, regulations and efforts in raising the public awareness level through education, training, supported research and information campaign (Art 6).

STATE RESPONSIBILITY FOR PREDICTABLE DAMAGES IN ENVIRONMENT EVENTS

Respect for human rights has become the inevitable part of constitutionalism in Europe after the WW2. The Universal Declaration of Human Rights of the UN (1948) determines the state obligations relating to human rights, such as to protect human life, dignity, property and health that are surrounded by material and procedural guarantees by the UN Covenants (CPR, ESCR, 1966) and the European Convention of Human Rights (1950). In cases of displacement certain measures shall be taken by the state, e.g. setting up temporary shelters, management of evacuation, vaccination, protection of assets in designated places even by limitation of fundamental rights. However, these human rights requirements are implemented – presumably – in democratic states in prosperity, while the periods and places of extreme conditions are increasing.

State initiative to acquire a further (dual) citizenship in order to prevent statelessness for abandoned nationals would be adequate measure but it depends on the consent of another state – and its state obligation for naturalisation in mass on the ground of bilateral agreement seems to be a bit futuristic. Although the prevention of statelessness and preferential acquisition of citizenship for stateless persons has been a part of UN and Council of Europe's treaties but it covers on individual cases based on full discretion of sovereign power. However, the sending island/lowland and receiving state may conclude on citizenship issues, too.

MANAGEMENT OF INTERNAL MIGRATION AND MASS MIGRATION

In absence of comprehensive international rules on the regime of entry, temporary residence and treatment with displaced persons belong to the national legislation. However, there are only some components of international standards and human rights as points of reference that would a bit reduce the diversity of national rules.

Furthermore, the international soft law determines how the territorial state must manage the extended internal movement. The UN General Assembly's Resolution (1998) contains 30 principles on mass internal displacement and refugees that requires the measures taken on designation of human habitats and residence respecting for unity of families. Accordingly, in case of emergency limitation of free movement and right to choose the residing place of inhabitants is lawful. Seeking family members and died persons is necessary as well as tracing the tombs. This document defines that all inhabitants have right to basic human needs, such as to nutrition, drinking water, shelter and medical treatment, moreover identification documents for and public schooling for displaced persons, minors shall be provided for all without delay.

ENTRY AND RESIDENCE IN THE TERRITORY OF ANOTHER STATE IS BASED ON NATIONAL SOVEREIGNTY

The diversity of national rules means that there are at least 200 domestic regime on border control and migration management setting up national preferences and restrictions (refusal at borders, removal, expulsion, deportation, extradition rules) including the legal basis for authorised stay (visa, residence permit). The right to return, free movement and residence shall be provided only for nationals according to the UN Covenant of CPR (1966), thus all non-nationals are subjected to the discretion power of the territorial state authority.

Furthermore, only soft law rules can be referred on forced migratory movements in the context of incapable, non-democratic state, such as the principles of temporary reception and shelter for protection seekers in harmony with the international solidarity of the documents on the territorial asylum (COE, UN). Rejection of forced migrating people at the border is not compatible with humanitarian principles unless there is a compelling state security reason for refoulement. The classical state security means severe political, military or police risks but prevention of environment degradation, pollution or waste by mass influx has not generally accepted.

DURABLE SOLUTION FOR MIGRANTS

It would cover on settlement, integration, re-settlement into a final destination state or return home making their removal an exceptional measure by the territorial state inspiring it to apply legal, social, economic and cultural integrative measures in favour of foreigners. This policy and its enforcement belong also to the sovereignty of states beyond the general respect for human rights of inhabitants. Through bilateral agreements on readmission of own nationals or other displaced persons or undertaking of yearly defined quota of refugees there is some chance to improve the durable solutions. Sometimes the UNHCR intervene to receive special vulnerable groups in catastrophes, wars or refugee waves. Moreover the soft law on voluntary repatriation and integration would affect the state policy.

In brief, the national legislation can do its best for management of environmental displacement in the power of sovereign on determination of entry, refoulement, removal, reception and humanity. For instance, Hungary has been reluctant to adopt comprehensive rules on displacement in the context of regional environment degradation, extreme conditions and mass migratory movements. Although the failed Bill on national climate change (2010) and mitigation framework would have contributed to the political recognition of climate change in Hungary, the legislation has been related only to the transposition of the EU law. A wider approach requires the individuals' responsibility in saving energy, in reduction of ecological effects, and in contribution to funds for persons in need worldwide. We have to march towards the *climate justice by the global climate citizenship* (HARRIS, 2008) based on moral duties of state as well as citizens. Today we are far from this mental movement.

CONCLUSIONS

The *international standards on mass migration have been fragmented and deficient* (UNHCR, 2008b) because it can cover on victims of frozen political climate providing refugee status or temporary, additional protection in another state based on individual assessment. These international rules may exclude undeserving migrants, while the non-refoulement requirement would guarantee temporary presence of forced migrants without legal statement for applicants. Displaced persons due to the climate change, environmental degradation are vulnerable leaving our country of nationality: they are not entitled to entry and residence in foreign state unless the international community is developing institutional co-operation and a specific legal regime to this case.

The legal rules on forced mass migration due to the environmental degradation (climate change, natural disasters, etc):

- Are missing providing alternative living conditions for own population of the incapable or ceasing state;
- Are partly applicable on the grounds of the humanitarian law if there is a war/fare situation between states or armed conflict in closed relation to the degradation; or if persecution on the grounds of race, religious, social status, political opinion or nationality of the groups is in closed relation to the degradation, and finally, these rules
- Are hardly applicable in absence of effective system of solidarity and burden sharing on reception.

The *legal rules on migrating individuals due to the environmental degradation* require entry and residence conditions that shall be met as determined in about 200 national legal systems; their essence is the self-subsistence, absence of risks in public health and public order by foreigners, consequently only a small part of the endangered population as well-to-do can manage individually an alternative life space. While the Union citizens' right to free movement together with family members is ensured inside the EU, there is no subjective right to entry and reside in any foreign state, its allowance belongs to the sovereignty and discretion power of the each state/authority. It contains individual assessment for asylum seekers/refugees (1951 UN Convention), minors (1989 UN Convention), protection seekers against torture, inhuman, degrading treatment (1966 UN Covenant, UN CAT, 1950 ECHR) and perhaps for de jure/de facto stateless persons in some states (1954, 1963 UN Conventions).

Taking into account the ongoing humanitarian reform of the UN, a development of legal standards would be inserted into the post-Kyoto process or UN Framework Agreement. It may cover on:

- Definition of individual and mass migration of forced displacement due to environment degradation setting up a new legal entitlement of forced victims for entry, transit, residence and settlement in another state. (WILLIAMS, 2008) It will prevent the abuse the existing legal rules on international mobility. For this reason clear principles shall be defined on priorities of overlapping/competing human rights of climate displacement with refugees, statelessness or victims of war in such a multi-factored appearance. This new legal regime must determine the minimal conditions of respected dignity and social security for all habitants in the case of mass influx;
- International protection (reception and residence) shall be provided at least temporarily for displaced persons due to the ceasing home state (statelessness prima facie);
- Minimum substance of human rights to nutrition, residence and accommodation on a designated place, drinking water, basic health care, inquiry of split family for all inhabitants regardless their nationality respecting for human dignity and sustainable environment (similar to the refugee status or temporary protection for non-returnee on natural disasters as it is available in Scandinavia or in US);
- The principles and operating system of the global solidarity (e.g. inserting into the UN Security Council decision making mechanism) sharing the sources, logistic, relief capacity and duty on taking environment protective measures. It shall be available during the time of mass outflow and mass influx/reception, both including rapid interventions;
- Enlargement of the mandate of UNHCR is required (TÓTH, 2002) providing international protection for displaced persons in climate change (natural disasters) in co-operation with UN emergency and humanitarian organs, UNICEF and IOM;
- Specimen regional agreements on effective co-operation between the national, international and sub-national organisations, NGOs in favour of reception, registration, legal protection, resettlement of displaced persons in climate change and on burden-sharing is also urged (UNHCR, 2009a).

SUMMARY

The Kyoto Protocol contains numerous preventive measures on mitigation but nothing on how to administer the mass migration due to the insufficient government actions combating global warming. In this way it would be supplemented by the conference of party states on *how to handle the international (supranational) movements, forced displacement and reception of displaced persons in climate change (natural disaster).* The main modelling rules would be inserted to the text by amendments on the grounds of the international consent (see the Art.18, 20)

The mentioned *development of law is based on recognised limitation of national sovereignty* that shall be *balanced with enforceable human rights due to the sufficient international co-operation.* There are two options in model setting taking into account the necessary and proportional limitation of liberty establishing better the human and natural security:

- Well applicable international rules on collective prevention and burden sharing (e.g. in evacuation, resettlement of persons in case of natural disasters or climate change) in particular if the responsible state is not able or reluctant to protect own population's life and property (UNHCR, 2009b), or/and
- Extension the lawful channel of international migration in all states that are able to receive forced victims of environment displacement, in particular if events would not be predictable (JOHNSTONE, 2008b), and supplementary obligations on protection for the state of origin and reception shall be attached to it.

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Economic Effects of Climate Protection Measures

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Keywords: climate policy, mitigation, reduction, resource efficiency, economic measures

ABSTRACT

The fact of climate change and its consequences are recognized by a growing number of politicians, and more-and-more countries join the international actions aiming the reduction of harmful consequences. The climate policy measures are evaluated variously by the countries in different economic situations; this is why conflicts may arise regarding the adoption and introduction of the measures.

Three variants of measures are possible: the reduction of CO_2 emissions (mitigation), adaptation to new situations and the more efficient use of resources. Innovative solutions should be developed to increase efficiency by which the existing resources can more fully satisfy the needs of the growing population. In addition, measures for the mitigation and adaptation are inevitably necessary, too.

The responsibility of scientists is to analyze the social and economic consequences, the advantages and disadvantages of measures related to the climate change, before the implementation. Economic and social analysis should be performed at global, national, corporate and family levels, and strategies should be formed and decisions should be taken at these levels.

CONFLICTS, THE RESULT OF CLIMATE POLITICAL MEASURES

The climate political measures primarily restrict the emission of CO_2 from fossil sources but they concern also further greenhouse gases (e.g. methane N2O, FKW s, H-FKW s, SF6 etc.).

Table 1: The greenhouse gases

The greenhouse gases	Label
Carbon dioxide	CO_2
Nitrogen oxides (laughing gas)	N_2O
Methane	NH_4
Perflourierte fluorine coal hydrogen	FKW
Containing hydrogen fluorine coal hydrogen	H-FKW
Sulphur hexafluoride	SF_6
Nitrogen oxides	NOx
Not methane fugitive organic connections	NMVOC-s
Carbon monoxide	CO
Sulphur dioxide	SO_2
Ammonia	NH_3
Fine-grained materials	PM10, PM25

Source: UNFCC, 2009

Sources of greenhouse gases are primarily energy production, heating and cooling, traffic, industry and farming. These are such anthropogenic economic activities that are the result of increasing standard of living and the total population where mankind plans not only a retention but also further performance rise.

Table 2: The most important GHG sources (examples) "The greenhouse gases"

CO_2	CH_4	N_2O	FKW, H-FKW, SF_6
Power stations, Transportation, Heating, Industry, Farming Waste dumps	Mining, Natural gas and oil, Keeping of animals, Sewage treatment, Waste dumps	Arable land, Sewage treatment, Keeping of animals, Burning of fossil heating substances	Semiconductor-production, Electrical lines, Distribution Aluminium-production, Magnesium- production

Source: UNFCC, 2009

However, due to this a global conflict, between the present and future claims, between developed and developing countries as well as between the economy and the natural environment will develop. However, this future always gets closer to us, the effects of the climate change become more elementarily strength on mankind soon on everybody have an effect independent of whether they were ready to accept the compulsory measures being connected with the climate change or not. The danger can also appear that these lead to drastic measures for demonstrations, riots, wars for what the history of mankind already gave many examples.

With the declaration of the summit meeting of Copenhagen one can declare that in the interest of avoiding the risks of the dangerous climate change the global average temperature until end of the 21st century can only be higher by 2 ºC at the most than in the ages of the industrial revolution. However, greenhouse gases of anthropogenic origin can remain in the atmosphere for 10 up to 1000 years. This means that cumulative emission also plays an important role besides the given the issues. Therefore the anthropogenic cumulative CO_2 -emissions might not exceed the 1000 Gt limit in the period between 2000-2100 (Carbon-space). This quantity already reached one third of the limit between 2000 and 2009 therefore the earlier we can reach an essential emission reduction, the better. (MEINSHAUSEN ET. al., 2009).

TASKS OF SCIENCE

Two important incumbencies have to be mentioned in the circle of the climate protection measures. On the one hand, politicians and even people should accept that we face a hard problem affecting the entire mankind in order to set up effective regulations and control. On the other hand, it is the task of science to search for solutions that help the diminution of the issues (mitigation) and thus adaptation can be carried out successfully.

Solutions can also lead to positive changes in the quality of life, standard of living in the given situations shall be developed. Such solutions can be reached primarily by the "alternative" technologies, the innovations, and the more efficient usage of the resources available. Therefore we cannot calculate only with restrictions and relapses but also with developments in the future.

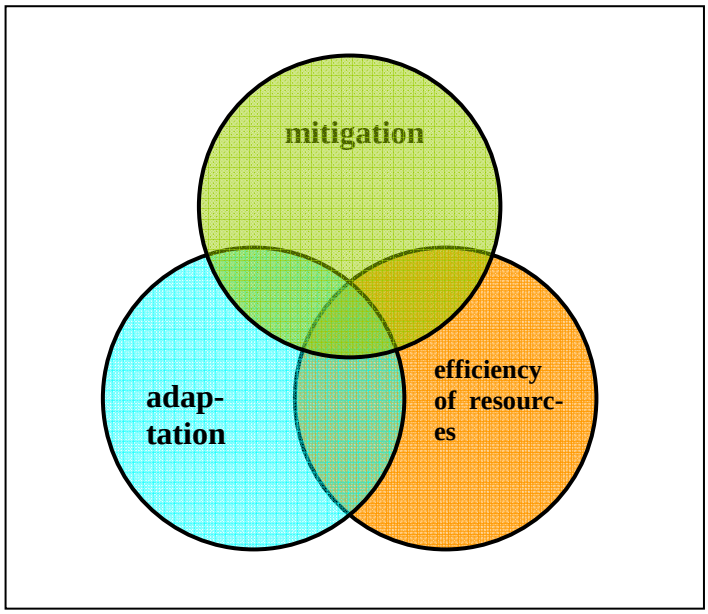

Figure 1: The three possible ways of realizing emission reduction

The role of science is undoubtedly important in the preparations for climate protection measures. However, when economic sciences besides physical sciences, life sciences and engineer sciences become more into this, it always stresses national economy teaching, business economy teaching and management sciences. Air also became just as important and restrictedly available resource as raw materials, energy sources and the country. Based on this air as an exceptionally important resource shall be treated as an object of the economic activity as well.

One must be used to the Carbon-space available being valuable for what different interests collide. As in the case of other important restricted resources the efficient use of the air and the careful retention of its quality will be important. Even other resources available for mankind should be restructured so that coherent tasks presented by the climate change can be solved successfully by their management. However, this is inconceivable without long-term planning, efficient organization and consistent control. It is not by chance that nowadays we talk not only about climate strategy but also about climate controlling.

There are numerous examples on the importance of economic analysis and evaluation. Among such measures the more conceivable alternatives promising the most favourable success shall be selected, considering possible advantages and disadvantages bearing in mind the financial and other resources available. However, these analyses involve the uncertainty of unexpected events as they are very complex taking into account the structure of the economic systems and mutual connections. Such analyses have to apply a wide range of mathematical and economic scientific models and sophisticated analysis methods for the successful meeting of climate political decisions and measures. Economy teaching can become an active partner of "green" sciences with that.

The global and individual economic analyses and decisions can have the strategy formation and operative economic activity of individual enterprises, even in the private sector with increasing importance in the future. In a market economic situation the economic organizations cannot be excluded when the market effects must be restricted or influenced due

to important society and environmental reasons. The businesses have to receive adequate information on the effects of the climate change, and on future measures. Individuals and families can, on the one hand, influence actively the processes of emission reduction with their purchase and investment decisions, on the other hand, they can also lead politicians and the economy towards the right strategic direction.

Table 3: Levels of economic measures for efficient emission reduction

Global level	Worldwide examinations International strategy development International agreements Control
Supranational and national level	Strategy development Legislation Regulation Control
Enterprise and institutions	Strategic analysis Strategy development Operative execution "Green" Controlling
Individuals, families	Environmental consciousness Motivation Private decisions Control

Source: own case

The economy can with the help of adequate regulations and frame systems in conformity with the market (e.g. CDM: Clean Development Mechanism, JI: Joint implementation, EU-ETS: Emission trading scheme) have such abilities and strengths that make adaptation to efficient stationary development possible. The measures carried out up to now should be developed and spread further.

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Nuclear Energy in Hungary – History, Present and Future

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Keywords: nuclear energy, nuclear installations in Hungary

ABSTRACT

In the paper current status of the Hungarian nuclear energy sector will be presented. The nuclear power plant Paks, facilities of the nuclear fuel cycle and related training and research institutions will be introduced. A short outlook concerning the short- and medium-term future of Hungarian nuclear industry will be discussed.

INTRODUCTION

The role of the nuclear energy in the Hungarian electricity sector is indisputable: the Paks Nuclear Power Plant produced the 43% of the national electricity production in 2009, 35 % of national consumption, so Hungary is in the top of the country list concerning the nuclear share in the electricity sector. According to the data of the International Atomic Energy Agency (IAEA), Hungary had the 7th largest nuclear share in electric power production in 2009.

The nuclear industry could increase its importance in the future in the country, because - as a consequence of the special position of the Hungarian energy sector (very highly depending on the Russian natural gas) and as a fight against the climate change - the national energy strategy includes the construction of new nuclear units.

This expansion calls for the broadening of the research and development activities in the field of nuclear technology and for the maintaining of the level of the training and education of the designer, operational and maintenance staff of the new units. For the fulfilment of these tasks the further operation of the present Hungarian research and educational nuclear facilities is necessary.

The present and the prospective use of the nuclear energy is unrealizable without the safe close of the nuclear fuel cycle. The back end of the cycle includes the management and the final disposal of the low and intermediate level waste, the interim storage of the spent nuclear fuels and the long term disposal of the high level waste coming from the dismantling of the nuclear facilities.

NUCLEAR FACILITIES IN HUNGARY

THE PAKS NUCLEAR POWER PLANT

The only nuclear power plant in Hungary is the Paks Nuclear Power Plant (Paks NPP). The site is situated at the east bank of the river Danube, 124 km to the south from Budapest, near the town of Paks.

Figure 1: Paks Nuclear Power Plant

he Paks NPP operates with 4 units, equipped with Soviet-designed VVER-440 type pressurized water reactors.

The launch of the Hungarian nuclear programme was decided in the early 60's, however, the construction of the Paks NPP started only in 1974. The first unit was connected to the grid in 1982, the other units in 1984, 1986 and 1987, respectively.

The original 440 MW electric output of the units had been increased to 470 MW in the 90's by efficiency improving modifications in the secondary circuit. In the last decade a new power upgrade project – following the international nuclear operational trends - was launched: aiming 500 MW electric output (108% of the reactor initial power). The performed modifications included:

- New fuel assembly design (allowing power upgrading),
- Modernisation of the in-core monitoring system,
- Reconstruction of the primary pressure control system,
- Modification of the turbine and the turbine control system.

Unit 4 achieved the 500 MW electric output in September 2006, Unit 1 in July 2007, Unit 2 in December 2008, and Unit 3 in November 2009

The owner of the Paks NPP is the Hungarian Power Companies Ltd. (MVM Zrt.), a state-owned utility company. The operator is the Paks Nuclear Power Plant Ltd.

Now, after completing the capacity upgrade project for the units, the nominal electric power of the Paks NPP is 2000 MW. In 2009, the NPP produced 15,427 GWh electric energy, that gave the 43% of the domestic electricity production. The unit price of the electric energy of the power plant was 10.67 HUF/kWh (3,5 Eurocent/kWh), so the Paks NPP is the cheapest electricity producer in the country. Its operation spares as much oxygen per year, as the annual oxygen production of the Hungarian forests.

RESEARCH AND EDUCATIONAL NUCLEAR FACILITIES

With its start-up in 1959, the Budapest Research Reactor in the KFKI (Central Physics Research Institute) is the oldest nuclear reactor in Hungary operating yet. The Soviet-designed reactor started its operation with a thermal power of 2MW, but after a reconstruction and power uprate project, its nominal thermal power is 10 MW since 1993.

The Budapest Research Reactor serves as a high flux neutron source (Budapest Neutron Centre) for basic and applied research, in the following fields: materials science, radiochemistry, reactor engineering, simulator development, safety analysis, reactor physics, thermohydraulics. Other tasks of the reactor are: isotope production, neutron radiography, material analysis, education.

Figure 2: Budapest Research Reactor, KFKI

The spent fuel of the reactor was send back to Russia in 2008 under the Russian - American „Russian Research Reactor Fuel Return" (RRRFR) program.

The Training Reactor operates at the Institute of Nuclear Techniques of the Budapest University of Technology and Economics (BME NTI). The Hungarian designed, pool-type reactor reached the first criticality in 1971, and has a nominal thermal power of 100 kW.

The uniqueness of the Training Reactor is given by the fact, that its operation is subordinated to educational purposes, i.e. it serves as a demonstration tool of reactor operation and other nuclear techniques for students in the higher education.

The Training Reactor is the scene of reactor operation exercises for undergraduate and graduate students and also serves as neutron- and gamma-radiation source. The reactor has radiochemistry, thermal-hydraulics, neutron- and reactor physics laboratories, as well as laboratories for radiation protection measurements. Extensive research work is going on in the institute and at the Training Reactor too.

Figure 3: Training Reactor, Institute of Nuclear Techniques, Budapest University of Technology and Economics

The main educational tasks of the Institute of Nuclear Techniques are the following:

- Support physics and energy engineering education (nuclear-related courses in the field of reactor physics, thermal-hydraulics, nuclear safety, radiation protection, nuclear measurements and instruments and radiochemistry)
- Educational activities for other engineering faculties and even other universities
- Post-graduate education: PhD school and post-graduate training course for nuclear reactor engineers
- Activities in European Nuclear Education Network Association (ENEN) - e.g. 3-weeks long Eugene Wigner Course for Reactor Physics Experiments.
- Beside the regular university education there are about 2-3000 secondary school students visiting the reactor annually, which helps the secondary school teachers in the basic nuclear physics education. In the last two years a complex renewal program of the training reactor and the connected laboratories was started with the financial support of the Hungarian nuclear industry.

FUEL CYCLE RELATED FACILITIES

The management, interim storage and the disposal of the Hungarian radioactive and nuclear wastes and the spent fuel is the task of the state-owned Public Limited Company for Radioactive Waste Management (PURAM). It is the operator of the Radioactive Waste Treatment and Disposal facility at the Püspökszilágy site (low and intermediate level waste disposal for institutional waste), the ISFS (Interim Spent Fuel Storage) at Paks, and the National Radioactive Waste Repository at Bátaapáti. The Bátaapáti facility is under construction now, and is planned for the final geological disposal of the low and intermediate level waste from the Paks NPP.

FUTURE OF THE HUNGARIAN NUCLEAR SECTOR

The originally designed lifetime of the four Paks units will expire between 2012-2017. A feasibility study about a 20-years extension of the operational time was carried out in 2000. The study concluded that there is no obvious technical problem or safety concern that could prohibit the extension, and that the project is reasonable from the economical point of view as well.

The lifetime extension project made necessary the launch of a complex ageing management program, which included the introduction of farseeing operation of the units for the conservation of the systems, structures and components, the monitoring of the systems possibly affected by the ageing, and the intervention if needed (replacement of aged systems or components).

According to a safety review of the major systems of the Paks NPP, the reactor pressure vessel and the steam generators are of special importance, because they cannot be replaced. Therefore a special ageing management program was launched for this items.

In November 2006 the Hungarian Parliament accepted in principle the concept of the service lifetime extension with a vote rate of 96.6%. The lifetime extension follows an international trend, for example in the USA almost 60 reactors have gained the licence renewal (for 60 years instead of the originally planned 40 years) from the authority.

The Hungarian energy policy consists the preparation of the construction of new nuclear units. The MVM Group started a project in 2007 for gaining the approval of the Hungarian Parliament for the construction. On 30 March 2009 the Parliament gave its principal consent by 96% to the preparation works of the possible new units at the Paks site. (The Paks site was originally prepared for six units.)

The type and the supplier of the possible new unit(s) is not decided yet, but the main considerations are clear: an advanced (3rd generation) light water reactor-type with 1000-1600 MW electric output and 60 years operational time, with load-following operation is needed. At the moment, four advanced types are under consideration: AP1000 by Westinghouse, EPR by Areva, AES-92/AES-2006 by Atomstroieksport, and Atmea-1 by Mitsubishi-Areva.

SUMMARY

Status and future of nuclear energy in Hungary was presented in the paper. Besides the Paks Nuclear Power Plant present installations of the nuclear fuel cycle were described together with the research, education and training facilities. Current status of the nuclear power plant, its lifetime extension and the possibilities of new units have been discussed.

Most recent results of wind power utilization

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ABSTRACT

According to the data of the European Wind Energy Council 20 new wind power plants in average were constructed and connected to the network in Europe in 2009. Thus wind power plants of 75 GW capacity produced electricity at the end of 2009. In average wind conditions this installed power corresponds to 161 TWh electric energy production amounting to the cover of 4% of the total energy demand of Europe. In 2009 investors spent 45 billion Euros in wind power plant projects all over the World. Wind power became considerable and undoubtedly important member of the energy market of the World. The wind power plants of 158 GW capacity operating worldwide are capable of producing 340 TWh electric energy avoiding the emission of 204 million tons of CO_2 over one year.

Despite capacity limits on wind power plants more-and-more people are interested in wind power plants and in small power wind generators that can be used in households. This paper presents the current situation of wind power utilization in Hungary and the expected processes until 2020.

FACTS AT THE BEGINNING OF 2010: NEW EU TARGETS FOR 2020 (CLIMATE PACKAGE)

The European Union set the following targets to be realized by 2020:

- Reducing green-house gas emission by 20 %,
- Increasing ratio of renewable energy resources to 20 %,
- Reducing total primary energy consumption by 20 %,
- Increasing ratio of bio-fuels to 10 %.

These targets raise several questions.

How can these targets be achieved? Why international (OECD) prognoses show a totally different trend? How realistic are these targets? Following the partial completion of earlier targets why were even more ambitious targets set for 2020? It seems absolutely certain that constructing wind power plants will play a leading role in realizing the above targets.

SITUATION OF WIND POWER IN THE EUROPEAN UNION

According to the prognosis related to electric energy production wind power will be the most significant renewable energy resource in Europe (Figure 1).

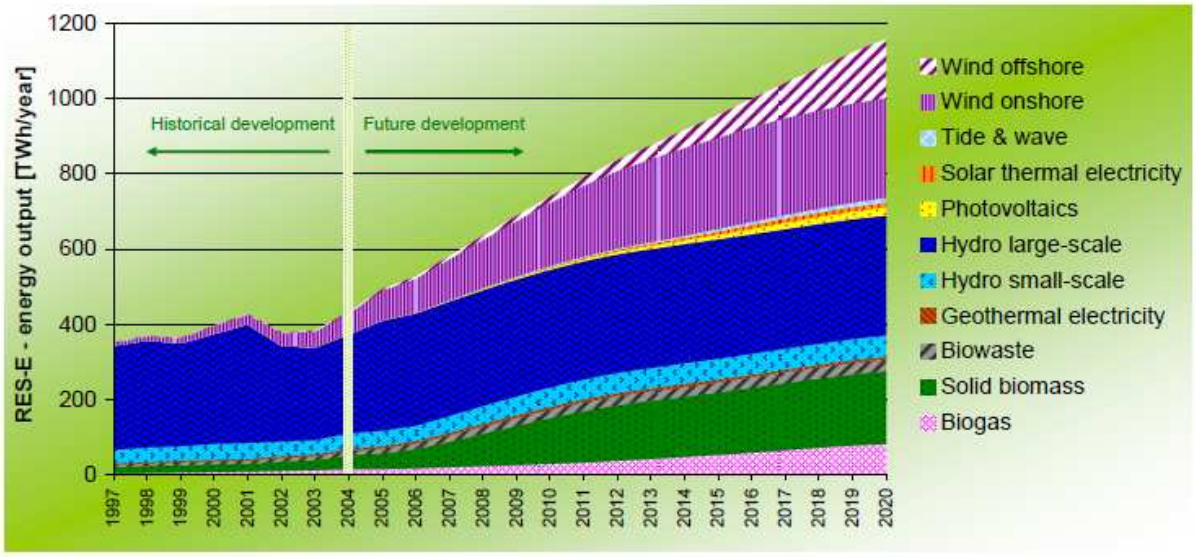

Figure 1: Electric energy production prognoses for 2020 in the EU (EC, 2007)

Wind power became a doubtless important part of the energy market of Europe and the World. The most important reasons of this are the followings:

- Wind power is carbon dioxide free energy production way therefore it should be given preference as part of the fight against climate change.
- Wind power plants are classified into the group of plants that can be constructed fastest and with relatively the least investment.
- It contributes to the diversification of energy production and to increasing energy safety.
- Favourable social-economic effects of wind power industry: it employed 400000 people directly or indirectly in 2009 (EWEA, 2009).

Wind power plants provide not only CO_2 free energy production but their specific CO_2 emission related to their total life cycle is also very favourable. Based on the Global Wind Energy Council it can be stated that power increase of wind power utilization has been exponential in the last one and a half decades (EWEA, 2010). Compared to the 40000MW power operated at the end of 2003 calculating with 25% of increase, the total power of wind power plants operated throughout the World was almost 158000MW in 2010 and 75000MW out of this was operated in the European Union (GWEC, 2009).

POSITION OF WIND POWER PLANTS IN HUNGARIAN ENERGY POLICY

The Parliament accepted the energy policy for 2008-2020 (Parliament decree 40/2008 /IV. 17./) in which the realization of the following three important aims is set:

- Supply security, within this the most important is the reduction of import dependence important ways of which are energy saving and application of renewable energy resources.
- Competitiveness. It can be achieved by reducing costs with the help of energy saving and the application of renewable energy resources again.
- Sustainable development.

Regarding this, environmental protection is an important aspect. In its realization again energy saving and the application of renewable energy resources are of primary importance.

Apart from energy policy the route of realizing national energy targets is identified in the National Energy Efficiency Action Plan (2019/2008 /II.23./) government decree). Considering the development of renewable energy resources, the government accepted the strategy of increasing renewable energy resource application (2148/2008 /X.31./ government decree).

Renewable energy utilization target in Hungary by 2020: 13%. Currently (data of 2009) renewable energy resources give 7.4% of the total final energy consumption.

Considering electric energy production the planned green electricity ratio is 20-21% for 2020 which is fourfold of the current ratio. More effective utilization of wind power can contribute greatly to realize this target. Hungary has significant potentials (Figure 3). The national potential energy at 75m: 204OJ/year (Hunyár, 2005).

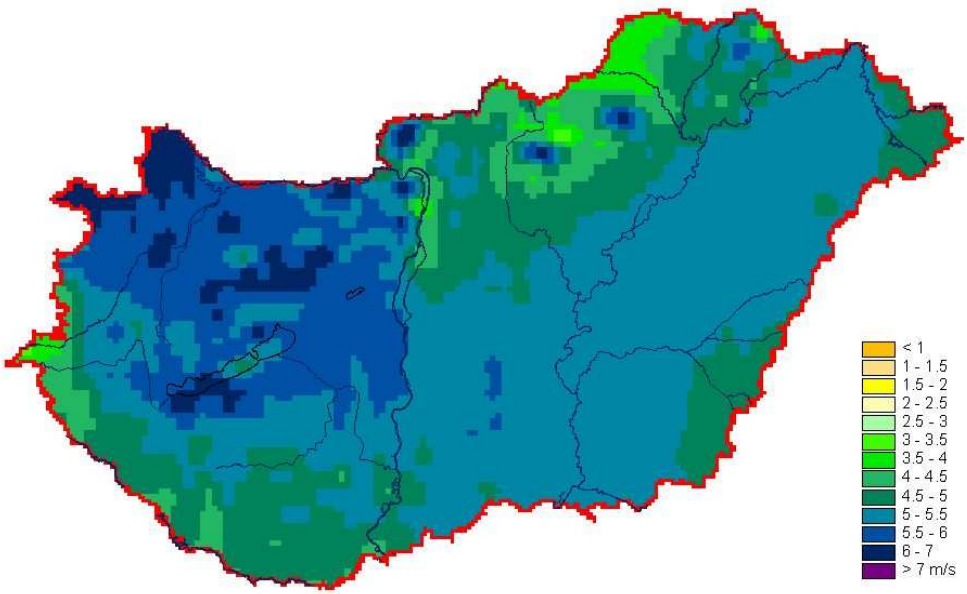

Figure 2: Wind speed distribution at 75m (WANTUCHNÉ ET AL., 2005)

Comparing the theoretical potential of renewable energies in Hungary (Table 1), wind power is in a significant position (wind power potential H=75m, D=75m, E=56.85TWh (204.7PJ/year), P annual average = 6489MW). The total renewable energy potential of Hungary is 2665.246-2790.406PJ/year. The realistically utilizable part of this potential is 405 – 540PJ/year (15-20% of the total potential) amounting to 30-40% of the Hungarian energy demand.

Table 1 Theoretical renewable energy potential of Hungary

Energy resource	Theoretical potential (PJ/year)
Active solar thermal potential	48.815
Passive solar thermal potential	37.8
solar thermal potential in agriculture	15.911
Solar photovoltaic potential	1749.0
Water power potential	14.3
Wind power potential	532.8
Biomass-energetic potential	≈250
Geothermal energy potential	63.5

Development of Hungarian wind energy production is held back by the complex and frequently changing regulations and associated permission procedures.

The 246/2005. (XI. 10.) government decree on the modification of the 180/2002. (VIII. 23.) government decree on the execution of Act CX of 2001 on electric energy resulted in four steps in the permission procedure of wind power plants. It prescribed the acquisition of the joint small power plant permit at the Hungarian Energy Office (HEO). Referring to electric energy network operation reasons the 330MW wind power plant power establishment limit was introduced in 2006 that was effective over the entire country.

Until 16th March 2006 claim submission arrived for 1138MW of wind power plant power. In the case of wind power plant parks satisfying the set system of conditions, 51% of the claimed power was permitted by the HEO. Uncertainty of the regulations is reflected in the fluctuation of newly invested wind power plant power in the given years.

From 1st January 2008 introduction of Energy Accepted Compulsory (EAC, 389/2007. (XII. 23. government decree) regulations in relation to electric energy industry are modified again resulting in problems in keeping the timetable of wind power plants.

Despite difficulties the permitted 330MW wind power plant power has been realized at the end of 2010. Electric energy produced from wind power has increased continuously over recent years, this increase has exponential character, produced electric energy has been doubled in recent years.

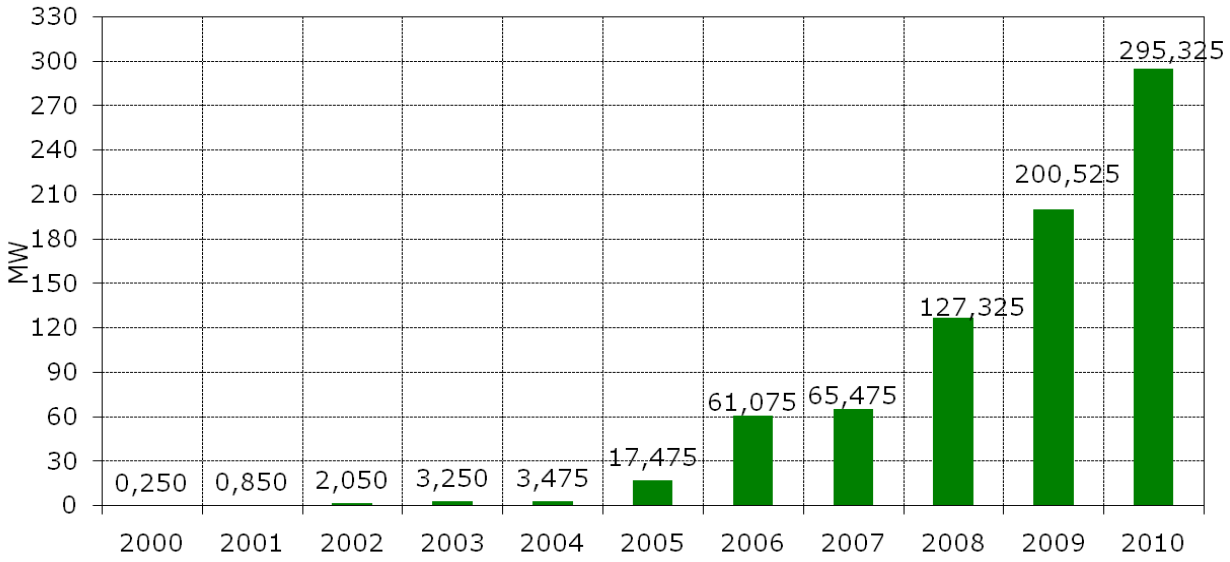

Figure 3: Total invested wind power plant power in Hungary (01/05/2009)

One of the most important issues in the development of Hungarian wind power industry is whether green energy is expensive in Hungary or not. Appropriate informing of the inhabitants and making the advantages of wind power utilization understood are important. Supporting electric energy production from wind power is not the cause of raising the price of residential electric energy by 3 Ft/kWh!

The other very important factor in the development is the stabilization of the regulation system, thinking over the energy accepted compulsory might be useful.

According to the survey made by the Hungarian Transmission System Operator cPlc (MAVIR ZRt.) and the Hungarian Wind Energy Council in October 2008:

- Not the network capacities set the limits;
- It is necessary that the Hungarian Energy Office and the MAVIR make possible that wind power plants, wind power plant parks co-operate with power plants using different technology by establishing a Virtual Regulation Centre;
- Producers regulated by Energy Accepted Compulsory having opposite interest currently have to be involved in the market of system level services;
- Advancement of entities producing according to the series timetable, non controllable at system level has to be reduced;
- Central application of consumer side influencing measures (DSM) is recommended in order of controlling the system;
- Support of spatially diverse plantation of wind power plants is sensible;
- Improving the accuracy of system loading and wind forecasting, estimating applications (MAVIR – National Meteorological Survey);
- Online wind power plant production forecasting system has to be realized.

Consistent realization of the conditions described above may enable the increase of wind power plant power in subsequent steps in Hungarian electric energy network – realizing the 1000MW scenario – parallel to the continuous monitoring of the state of the network (Figure 4).

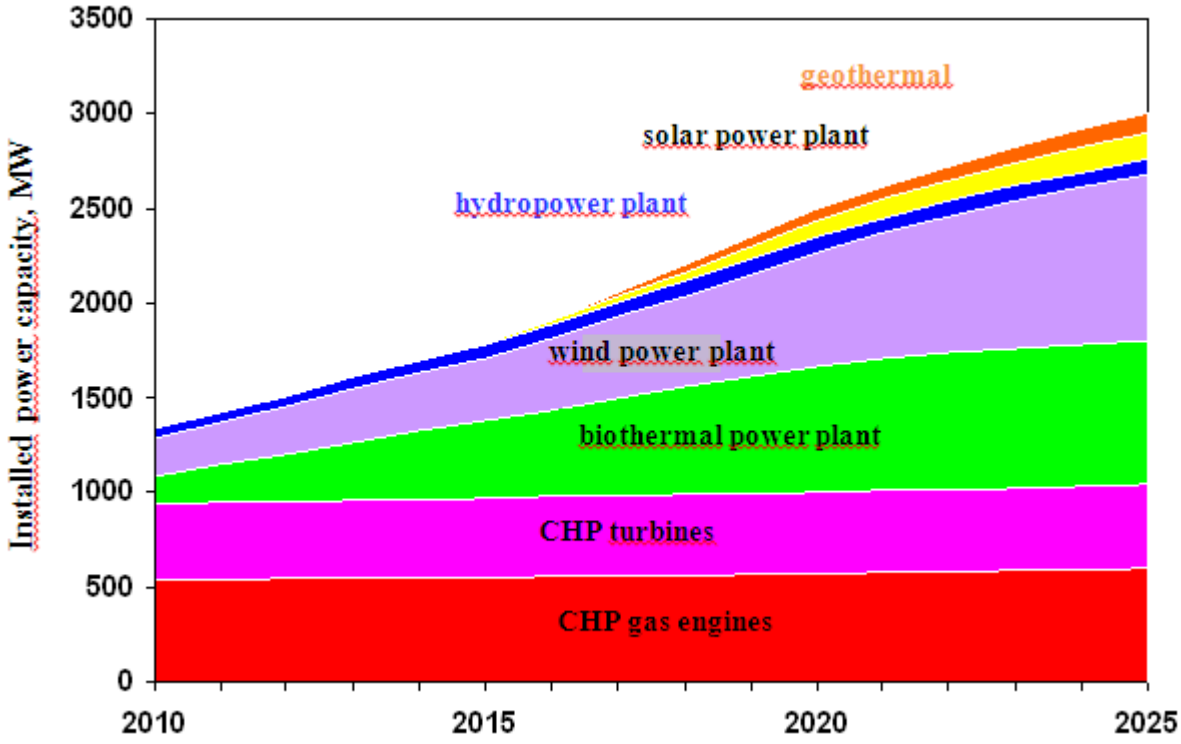

Figure 4: Planned small power plant performances between 2010 and 2025
Installed power capacity, MW
Geothermal, solar power plant, water power plant, wind power plant, bio-thermal power plant, using turbine, using engine

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Studying the Wood Production of Arborescent Plantations Planted for Energetic Purposes in the Framework of the SOSKLIMA Project

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ABSTRACT

The project entitled calculated energetic utilization by species of domestic tree species having outstanding yield of extreme production habitats caused by climate change, or called SOSKLIMA in more known name and associated research were started in 2007 and has been carried out since then in co-operation of the Silvanus Group Tree Nursery Producer and Distributor Ltd., the Central Agricultural Office, the Faculty of Forestry, University of West Hungary, Research Institute for Fruit growing and Ornamentals in Érd. The aim of the project is to improve fast growing. Domestic tree species that utilize well forestry border habitats.

INTRODUCTION

It has been accepted commonly that the three base pillars of sustainable development are: sustainable operation of the economy, realizing reasonable, flexible social relations capable of self corrections, preserving environmental and natural resources.

The Hungarian economy consumes energy not significantly higher than the average, the efficiency of this consumption is more of a problem. As 87% of resources applied are fossil energy resources their consumption is of greatest risk. Therefore the primary aim is to increase the ratio of renewable energy resources or to reduce consumption of fossil energy resources so that the utilization can be prolonged.

Significance of renewable energy resources is that their consumption corresponds well to the principles of sustainable development and presents less harm to Nature. Bioenergy is among the most important renewable energy resources. The ratio of renewable energy resources in energy utilization has to be increased.

Increasing demand of wood (dendromass) utilizable for energetic purposes can be covered by traditional forestry together with energetic plantations of short cut cycle.

Main goal of plantation wood production is to produce the predetermined wood in large quantities in homogeneous quality if possible in the optimum production area. These stands are characterised by intense management. In Hungary such plantations are the poplar and willow plantations having quantity wood production purposes, short cut cycle plantations for energetic purposes (willow, poplar, acacia) and in some extent the acacia groves managed intensely (JUHÁSZ, CSIHA, MAROSI, RÉDEI 2009).

According to the new forest act the term "wood plantation" means "wood composed primarily of foreign tree species planted in standard network and managed intensely with cut cycle of at least 15 years". The act classifies areas that were qualified as wood plantation into forests of free management. Plantations for energy purposes planted in areas of agricultural cultivation produce dendromass fast and in large quantity. They also provide rational cultivation in areas that were withdrew from traditional agricultural cultivation (due to the effects of processes in their environment). In this way they provide not only large quantities of energy plants but in favourable conditions the utilization and profitability of agricultural areas can be improved as well. It is also important that following the hectic character of food industrial processes, these plantation areas can be restructured to arable land at any time (establishment of plantations do not require the changing of the cultivation classification either).

AIM OF THE INVESTIGATIONS

Most promising willow species of the project is the Salix alba 'Express' one of the most tolerant genotypes of production site extremes. Ratio of growing shoots and striking roots are high even in very dry and extremely wet production sites. The aim of field surveys related to Salix alba 'Express' was to measure the expectable wood production in the experimental plantations. Our aim during the project is to work out a product estimation system where the expectable natural yield can be estimated accurately based on a few basic parameters (tree species, stem diameter, number of trees per hectare, etc.) that can be measured easily. Our basic hypothesis was that the stem diameter will be the leading data as in the case of young trees stem diameter and wood-mass shows closer correlation than height and wood-mass.

PROCEDURE OF INVESTIGATIONS

In order to determine the expectable wood yield in the year of cut we have to define first the correlations and parameters to be measured with the help of which the wood yield model for the given wood species can be set. Literature provides two fundamentally differing measurement technology for determining the wood yield of almost bush shaped energy plantations:

- Destruction free overground biomass determination,
- Overground biomass determination with destruction.

Significant difference between the two methods is that such input data are used in the case of the first that can be obtained directly from one of the average data of the plantation, in the second processing the samples taken from the plants give results for determining the expectable wood yield.

Selecting the method, cost and time effectiveness have to be considered (NORDH AND VERWIJST 2004). On 4 years old Salix clone stands the two overgorund biomass determination methods were compared. In the course of the study destruction free and destruction overground biomass determinations were carried out in various clones. In the first case stem was measured in the natural wet state and mass – stem weight correlations were measured while in the second case the weight of the dry material of the destructed plants was

measured. Average difference between the two measurements was not significant. Only 3% difference was detected between the two weights. Based on the results, it can be stated that in industrial terms the destruction free measurement method gives reliable results, however, the necessity of developing the method was also emphasized by the developers of the process. It has to be noted, however, that the study was performed in the first production cycle thus no data is available for similar sampling methods in the following cycles.

Areval, Volk, Bevilaqua and Abrahamson (AREVAL, VOLK, BEVILAQUA AND ABRAHAMSON 2007) compared biomass equations for independent data sets calculated by different methods that describe the wood production correlations of short cut cycle wood plantations. On the logarithmically transformed data of the dependants allometric equations were calculated: according to the regression of general smallest square sums, and according to the regression of weighted smallest square sums. Furthermore, non-linear regression equations were calculated as well. Closest correlation is given by the first calculation method.

Sampling method chosen by us had to meet the following criteria:

- Sampling can be applied in stump sprouting stands of various age (following the second, third cut as well),
- Method requiring smallest time,
- Method that can be performed fast by two or three people.

Based on these the selected sampling method is the following: systematically performed destruction free on site mass measurement in low sample stem number percent proportion depending on the size of the area.

Measurements were performed between 26th January and 2nd March 2010 according to the following: Sample rows were selected in the plantations and their United National Projection co-ordinates were measured by a GPS. Number of sample rows was determined depending on the size of the area (see below). First sample tree was marked 5m from the first tree of the sample row (1/1; row/tree), its marking number was written onto the stem, then it was cut 5cm above the surface (average cut height of harvest). Sample trees were marked by 10m and 20m depending on the size of the area and the stem distance of the plantation. If no trees can be found in the spot measured the so called “nil tree” is recorded with the appropriate number. As the plantation network had given parameters providing steady proportion of sampling was possible.

Measurements were performed on samples from plantations created in completely different production sites. Following the assessment of the first results further examination series will be required for which separate long-term examination methods were developed.

Average bottom and chest height diameter of the cut stem were measured. This can be performed by perimeter measurement with traditional tape-measures or π-bands or by measuring the diameter directly with a calliper. In the latter case two measurements perpendicular to each other are required. This latter was chosen by us. Measurements were accurate to the mm.

After this the length of the sample tree (height) then its weight was measured with accuracy to the cm and to 10 grams respectively. Number of sample rows and length of the measurement sections were determined so that the number of sample trees was at least 1% of the number of trees in the stand.

At least 15-20% of the sample trees were cut and transported into the laboratory for firing technology measurements. For this purpose sample trees were selected to represent the average tree. These were cut into pieces and transported into the laboratory in a plastic bag with individual identification labels.

Stem analysis of a 4 years old Salix alba 'Express' was carried out (Figure 1). The analysis shows that the increment and average increment curves of the tree species when it is 5-6 years old will cross each other, i.e. this will be the technical cut maturity age.

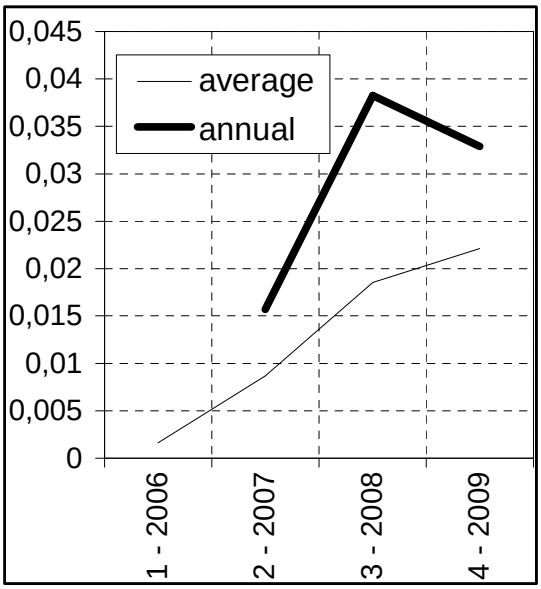

Figure 1: Increment and average increment of the 4 years old Salix alba 'Express' Source: own construction

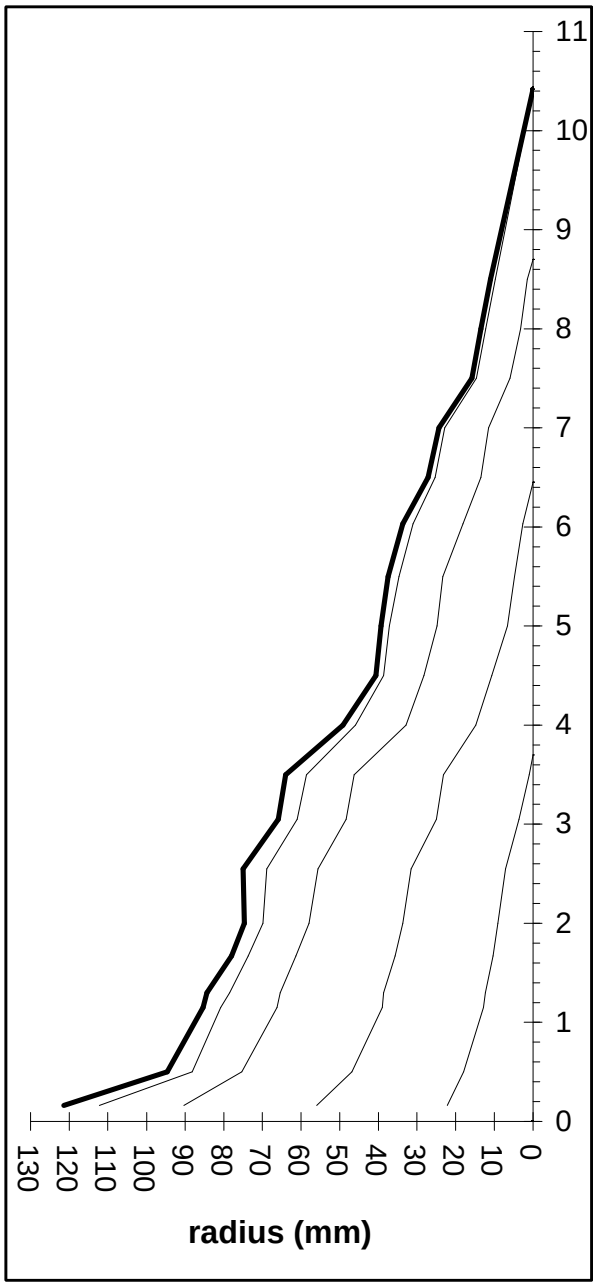

Figure 2: Stem profile of the 4 years old Salix alba 'Express'Source: own construction

Figure 2 shows the stem profile based on our standard stem analysis. It is clear that the growth in diameter in each year is significant as is the growth in height.

PROCESSING AND ASSESSMENT OF THE OBTAINED DATA

As (in accordance with our basic hypothesis) wood-mass shows closest correlation to the bottom diameter no chest diameter was measured later (Figure 3). This also made the work easier as following the first cut of the stand shoot growing started and around 5-6 shoots grew from one stump measuring both the bottom and chest height diameter of which would have resulted in the loss of much time providing neither the database required for the correlation parameters between chest height diameter and wood-mass.

Although Salix alba Express is the most tolerant genotype regarding the production site great differences were found in the planted experimental stands.

Model area Borjád:
parcel A: 49.18 t/ha parcel B: 16.76 t/ha parcel C: 7.70 t/ha

Model area Palánk:
parcel B: 26.63 t/ha parcel B: 19.57 t/ha

Data above are values measured when the average trees were cut and calculated frim the natural weight and tree number of the stand for one hectares.

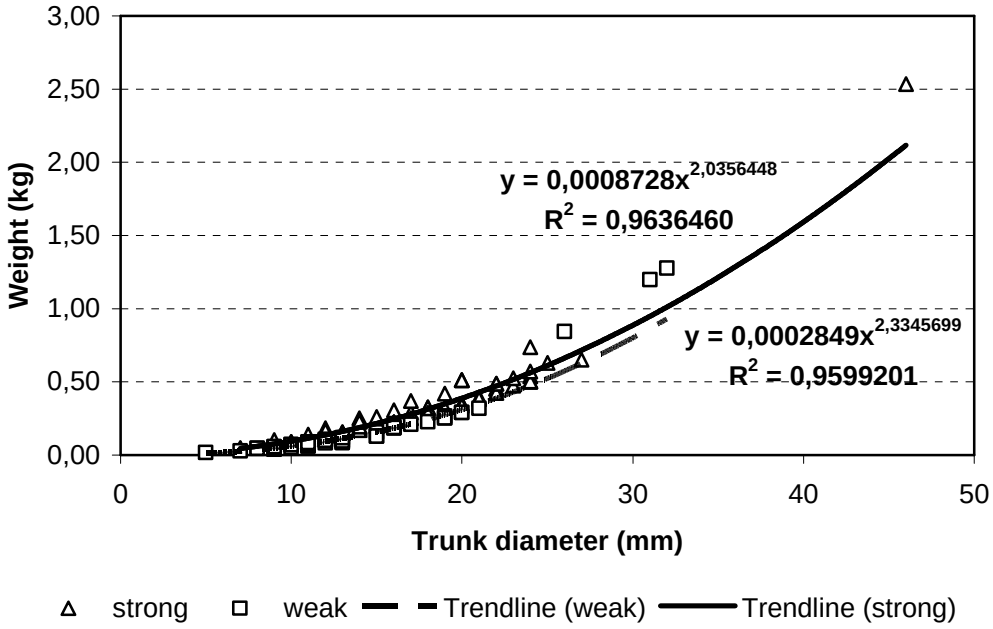

Figure 3: Wood yield graph of the two parcels in the vicinity of Palánk
Source: own construction

Although success of growth of Salix alba 'Express' was 100% in the model areas, studying its further growth it shows great sensitivity to production site extremes verified by the data above.

In the base colony of Salix alba 'Express' planted in the seedling-nursery at Kapuvár-Kistölgyfapuszta of the Silvanus Group Ltd. seven trees were selected that represent the stand

as average trees. Chest height (130 cm) was marked on the seven trees where their periphery was measured in every fortnight with accuracy to the mm and an average diameter was calculated from these data. These data are compared to the precipitation data of the given two weeks. Parallel to this samples were taken from the stand in every four weeks in order to determine dry material content.

Laboratory analysis of these samples and studying the correlation between growth and precipitation are currently under processing.

CONCLUSIONS

Producing wood material utilizable for energy purposes in energy plantations can be important primarily for private forest managers. However, it could be sensible to deal with it for those state owned forests where production site conditions verify it. Based on the current trend of climate change these areas will increase as forestry climate zones shift (drought damages and unsuccessful afforestations will be more frequent). In areas where no other trees apart from "firewood" can be produced as a result of forest management and forest is of economic purposes, establishment and management of energy forests are justified. Energy willow can be utilized not only as an energetic plantation with short cut cycle but it can be planted as firewood forest (with 6-15 years of cut cycle), however, no particular experience is present regarding this so far.

INVESTIGATIONS CURRENTLY UNDER WAY

Currently leaf area index determination and growth section analysis within the growing season are planned to be performed. Studying the complete leaf structure of the sample trees necessary for the analysis is currently under way (digitizing the samples, assessing the data, determination of the accurate correlation). As the growing season became prolonged in the case of this willow clone comparison of the growth and precipitation data has not been completed yet.

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On the Physiological Effects of Static Magnetic Fields

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Keywords: static magnetic fields (SMF), physiology, experimental pain models, mice

ABSTRACT

Organisms have been adapting to the geomagnetic field during the 100 million years of phylogenesis. Some contemporary species have been shown to even use this field. Already small fluctuations in the magnetic field induce physiological effects in humans. This brief survey reports on these effects experienced in so far scientific explorations in the literature. At the same time we mention experimentally proven physiological effects induced by manmade sources of magnetic field emphasizing domestic experiences. The proliferation of nuclear magnetic resonance imaging (MRI) in medical diagnosis has encouraged this field of science. Mostly the experiments based on models of pharmacology and neurology have succeeded in achieving positive results in Hungary. Based on these results we can postulate the followings: (i) a static magnetic field can be constructed that has an experimentally proven statistically significant physiological effect, (ii) this effect is biological: the magnetic field exposure stimulates the endogenous systems of the organism to overcome a specific pathological process. We primarily look for the answer, whether we could use this phenomenon in human therapy.

INTRODUCTION

The threefold interaction of magnetic fields with the climate and also with the biosphere seems obvious today (Figure 1). Either one of the ingredients undergoes an alteration; it certainly induces changes in the other two. Our present study focuses on the interaction between human made static magnetic fields and the homeostasis in the ecosphere.

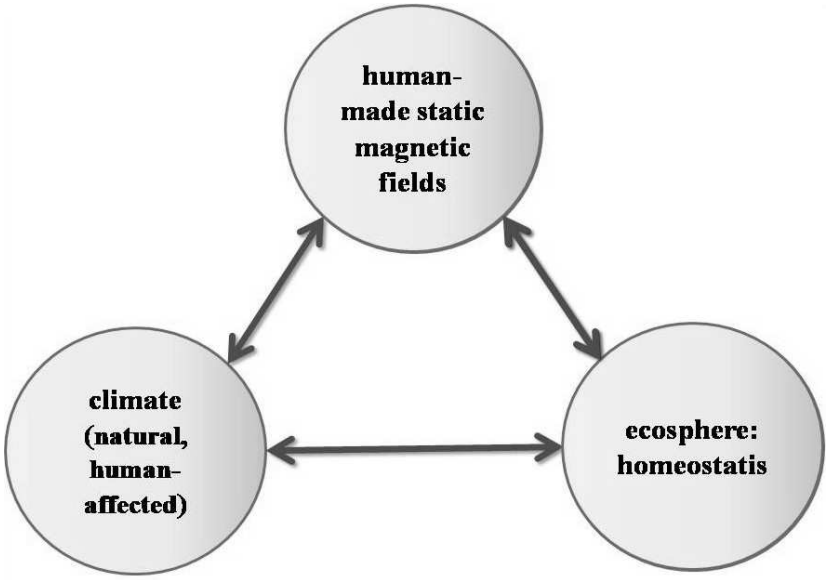

Figure 1: Representation of the threefold interaction between magnetic fields, climate and biosphere

Many studies aimed to reveal why and to what extent magnetic changes of our environment can be made responsible for variations of the climate (SHARMA 2002). It seems that changes of the magnetic field do not directly influence the climate, but rather through its interaction with the ionizing radiation arriving at Earth from primarily the Sun. This is an influence we face every day. Global warming for example is attributed today to solar rather than to human activity (SVENSMARK AND CALDER 2007). Another effect should be mentioned here, when Earth's magnetic poles reverse. This is very likely to happen in time intervals well exceeding the lifetime of several human generations (DUMÉ 2006).

Most recent studies revealed that phylogenesis has indeed not degraded magnetic sensors in organisms. Beyond the long known facts that magnetotactic bacteria exist (YAMAMOTO ET AL. 2010), eusocial insects (WAJNBERG ET AL. 2010), elasmobranch fishes (MOLTENO AND KENNEDY 2009), migrating birds (STAPPUT ET AL. 2010) and even mammals, bats (HOLLAND ET AL. 2010) use the geomagnetic field for orientation, hiding, and hunting. Human sensory ability to detect static magnetic fields and the corresponding behavioural changes have been long questioned (BERK ET AL. 2006) even being aware that MRI would not function, if the human body did not react under an external magnetic field. Anyone, who has ever approached a strong static magnetic field (the bore of a 3 T MRI for example) knows for sure that the field can be sensed at least in the form of a discomfort feeling. A strong magnetic field interacts with those static particles in our body that are originally magnetized as ferro-, dia-, or paramagnets. Our body material has overall diamagnetic characteristics due to its high percentage of water – giving basis to MRI.

Unpleasant effects have been reported from patients under MRI diagnosis (SCHENCK 2005). Different modalities work: bright stars (visual apprehension), nausea (visceral apprehension), motion sickness (vestibular apprehension), metal taste (gustatory apprehension), headache (multiple modality possibilities) and other "side effects" occur regularly. On the other hand, the natural requirement of improving image resolution in MRI design resulted in the application of ever stronger static magnetic field components up to a point, where experimental evidence did not support the use of such any more (MCENTEE 2007). The lower threshold value of the magnetic field leading to perceptive human inputs is not well defined yet probably due to the fact that (i) it shows large variety among individuals similarly to other

sensory threshold values, (ii) humans manipulate their feelings by psychosomatic processes. However, we understand that discordant inputs can create conflict in the brain (BRANDT 1999). We have also learned that peripheral nerves are the easiest to stimulate by either electric or magnetic fields (KANGARLU AND ROBITAILLE 2000), since their threshold levels are the lowest. For equal response visceral nerves need stronger excitation/stimulus than peripheral ones.

Experimental models help researchers study nerve stimulatory effects, where a psychosomatic input would certainly complicate the assessment of the results (LE BARS ET AL. 2001). They also make the experiments less time and money consuming. We therefore, applied murine pain models to reveal the lower limit of magnetic induction that can demonstrate changes in pain perception. Our null hypothesis was that above a specific threshold value, changes in the magnetic field can be perceived by mice and this is shown by their response.

RESULTS

A widely used experimental model for acute pain is the writhing test. An intraperitoneal (ip) injection of some slightly irritating material (e.g., acetic acid) induces nocifensive responses, so called writhings that can easily be measured. The excitation occurs directly at the viscera. Figure 2 shows the average number of writhings for untreated (control) mice, and for mice that spent the 30 min duration of the experiment following the acetic acid challenge under inhomogeneous static magnetic field (SMF) exposure with their whole body. Error bars represent S.E.M. (standard error of the mean) values.

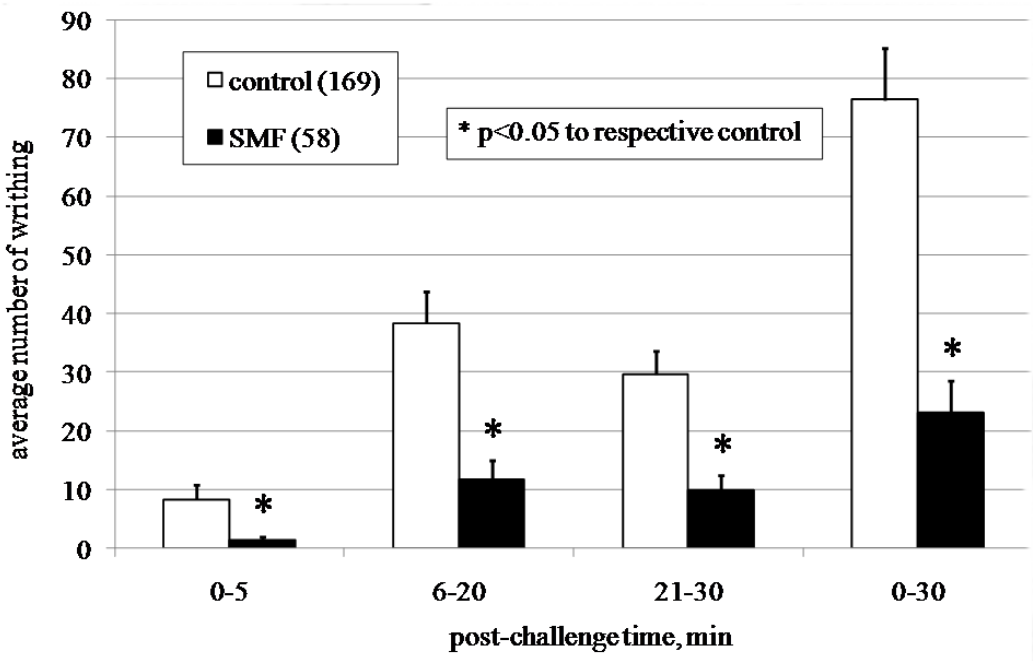

Figure 2: Inhibitory effect of static magnetic field (SMF) exposure on abdominal contractions (writhings) induced by the intraperitoneal injection of 0.6% acetic acid. Mice were placed into the SMF exposure chamber (treated) or into a sham box (control) 5 min before the injection of the acetic acid, and stayed there during the whole experimental period. Results are shown as averages±standard error of the mean (S.E.M.). Animal numbers per group are given in parentheses. * means p<0.05 (one-way ANOVA) at the 95% confidence level compared to respective control.

The effect is an over 80% inhibition of pain response in case of those mice that were exposed to the SMF compared to control with a statistical significance $p<0.00001$ (one-way ANOVA) at the 95% confidence level for the complete 30 min period of time.

Looking for the background mechanism we may selectively antagonize some specific receptors that are common in the murine and human organism. GYIRES ET AL. (2008) observed that, by pretreating the animals with subcutaneous naloxone (NX), a selective μ-opioid receptor antagonist, the inhibition was completely reversed (see Figure 3).

In other acute pain models, such as in the formalin or in the carrageenan model, SMF exposure worked equally efficiently even in the first (acute somatic nociception) phase of the model, where no concurrent systemic solution is offered in up-to-date medical therapy (SÁNDOR ET AL. 2007). Capsaicin sensitive fibres (C fibres) were proven to also play a role in the mediation of pain inhibition by SMF exposure. In order to study this, C fibres were selectively desensitized by pretreating mice with resiniferatoxin. The nocifensive reaction times as well as the mechanical allodynia of the hind paw that significantly diminished in the SMF exposed group, was up to control level in the desensitized and SMF exposed animals. In another experimental series ANTAL AND LÁSZLÓ (2009) proved that the mechanical allodynia of the hind paw of mice with induced neuropathic pain (Seltzer model) plus daily 30 min SMF exposure goes back to the level of control mice following the 3rd postoperative week. This is all the more surprising, since neuropathic pain management is also an open question in human medicine. Reproducing the experiments in the SMF of a 3 T clinical MRI we proved that this technique could be regarded as invasive at the level of magnetic fields (LÁSZLÓ AND GYIRES 2008).

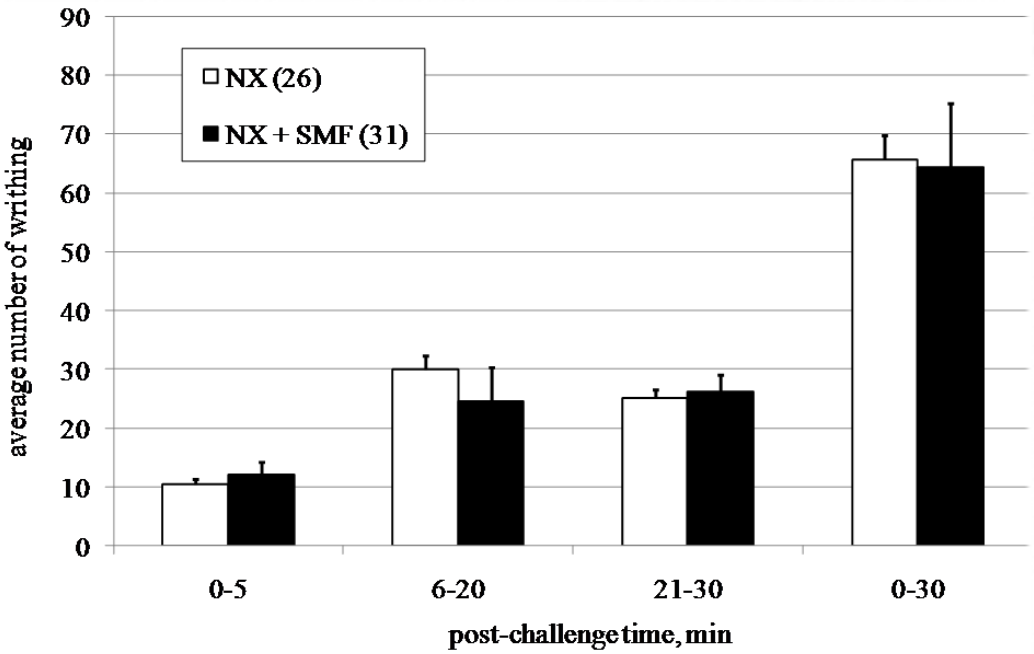

Figure 3: Inhibitory effect of static magnetic field (SMF) exposure on abdominal contractions (writhings) induced by the intraperitoneal injection of 0.6% acetic acid. Mice were pretreated with μ-opioid receptor antagonist naloxone (1 mg/kg, NX) injected subcutaneously. They were either placed into the SMF exposure chamber (treated) or into a sham box (control) 5 min before the injection of the acetic acid, and stayed there during the whole experimental period. Results are shown as averages±standard error of the mean (S.E.M.). Animal numbers per group are given in parentheses.

We may conclude that static magnetic fields penetrate into our lives both virtually and in reality. Static magnetic fields play a role in our climate, they assist animals' survival, they create discomfort under MRI diagnosis, and they may even have therapeutic importance in human medicine. Further evidence-based studies are on their way to show the significance of static magnetic field exposure in creating or restoring homeostatis.

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Section 4
Technology and the Future

Lufthansa Aviation Biofuel, a Route to Sky Friendly Energy

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Keywords: Aviation, fossil fuels, biogenic fuels, future development tendencies

ABSTRACT

Commercial Aviation Alternative Fuels Initiative (CAAFI) consists of 70 members. Lufthansa is the only airline involved. Companies, research institutes, universities, associations, individuals active in the field of algae biomass inside and outside the EU are invited to join the association.

European Algae Biomass Association (EABA)
The objectives are to act as a catalyst for fostering synergies among scientists, industrialists and decision makers, to promote interchange and cooperation in the field of biomass production and use, and to create, develop and maintain links between its members and defend their interests at European and international level.

Aviation industry is taking first steps to stimulate all stakeholders to contribute their specific part for a large scale use of biofuel in aviation.

The use of biofuel for aviation makes sense, because it would reduce the CO_2 food print considerably.
But there are still a lot of challenges to master.

INTRODUCTION

Biofuels have a high potential and a demonstrated feasibility, but the market does not exist.
What are the barriers to introduce biofuels?

- Step from laboratory to industrial scale plant.
  - Breeding, cultivation, harvesting standards, in the beginning
  - Large-scale production technology in the beginning
- Feedstock Availability
  - Massive gap between demand and availability
- Fluctuating Profitability
  - Production costs still high
  - Profitability depends on global crude-oil-price
- Role of oil companies
  - No core business
  - Not on top-agenda
  - Lack of incentives to get over market barriers

The beginning is already half the way to success. (Korean wisdom)

Commercial Aviation Alternative Fuels Initiative (CAAFI) is promoting the use of Biofuel Membership Structure:

- Aerospace Industries Association
- Federal Aviation Administration
- Air Transport Association
- Airports Council International – North America
- Sponsors

AVIATION SPECIFIC ASPECTS FOR THE USE OF ALTERNATIVE FUELS

Priority for Drop-in fuel (can be mixed with kerosene):

- existing aircrafts can use it
- existing ground-infrastructure can be used

Specification:

- ASTM spec. for 50% blend with Fischer-Tropsch fuel ready, 100% nearly ready.
- HVO in preparation, expected to be ready 2011.

Total demand and biofuel volumes* for the Lufthansa Group 2010-2050

2% net volume growth per annum

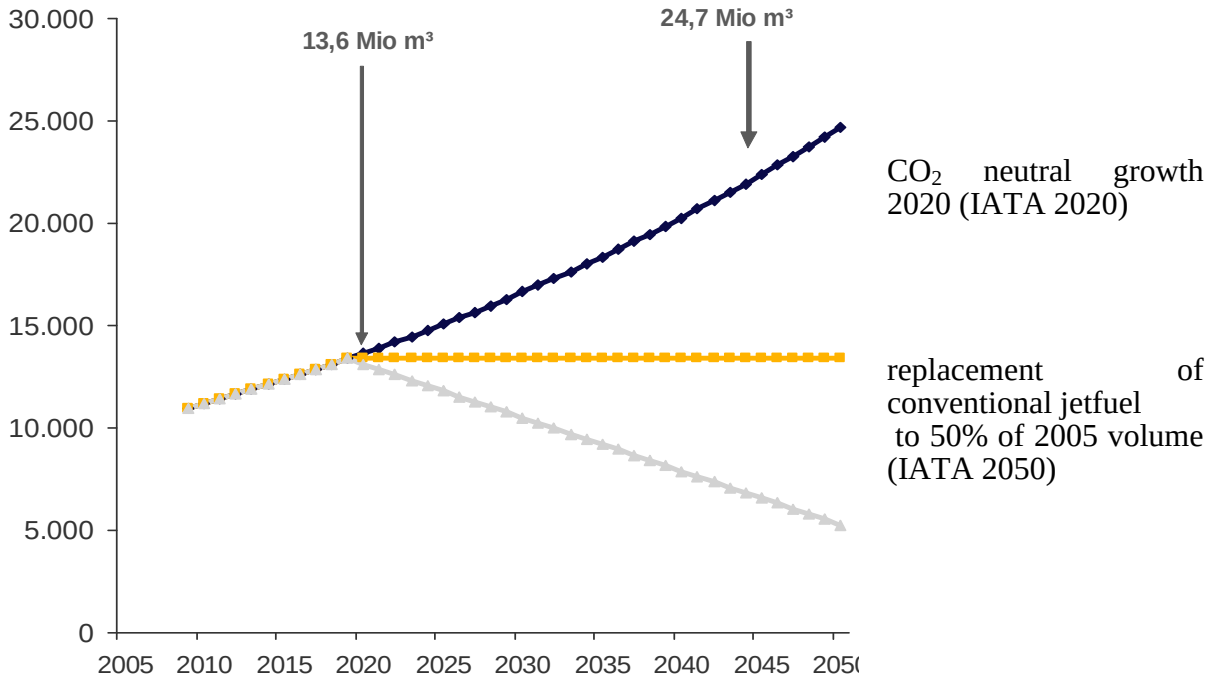

Figure 2: Industry Concept of Carbon Neutral Growth

The industry approach to mitigate climate change.

Industry targets:

- 2010: 1.5% p/a fuel efficiency. Working towards CNG
- 2020: CNG from 2020. Implementation of global sector approach
- 2050: 50% reduction in net CO_2 emissions over 2005 levels

DRIVERS FOR ALTERNATIVE FUELS

Crude oil is limited:

- Price is increasing and volatile
- Dependency from import

Environmental issues brought additional boost and is the current priority topic.

Lufthansa has decoupled transport capacity from fuel consumption by a factor of two. Carried through operational improvements and fleet modernization almost half of the growth since 1991 was CO_2 neutral.

The role of aviation in the current climate is ca. 1,6%.

Various sustainable biomass feedstock is available (see Figure 1).

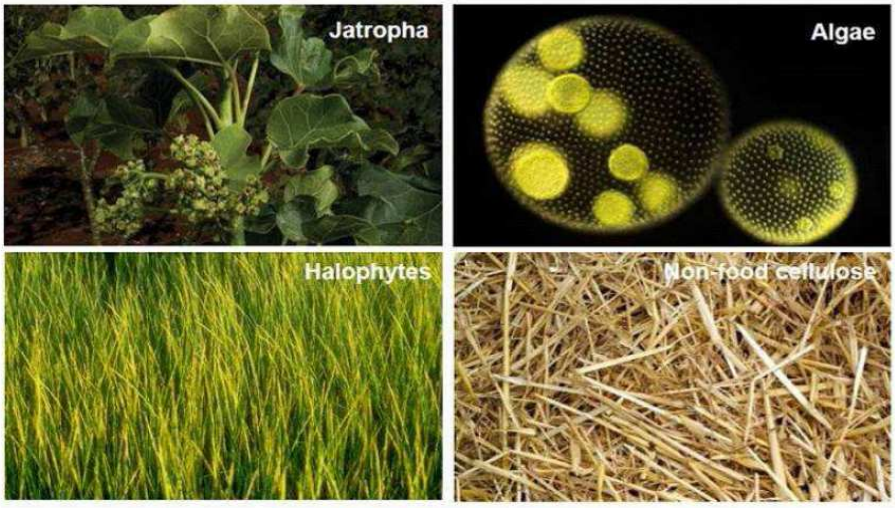

Figure1: Sustainable biomass feedstock

Future fuels should have a lower life cycle CO2 emission

Relative CO_2 emissions from alternative fuel options compared to jet fuel are:

- Jet fuel from crude oil: 1,0
- Liquid hydrogen from water and nuclear power 0,0
- Biojet fuel 0,4
- Liquid methane from natural gas 0,8
- Methanol from natural gas 1,3
- Jet fuel from coal with sequestration 1,5
- Jet fuel from coal 1,9
- Liquid methane from coal 2,2
- Liquid hydrogen from coal 3,6

PLANT BASED FEEDSTOCK REDUCES CO_2 CONTENT OF THE ATMOSPHERE IN A NATURAL WAY

- Lower CO_2 lifecycle
- Does not compete with food or promote deforestation
- Promotes local and regional solutions and economies

Comparison fossil fuels vs. biofuels shows, that biofuel is more complex, needs more steps from plantation to consumer, there are more „bottlenecks“ and more seasonality.

THREE FEEDSTOCK-PROCESSING COMBINATIONS FOR BIOFUELS IN AVIATION

Table 1: Processing and products from feedstock

Feedstock	Processing	Product
1. Sugarcane (Glucose)	Fermentation	Bioethanol*2nd Generation
2. Wood, organic Waste (Ligno-Cellulose)	Pyrolyse (Fischer-Tropsch-Synthesis)	FT-Biodiesel*2nd Generation
3. Vegetable Oils (Palm oil, Jatropha, Camelina, Algae)	Hydrotreatment („cracking“)	HVO-Biodiesel*2nd Generation (HRJ) (Bio-SPK)

BIOMASS FEEDSTOCK NEEDED TO COPE WITH LH – DEMAND 2025

Total LH demand in 2025: 3.256.000 m3

Table 2: Arable land required for iomass production

Feedstock	Oil per hectare (l ha/a)	arable land required	Remarks
Corn (Mais)	172 l	473.255 km^2	not suitable for jetfuel
Rapeseed (Raps)	1.190 l	68.403 km^2	not suitable for jetfuel
Camelina (Leinöl)	1.200 l	67.833 km^2	field rotation crop!
Jatropha (Purgiernuss)	1.892 l	48.023 km^2	Potential on degraded land!
Palmoil (Palmöl)	5.950 l	13.680 km^2	Clean and cheap, but food vs. fuel problem
Microalgae (30% drymass oil)	58.700 l	1.387 km^2	not available in 2025
Microalgae (70% drymass oil)	136.900 l	595 km^2	not available in 2025

SUMMARY

The use of Biofuel in aviation is an important step to considerably reduce the CO2 food print of these .industry. Various sustainable biomass feedstock is available today. Up to now the needed area for growing the biomass to fulfil the total demand is still high, but could be reduced by using Algae as biomass. More efforts are needed to stimulate all stakeholders to deliver their contribution. First steps are made by different international organizations like CAAFI and SAFUG.

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Climate Change and Biomass Production in Hungary and in the Region

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Keywords: Biomass, bioenergy, biomass production, climate change

ABSTRACT

In Hungary the portion of agricultural areas is 62 % of the national territory. This is over average in the European Union. However, a large share of this area has been not sufficiently exploited. The use of these areas for bioenergy production would reduce the CO_2 emissions and the energy imports. Uncultivated lands may be involved in the production of biomass. The agricultural structure can be formed with appropriate long-term contracts, which can also safe the livelihoods of the rural population. The advantages of the biomass use, against other renewable energy are greater independence from the short-term weather change.

INTRODUCTION

EU regulations are very important for using biomass. The main relevant EU directives are the following:

- 2009/28/EC „support of renewable energy resources" - The renewable energy production has to be increased by 12% in 2010, by 15% in 2015 and by 20% in 2020. The target for Hungary is 13% by 2020.
- 2003/30/EC „use of biological fuels" - The directive aims a ratio of 5.75% of biological fuels to mix to fossil fuels in 2010, increasing to 10% by 2020, according to its energy content.
- 2001/77/EC „green electric energy support" - In 2010 the share of „green" energy in the EU must be increased to 22.1%, in Hungary the share is 3.6%. In the year 2008 the share of „green" energy was c. 5.4% of the whole current production in Hungary. At this field Hungary surpassed the EU requirement.

BIOMASS TYPES

Biomass is the mass of living biological organisms in a given area or ecosystem at a given time. The different biomass types are:

- Primary biomass, whole plant production in the biosphere
- Secondary biomass, biomass of animals, including several organic extrements
- Tertiary biomass, processing of biomass, use of several by-products in the course of preparation e.g. food products and organic wastes

CAPACITY OF BIOMASS PRODUCTION IN HUNGARY

The total biomass capacity of Hungary is estimated at 350-360*106 tons. The primary produced biomass is 105-110*10^6 tons per year. The Hungarian renewable biomass stocks contribute to the production of agricultural main and by-products with about 57-58*10^6 tons per year. The forests produce 9 million tons biomass per year (GŐGÖS, 2007).

The utilization of biomass has a variety of ways. The easiest way is the direct combustion. Important application fields are:

- The use of wood by-products in the supply of technological processes with waste heat
- connection of biomass processing and long distance district heating
- Electricity production and
- Conversion into biofuel.

APPLICATION OF BIOMASS PRODUCTS IN HUNGARY

Applications of biomass can be differentiated in:

- Direct utilisation: burning, without or with preparation
- Indirect utilisation: use of vegetable oils as biodiesel after estering, fermentation to alcohols and use as fuel, use as liquid fuel or combustion gas after chemical reactions, liquefaction or gasification, and use as biogas after anaerobic fermentation.

Biomass comes as by-products from fife sphere: forestry and crop residues, energy plantation, animal husbandry, food and beverage, industrial and municipal wastes.

Figure 1 shows the biomass renewable energy amount per area of the EU member states (KSH, 2008).

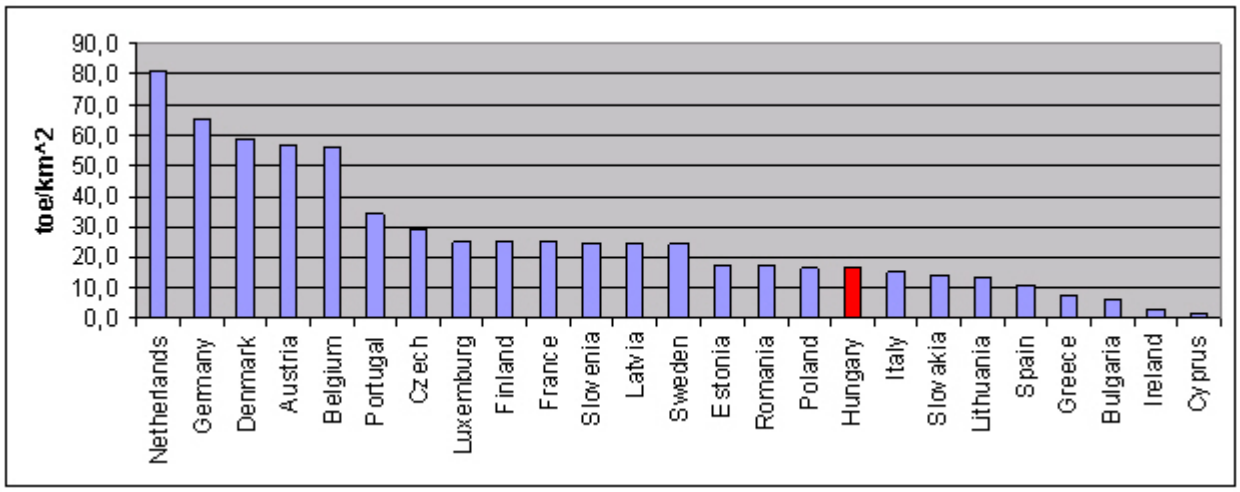

Figure 1: Production of biomass as primary renewable energy in the EU in 2008

PROPORTIONS OF HUNGARIAN BIOMASS UTILISATION

Only a small portion of the agricultural primary biomass takes for direct human food, c. 4.5 to 5.*10^6 tons, about 16-17*10^6 tons are used for animal feed. Further, the industrial process is about 6.0 to 7.0*10^6 tons (see Figure 2).

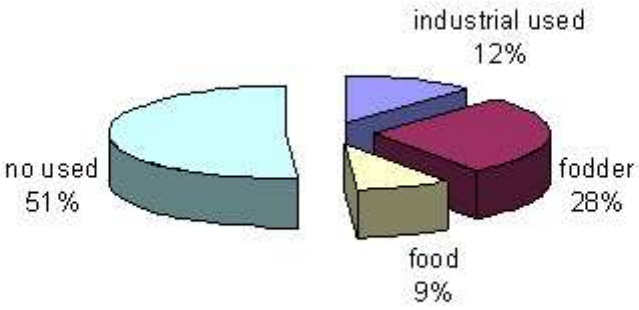

Figure2: Share of use of annual produced biomass

STATE OF THE ART OF PRODUCTION

The main reason of the large amount of unutilized agricultural products is the agricultural infrastructure which is not following the change of the land ownership and the land use. Similarly, neither the melioration not the drainage followed the change. Irrigated areas are compared to the licensed areas only around 50%, which is about 2 % of the total agricultural area.

In addition, there is no adequate fleet of modern. engines and vehicles The old machineries have high consumption. The other problem is the low number of vehicles and working machines. The number of agricultural machines in Hungary is c. 1 per 50 hectares, the average EU level norm is c. 1 machine per 18 hectares.

IMPACTS OF CLIMATE CHANGE

Biomass production and utilization in Hungary could be negatively influenced by climate change. Especially the increase of extreme weather situation could lead to losses in the biomass production. Figure 3 presents the fluctuation of maize production because of the low level of mechanisation and automatisation of the production in the Hungarian agriculture.

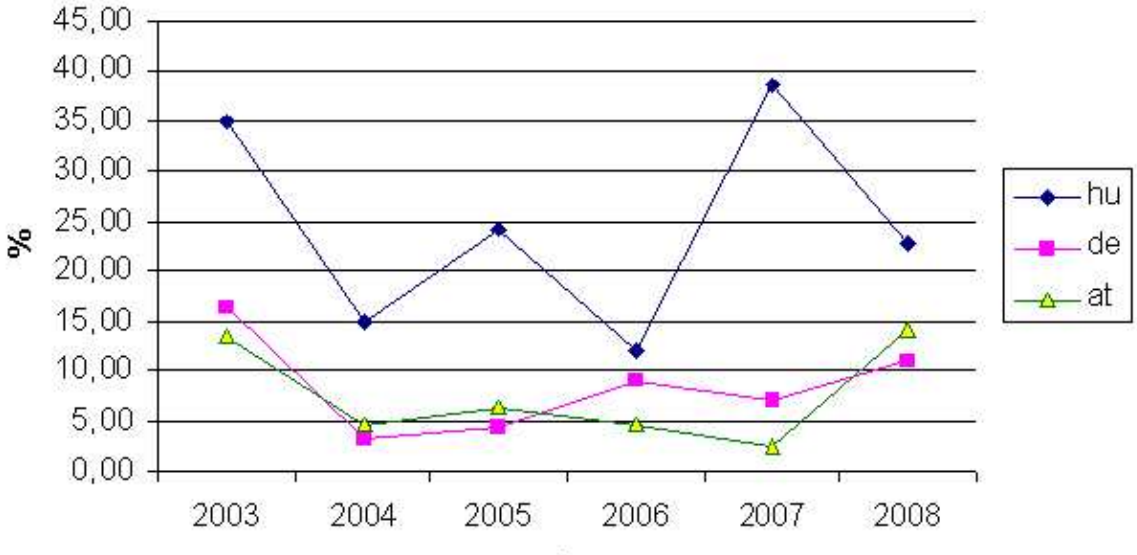

Figure 3: Fluctuation of maize production per hectare to the average level of the last 6 years

Yield functions show a high fluctuation of the maize production. The year 2003 and 2007 compared to the average for the last 6 years grown less than 35-40% corn, as compared to Austria and Germany, up to 18% in the yield per hectare. This follows the previously mentioned lack of appropriate technological conditions.

This resulted, that a number of domestic ethanol plant build failed. From 2006 to about 20 bio-ethanol production plant would be built, but the year 2007 due to these extremely low maize production has not been achieved.

If compared the grain of maize per year and ethanol production with similar data from Germany, we find a much higher production of maize per year in Hungary, however, yet only one-third of the annual production volume of ethanol.

PREDICTIONS FOR BIOMASS PRODUCTION

The expected effects in Hungary are the following (CSETE, 2005):

AGRICULTURE

Predictions forecast several scenarios:

- Through increased CO_2 concentration in the atmosphere the mass of grain decreased, the stalks and the leaves increased.
- 44,900 ha flooded in 2009; half of this area is agricultural area, such as farmland. The areas near rivers and lakes are the most endangered areas. The evaportranspiration decreased.
- A temperature of +0.5°C decreases the mass of potatoes by 20%, +1.0ºC to 25-30%. The highest decrease is expected in eastern-Hungary.
- Wheat, rye, barley, potato and maize can be optimally produced 100…150 km north of Hungary with an increase of +1.0°C.
- In 2003 through the dry years the production of corn decreased by 27%.

FORESTRY

Predicted facts for forestry are:

- Decreased ground-water means forests are replaced by grasslands
- There is an increase of damage from animals, wind, forest fires and erosion. Original species can move only 1 - 4 km per decade
- Current species, such as beech, hornbeam and oak will be endangered.

In the future expected the increase of impacts of climate change. It is forecast that by 2100 more and more frequent hot days, decrease the number of cold winter days, the spring precipitation will decrease, which is very important for biomass production not only for Hungary, but especially in Central and Southern Europe.

PREDICTIONS FOR EUROPE

Figure 4. shows the most vulnerable areas of the Mediterranean Sea.

Figure 4: Impact of climate change on biomass production in Europe

To meet the increased demand of the paper and furniture manufacturers, and consumption of biomass power plants will be increasingly difficult. Agricultural and forest management will be increasingly difficult due to extreme weather situations. Intensive forest management should continuously satisfy the safe the conservation of endangered biodiversity.

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Quantifying the Amount of Carbon Stored in Wood and Paper Products in Hungary

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Keywords: climate change, carbon storage, carbon flow model

ABSTRACT

The Faculty of Wood Sciences is an active part of the TÁMOP-4.2.2-08/1-2008-0020 research program, running in the University of West Hungary, which is dealing with the climate change and its consequences. The first sub-theme of the Woodworking Technologies is running on the carbon stored in wood products. Our first results are summarized below.

The wood products store the carbon for decades, so they can help to moderate the climate change. The presented results are showed the amount of the carbon, stored in wood products in Hungary. The amount of the stored carbon at 2009 reached 25 Tg in sawnwood, in papers 7 Tg, in panels cca. 3.5 Tg, and in other industrial roundwood 4 Tg. So the whole pool was about 40 Tg in 2009 in Hungary. Carbon flow model is being built; the necessary on-site surveys have begun.

INTRODUCTION

At the end of the 18th century the carbon dioxide gas concentration in the air was 260-280 ppm, which has increase to one and half times greater (2005: 379 ppm) (IPCC WGI 2001, IPCC 2007). The carbon dioxide concentration increase is attributed mainly to the use of fossil fuels (oil, gas, coal) and the lands changes (e.g. deforestation). On the other hand plants built the carbon-dioxide from the air in their organs by the photosynthesis. Forests have the largest biomass, it is appropriate to examine the forests, including wood how much carbon is in them, and how much the amount of carbon is stored in wood products during their life cycle. Of course a part of the carbon content of the harvested roundwood gets back into the atmosphere soon due to the oxidization (decay of short life products or burning). But another part of the carbon is stored for decades or even centuries in the long life products. But there are other effects of the using of wood: CO_2 reductions based on material substitution and CO_2 reductions based on energy substitution.

If some products are made of wood instead of energy-intensive materials, it will cut greenhouse gas emissions. This is easily illustrated with an example. A simple spoon can made of wood, stainless steel or plastic. If we made a wooden spoon much less energy used and greenhouse gas emissions is lower (wooden spoon needs 0,2 MJ, the steel spoon 5,9 MJ and the plastic spoon 6,3 MJ energy respectively) (Forestry Commission 2009). In other words, if a wood spoon is prepared, it reduces emissions by 95%. Of course the selection of materials in everyday life is much more complex, there are many products which never make out of wood, or not the best choice the wood for raw material.

If we use wood to make some kind of energy, the CO_2 emission per kJ will be less, than the others (oil or gas for example). Unfortunately in Hungary in the fight against global climate change, the wood burning is more important than wood products production, while with the energetic use of wood the carbon returns to the atmosphere in the form of carbon dioxide, and the products are storing or could store it. It is true that the carbon dioxide returns into the atmosphere, is not fossil but recent, it was built into the wood within a reasonable period.

AIMS

The main aim of the whole research to determine the volumes and life time of the utilized wood, wood and paper products and on the basis of the volumes calculate the carbon amounts stored annually. Further aim is to draw up trends for the future with the help of the historical data and create a model of carbon flow between the various wood products in Hungary. In this work some results were presented.

METHODS AND RESULTS

The wood products are belonging to the forest sector's carbon cycle, and they are managed as a part of the distinct land-uses, including forests (IPCC 2006). Before the early 1990s, man said, that the amount of carbon stored in harvested wood products does not change. As a result, in most cases, wood is considered to have decomposed during the harvested year, because sooner or later anyway decomposes (IPCC 1996, SOMOGYI 2007A, 2007B). Many researches show that the amount of carbon stored in wood products is increasing year by year (e.g. HEATH ET AL. 1996). For example WINJUM ET AL. (1998) suggested, that in 1990 the amount of carbon stored in harvested wood products was increased with 139 Tg globally and annually, in long life (5 years or longer) wood products. Following these researches, many countries have already calculated the carbon content of their different wood products, and the resulting carbon reservoir changes and trends. Such survey was made among others for the USA (SKOG, NICHOLS 2000), the United Kingdom (THOMSON, MILNE 2005), Norway (FLUGSRUD 2001), New Zealand (FORD-ROBERTSON 1997), Finland (LATURI ET AL. 2008), Switzerland (WERNER ET AL. 2005) Portugal (DIAS ET AL. 2005), Australia (JAAKKO 1999). For Hungary, such a detailed survey has not been made yet.

CARBON POOL SIZE

To estimate the carbon content in wood products, higher level methods are available yet. These methods require data are reached from the FAO or the SFS (State Forest Service) database and thus the flux of the carbon can be estimated, but this will be carried out only rough estimates. A rough estimate of the carbon pool size from 1960 to 2009 was made. The FAO database and WINJUM'S (1998) data for the life times, the rate of the long life products etc. were used. Production, export and import were counted for other industrial roundwood, sawnwood, wood based panels, paper and paper products. The quantities were converted to mass, reduced by the oxidized fraction and carbon content was calculated (for detailed method see WINJUM ET AL. 1998).

SURVEYS IN FACTORIES

To make a more detailed estimate for the amount of carbon stored in harvested wood products we have to create our own carbon flow model in the different levels of wood products. The carbon flow in the system should be examined in several stages. First, the main data help to predict (1) the volume of the carbon drift from the forests to harvested wood. Of course, only part of the wood will be utilized, the other part will remain in the forests as slash. But we must take into the account the roundwood imports and exports, which affect the carbon balance. On the next step (2) primary products, by-products and wastes are formed from the roundwood. In most cases, the resulting solid wastes serve raw materials to other processes, storing. In these wood product categories also should be consider the impact of the imports and exports. Finally, (3) the primary products will be end-use products. The statistical data of the further processing (finished (end-use) product), are difficult to use. First, today about 20 thousand types of wood products are in the world, on the other hand usually the data of the end-use products are not in volumes (m^3, tones), but in cash (HUF, EUR). It makes difficult to calculate the amount of wood used.

Of course, at all levels of the process must be consider the fate of the by-products and wastes, and in case of burning them they leave the carbon pool. Therefore it is important to estimate that how much waste (e.g. bark) arose in each levels by parallel the products, and the amount of the wood get into each product. Thus, by the statistical data a notable direct data collection and industrial monitoring should be performed. In order to develop our model, we should be determined – as far as possible – the life-time of the products, because annual carbon dioxide emissions from their decay must estimate. The carbon pool must be corrected with these values. We should also differentiate and identify fractions, with shorter or longer life-times, or differ in other respects (e.g., recycling). In order to complete our model, we have to estimate the product and by-product (waste) ratios during different operations in different major sectors. That's why we began surveys in different factories. In a window and door manufacturing factory we investigated the input and output values. We made questionnaire surveys in the area of saw industry too. The assessed questionnaires covered almost a third of the production in Hungary.

RESULTS AND DISCUSSION

CARBON POOLS SIZE

The carbon pool size with these data was drawn up (see Figure 2). The carbon pool is still increasing in all product categories; especially the sawnwood has great pool. At 2009 it reached 25 Tg, but papers have 7 Tg, panels have cca. 3.5 Tg, and other industrial roundwood have 4 Tg. So the whole pool is about 40 Pg in 2009.

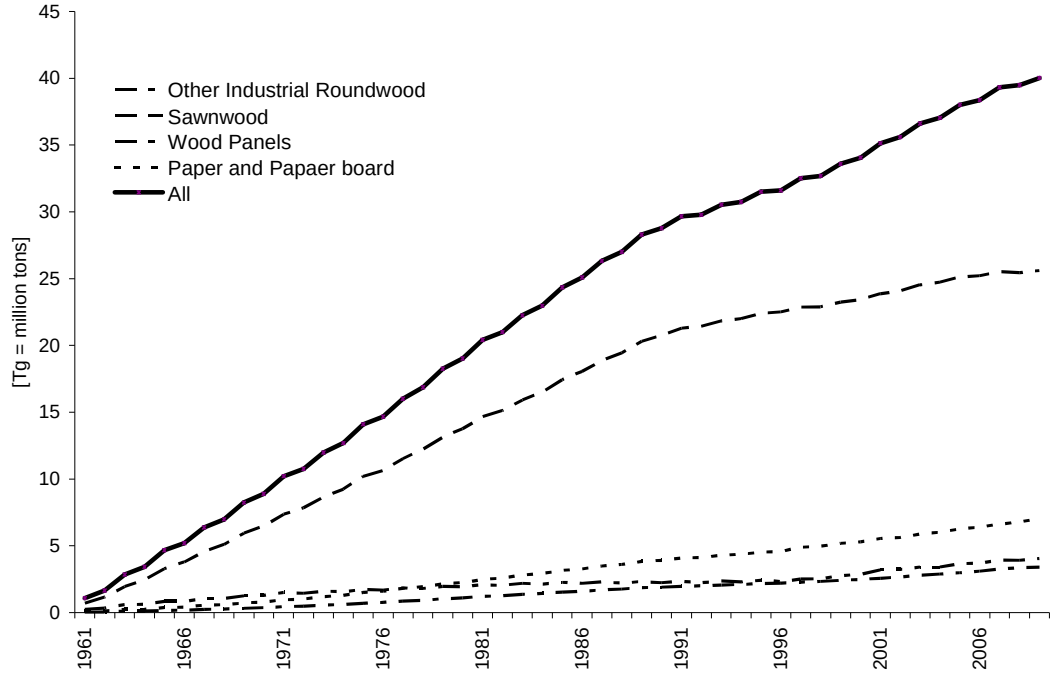

Figure 1: Carbon pools in different product types

A breaking-point can be seen on the trend line of the whole pool, the increase of the pool is less from 1990. The political system change may cause it. The amount of the harvest, the imports were dramatically decreased, the production potential of the wood industry were sintered (e.g. factories were closed).

SURVEYS IN FACTORIES

Table 1: Inputs and outputs in a window and door factory

Input	Weight [kg]	Rate [%]	Output	Weight [kg]	Rate [%]
Raw materials	437.93	97.48	**Recycling (wrong parts)**	20.66	7.79
Recycling from other processing	11.32	2.52	**Recycling to other process**	14.32	
All	449.25	100	**Waste (small parted)**	26.06	
			Waste (sawdust)	6.88	28.73
			Waste (briquette)	96.11	
			Usage as firewood	64.08	14.26
			Product	221.14	49.22
			All	449.25	100

Table 1 shows the result of the survey of the window and door factory. We found that from the input timber about 50% products was made, 7.8% were reinvested, and the remaining 43% were waste, energy recovery or removed from the system.

Results of questionnaire surveys in the area of saw industry are showed in Table 2. We found, that the product ratios in the case of hard broadleaved species and pine trees slightly higher than 50%, while in the case of soft broadleaved species (for example poplars) it is under it. The proportion of by-products is high, which were mostly recovered through energy.

Table 2: Product and by-products ratio in Hungarian sawmill industry

	„Hard" broadleaves	**„Soft" broadleaves**	**Pines**	**Average**
Processing	100.0%	100.0%	100.0%	100.0%
Product	50.1%	39.3%	53.3%	47%
Sawdust	13.5%	12.2%	11.6%	12%
Small parted b.p.	20.5%	13.3%	5.2%	11%
Chips	15.3%	27.8%	23.3%	24%
Bark	0.6%	5.4%	6.6%	5%
All by-products	49.9%	58.7%	46.7%	52%

CONCLUSIONS

In the next step we want to make a different type of estimate to determinate the amount of the stored carbon. This method is based on the currently valid recommendations of the IPCC. In addition, we want to create a national inventory, in which we'd like to estimate the quantity of each wood product.

Based on the results of the research so far: The importance of the wood and wood products can be high in the climate policy, because they store the carbon (from the air) for a long time; and our model is suitable to explore the amount of carbon stored in wooden houses, furniture and other products in Hungary.

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Photocatalytic Wastewater Treatment

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Keywords: photocatalysis, wastewater treatment, titanium dioxide, amino acids, aromatic surfactants, process control, pilot equipment

ABSTRACT

A vast number of poorly degradable organic materials deriving from industrial or domestic resources can contaminate our environment already at the point of production, or during their transportation and usage. Heterogeneous photocatalysis based on titanium dioxide proved to be very efficient for the removal of such organic pollutants. Environmentally friendly mineralization of various amino acids (aspartic acid, serine, cysteine, and phenylalanine) was realized in our laboratory. The results clearly demonstrate that both the carboxylate and the amine groups play crucial role in their photocatalytic degradation. Mechanistic studies on photocatalytic oxidation of some aromatic surfactants indicated that the cleavage of the aromatic ring, and thus the total mineralization needs the presence of dissolved oxygen. For an efficient treatment of surfactant-polluted wastewaters, a cascade system has been developed both at laboratory scale and as a process-controlled pilot equipment.

INTRODUCTION

A considerable part of man-made pollutants that get into our natural environment is toxic and/or biologically non-degradable. Some of these materials upset the balance of the biosphere, or spoil the resources of drinking water (MANAHAN 2000). Amino acids, for instance, may be one of the key components of wastewaters in pharmaceutical and food industry. Several detergents also belong to the pollutants as a consequence of their wide application in numerous technologies and in different everyday activities as well. Their biological degradation is rather slow. Photocatalytic treatment, however, can promote their subsequent biological decomposition or it can be used also for their final mineralization (HORVÁTH ET AL. 2005).

Two main kinds of photocatalysis can be distinguished: homogeneous and heterogeneous photocatalysis. The latter type may offer more versatile utilization. For heterogeneous photocatalysis various photoactive semiconductors can be applied. Such semiconductor particles (SP) are readily excited by photons of higher energy than the band gap between the valence and conduction band (VB and CB). The photon absorption results in the formation of an electron-hole pair inside the particle. These species can be recombined within the semiconductor particle or can migrate to the surface of the particle where, in the aerated aqueous reaction mixture, the primary electron transfer reactions compete with recombination, resulting in highly oxidizing radicals:

$SP + h\nu \rightarrow SP\{h^+:e^-\}$ (generation of $\{h^+:e^-\}$pair) (1)
$SP\{h^+:e^-\} \rightarrow SP$ (recombination) (2)
$SP\{h^+:e^-\} + O_{2(aq)} \rightarrow SP\{h^+\} + O_2^-$ (electron transfer from CB) (3)
$SP\{h^+\} + H_2O \rightarrow SP + HO^\bullet + H^+$ (electron transfer to VB) (4)

For the environmental application of SPs, the following characteristics are required: chemical and biological stability, non-toxicity, relatively low band gap energy, the photogenerated holes should be highly oxidizing, and the photogenerated surface electrons reducing enough to produce superoxide ions in the presence of oxygen, and relatively low cost. In several respects titanium dioxide (TiO_2) proved to be the most appropriate one for this purpose. Photocatalytic procedures based on nano-sized TiO_2 semiconductor particles were successfully applied for mineralization of organic pollutants, such as various amino acids as well as detergents (SZABÓ-BÁRDOS ET AL. 2008a, 2008b, 2010).

PHOTOCATALYTIC TREATMENT OF POLLUTANTS

DEGRADATION OF VARIOUS AMINO ACIDS

More than a decade ago studies began on the photodegradation of amino acids over UV-excited TiO_2 particles (HIDAKA ET AL. 1997). Environmentally friendly mineralization of various amino acids (aspartic acid ($HOOC\text{-}CH_2\text{-}CH(NH_2)\text{-}COOH$), serine ($HO\text{-}CH_2\text{-}CH(NH_2)\text{-}COOH$), cysteine ($HS\text{-}CH_2\text{-}CH(NH_2)\text{-}COOH$), phenylalanine ($C_6H_5\text{-}CH_2\text{-}CH(NH_2)\text{-}COOH$)) was realized in our laboratory too (SZABÓ-BÁRDOS ET AL. 2010, 2011a). The results of these studies clearly demonstrate that both functional groups of the amino acids play crucial role in the photocatalytic degradation via formation of stable surface complexes. Besides, functional groups display opposite behaviours in electron transfer reactions at the surface of TiO_2 particles excited by photons of higher energy than the band gap. The amino group may accept an electron from the conduction band, while the carboxylate group can transfer electron to the valence band hole.

$R\text{-}CH(NH_3^+)COO^-_{surf} + e^-_{CB} \rightarrow R\text{-}CH(^\bullet NH_3)COO^-_{surf}$ (5)
$R\text{-}CH(NH_3^+)COO^-_{surf} + h^+_{VB} \rightarrow R\text{-}CH(NH_3^+)COO^\bullet_{surf}$ (6)
$SH\text{-}CH_2\text{-}CH(NH_3^+)COO^-_{surf} + e^-_{CB} \rightarrow {}^{-\bullet}SH\text{-}CH_2\text{-}CH(NH_3^+)COO^-_{surf}$ (7)

In the initial part of the irradiation, the reduced forms of the amino and thio groups were formed (such as NH_3 in the case of aspartic acid and H_2S for cysteine, Figure 1).

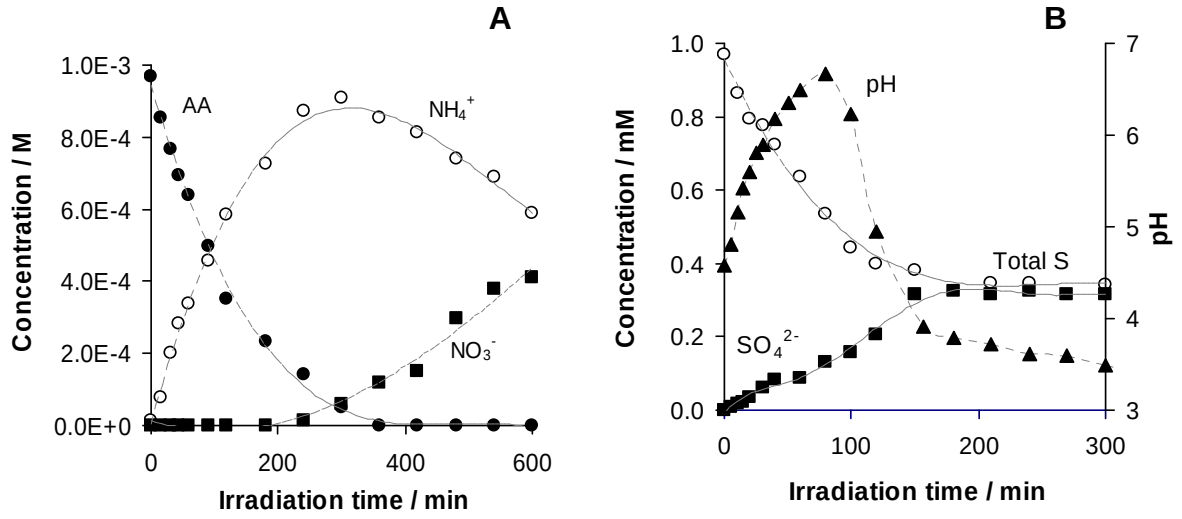

Figure 1: A) The disappearance of the starting material (●) and the concentration of the formed ammonium (○) and nitrate (■) ions during the course of the photomineralization of aspartic acid (AA) over Degussa P25 TiO_2 at initial pH ≈3.5. B) The change of pH (▲) and the concentration of SO_4^{2-} (■) and the total sulphur content (○) during the photocatalytic oxidation of cysteine

$$R\text{-}CH(^{\bullet}NH_3)COO^-_{surf} \rightarrow R\text{-}CH(^{\bullet}NH_3)COO^- \rightarrow R\text{-}^{\bullet}CH\text{-}COO^- + NH_3 \quad (8)$$

$$R\text{-}CH(NH_3^+)COO^{\bullet}_{surf} \rightarrow R\text{-}CH(NH_3^+)^{\bullet}COO \rightarrow R\text{-}^{\bullet}CH\text{-}NH_3^+ + CO_2 \quad (9)$$

$$^{-\bullet}SH\text{-}CH_2\text{-}CH(NH_3^+)COO^-_{surf} \rightarrow {}^{-\bullet}SH\text{-}CH_2\text{-}CH(NH_3^+)COO^- \rightarrow {}^{\bullet}CH_2\text{-}CH(NH_3^+)COO^- + HS^- \quad (10)$$

Hydrogen sulfide (HS-) is protonated to form H_2S, which is transferred to the gas phase (then detected as yellow CdS colloid, after absorption in $CdSO_4$ solution). Thus, in the case of cysteine, the total sulphur concentration of the reaction mixture decreases in the initial period of the photocatalytic treatment (Figure 1B). It is accompanied with the increase of pH because of the formation of ammonia. At a longer period of irradiation (in other words at a higher dose of UV photons), these products are transformed into oxidized species such as nitrate and sulphate ions, respectively. Since these oxidation reactions generate protons, the pH of the reaction mixture significantly decreases (Figure 1B). Further reactions of the intermediate radicals with superoxide result in the formation of keto acids, aldehydes and amides.

In the case of L-phenylalanine, under anaerobic conditions, formation of hydroxyphenylalanine isomers such as L-tyrosine (4-hydroxyphenylalanine) was observed with various analytical methods (SZABÓ-BÁRDOS ET AL. 2011a). Hydroxylation of the phenyl group was accompanied by the slight mineralization of the aliphatic part, producing CO_2 and NH_4^+. In the aerobic system, further hydroxylation, then ring fission of the aromatic group occurred leading to the total mineralization of this amino acid within several hours of photocatalytic treatment.

DEGRADATION OF SURFACTANTS

Man-made anionic surfactants are mostly sulfonated organic compounds that are present in many industrial processes as well as in consumer products. Linear alkylbenzenesulfonates (LASs), are applied in laundry and cleansing. Sulfonated aromatics are mainly used as fluorescent whitening agents and intermediates for the manufacturing of azo dyestuffs,

pharmaceuticals, and tanning agents. Aromatic sulfonates without long alkyl side chains (e.g., benzene- and naphthalenesulfonates) have been found in wastewater effluents, surface waters, landfill leachates, and even in tap and drinking water (RIEDIKER ET AL. 2000). During the past several years, naphthalenesulfonates were found in the river Rába, and are suspected to cause foaming. Mono-, di-, and trisulfonic acids of naphthalene have been examined with TiO2-based photocatalysis. During the photocatalytic treatments, the pH of the irradiated suspensions gradually decreased, indicating that a fast cleavage (detachment) of the sulfonic groups and the formation of sulphate took place as initial key steps of the mineralization mechanism (Eq 11).

$$RSO_3^- + HO^\bullet \rightarrow H^+ + SO_4^{2-} + R^\bullet \quad (11)$$

In accordance with this conclusion, the lowest initial rate of mineralization was observed for the degradation of the trisulfonic derivative (i.e. concentration decrease of the total organic carbon, TOC), but also the highest overall change in pH (i.e. acidification) was experienced in this case compared to the mono- and disulfonic compounds.

Our detailed analysis of the photocatalytic degradation of 1,5-naphthalenedisulfonate clearly indicated that the initial step of degradation is oxygenation (hydroxylation) of the starting surfactant, although desulfonation and some mineralization, i.e. decrease of TOC, indicating carbon dioxide generation, also take place at this stage (SZABÓ-BÁRDOS ET AL. 2008a). Further oxygenation and desulfonation lead to the decomposition of the diaromatic naphthalene system, then to ring fission, producing diols, aldehydes and carboxylic acids on the side-chains, and finally to total mineralization.

The photocatalytic oxidation of benzenesulfonate (as a pollutant in various industrial wastewaters) was also investigated. Similarly to our observation in the case of the photocatalytic oxidation of phenylalanine, the aromatic ring undergoes hydroxylation in the anaerobic system too, however, for ring-opening reactions, i.e. for total mineralization, the presence of dissolved oxygen is indispensable (SZABÓ-BÁRDOS ET AL. 2011b).

DEVELOPMENT OF REACTOR SYSTEMS

LABORATORY SCALE

For an efficient degradation of surfactants (and other industrial pollutants) a cascade system of photoreactors at laboratory scale has been developed. At the first stage of the procedure, air-bubbling cannot be used to introduce oxygen as electron acceptor in this system because of the strong foaming in the case of tensides. Instead, addition of hydrogen peroxide was applied for this purpose. For lack of air-bubbling, stirring and circulation of the reaction mixture is realized with a liquid pump. In this closed, 3-dm^3 reactor, a nearly total coversion of the surfactant, e.g., dodecylbenzenesulfonate, can be achieved, predominantly via desulfonation (Eq 11). Within a 6-hour irradiation period, the concentration is reduced to 0.5-0.8 mg dm^{-3}, which is below the foaming limit (ca. 1 mg dm^{-3}).

In the second stage of the procedure (in the next two photoreactors), air can be utilized for both oxidation and stirring, providing a more environmentally friendly method. Mineralization of the organic intermediates formed at the first photolysis stage takes place in this period of irradiation (from 7 to 18h). Cleavage and oxidation of the longer hydrocarbon

tails are the main steps in this process. A catalyst concentration of 1 g dm^{-3} proved to be the most favourable even at the higher concentration of surfactant. The irradiated photocatalyst can be re-used for further cycles. An almost total mineralization of the organic contaminants in a strongly polluted industrial wastewater sample (TOC > 5000 mg dm^{-3}) was achieved in this cascade of reactors within 30 hours.

PILOT EQUIPMENT

On the basis of the results of the laboratory-scale reactor cascade, a home-built pilot system involving three photoreactors of 200 dm^3 volume each has been developed for industrial utilization. Appropriate light sources (long-life fluorescent 40W BL, UV-A (315-400 nm)) have also been developed for this system. Similarly to the laboratory-scale reactors, in the first reactor the TiO_2 suspension is circulated by a liquid pump and H_2O_2 is the only oxidizer is the system. In the case of the next two reactors, air-bubbling can also be utilized. The fourth stage of this system serves for the separation of the catalyst from the cleaned water, utilizing sedimentation. Thus, the catalyst can be recycled, realizing an economic way of its application. The values of pH, peroxide concentration, temperature and liquid level can be controlled with a programmable built-in processor using the signals of the on-line detectors (SZABÓ-BÁRDOS ET AL. 2008b). By means of the remote-controlled valves and pumps, and the appropriate tubing, these reactors can operate in both serial and parallel connection, depending on the actual demands.

SUMMARY AND OUTLOOK

In this study TiO_2-based heterogeneous photocatalysis was successfully applied for efficient mineralization of various amino acids and surfactants. The degradation mechanisms of different amino acids and aromatic sulfonates were determined, in both anaerobic and air-saturated systems. Development and application of a process-controlled and versatile pilot equipment based on a combination of photocatalytic reactors was accomplished for wastewater treatment.

Further development of this system is focused on the enhancement of the photocatalytic efficiency. A possibility of such an improvement is metallization of the TiO_2 catalyst because metal clusters hinder the recombination of photogenerated electrons and holes due to electron trapping (SZABÓ-BÁRDOS ET AL. 2010).

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Emergency Shelters: a Brief History of Architecture under Radically Reduced Living Conditions

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Keywords: emergency shelter, Henry David Thoreau, Richard Buckminster Fuller, Dymaxion Deployment Unit, Superadobe

ABSTRACT

Architects are heavily involved with the challenge to responding to natural disasters in providing temporary shelter for a population deprived from their homes. These solutions in most cases differ from the mainstream architectural practice in their strict focus on satisfying primary needs of humans. There are various methods to obtain maximum efficiency, including the erection of lightweight structures, the conversion of prefabricated elements into shelter or self-built edifices of materials available on site. The roots of these technologies can be found in the vernacular tradition, the architecture of a population less interested in articulating philosophical statements in their buildings other than a harmonious coexistence with nature. Not surprisingly, it is also a basis for the so called sustainable architecture of which practitioners often coincide with those active in humanitarian aid at catastrophe sites. The article provides an insight into the intellectual foundations of a non-pedigreed architectural practice and introduces some of its major practitioners.

INTRODUCTION

THE INTELLECTUAL FOUNDATIONS OF SPARTAN LIVING

The written history on architecture introduces the art of building as a representation of communal values in monumental form. The first conscious effort in questioning this traditional interpretation is associated with transcendentalism, a middle 19th century American literary movement contesting the intellectual establishment of the young country – both its religious bodies and its universities. The transcendentalist suggested that the ultimate goal of life is spiritual well-being and self-development which is not ensured within the framework of their receptive society. A simplified way of living and a reliance on the individual's intuitions may lead to a higher state of consciousness that transcends physical and empirical reality.

One of the most radical transcendentalist thinkers, Henry David Thoreau (1817-62) set out to prove this theorem through an experiment by living in a self-erected cabin (Figure 1) in the forests around Walden Pond in the Massachusetts countryside. His two year, two months and two days stay of self-sufficiency on the land of a fellow transcendentalist Ralph Waldo Emerson (1803-82) is documented in Walden; or, Life in the Woods (1854). It came to be a 'bible' for those feeling a void in contemporary living and are occupied with contriving alternatives, finding Thoureau's words adequately describing this vacuum: "While civilization has been improving our houses, it has not equally improved the men who are to inhabit them."

Figure 1: Statue of Thoreau and replica of his cabin near Walden

Thoreau self-appointedly lived under radically stripped conditions in a quest of reducing architecture to the service of primary needs and thus proposing an authentic American way of living. He was convinced that "It should not be by their architecture but by their abstract thoughts that a nation should seek to commemorate itself" and that sound thinking occurred under nature-bound, 'naked' conditions. This stream of thought, however never became dominant in the American architectural discourse, inspired several architects who, through their efforts in finding architectural solutions to harmonize the relationship between humans, society and nature provided prototypes also applicable for emergency shelters.

RICHARD BUCKMINSTER FULLER'S CONTRIBUTION

Richard Buckminster Fuller (1895-1983), the "friendly genius of the 20th century" was personally related to the transcendentalist movement, through his aunt Margaret Fuller (1810-1850), the editor of the transcendentalist journal, The Dial. His criticism on Harvard intellectualism manifested in his student revolts that led to his exclusion of the elitist university and a lack of obtaining an official degree, apart from the 47 honorary doctorates he was awarded later in life. Employing a more pragmatic approach than that of Thoreau, he confined his life to augment the efficiency of "Spaceship Earth" and thus providing adequate life conditions for the entire human race, as he put it: "To make the world work, in the shortest possible time, without ecological offence, or the disadvantage of anyone".

Interpreting architecture as the most resource consuming enterprise on the planet, most of his patented inventions address the economy of building methods, beginning in 1927 with a structural system of fibrous blocks, Stockade. However a full-hearted pacifist, Fuller was an active participant in both World Wars. During the First World War he joined the Navy and the service on a boat provided him lessons on efficient living. However initially intended to satisfy needs of everyday living, his development on prefabricated, low cost and quick to erect shelter, the Dymaxion Deployment Unit (Figure2) served military purposes in the Second World War housing radar crews on the Antarctica. The DDU is essentially a conversion of a grain silo to shelter, an idea often taken up to economize building, also in form of container conversion.

Figure 2: Fuller's Dymaxion Deployment Unit sheltering American soldiers during WW2

The most frequently employed Fuller invention utilized to resolve pressing housing needs is what Bucky is most known for, the geodesic dome. The geodesic structures are spherical solids and as such enclose the most amount of space with the least amount of material. They are the demonstration of an alternative geometry based on a 60 degree coordinate system established by Fuller and named Synergetic Energetic Geometry. Geodesic structures have theoretically no size limits: Fuller proposed several large scale domes, such as Cloud Nine, a 1.9 km diameter dome capable of housing autonomous communities of several thousand people. (Figure3)

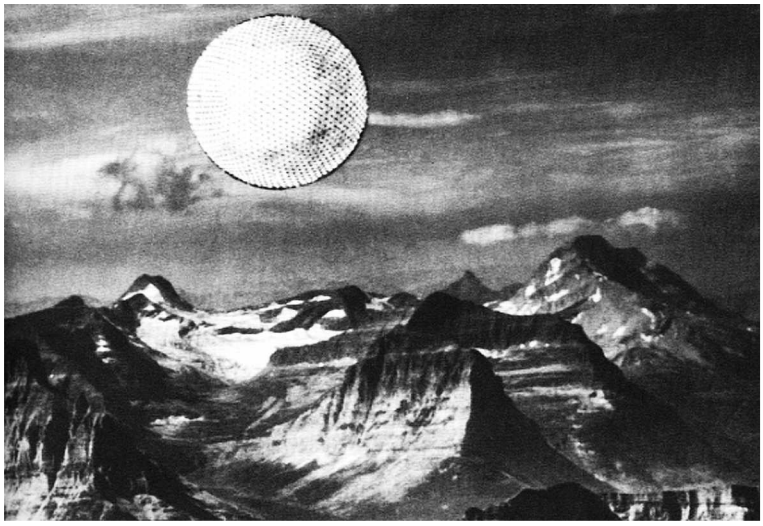

Figure 3: Cloud Nine, Bucky's proposal for a floating geodesic dome

Similarly to Thoreau, Fuller considered his life as an experiment, appointing himself 'Guinea Pig B' and lived in a geodesic residence with his family on their property in Illinois. His students and followers, the "Bucky folks" continue to spread and develop his ideas and erect dome-dwellings out of various materials on various scales, from polymers through cardboards to reused car-parts. Apart from the around 300,000 constructed domes worldwide, several enterprises are founded to produce ready-to-erect geodesic domes. They adhere to Bucky's notion to employ nature's principle 'multiplication by division' and generously offer their proficiency and products to relief building shortage wherever it occurs.

NADER KHALILI AND THE CAL-EARTH INSTITUTE

It was also a self-appointed exile that resulted in the life of the Iran-born, US resident architect Nader Khalili (1936-2008) to dedicate his architectural activity for the betterment of living conditions on Earth. In 1975 he returned to his home country and made a journey to the deserts on a motorcycle to study traditional mud buildings. Based on this experience he developed a building technology which he called Superadobe. His aim was to work out a quick and easy to learn construction method that can make use of any soils and need no specific tooling, scaffolding and forms. The answer he came up with is almost banal, the filling of sandbags with earth and tamping them, in order to ease construction in gradually decreasing in diameter circular shape and inserting barbed wire between layers to act as mortar and thus achieving earthquake resistance.

The sandbag-dome building technology was refined over two decades within the Khalili-founded Cal-Earth Institute in California, and under the support of UN agencies a 25-step manual was devised which is free to download from the internet and can be printed on both sides at an A4 sheet, thus making it a handy reference for the erection of shelters even under radically reduced conditions. This technique was widely used as a response to the 2005 earthquake in Pakistan, where winter weather condition required dwellings of sufficient insulation capacity. Not only an architect, but educator, poet and translator of 12th century Persian poet Rumi, Khalili is widely known for his humanitarian activity. His Emergency Sandbag Shelter Project was a recipient of the Aga Khan Award for Architecture in 2004.

Figure 4: Sandbag shelter under construction

CONCLUSION

There is no separate branch of architecture dedicating itself for disaster relief; emergency shelters employ timeless architectural solution surviving in vernacular traditions, upgraded according to present day technology. Although the putting up of refugee camps is a down-to-earth pragmatic affair, the motives are deeply rooted in philosophy and a conscious reckoning over the role and place of humans in the universe. The ever more frequent natural disasters impose the task not only on architects to deal with the reduction of living conditions. It is a hope that humans recognize their responsibility in defining their real needs and coming into terms with their real potentials so that eternal human values will not only be expressed under pressing needs, but become integrated into everyday.

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Effects of climate change in air conditioning technology

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Keywords: air-conditioning, risk-based modelling, risk level, enthalpy distribution function

ABSTRACT

Selection and design of air conditioning systems in Hungary are based on a determined modelling state. In the last decade this was a safe enough basis for the management of systems. As a result of the changes in the macro-climate, however, there has been a major increase in summer temperatures. Taking into account this fact and the need to develop the earlier deterministic modelling techniques we chose to focus on risk-based modelling.

INTRODUCTION

Selection and design of air conditioning systems in Hungary are based on a determined modelling state. Design parameters given in guidelines and technical regulations have been determined based on results from former longer periods. Although there were summer days, on that ambient temperature was higher than the design value. However, these take few percent (only a few hours or days) in respect of the total cooling period. Due to this, guidelines and prescriptions usually neglected the expected risk of design value. In the last decade all around the World and in Hungary changes in the macro-climate could be detected. Summer periods hotter and longer than earlier occurred. The same applies for winter as well. The period between the more extreme winter and summer gets shorter. This is why design values according to Hungarian standards need to be revised.

METHODS

Increase of outdoor temperature especially in the summer was no doubt experienced in the last decade. It is clearly justified by meteorological data. These changes influence significantly air conditioning technology. As a result of macro-climate change the outer heat load on buildings increases. Further disadvantageous effects are presented by the changing of the architectural style, the increase of the ratio of outer window surface. Disadvantageous effects are also presented by the deterioration of the operation conditions of air conditioning equipment (liquid refrigerators). Increasing indoor heat load with increasing outdoor heat load shall be compensated by the air conditioning systems.

Macro-climate change resulted in that public comfort buildings (hotels, theatres, restaurants, office buildings, etc.) cannot be used without air conditioning. This resulted in the advancement of air conditioning systems and increasing importance of reducing energy usage.

Based on these, the most important tasks are the following:

Reducing the outdoor heat load of the building:
Reducing heat load makes the application of outer shading structures essential, in this way outdoor heat load can be reduced by 50-70%. These require various co-operations between the architect and the building engineer.

Producing air conditioning equipment for the new outdoor temperature:
Refrigerators have to operate at higher outdoor temperature. In the case of buildings, outdoor temperature of 40°C has to be considered instead of 32-35°C when calculating the operation of the condensators.

Sizing of air treating centres based on the risk principle:
Sizing air treating centres in Hungary is based on the standard outdoor air condition of temperature: 35°C and moisture content: 45%.

Planning engineers have to oversize the equipment. Greater equipment requires greater investment and operation costs. On the other hand, the safety of sizing air conditioning systems increases. This requires the application of a new way of thinking, sizing on the basis of the risk principle. Current technical specifications do not give enough information for planning engineers.

Sizing air conditioning systems based on the risk principle has been studied since 2000 in the Department of Building Service, Budapest University of Technology and Economics. In the course of this, the temperature and moisture content of outdoor air has been recorded by 5 minutes sampling and measurement since 2003. Physical and mathematical models of the air treating centres based on probability theory were worked out. Enthalpy and temperature distribution functions of the outdoor air were composed from the measurement results.

With the help of the mathematical model the distribution and density functions of the specific cooling power were determined. Interpretations were made breaking down by month regarding daily (07-19 o'clock) and continuous 24 hours air conditioning centre operation.

Based on the distribution function of the specific cooling power, the investor can choose the risk level. This gives the required cooling power. Based on this, oversizing is not accidental or optional but selected according to the risk levels. The paper highlights the results of the research. Figure 1 presents the distribution function of cooling enthalpy. Table 1 summarizes the results of recent years.

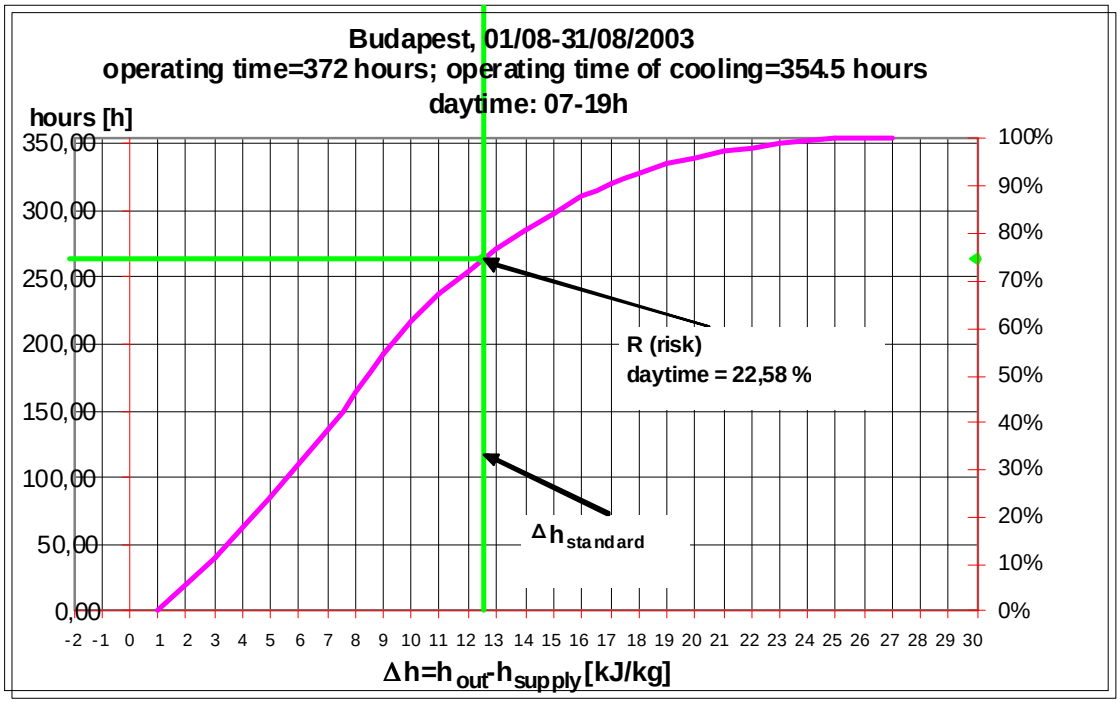

Figure 1: F(X) distribution function of cooling enthalpy differences (Cooling time period, when Δh > 0 kJ/kg)

Table 1: Risk level, % P(Δh) > 12.5 kJ/kg

Daytime (7-19 o'clock)	operation	Daytime	operation	Daytime
2003	0.00	7.78	13.17	22.58
2004	0.00	0.00	5.38	1.88
2005	0.54	0.00	15.05	0.00
2006	2.69	37.50	24.73	7.26
2007	0.00	3.21	18.02	6.39

SUMMARY

We proved that based on the measurements conducted in 2003-2007 the outdoor dimensioning values specified in standards are adequate nowadays. Owing to the macro-climate change the risk levels are higher.

The developed measuring and modelling method ensures that the outdoor air database can be extended in the coming years in the framework of a research.

The risk-based modelling can be executed already on the basis of the present results. Its application serves the interest of investors, engineers and constructors. Design outdoor parameters can be determined knowing the risk level.

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An Innovative Technology for Dynamising our Economy: Heat Pumping

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Keywords: energy saving, geothermal energy, innovation, heat pumping, renewables

ABSTRACT

Characteristic of heat pumps: they multiply the electric energy input used for their operation – by renewable energy – 3-6 times nowadays.

László Heller as a Hungarian engineer discussed the wide range utilization of heat pumps in energetics scientifically for the worldwide energetic public.

Heat pumping technology among other heating methods deserves wider utilization in Hungary due to its excellent quality advantages (energy efficiency, pollutant emission, heat comfort) in forthcoming years.

The World and Hungary in it became matured enough to apply heat pumps in a wide range.

INTRODUCTION

When the usefulness of an energetic system is assessed nowadays its environmental effect is of primary importance. After turning to gas heating today the application of heat pumps gets into the spotlight. Spreading the heat pump technology as a sensible tool for utilizing our renewable energy resources could bring the breakthrough in the development of our country. It utilizes such energy resource for the ~40% energy saving in average that does not increase our GHG[1] emission, moreover, its use would bring significant air pollution reduction globally (Figure 1).

[1] GHG: green-house gases (water vapour, carbon dioxide, methane, nitrogen-dioxide, gases containing fluorine).

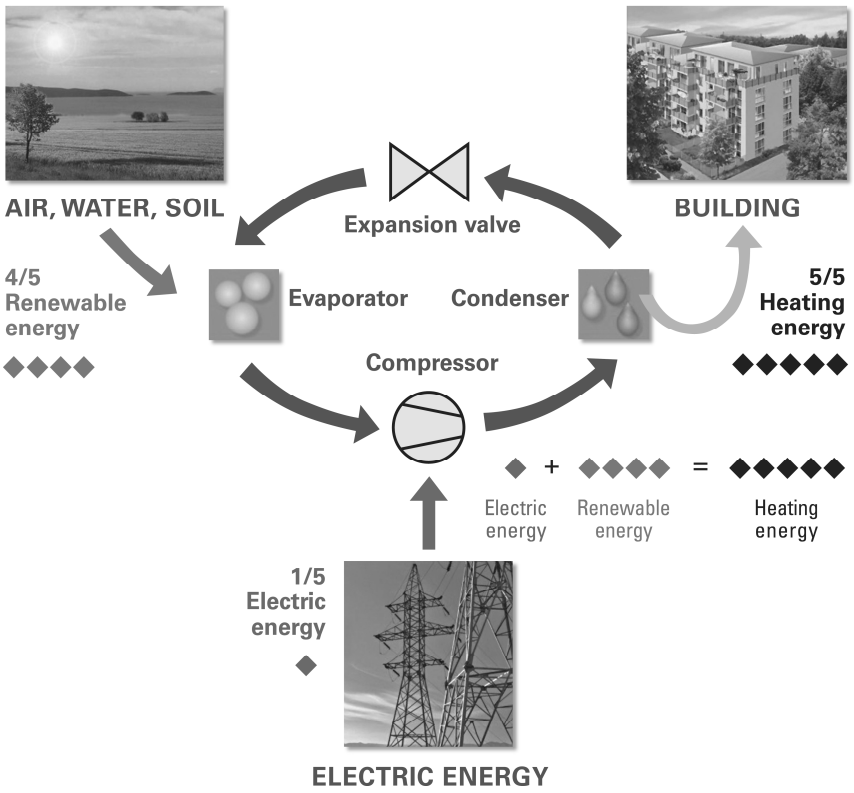

Figure 1: Increasing energy efficiency by heat pump system
(Renewable energy resources: air thermal, hydrothermal and geothermal energy)
Illustration by Magdolna Handbauer

Let us see when the operating energy is not from renewable energy resources in 100%:

- if 70% of electric energy is produced from renewable energy resources and
- the average Seasonal Performance Factor of the electric heat pump is 4.0, the heat pump in the example

utilizes renewable energy resources in $25 \times 0.70 + 75 = 17.5 + 75 = 92.5$ percent; (1)

- if 7.5% of electric energy is produced from renewable energy resources (this was the rounded ratio in Hungary in 2009 according to the report of the Hungarian Energy Office) and
- the average Seasonal Performance Factor of the electric heat pump in the example is again 4.0, the heat pump mentioned above

utilizes renewable energy resources in $25 \times 0.075 + 75 = 1.875 + 75 \approx 76.9$ percent. (2)

Heat pumps have Hungarian relation in that the heat pump with a compressor developed with the collaboration of László Heller (Figure 2) brought the breakthrough in the history of this technology.

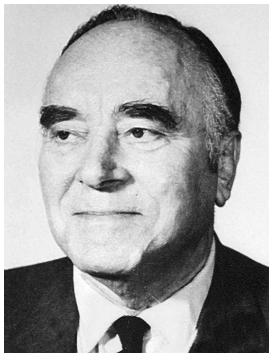

Figure 2: László Heller (1907–1980)
mechanical engineer, inventor, university professor, member of the Academy
(Denominator of the recommendation entitled "Heller László Scheme, a job creating initiative")

As a Hungarian engineer, László Heller outlined scientifically for the energetic public of the World the possibility of incorporating heat pumps into energetics. He called attention to that the continuous increase of the power plant efficiency (η power plant), the network efficiency (ηnetwork), the coefficient of performance (COP [kW/kW]) and the average seasonal performance factor of the heat pump system (SPF [kWh/kWh]) – that will take place undoubtedly with the development of technology – will improve continuously the profitability of heat pumps. With the worldwide spreading of heat pumps his thoughts are verified today (Figure 3).

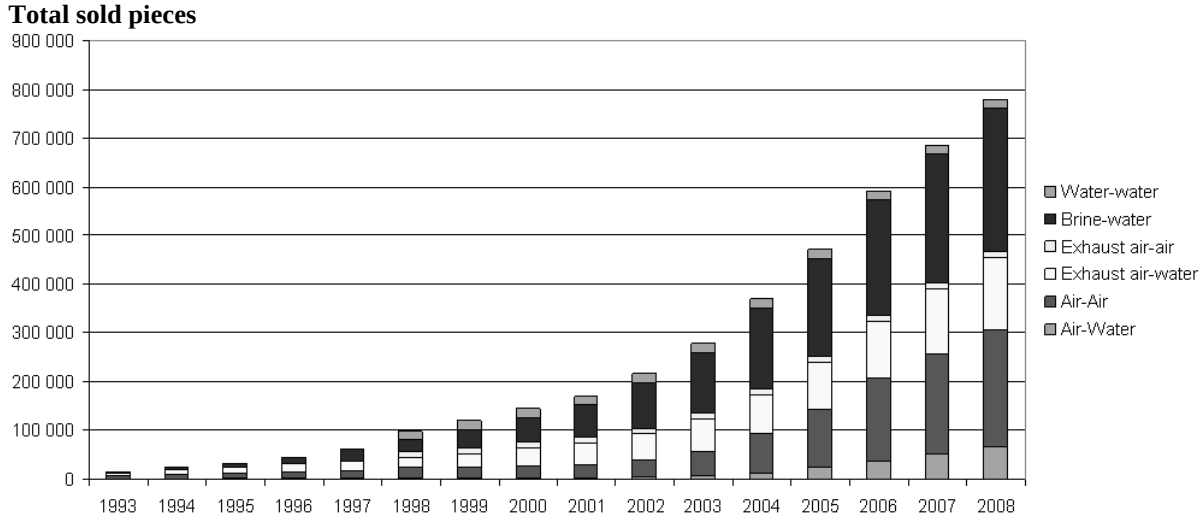

Figure 3: Example for heat pump statistics (Total sold heat pump [accumulated pieces])
Source: Swedish Heat Pump Society (SVEP)

László Heller received his mechanical engineer degree in the Technical College of Zurich (ETH) in 1931. In the course of his engineering consultant work – working on the modernization of the Goldberg Textile Factory – he was the first to recommend the use of heat pumps already in 1937. His opportunities in industrial energetics and his experiences of heat pumps in Zurich – the town-hall in Zurich has been heated by heat pumps since 1938 – encouraged him to seek new solutions in the field of heat pumps. He submitted his dissertation summarizing the results of his detailed research to the Doctoral Board of ETH in Zurich in 1984 on the basis of which he received the title of doctor of technical sciences (HELLER 1948, KORÉNYI and TOLNAI 2007).

Among the plans of the professor who established a new school of thought and who specialized in heat energetics was the idea to heat the Hungarian Parliament and the Technical University by heat pumps extracting heat from the Danube (Figure 4). Based on the above, the statement is verified that the pioneer of the heat pump industry is László Heller! In 2009 a reviewed professional textbook entitled *Heat pump systems. On the centenary of the birth of László Heller* was published by Hungarian authors (KOMLÓS ET AL. 2009).

Figure 4: Image for the idea of László Heller (non realized plan) produced by graphic Magdolna Handbauer

Nowadays heat pumps can be applied to heat buildings, however, they are suitable for ventilation and sanitary hot water production as well (Figure 5). In this way they can be used for low temperature central heating operating with hot water most suitable for human nature and temperature sensation, so called surface heating: large surface radiator heating (heat gradients of the radiator: 55/45 °C, then 40/30 °C instead of the former 90/70 °C and 75/60 °C). They are also suitable for floor, wall and ceiling heating and for tempering the building structure. In the case of these human centric radiating heating techniques the temperature of the air in the room can be less by 2-3 °C (or higher in the case of cooling) with similar comfort feeling reducing potentially the heating or cooling energy consumption by 10–15%.

Heat pump systems can be applied well for local government installations, swimming pools, baths, public buildings, residential or other accommodation buildings, industrial and agricultural buildings: plant houses, cattle houses; tempering irrigation water; drying, food industrial purposes, district heating and cooling. Outstanding quality advantages of the heat pump technology among various heating techniques are: minimal local pollutant emission, large ratio of renewable energy utilization, heat comfort, energy efficiency.

Our aim is to increase energy efficiency as soon as possible installing less air conditioning", fluid coolers and refrigerators for heat pumping tasks, to prepare for introducing related EU directives in Hungary and to encourage the installation of quality heat pump systems in the interest of Hungarian energy consumers.

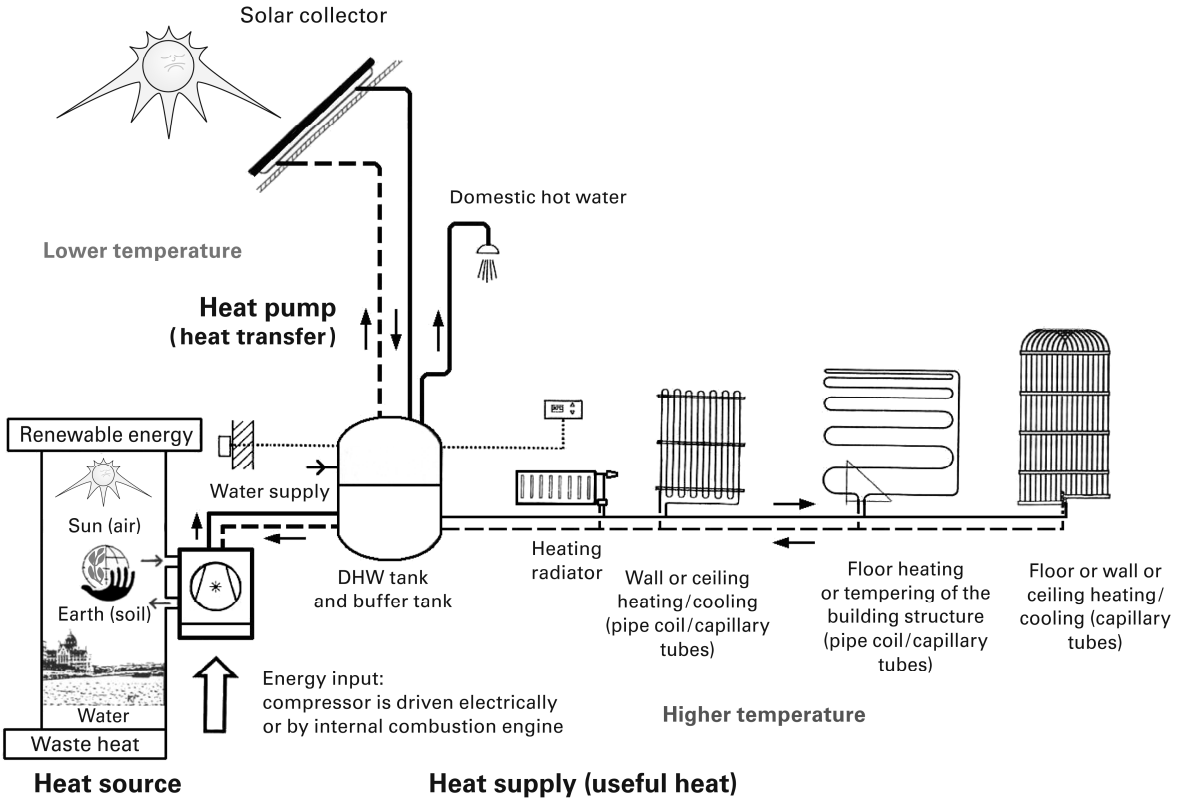

Figure 5: Theoretical outline sketch of a system using solar panels and heat pumps

HEAT PUMPING TECHNOLOGY

Increase of the following factors contributes to the development of the heat pump technology in Hungary as well in the forthcoming years:

- Creating jobs,
- Energy prices (prices of related alternative fuel),
- Import ratio (energy resources, new instruments and equipment),
- Ratio of electric energy from renewable energy resources,
- Power plant efficiency (calculated from the efficiency of all power plant technologies in Hungary and their ratio, the value has been increasing from the start) – it is and expectedly will be increasing in the future as well),
- network efficiency (transporting and distributing efficiency, a value increasing only in the long-term),
- COP value of heat pumps (increasing value due to the economic competition),
- Average seasonal performance factor of the complete heat pump system (the complete heat pump system including the heat source/consumer and the heat releaser/uptaker sides, increasing value due to continuously developing solutions),
- Efficiency of building insulation,
- Smaller heating temperature as a result of surface heating (floor, wall and ceiling heating) and of large surface radiator heating,
- Spreading of central heating and/or cooling.

These factors will improve continuously the market conditions for the advancement of heat pumps and heat pump systems with the development of technology.

ECONOMIC ADVANTAGES OF HEAT PUMPING

Conditions of our country, namely the solar energy and geothermal energy potential of Hungary together with its high level intellectual capital favour the spreading of the innovative heat pump technology utilizing renewable energy. Heat pumping is an innovative technology the establishment of which adjusted Hungarian conditions is not complete yet, especially in the case of borehole heat exchanger and heat pump systems. Installation of the developed western technologies alone cannot ensure effective operation as for example the hydrological, geological and meteorological conditions, heat insulation and central heating of the buildings in Hungary may be different.

Therefore there is the possibility to establish technologies competent elsewhere as well by determining the sizes of systems for the Hungarian conditions and these can be exported as well. There are Hungarian results in the field of the technology already (e.g. development of the Vaporline® GBI(x)-HACW heat pump family) and, thinking back to László Heller, the Hungarian profession is well established historically as well.

SUMMARY

Development, design, production and construction of heat pump systems may contribute to the re-start of our building industry, to the development of small and intermediate companies and to the establishment of new jobs. Almost seventy years old scientific work that can be regarded as a Hungaricum of one of the outstanding apostle of Hungarian engineers could be realized by establishing heat pump industry in Hungary. With the help of the New Széchenyi Plan, the heat pump programme could become the breakthrough of dynamizing our economy. At the time of Hungarian presidency of the European Union the Danube Region Strategy of the EU is discussed therefore we have the chance to start a Heat Pump Programme!

"If you ask me whether it is too late to reverse all the destruction man made to Nature my answer is no, we are not too late. Until there is the will it is never too late. If people want something together, they are going to do that reaching their target whatever it would be." (VINCZE A.T., 2003)

Edward Teller (1908−2003)

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Ways of Reducing the Energy Consumption of Buildings

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Keywords: energy efficiency, energy demand, building engineering

ABSTRACT

The 2002/91/EC directive played a key role n controlling the energy efficiency of buildings. Significance of the directive is justified by that in the European Union around 40 % of the energy consumption and 36 % of carbon dioxide release are associate with buildings. Corresponding to the directive national decrees occurred. In 2010 the 2010/31/EU directive on the energy efficiency of buildings was issued which is the modified version of the 2002/91/EC directive. According to the new directive in order to achieve cost optimalised energy saving investments minimum requirements have to be determined for each building engineering element, moreover minimum requirements for building engineering systems also have to be identified. The new directive states that buildings used or owned by authorities have to have around zero energy demand after 31st December 2018 while after 31st December 2020 all new buildings have to have around zero energy demand. In order to achieve the above targets member states have to work out financial incentive systems. Realizing the above regulation system energy consumption of buildings will decrease significantly.

INTRODUCTION

In the last thousand years the concentration of carbon dioxide, methane and nitrogen oxides in the atmosphere had been increasing and this process has intensified over the last hundred years. Close correlation between the increase in the concentration of carbon dioxide and global warming is illustrated in Figure 1.

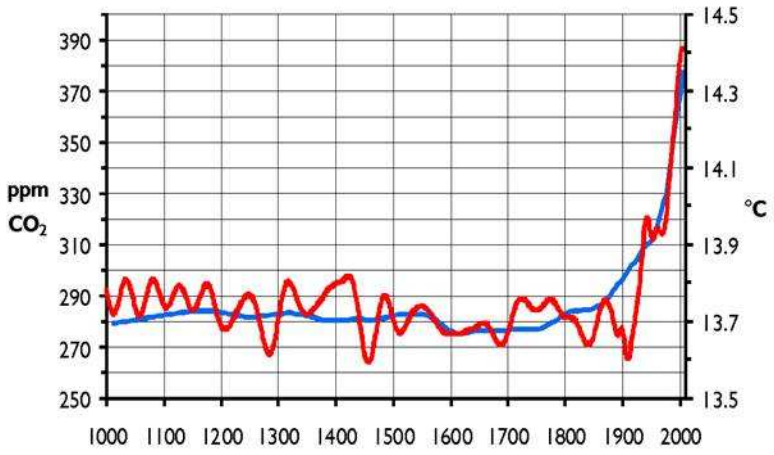

Figure 1: Close correlation between the increase in the concentration of carbon dioxide and global warming

The European Union has taken major steps in reducing green-house gases since the beginning of the 1990s. Such are the Framework Convention of Climate Change of the UN (UNFCCC, 1992), the Kyoto Report (1997), then the European Climate Change Programme (ECCP, 2000). In the Kyoto Report the 15 EU member state at that time accepted to reduce the release of green-house gases by 8 % compared to the 1990 base year in the time period of 2008-2012. In 2007 Hungary agreed to a reduction of 6 % compared to the average release of the 1985-1987 period. Main task of the European Climate Change Programme to develop a strategy necessary to achieve the targets of the Kyoto Report.

In accordance with the Energy Performance of Buildings Directive the following decrees were issued in Hungary:

- 7/2006. (V.24.) TNM decree on determining the energetic conditions of buildings;
- 176/2008. (VI.30) government decree on certifying the energetic conditions of buildings;
- 264/2008. (XI.6) government decree on energetic inspection of heat producing equipment and air conditioning systems.

The past 8 years justified the need of the Energy Performance of Buildings Directive but in 2010 the amended version of the directive the "recast" (31/2010/EU) was issued. The principle of the Energy Performance of Buildings Directive (2002/91/EC - EPBD) was retained by the new directive but greater emphasis was put on the cost effective solutions, on the control and quality assurance systems.

MOST IMPORTANT ELEMENTS OF THE ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE (2002/91/EC)

UNIFORM CALCULATION OF THE ENERGY CONSUMPTION OF BUILDINGS

A uniform energy consumption calculation method is necessary for the comparison of buildings with different functions. Uniform calculation of the energy consumption of buildings involve: structures bounding the building, heating and HMV system, ventilation system, artificial lighting, solar systems, natural ventilation, inner air condition, CO_2 emission. The calculation method gives flexibility to the designer in creating the optimal system in order to reduce energy consumption – and from investment and operation points of view – considering the energy demand of the entire building. Energy consumption of buildings has to be given in primary energy resource equivalents.

REQUIREMENTS FOR THE ENERGY CONSUMPTION OF BUILDINGS

Member states have to take necessary measures in order to ensure minimum energy consumption of buildings. In the case of new buildings with an effective ground space of 1000 m^2, technical and economic possibilities of installing systems that apply renewable energy resources and of connecting to the district heating network have to be assessed prior to the start of construction.

ENERGY PERFORMANCE CERTIFICATE OF BUILDINGS

Legal regulation of certifying the energy of buildings has to be established by 4th January 2006. When constructing, selling or letting a building it has to be ensured that the owner, the possible customer or tenant receive the certificate of the energy consumption of the building. The certificate must contain recommendations for the effective reduction of energy consumption.

REGULAR INSPECTION OF BOILERS AND AIR CONDITIONING SYSTEMS

In order to reduce energy consumption and carbon dioxide emission member states order the regular inspection of boilers with an effective power greater than 20 kW. Boilers with power greater than 100 kW have to be inspected every other year. In the inspection of heating systems operated by boilers older than 15 years and having a power greater than 20 kW recommendations have to be given to reduce energy consumption. Energetic inspection of air conditioning systems with a power greater than 12 kW also has to be performed. Similarly to certain boilers this inspection has to be completed by recommendations to reduce energy consumption efficiently.

7/2006. TNM DECREE

The 7/2006. (V.24.) TNM decree includes the determination of the energy performance of buildings. The decree covers the determination of required values for building structures and the calculation method to be applied. According to the 7/2006. TNM decree, new buildings and buildings renovated significantly have to meet a three-level requirement system. Requirements involve the heat transfer factor of the elements of the building structures, the specific heat loss factor of the building and the total energy performance of the building. The calculation is not related to the size state, instead we calculate the primary energy demand of heat, sanitary hot water, ventilation, machinery cooling and lighting in kWh/m^2.

176/2008. GOVERNMENT DECREE

The 176/2008. (VI.30.) government decree identifies the certification of energy performance of buildings. The certificate is given on the basis of the calculation determined in the 7/2006. TNM decree. Energy performance quality is always indicated by a ratio in percent of the total energy performance of the analysed building or individual function unit compared to the total energy performance of a control building or individual function unit having similar geometric size and purpose and meeting just the minimum requirements. Label and description of quality classes of buildings or individual function units based on the percent of their total energy performance in relation to that of the control building or unit are given in Table 1.

Table 1: Label and description of quality classes of buildings

A+	**<55**	**Very energy efficient**
A	56-75	Energy efficient
B	76-95	More efficient than the requirements
C	96-100	Efficient appropriate
D	101-120	Approaching the requirements
E	121-150	Better than average
F	151-190	Average
G	191-250	Approaching average
H	251-340	Poor
I	341<	Wrong

264/2008. GOVERNMENT DECREE

The 264/2008. (XI.6.) government decree regulates the energy inspection of heat producing equipments and air conditioning systems. Effect of the decree covers all heat producing equipment with effective nominal power greater than 20 kW supplying buildings and building parts that have rooms applied for longer stay, air conditioning systems with effective nominal power greater than 12 kW and heating systems older than 15 years and operated by heat producing equipment with effective nominal power greater than 20 kW. Heat producing equipments with effective nominal power of 20-100 kW using non renewable liquid and non renewable solid fuel or heat producing equipment with effective nominal power greater than 100 kW using gas fuel have to be inspected at every four years calculated from the date of setting into operation.

31/2010/EU DIRECTIVE ON ENERGY PERFORMANCE OF BUILDINGS

The 2010/31/EU directive on energy performance of buildings was issued in 2010 and this is a recast of the 2002/91/EC directive. The new directive is frequently referred to as EPBD recast, however, numerous significant changes were made.

CALCULATING ENERGY PERFORMANCE OF BUILDINGS

The new directive underlines that it is sensible to consider European standards when applying the national calculation method including the 2009/28/EC directive (supporting energy produced from renewable energy resources) as well. In the course of calculations buildings are recommended to be classified in the following categories: family house, block of freehold flats, offices, educational buildings, hospitals, hotels and restaurants, sport facilities, trade servicing buildings, other type of energy consuming buildings. The target of introducing the new directorate is the application of calculation methods with the help of which results will be comparable in different member states.

SETTING UP MINIMUM REQUIREMENTS RELATED TO ENERGY PERFORMANCE

In order to achieve cost optimalised energy saving investments minimum requirements have to be set up for every building unit that influences significantly the energy efficiency of outer bordering structures. For the application of the comparative method framework in the member states representative residential and non residential reference buildings have to be identified. Energy efficiency measures have to be worked out for the reference buildings and their expected costs over the economic life of the building (benchmarking).

DETERMINATION OF THE REQUIREMENTS FOR BUILDING ENGINEERING SYSTEMS

The energy performance directive described minimum requirements for building structural elements but identified no requirements for building engineering sub-system elements or for the entire system. Based on the new directive requirements have to be established for the building engineering systems in the case of new building engineering equipments or their replacement, modernization. System requirements are effective for heating, HMV, ventilation and air conditioning systems as well. Requirements are also effective for those building engineering parts that are not under the effect of the Ecodesign directive.

BUILDINGS WITH ALMOST ZERO ENERGY DEMAND

The new directive prescribes that buildings used or owned by authorities have to have almost zero energy demand after 31st December 2018 while after 31st December 2020 all new buildings have to have almost zero energy demand. In order to achieve the above aim member states have to work out financial incentive systems.

ENERGY PERFORMANCE CERTIFICATES

Certificates have to give recommendations to what measures are sensible to make in order to improve cost efficiency at the level of cost optimalization. Beyond the conditions described in the energy performance of buildings directive the 2010/31/EU directive decreased obligation from 1000 m^2 to 500 m^2 at the time of the decree coming into force and then from 15th July 2015 down to 250 m^2. In the case of selling or letting the building the energy performance classification has to be given in advertisements in the media or a copy of the energy performance certificate or its copy has to be given to the new lessee or owner (see Figure 2).

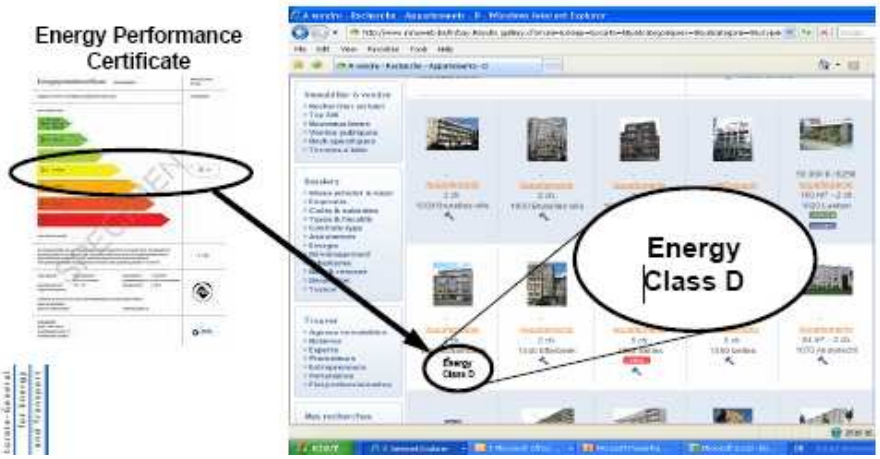

Figure 2 Energy performance certificate

ON SITE INSPECTION OF HEATING AND AIR CONDITIONING SYSTEMS

In the new directive, inspection of heat producing equipments includes all heating systems operated by heat producers with effective nominal performance greater than 20 kW (not only the heat producing equipment). In the inspection report of heating and air conditioning systems recommendations for reducing energy usage considered at cost optimalized level have to be suggested.

INDEPENDENT CONTROL SYSTEM

Member states have to provide an independent system to control energy performance certificates and reports of heating and air conditioning systems. The control has to cover a significant ratio of analysis reports statistically and have to discuss the control of input data and results together with discussing the onsite control of the given building.

SANCTIONS

It is a significant change that according to the new directive, member states have to determine sanctions so be applied in case of breaking national decrees and member states have to do all they can to ensure the realization of such measures and regulations.

TAKING EFFECT

The new directive was issued in the Official Journal of the European Union on 18th June 2010, it took effect on 8th July 2010 while the 2002/91/EC directive loses its effect on 1st February 2012. Member states have to issue those regulation and public administration measures that ensure the implementation of the directive until 9th July 2012. Regulations have to be applied from 9th January 2013 at the latest.

According to the report of the Central European University carried out in 2010 (ÜRGE-VORSATZ, 2010) among the 5 studied cases, it is practical to perform renovation in order to achieve complex energy saving with a rapid accomplishment tempo (S-DEEP-1) thus over 20 years Hungary can achieve that only buildings of almost zero energy demand will exist. Moreover, this version is most preferable regarding effects on employment as well (Figure 2).

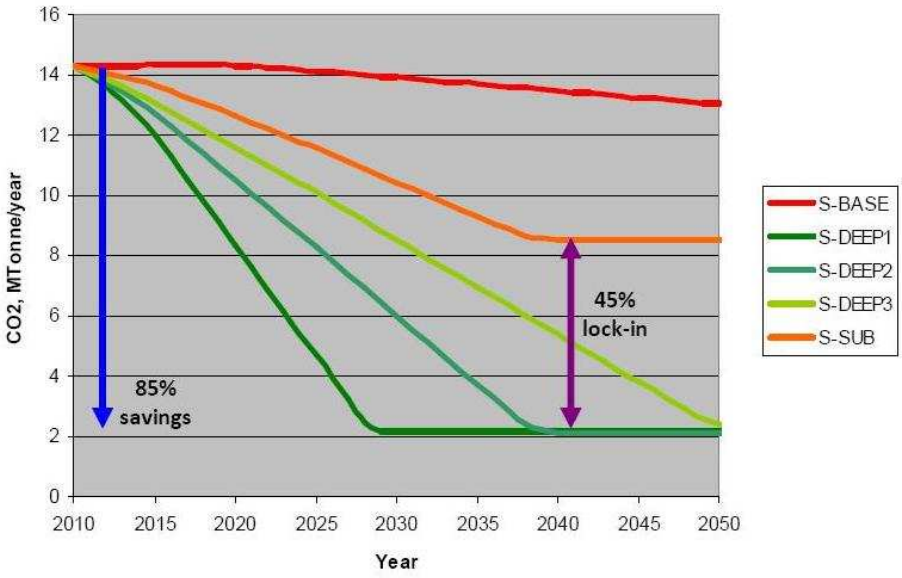

Figure 3: CO_2 emission – Residential and public buildings (Together with buildings built after 2010)

SUMMARY

The EU's Energy Performance of Building Directive, introduced in 2002 and recast in 2010, is the main legislative instrument for improving the energy performance of our building stock. Its impact becomes tighter regulations for construction and renovations, building certification schemes, inspection for heating and air-conditioning systems. We have a lot of possibility to reduce the energy consumption of buildings. Energy consumption of building takes 40 % of the total energy consumption. By 2020, all new buildings constructed in Europe must be nearly zero energy buildings. This paper demonstrated the ways of reducing energy consumption of buildings.

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Climate Change Impact Analyses Techniques Applied to Plant Production

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Keywords: adaptive strategy, climate indicator, modelling, phenology, plant production, risk

ABSTRACT

Agro-ecosystems and the effects of different types of factors in it and the connections between its elements can be described with discrete differential equations. If we involve many more factors in the system, it can be analysed using applications of the graph theory methods. It is proved with a stochastic dominance criterion that the production risk of e.g. field crops, grapevine and apple production is increasing in the last years; the rate of it is even getting fast in all of the cases we investigated. We tried to find the reason for this, analysing the climatic needs of these plants in different periods of their growing. We constructed climatic indicators which show the reaction of plants to the changing conditions.

We have used comparison analyses for different climate scenarios and their baseline scenario. We showed that the starting points of the phenological phases of plants are getting earlier with the increasing temperatures of the changing climate. The development of plants and their expected yield under the changing conditions can be followed by using the cost and time friendly method of modelling. By applying virtual experiments it is possible to give predictions using climate scenarios, so it is a very suitable tool for investigation of the future circumstances and finding adaptive response strategies. The aim of our work is to support both researchers and farmers with our results in their decisions and guidance. The experts are interested in how to avoid the worst effects of the changes and how to benefit from climate change, if possible.

INTRODUCTION

It is evident that climate is changing nowadays. Rising temperatures may allow earlier sowing dates, enhance crop growth and increase potential crop yield. On the other hand, rising temperatures increase the water demand of crops. In addition, extreme weather events such as droughts and floods have increased, which implicates many serious problems in agriculture. There are many results of how the quality and quantity could change depending on different nutrition supply (SZALAY ET AL, 2009), or other agrotechnical elements. Climate and its change determine agricultural production in many ways. Having regional climate models it is possible to analyse interactions of these factors with meteorological circumstances, as well. In this work first we show the methods and some examples of climate change impacts research for plant production.

We traced the production risk using production data of the last few decades, we have defined climate indicators of climate needs of the plants and analysed the changing frequency of them for the past and the future scenarios, we have used simulation method for analysing the changes in plants phenological phases and future production with different circumstances, harvest index, etc. The case studies for climate change impact analyses are presented by comparison analyses for different climate change scenarios.

EXPERIMENTAL METHODS

CLIMATE DATA AND CLIMATE DESCRIPTION OF THE RESEARCH LOCATION

Climate scenarios can be defined as relevant and adequate patterns of the climate characteristics in the future. The latest version of the 3-dimensional Regional Climate Model, RegCM3 (developed in the International Centre for Theoretical Physics) is available with the horizontal grid spacing of 10 km over the Carpathian Basin and its surroundings (Torma et al, 2010). We show examples of comparison analyses for a scenario for the middle- (2021-2050) and the end of the century (2071-2100) compared to their baseline scenario, representing the 1961-90 past years.

THE KKT CLIMATE RESEARCH DATABASE MANAGEMENT SOFTWARE AND THE PRODUCTION DATA

In order to collect, organize, manage and search databases for climate change research in a friendly way a special data management system was needed. An indicator-search software KKT has been developed at Corvinus University of Budapest, Department of Mathematics and Informatics (SZENTELEKI ET AL, 2007). Frequency calculations were made with the help of this program using the daily precipitation and temperature data forecasted by climate scenarios. Beside the meteorological databases, it contains the crop production data we used for risk analyses. The production data are from the Agricultural and Environmental Statistics Department of the Hungarian Central Statistical Office (KSH) for all counties, for the time interval 1951-2005.

A NEW STOCHASTIC EFFICIENCY METHOD FOR DETECTION OF THE PRODUCTION RISK

For analysing the production risk, the data of the Hungarian regional yearly crop results were applied. The yield data were fitted by regression. For making the production data comparable, we have eliminated the trend effects by using the Phillips method (HARDACKER ET AL, 2004). The climate scenarios are given for different time intervals as independent patterns and not as time series, so for comparison we have used distribution functions and the first order stochastic dominance criterion based on the subjective distribution functions and also the E,V – efficiency criterion were considered (LADÁNYI AND ERDÉLYI, 2008).

SIMULATION METHOD, THE 4M CROP MODEL

In our modelling research we used the 4M model, which has been developed by the Hungarian Agricultural Model Designer Group (FODOR, 2002). It contains several models to describe the physiological interactions of soil - plant systems and offers a possibility of building up different system models in it for the specific purposes of the users need. The CERES model was chosen to be a starting point and was adapted to Hungarian circumstances. The simulations were run for the daily average temperature, precipitation amount and radiation forecasted by climate scenarios.

PRODUCTION RISK AND ANALYSES

Based on the production data of main crops, first we track how the production risk is changing with time in the last few decades. We can conclude that beside other non-climatic effects, the changing climate has considerable impact on crops yield; its variability is increasing with the variability of meteorological parameters, especially with shortage of precipitation. First we examine the production data of crops by analysing how the production risk has changed with time. The observed time interval was 1951-2005, applying the stochastic efficiency criterion we proved that the risk of crop production has increased. The most evident risk increase was in the last two decades. The same can be proved with the E,V - efficiency method.

RESULTS AND DISCUSSION

INDICATOR BASED ASSESSMENT

The next step is studying the climatic needs of the plant through the most important periods of its development. In search of the reasons we have analysed statistically whether the climate needs of the crop will be satisfied or not in its important growing periods. Using historical data and regional climate model scenarios we could detect the reasons of risk increase in the past and forecast the potential main points of future risk. The most important periods of plant development were defined according to Z. VARGA-HASZONITS (1987): we analyzed the sowing-emergence phenological phase, the stem elongation – spikelet initiation period and the anthesis-grain filling phenological phase.

For prediction we have used comparative statistical analyses based on climate needs of the plants, applying meteorological data of some climate scenarios and their baseline, again. The climate scenarios are given for different time intervals as independent patterns and not as time series, so for comparison we have used distribution functions and the first order stochastic dominance criterion. We present the example of results for Hajdú-Bihar County on Figure 1.

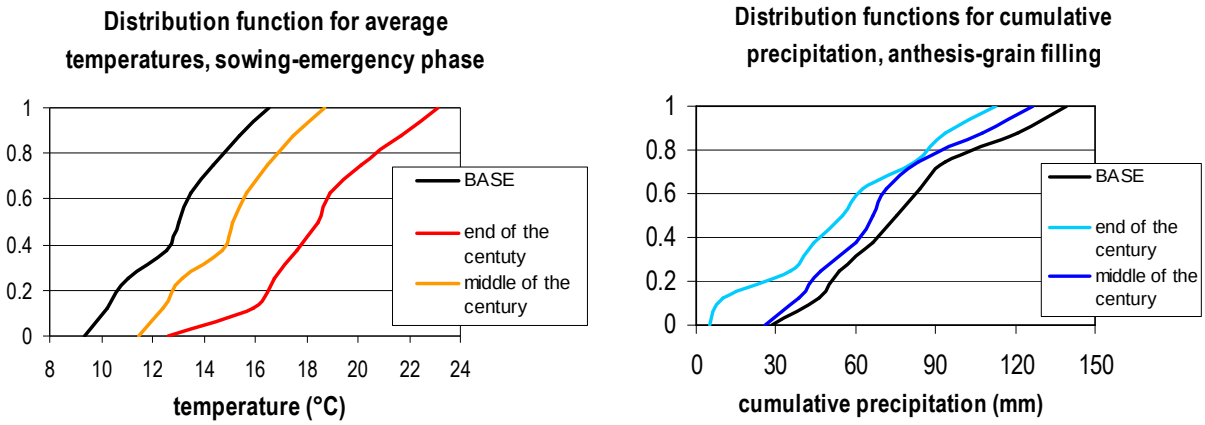

Figure 1: The first order stochastic dominance criterion for the average temperature values in sowing-emergence phenological phase (left) and for the sum of precipitation in the anthesis-grain filling period (right)

CROP GROWTH SIMULATION RESULTS

Research on the effects of climate change on agricultural cultivars is supported by crop growth models. It could be well applied in planning adaptation strategies, as well. Simulations provide facilities for the low cost analyses of the effects of many factors, both independently of each other and in combination. In order to check the reliability of the used crop model, we have compared the simulated yield results with the historical production data. We have concluded that the model operates with small variation and the predicted yield is close to the measured ones. The application of these crop-models is justified in many national climate change impact research projects (FODOR AND KOVÁCS, 2005).

Next we give some examples of how to benefit from simulation modelling in coping with the possible changes. Using these crop models we examined the effects of climate change on maize and winter wheat by tracing their change in phenology and expected yield.

SHIFTING OF THE PHENOLOGICAL PHASES

In case of crops, where phenological phases depend on the accumulated heat unit, the phenophases could become shorter. In summary, it can be said for maize and winter wheat that the phenological phases might happen earlier in the future as a result of temperature increase. Simulation results show harvesting is predicted to be about one day in ten years earlier in the future. Analyzing the results we can see not only the shifting of the period of grain development, but also that climate change has a good influence on grain mass of the plant: besides the shifting of the grain development period for eight days earlier date we detected that the average production is predicted to be higher in the future than before. Based on the predicted values we can conclude that climate change might be good in winter wheat production of Hungary. The simulation result for the climate scenario gives about 13% of winter wheat yield increase compared to the simulated value with the input of the historical data.

MODELLING MAIZE BIOMASS FOR THE FUTURE

Energy potential of Hungary is approximately half-half of products and by-products. Maize is an energy crop with significant by-production. We analysed the effects of changing temperature on the proportion of grain, leaf, corn-stalk and root in corn biomass. Using biomass as a substitute for fossil fuel is highly prioritized, but the primary aim of agricultural production is food and feed supply. Converting secondary biomass, plant residues to valuable energy products might be a solution; or predicted better harvest index, as well.

In response to climate change, the agricultural sector has to cope with the impacts of it, the effects of variability on crops, and the shift in water and land use management. We used the model for tracing when is the plant suffering from precipitation shortage in its development (Figure 2), and also to see whether it is worth irrigating or not.

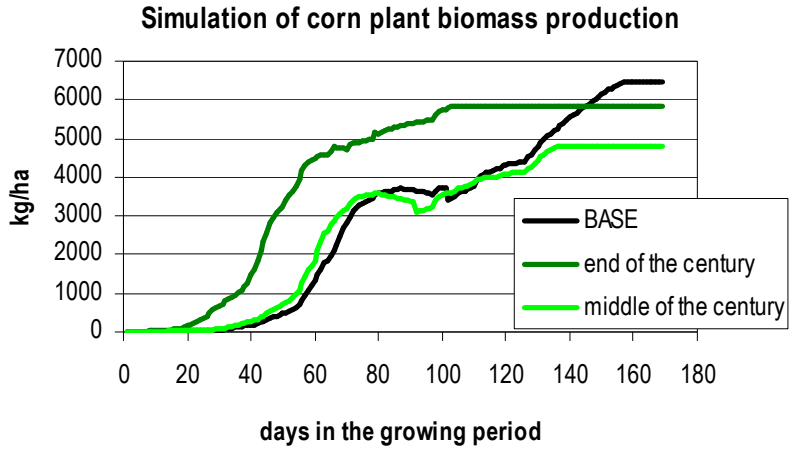

Figure 2: Plant development show precipitation shortage around the 90th day of simulation

We have tested the efficacy of different irrigation patterns. Comparing runs without treatment and runs with irrigation, it was found that maize biomass and grain levels increased significantly for all scenarios in case of irrigation. According to our results we can state that irrigation at optimal time can even double the yield, but repeating irrigation one more time is not worth. Decreased precipitation amounts are very probable in the future; this probably means that economic aspects about not using watering on crop fields are worth reconsidering.

CONCLUSIONS

The calendar of the nature, together with the development process of plants is changing. The starting dates of the phenological phases of plants are valuable indicators of climate change, because they are sensitive to temperature and easy to observe. In regions where temperatures are near the optimum, under current climatic conditions, increasing temperature and less precipitation would probably lead to decreased yields. Wheat and barley are crops sown in autumn or early spring, maize is sown in spring. Thus a wet period early in spring or a summer drought will affect these crops differently. It is shown, that climate change could be in favour of winter wheat because of the carbon-dioxide increase, but arises lots of question for maize.

The application of regional climate models has been becoming more and more often focused. Besides investigating the impacts it may be the basis of action plans of the response, prevention and adaptation strategies of given regions. Applying crop models we can do many virtual experiments on very low cost and in very short time. The results can help the scientists in improving new, drought resistant, better quality (SZALAY ET AL, 2008) and more successfully adaptable species, which can benefit from increasing carbon-dioxide. Models can help us in designing experiments and estimating the present and future characteristics of the investigated system and to prepare agro-technological advising for optimal interventions for plant growers.

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Section 5
Red Sludge Catastrophy in Hungary

Connection Between Climate Change and the Red Sludge Catastrophe

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Keywords: cointainment technology, history of disasters, red sludge, climate research, predictions, future tasks

ABSTRACT

Red sludge is a mixture of several metal compounds as the by-product of aluminous earth production. Attention focused on it in Hungary on 4th October 2010 when in the course of an industrial accident the dam of a sludge reservoir broke and vast amount of dangerous waste was released onto the surrounding areas. The red sludge flooding over 800 hectares caused immense ecological loss.

INTRODUCTION

HISTORY OF SPILL ENVIRONMENTAL CATASTROPHES

Hungary's toxic sludge disaster is not the first time a containment dam has failed.

Aurul Gold, Baia Mare Romania, 2000:

- The disaster in Ajka is reminiscent of the catastrophe in 2000. The containment dam holding by-products from gold processing failed. Drinking water was poisoned; a massive fish population was killed

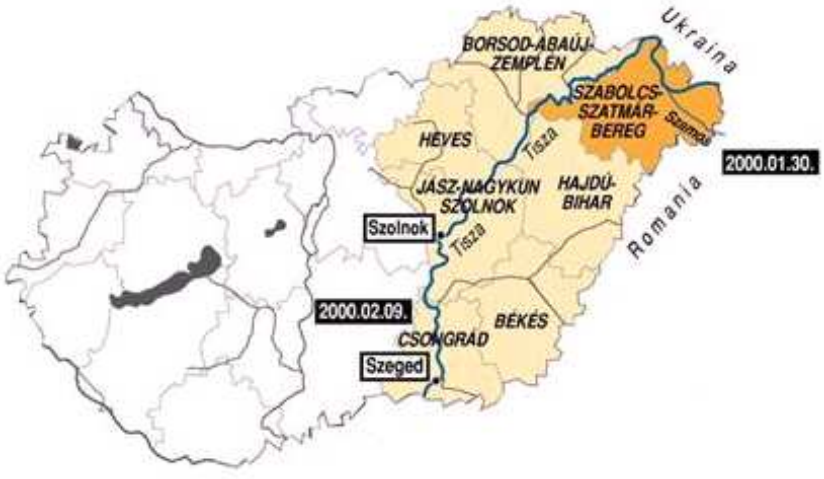

Figure 1: Process of the cyan contamination in the Tisza
Source: [origo]

Los Frailes mine, Aznalcollar Spain, 1998:

- 4 - 5 million m^3 of toxic tailings spewed into the surrounding area of 25 000 acres, or 10 000 hectares. The spill occurred because the soil below the dam slid forward the river, causing the dam walls to break

Marcopper mine, Marinduque Island Philippines, 1996:

- The company produces copper. The mine tailings began to leak from their holding container into the rivers. Over the next few days between 2 and 3 million m^3 of slurry escaped

Kingston Fossil Plant, Harriman Tennessee USA, 2008:

- The holding wall of an ash pond gave way and 4 million m^3 of gray coal ash poured out. The spill covered 300 acres, or 120 hectares with a gray blanket and ran into the nearby Emory River, leaking arsenic, lead, chromium, manganese and barium into the water.

Figure 2: Gray ash hazard, USA 2008
Source: aol news, Google Earth

TOXIC SLUDGE CATASTROPHE IN HUNGARY

The disaster occurred late on Monday, the 4th of October when a reservoir burst at the Ajkai Timföldgyár Zrt. aluminium plant. The reservoir released a tidal wave of thick red sludge, which immediately mixed with floodwater that had built up in the region for days.

WHAT IS RED SLUDGE?

Toxic sludge is a strong, alkaline substance, which is a by-product of aluminium processing with sodium-hydroxide. It is partially made up of iron oxide, giving it a red colour.

Figure 3: Red sludge hazard, Hungary 2010
Source: aol news, Google Earth

VAHAVA PROJECT

Climate change can be associated with several hazards nowadays. Already between 2003 and 2006 the VAHAVA project described the expected major hypotheses in the future related to climate change from which the following had a role in the case of the red sludge hazard:

- Warming is increasing in the Carpathian Basin
- Annual average precipitation is decreasing
- Frequency and intensity of extreme weather events is increasing.

The main objectives of the VAHAVA project can be summarised in two points:

- Preparation of the Hungarian society and economy for a probably warmer and drier future
- Creation of a fast responding technical, financial, organisational system, which is able to prevent or handle the damaging effects of foreseen, or unexpected extreme weather events.

METEOROLOGICAL DATA OF THE HUNGARIAN METEOROLOGICAL SERVICE OMSZ

Meteorological data prove apparently that monthly precipitation exceeded the average value throughout the country and in extended areas more than double of the average rained in the months before the break of the dam.

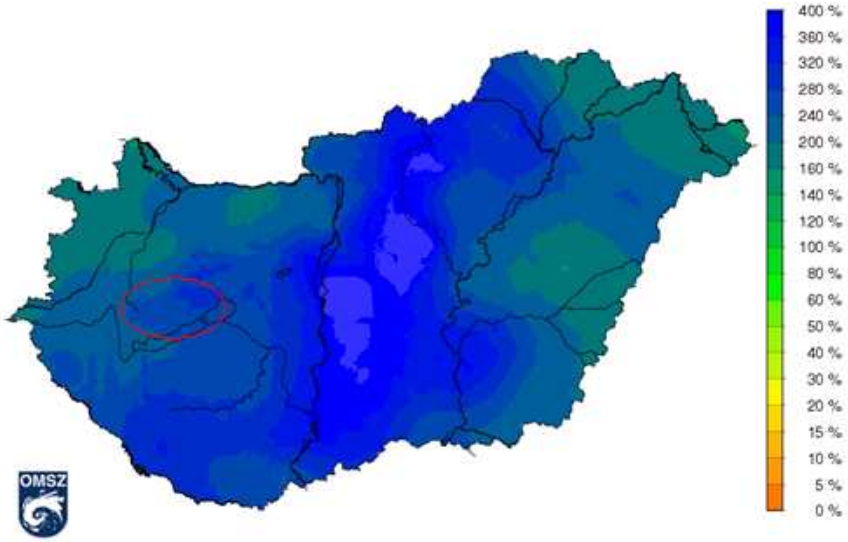

Figure 4: Ratio of the amount of precipitation compared to the average of 1971-2000 in the month before the hazard, Source: OMSZ

In the month before the hazard daily precipitation exceeded 10 mm in a national average on 5 days. Outstanding values can be associated with the cloud system and precipitation of Mediterranean cyclones.

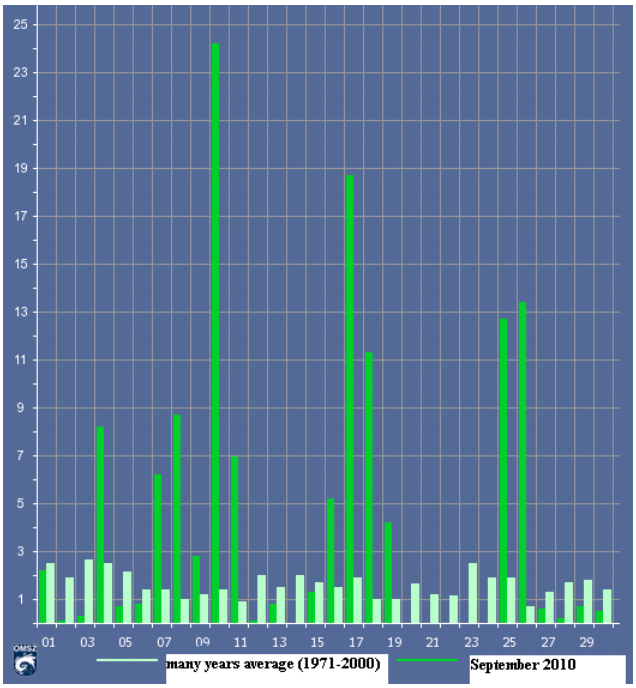

Figure 5: Daily totals of precipitation in relation to the 29 year average in mm, Source: OMSZ

In the course of the accident the north-western dam of panel X. of the red sludge reservoir was broken. As a result, 600-700 thousand m^3 of a mixture of red sludge and basic water flooded the deeper parts of Kolontár, Devecser and Somlóvásárhely settlements via the bed of the Torna stream. According to the reports the further 810 ha of agricultural areas – 300 ha of which is grassland, 310 ha is prepared arable land – covered by the red sludge were damaged presumably so severely that even soil replacement cannot be a complete solution therefore they will have to be removed from cultivation for a long time. The Central Agricultural Office introduced grazing and partial hunting, cultivation prohibition for indefinite time period and in the case of grown vegetation and fruits trading and consummation prohibition. Solution for these areas can be presented by energy plantations.

Figure 6: Picture of the flooded containment pond after the dyke broke Source: MTI

RECOMMENDATIONS

For avoiding such accidents prevention is very important. Prevention is composed of the following processes:

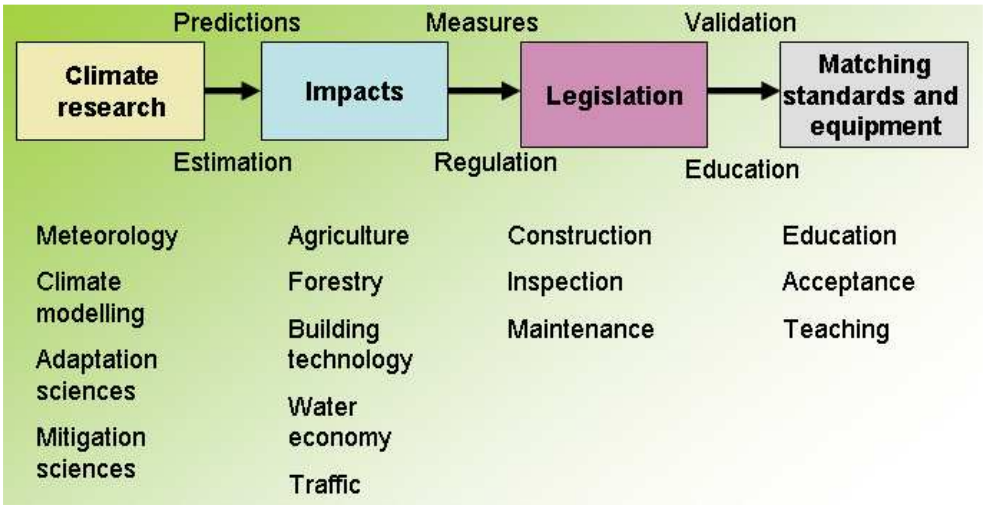

Figure 7: Structure of the prevention system

Current deficiencies of the system shown in Figure 7:

a) The first problem is the improvement of climate models. Current models do not give precise predictions about intervals of processes.

b) The second question is the fitting of standards of inspection and maintenance for containment ponds and methods and equipment. Further it is very important, to flexibly adapt the objectives of climate research projects.

c) The third important field is education. In future we aim to increase the average level of knowledge of environmental and climate protection.

d) The problem is very complex. Only the cooperation of several sectors in society can lead to a speedy improvement.

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Ecological Consequences of the Red Mud Catastrophe in Ajka Regarding Soils

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Keywords: red mud, Kolontár, soil contamination, soil remediation, short rotation coppice

ABSTRACT

The 4th October 2010 red mud catastrophe at Kolontár was one of the most devastating human and environmental hazards of recent years [1]. Numerous, sometimes contradictory news appeared regarding the extent of damage to the soils. Based on our onsite investigations we agree to the statement of the Hungarian Academy of Sciences namely contamination is limited to the upper 10-20 cm of the soils [2]. Effects are practically reversible and the ecological system of the soils will be able to regenerate the soil expectedly within a short time period. Condition of reducing damage is the removal of the red mud from places where its thickness exceeds 5-10 cm. Following measures have to target the reduction of the pH of soils and the regeneration of their biological activity. Regarding the further utilization of the area – considering human factors as well apart from ecological conditions – plantation of arborescent vegetation can be one possible solution.

INTRODUCTION

Is there any hope for the habitats to be productive again following the red mud catastrophe at Ajka? How much agricultural areas were contaminated in reality? In the following we present what happened in the soil and what is going on in there? How permanent these happenings are, can we trust in the extraordinary organization and stability of Nature that may produce preferable and productive soil conditions again?

WHAT IS RED MUD?

Red mud is the side-product of alum earth production, a strongly basic (pH 13) material containing toxic metal compounds over the average, however, not in dangerous concentration. The solid phase is the product of silicate decay under tropical-subtropical conditions. Thus it is a natural material of 1-2 µm grains, having specific area of 7.3-36 m^2/g, that is powdering away when dry, and tixotropic when wet. After treatment with NaOH only Na ions are adsorbed on its surface maintaining a sol state colloid chemically. Red mud destroys life if released into Nature, however, consequences of this destruction appear primarily in the short-term.

Composition of the red mud at Ajka, according to the data published on the webpage of MAL cPlc following the accident is presented in Table 1 [6].

Table. 1: Composition of the red mud

Proportion	Substances
40–45%	Fe_2O_3 (iron(III)-oxide), this produces the red colour of the mud
10–15%	Al_2O_3 (aluminium-oxide)
10–15%	SiO_2 (silicon-dioxide) present as sodium- or calcium-aluminium-silica
6–10%	CaO (calcium-oxide)
4–5%	TiO_2 (titan-dioxide)
5–6%	Na_2O (sodium-oxide, transforms into sodium hydroxide with water)

Figure 1: Area affected by the catastrophe Source: Wikipédia, 2010

EFFECT OF RED MUD ON THE SOIL

Soils have a very important characteristic in the form of their significant absorbing ability, so called buffer ability for reducing outer impacts. This buffer ability can be characterised by the buffer capacity (magnitude of absorbing effect) and the buffer rate (absorbing effect over a period of time).

It is possible that the buffer capacity of the soil enables it to reduce the effect of harmful material (if they get into contact with the soil slowly and in small concentration) but if changes take place rapidly and the soil cannot reduce them in time then the change in state happens. These can be even artificial measures improving productivity (e.g. chemical improvement of sodic soils) or effects influencing the productivity of a soil negatively.

In our opinion the effect of red mud on the pH and adsorption conditions of soils occurs in the short- and medium-term. Since the processes are reversible, if the soil solution is diluted, namely it rains (pH value of rain is around 5-6) or the soil is irrigated, its pH value will approach the original pH shortly. The same is true for adsorption processes as well.

WHAT ARE THE MOST IMPORTANT EFFECTS ON SOILS THAT WE HAVE TO CALCULATE WITH?

EFFECTS OF THE LIQUID PHASE OF THE RED MUD ON THE SOIL SOLUTION

We have to calculate with very high pH value of the liquid phase of the red mud and its effect [3; 4]. The basic solution raised the pH of the soil solution according to the grade of contamination. Naturally the change is the more significant the more the original pH values of the soils differ from each other:

Consequence of the effect on the pH of the soil

- The strongly basic pH affects the habitat of the soil microbes via the soil solution,
- Deterioration of the soil structure,
- Deteriorates water and nutrient uptake possibilities,

The effect is a reversible process, in the short- and intermediate-term.

Changes in the adsorption complexes of the soil influence

- Soil peptizing, the connection of certain soil particles into structural forms. Via this the pore space, air and water balance of the soil,
- Disadvantageous cation composition as a result of high sodium saturation influences disadvantageously the structure of the soil as it helps the dustification of the soil and the deterioration of the structure of the soil,
- Due to the processes mentioned above – similarly to sodification – poor water and soil uptake possibilities characterize the soil.

The effect is a reversible process, in the short-term.

Effect on soil biological processes

In the strongly altered chemical environment biological composition changes significantly as well, first micro-organisms and soil dwellers are destructed and it is a question in what time range can they regenerate and how can we help it?

The consequences are:

- Biological activity of the soil may decrease to zero,
- Ceasing biological activity stops the nutrient supply of the soil therefore the soil Becomes unproductive until the biological activity returns,
- In the case of smaller contamination biological composition changes only partly causing: decreasing biological activity, the microbial composition changes according to the extent of contamination.

The effect: significant in the short-term, soil biological intervention is recommended.

EFFECTS OF THE SOLID PHASE OF THE RED MUD (CLAY PARTICLES)

The solid parts like the red mud particles are practically silicates, clay minerals in the bauxite formed millions of years ago, grinded into fine grains and iron and aluminium compounds exposed in the basic environment and by the chemical treatments. They can change the century and millennial result of soil development as they can enter the pore network of the soil due to their size being in the clay fraction (<2 μm):

- They reduce the diameter of the pores choking the pores. As a result water movement in the soil is made difficult as moisture will not be able to infiltrate into the deeper layers of the soil, when water stops in the pores near the surface the soil becomes saturated.
- As a result the soil will be depleted in air resulting in a habitat disadvantageous for living creatures.

The effect is due to their tixotropy effect they enter the soil pores in significant rate therefore their effect will not be significant.

Colloid chemical effects of the solid parts are present, as clay minerals themselves bind adsorbed sodium ions in significant rate. Desorbed Na ions make the soil basic.

The effect is a short-term reversible process, its effect will not be significant.

Therefore monitoring-like ecological observation and within this soil examinations in selected areas and the increase of the chance of any restart on them are necessary.

Measurement values of three soil profiles from the agricultural areas between Kolontár and Devecser flooded by red mud are presented in Table 1.

It is clear that samples from site 1 were taken by genetic horizons thus the upper level means a 0-40 cm layer. Here, red mud was a few cm thick on the surface of the soil and it was sampled together with the 40 cm thick soil layer. Measurement results show that if the red mud is ploughed under in 40 cm thickness an average soil is obtained the pH of which is only 8.7. Carbonic lime content is 7% and this would have kept pH between 7.2 and 8.3 originally as well. Humus content is 4.8% suggesting a soil of good organic matter provision. Due to the contamination the quantity of exchangeable cations was measured as well and the result shows clearly that Na ion content of this upper 40 cm soil mixture is significant amounting to 17% compared to the S value percent.

If soil reactions were not reversible or Na ions were further adsorbed on other surfaces, sodification would start soil chemically in the areas. Further conditions of this, however, are not present. Here bleaching water budget prevails resulting in gradual filtration from the surface towards deeper layers resulting in bleaching. As there is no Na supply precipitation will dilute the soil solution continuously thus pH will resume its 7.5-8.5 value characteristic for the soil.

The main question is the development of biological activity as the fundamental and essential elements of the nutrient cycle are biocenoses living in the soil.

Table 1: Measurement results of soil samples from three agricultural areas

Site	Size cm	pH H_2O	pH KCl	Sodium	Total_ salt	$CaCO_3$	H	T-value	Na+	K+	Ca_2+	Mg_2+	Na+S %
				%				1/z mmol/100 g					%
1	0-40	8.7	7.5	traces	0.036	7	4.80	26.4	4.5	0.88	19.7	1.28	17
	40-60	8.2	7.6	traces	0.017	7	2.08	18.5	1.3	0.55	15.6	1.03	7
	60-90	8.4	7.7	traces	0.013	13							
	90-100	8.5	7.8	traces	0.010	12							
2	0-10	8.5	7.7	0.212	0.052	21	7.19	48.4	6.8	0.89	38.3	2.50	14
	10-20	8.1	7.5	traces	0.022	19	4.92	43.1	0.9	0.49	38.6	3.07	2
	20-30	8.2	7.6	traces	0.025	16	3.92	39.2	0.7	0.79	34.0	3.68	2
	30-40	8.4	7.8	traces	0.021	26							
	40-50	8.4	7.8	traces	0.020	35							
	50-60	8.5	7.9	0.169	0.015	48							
	60-80	8.4	8.1	0.151	0.016	34							
3	0-10	9.8	8.9	0.476	0.170	18	4.89	34.4	16.0	1.07	16.4	0.87	47
	10-20	8.9	7.8	0.143	0.068	19	4.60	31.5	7.8	0.78	20.9	2.11	25
	20-30	8.4	7.7	traces	0.037	19	3.86	27.0	3.3	0.59	20.7	2.50	12
	30-40	8.3	7.7	traces	0.031	19							
	40-50	8.6	7.9	traces	0.030	22							
	50-60	8.5	7.8	0.043	0.022	19							
	60-70	8.6	8.0	traces	0.023	18							
	70-80	8.4	7.9	traces	0.029	21							

Note: site 1: 47°04’57,39”N - 17°29’06,93”E, site 2: 47°05’54,76”N - 17°28’00,27”E, site 3: 47°06’03,15”N - 17°27’21,12”E

WHAT CAN WE DO?

SOIL REPLACEMENT (IN THE UPPER 10-20 CM LAYER)

Necessity, extent and method of intervention depend on the extent of contamination [5]. In areas where the thickness of the red mud exceeds 10-15 cm it has to be removed from the surface, collected and transported to a safe place. Soil replacement is sensible only in the immediate environment of human habitats (residential areas) as costs of soil replacement are horrible.

ALTERNATIVE, NOT INCLUDED IN THE FOOD-CHAIN, PRODUCTION OF AGRICULTURAL AREAS USING ARBORESCENT PLANTATIONS

- Practical realization of land-use is going to be adjusted to ownerships in the future. In our opinion the regenerating ability of soils – thanks to their complex buffer capacity – is good therefore there will be no significantly extended unproductive areas;
- Continuing traditional production methods (arable land food and forage production) holds risk not from ecological point of view but regarding social political reasons;
- Forested areas, arborescent plantations and protective forests directly around the settlements can be utilized economically with meeting the landscape rehabilitation, landscape protection and environmental protection (air, noise and soil protection) requirements;
- In other areas woodland plantations utilized for energy purposes can be established depending on production conditions;
- Produced chops can be fired both locally in the biomass boilers of the settlement (recommended investments for local governments) and in the close Bakony Power Plant only a few kilometres away;
- In areas where red mud contamination is small it can be treated by surface neutralization, intensification of the biological activity, mixing into the soil (in the case of maximum 10-15 cm thick coverage or where "only" polluted water flooded the area). In these areas wood species to be planted can be decided during the habitat surveys for forestry purposes carried out generally in the autumn;

Potential solutions:

- In drier areas, in the case of shallow productive layer, acacia plantations for energy purposes treated by 3-5 years cutting cycle,
- In deeper areas with deeper productive layer and with appropriate water balance, poplar plantations treated by 2-3 years cutting cycle. In the case of the Transdanubian mountains, in the Bakonyalja forestry landscape the production of willow is not the proper idea,
- Due to the strongly basic pH other tree types (Siberian elm, oleaster, hackberry, false indigo, ailanthus, etc.) cannot be excluded either (based on the results of former forestry experiment research related to red mud);
- The established plantation network provides continuous cover and for the local farmers work, moreover it intensifies natural re-cultivation significantly;
- The main problem would be the basic pH, however, it is going to be diluted continuously thanks to the precipitation until spring and it would be near the original pH value. Recommended tree species have already proved themselves (sewage poplars, re-cultivation plantations, etc.);
- In the contaminated areas the restart of soil life will be required that could be triggered by either installing soil bacteria suspension or matured organic manure in the usual 40-50 t/ha quantity. Of course, numerous other natural material like alginite could be used successfully.

Knowing the wonderful world of our soils and their highly organized ecological system we believe in its renewing capacity!

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Possibilities of Phyto-Remediation on the Example of Leachate Treatment

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Keywords: phyto-remediation, leachate, biodegradation, communal waste

ABSTRACT

Leachate formed in communal waste depositories has high organic matter content and are contaminated by heavy metals. It is collected in storage ponds and poured back onto the depository at most sites. This is no long-term solution apart from presenting risk to the environment. Removal of the organic matter in sewage treatment plants is very expensive, the best way for this is phyto-remediation applying plants. In the course of this the most suitable plants incorporate pollutants into their body as nutrient removing them from the polluted water or soil. There are plants that can be utilised for energy purposes as well apart from their cleaning effect. Therefore it seems sensible to clean and utilise by such plants those areas that were contaminated by the red mud.

The presented technology is under patent-process (P 07 00100), the pilot model is on view at the Harkai street waste disposal site in Sopron.

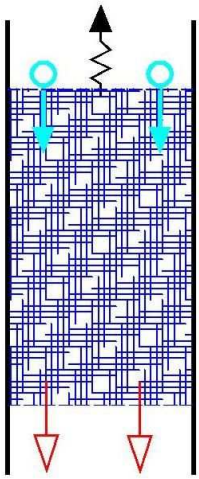
INTRODUCTION

Phyto-remediation means the cleaning of the environment from pollutants by crops. Our procedure is based on this mechanism as it solves the collection and treatment of leachate flowing from and seeping through the surface of communal waste depositories by natural-like, aesthetic eco-engineering technology. We chose the application of wetlands built onto water treatment. For this the water budget of the related area was determined and based on this the wetland was measured out. The technology is based on a solution in which ecosystem members utilize in co-operation the treatment of the water containing decomposable organic matter from the waste depository primarily by utilizing micro-biological processes based on aerobe/anoxic biodegradation and associated plant processes. The water of the wetland and the balance of the ecosystem were monitored for 3 years following the design and realization of the technology and this validated the parameters of the planned technology and verified the innovative eco-engineering tool currently not so widespread in Hungary.

TERM, FORMATION, TREATMENT POSSIBILITIES OF LEACHATE

Leachate is sewage the contaminants of which originate from waste disposal at a waste disposal site defined by a separate regulation (KvVm decree 28/2004. (XII. 25.) chapter 35.). Quantity and contaminant load of this leaching water have to be kept at such a low level by appropriate measures during the operation of the site as possible based on the best technology available. The decree identifies limit values and requirements against the quality of the water in case it would be released into surface waters or into the drainage system.

Leachate produced on communal waste depositories cannot meet the requirements of the decree or there are no appropriate surface waters near the sites or establishment of the drainage network is difficult.



	Aerobic decomposition	Anaerobic decomposition	Bleaching
Requirements	presence of oxygen, moisture	lack of oxygen, high water content	precipitation, pervious top layer
Reactions	oxidation, nitrification	reduction, denitrification	dissolution, ion replacement
Temperature	50–70 °C	35-50 °C	
Consequences	mineralization, sponge structure	consolidation, more solid structure	dissolution, bleaching, filtration capacity increases
Products	oxidation products, CO_2, H_2O	organic acids, CH_4, CO_2, NH_2, H_2S leachate	leachate

Figure 1: Processes within the waste

Annual water budget of the leachate reservoir is determined by the amount of precipitation falling onto the surface of the reservoir and the precipitation seeping through the disposed waste (leachate). Regarding the annual precipitation conditions of the country, the precipitation falling onto the surface of the reservoir – and a part of the leachate forming in drier areas – evaporates. Annual quantity of leachate (mm) varies between 10% and 25% of the annual precipitation (m^3/ha/year) depending on the coverage on the disposal site. During the decay of the disposed waste material so called disposal gas is produced by bacteria. These bacteria utilize leachate water in insignificant amount compared to the amount of forming leachate. The amount of excess water can be reduced by covering the depository, irrigating back, carrying away or cleaning the leachate.

ANALYSING THE SITUATION

Precipitation falling onto the surface of waste depositories dissolves various organic and inorganic matters. In the case of most depositories these are collected, however, at places – where natural filtration basement is present – they are released. In the regional waste management system that is currently under formation according to European requirements all waste depositories to be built will be insulated thus leachate will be accumulated.

Rolling back leachate gives no solution in the long-term as the contaminant content of water accumulates via the long years reaching a level that would threaten the consolidation and stability of the disposal site and in critical cases – e.g. during great rain – a possible spill would present critical risk to the environment. Cleaning leachate therefore is essential. Currently no disposal sites apply on site leachate cleaning in Hungary.

The treatment of leachate is made difficult by their variable discharge (showing no tendencies in either space or time) and by their even more variable chemical composition. The situation is made even more difficult by their high heavy metal and salt content and the presence of organic micro-contaminants; the basic potential toxicity. Leachate is more concentrated in composition even than sewage and sewage sludge.

RECOMMENDATION

The technology is based on the idea that the simplest and cheapest way of reducing high organic matter content is transforming them in a natural way based on ecological processes by plants. High salt and heavy metal content can be best disposed by water plants. For the reduction of cleaned leachate certain tree types of great water and nutrient demand are most suitable using their transpiration capacity and the water demand of their fostering soil as well. In the course of phytoremediation higher order plants with the help of the microbes associated with them clean the soil, the underground water, surface water or industrial sewage from inorganic and organic chemical contaminants. The anterior constituent of the term originates from the Greek “fito” word for ‘plant’. The term ‘remediation’ means the reparation, recovering, restoring of the given medium based on the Latin term “remedium” (medicine, healing). This term is used for reducing the concentration of chemical compounds contaminating the environment to such low value, the biological risk of which is acceptable.

One of the focused research field of our Co-operational Research Centre (KKK Nonprofit Ltd.) is the cleaning of leachate formed on communal waste disposal sites. In the course of our research we came to the conclusion that the physical and chemical technologies used widespread for the handling of the present problem would be too expensive (coagulation of organic matter) and would produce side products (sewage sludge, precipitate qualified as dangerous waste). Furthermore, they would not solve the problem of disposing the treated leachate. Therefore in our opinion, the problem could be solved by a two-step combined close-to-natural technology. Following a facultative pre-treatment in a lake, the leachate in the first step is cleaned in a pond planted with wetland vegetation by the plants and the micro-organisms stick on their surface. In the second step, the treated leachate is dehydrated by an energy plantation of water and nutrient consuming poplar-willow planted for this purpose.

Greatest advantage of the technology is that it solves the treatment and disposal of leachate in a way that presents no risk to the environment while producing a secondary raw-material at the site of the waste depository. A further advantage is presented by the low cost of the instalment of the system and by the fact that it can be adjusted to local conditions. Its specific energy demand is small and causes no pollution to the environment. The sludge developing in the facultative pond and the vegetation of the built wetland can be utilized by composting while the biomass of the energy plantation can be the source of producing fuel.

PRESENTING THE TECHNOLOGY

First unit of the system is the pond planted by a wetland ecosystem and insulated by foil. One characteristic feature of close-to-natural water cleaning technologies is long presence time, providing this is essential for successful treatment. Imitating natural wetland ecosystems the water level of the ponds can be controlled. Providing a slow flow around the dam designed appropriately ensures the demands (fluctuating water level, water depth, appropriate adhesion

surface, etc.) of various life forms (free floating, submerged and rooted, macro-phytons elevating from the water) living in the built wetland together with longer presence time.

The treated leachate is disposed in a Carolina poplar and willow plantation planted especially for this purpose. These species has relatively large water and nutrient demand therefore they clean further the water filtrating into the soil, however, the majority of the water is transpirated by them or incorporated into their body. It is practical to irrigate the plantation continuously in energy saving mode: gravitationally. Quantity of irrigation water has to be calculated taking into consideration the physical, chemical and water supply conditions of the soil together with the amount of annual precipitation and the water demand of the wood. Catching excess water can be solved by a collection ditch around the plantation.

Alterations to the groundwater can be observed by a monitoring well network. The technology is limited to the growing season; the leachate depending on its dissolved salt content (and of course its temperature) freezes in winter. In a pond with the appropriate size, however, the annual leachate quantity can be desiccated. Cleaning effectiveness of the facultative pond providing the pre-treatment is greatly dependent on the temperature of the water (critical temperature: below +16 °C). When planning the size of the system winter conditions has to be considered, namely due to the low temperature biological processes may not proceed or only very slowly proceed; however, much less leachate is produced (it becomes frozen) and use storage possibilities (storage ponds). Achievable cleaning efficiency in the growing season is between 80 % and 95 %. Leachate cleaned in such efficiency can be safely disposed in the energy plantation.

INVESTIGATIONS

Close-to-natural technologies start to operate 1-1.5 years after installation; i.e. when a stable system develops between the plants and the soil. The energy plantation (2500m^2) composed of one year old rooted shoots was completed in the spring of 2006 and the wetland pond was also installed at that time (1100m^2 in total). Therefore investigations were started ideally in spring 2007.

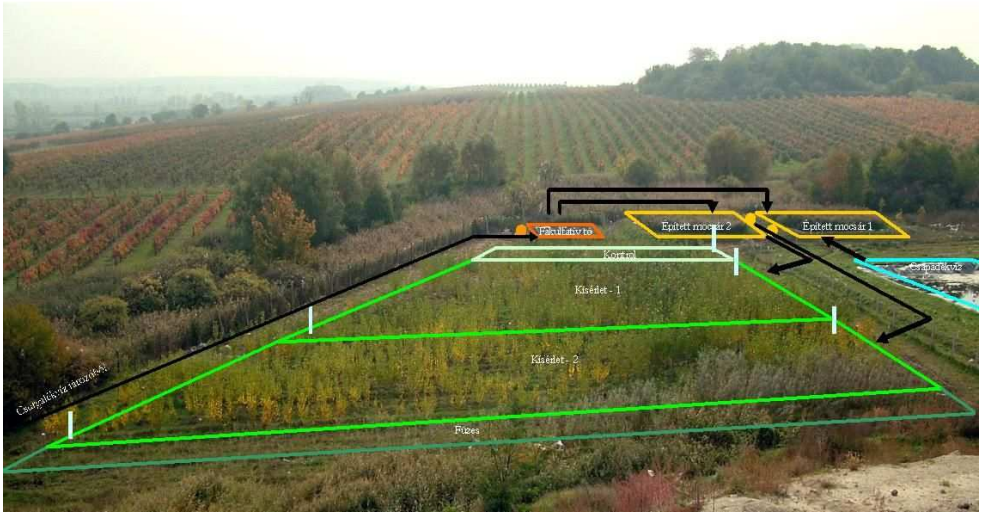


Figure 2: Spatial distribution of the experimental site

In the water-soil-plant complex descirbed above we examined the share of each component in cleaning and evaporation. Samples were taken 5 times from the same spots during the growing season.

Two types of leachate, undiluted and diluted to 50% were investigated in two separate ponds. Plants planted in the ponds and the technical parameters of the ponds were exactly the same. Those parameters of the water inflowing into and outflowing from the ponds that are prescribed in the regulations (KÖM-EÜM-FVM-KHVM joint decree 10/2000 (VI.2.)) and by inspection the health condition of the plants were investigated.

RESULTS OF INVESTIGATIONS

Water investigations from the water of the system were performed on samples taken from 5 spots (leachate – after facultative pre-treatment – after the concentrated pond – after the pond diluted by precipitation water - precipitation) and from the 5 monitoring wells (1 from the control parcel of the energy plantation and 2 each from the experiment parcels irrigated by water of different concentration).

In order to identify the accumulation rate of the plant samples from leaf and shoot taken from the plants of the energy plantation at the beginning and at the end of the growing season were investigated. We have been unable to identify changes yet from the investigation results. Based on inspection the plantation seems to be healthy showing no signs of toxication at all.
In conclusion it can be stated that negative effects of the leachate on the vegetation were not detected either in the wetlands or in the energy plantation. The cleaning mechanism operates efficiently, the treated water can be released into the sewage network or into the soil, however, it cannot be released into surface water yet. Based on the results of irrigation by waters of two different concentrations no significant differences were observed. Therefore future experiments will be operated by concentrated leachate only with connecting the ponds in series in order to increase cleaning efficiency.

CONCLUSIONS RELATED TO RED MUD

To peel off the upper soil over enormous areas even in a few cm thickness using soil replacement – is not realistic. It can be seen based on the above that there are certain plants that are most capable to clean contaminated areas, furthermore, in certain cases application of plant systems is the only sensible and economic way.

Carefully selected plant species rapidly overgrow contaminated soil thickness enabling survival by their roots penetrating deeper than contamination. They adsorb contaminants in their body, mainly in their roots and in smaller ratio in their stalk above the surface.

In our opinion with (energy) willow planted in flood-plain areas contaminated by red mud and with sunflower and rape planted in contaminated agricultural areas the upper soil layer could be cleaned successfully and economically. Plants could be utilized by firing or by producing bio-diesel providing in this way financial income from the agricultural areas even in the few years required for the cleaning of the soil.

Section 6
Topics for Environment and Climate Protection

Introduction of the Wuppertal Institute

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Keywords: sustainability research, Wuppertal Institute

ABSTRACT

The Wuppertal Institute's research findings are used to provide policy advice to decision-makers in politics, industry and society at international, federal and state level. Its application-oriented research is designed to help solving the problems of modern societies. Researchers of the Wuppertal Institute map out scenarios showing coherent paths to solutions and initiate constructive dialogues with stakeholders. The Wuppertal Institute is thus an important mediator between science and practice.

MISSION

The Wuppertal Institute engages in applied sustainability research. Its central focus is ecology and its relation to economy and society. The scientists working at the Institute research and develop models, strategies and instruments for sustainable development at regional, national and international levels. Central aspects of sustainability are "global balance" and "conservation and protection", guided by the principle that life on Earth should meet the requirements of those who inhabit the planet today without endangering the chances for future generations. We must therefore treat our planet and its resources with utmost care. Conceiving strategies for sustainable development requires an integrated approach both to policy and to scientific research. Our aim to live and work in a way that conserves resources often raises questions that cannot be answered by one area of policy alone or by a single scientific discipline. Our interdisciplinary research teams bring together the expertise of scientists, social scientists and economists as well as geographers and spatial planners, engineers, philosophers and historians.

SCIENCE COMPANY WUPPERTAL INSTITUTE

The Wuppertal Institute for Climate, Environment and Energy has its headquarter in North-Rhine Westphalia (NRW). It was founded in 1990 by the then state premier Johannes Rau, and work began at the Institute one year later. In 2004 the Institute opened a Berlin office with the aim of intensifying communication with its partners and clients in the German capital. In 2005, the Wuppertal Institute and the United Nations Environment Programme jointly founded the UNEP/Wuppertal Institute Collaborating Centre on Sustainable Consumption and Production (CSCP) in Wuppertal.

Professor Peter Hennicke was head of the Institute from 1st November 2000 until the end of January 2008. Until the appointment of Professor Schneidewind, as from March 2010, the Vice President, Professor Manfred Fischedick provisionally lead the Institute's research. The Business Manager is Brigitte Mutert-Breidbach.

The Wuppertal Institute has the legal status of a non-profit limited company (gemeinnützige Gesellschaft mit beschränkter Haftung, according to German law) and receives basic funding from the Land North Rhine-Westphalia. It is in the responsibility of the Ministry for Innovation, Science, Research and Technology of the Land North Rhine-Westphalia. Third-party funding supports most of the Institute's budget and projects.

The Wuppertal Institute's staff numbers approximately 170. Most of them are research staff and come from a wide variety of scientific disciplines: natural and environmental sciences, geography, systems sciences, engineering, planning, law, economics, political and social science.

PHILOSOPHY OF WUPPERTAL INSTITUTES SCIENTIFIC POLICY ADVICE FOR EUROPE AND THE WORLD

The Wuppertal Institute provides the scientific basis for sustainability policy and explores the options open to policy-makers in Germany and the EU and to the signatories of international agreements. The Wuppertal Institute thus forms a bridge between science and policy. Our researchers use their scientific know-how to help policy-makers choose suitable instruments for sustainable environmental, social and economic policies and to find ways of implementing them.
Policy advice is always about answering specific questions. For example: How to design a resource efficiency programme to make it sustainable? Once they have received a research assignment the researchers at the Wuppertal Institute map out scenarios, identify political management instruments and think about how to create positive incentive structures. The Wuppertal Institute evaluates the possible effects of political decisions from a scientific point of view. What ecological effects will particular instruments and measures have? What costs will be involved? And what will be the social implications? The Wuppertal Institute's scenarios and studies make the consequences of political action transparent and thus calculable.

RESEARCH TOPICS AND ORGANISATION

The Wuppertal Institute consists of four research groups.

- RESEARCH GROUP 1: Future Energy and Mobility Structures: Researchers here examine questions of technology and infrastructure, taking a systems analysis approach. In the fields of energy and mobility they explore what technical and social innovations will facilitate the transition to sustainable structures, what implications this process has and what chances it offers. Alongside dynamic potential analyses they seek to evaluate technology with a view to finding coherent paths of development.
- RESEARCH GROUP 2: Energy, Transport and Climate Policy: This research group focuses on strategies and instruments for effective and integrated energy, transport and climate policies at local, regional, national and international levels. A central theme is the synergy effects of policy strategies that support the sustainable development of energy and transport systems as well as climate protection generally. Policy instruments in the field of energy end-use efficiency are a further focus.
- RESEARCH GROUP 3: Material Flows and Resource Management. Researchers in this group investigate material flows from extraction of raw materials through to final disposal, taking account of the global "ecological rucksack" model as well as the land-use involved. They develop concepts, strategies and instruments to improve resource productivity and sustainable resource management from the regional and sectoral levels to the international level.

- RESEARCH GROUP 4: Sustainable Production and Consumption. This research group develops instruments, concepts and strategies to promote the transition to more sustainable patterns of production and consumption. Research centres on the development and market launch of products considered sustainable in terms of their entire life cycle as well as production processes optimised right the way along the added value chain.

The Wuppertal Institute is also well integrated in the international scientific community. Many guest researchers from around the world spend time at the Institute, bringing new insights to the Institute's own research groups and making intercultural dialogue part of its daily business. Since 2005 the Institute has also been running a programme to support doctoral students receiving many enquiries from other parts of Germany and from abroad. In co-operation with renowned universities the Institute is thus promoting a new generation of scientists and strengthening its academic standing.

INTERNATIONAL ACTIVITIES

Because the impact of climate change is felt all over the World, strategies for saving planet Earth must be conceived, designed and implemented globally. Moreover, time is running short, if we are to keep global warming within tolerable limits. Sustainability research and research into the impact of climate change are therefore organised internationally. Individual institutes pool their resources in research consortiums in order to come up with an adequate response to these global challenges as quickly as reasonably possible. The Wuppertal Institute is a recognised member of the international science community and is closely networked with it. Our researchers take on demanding and extensive assignments in major EU and UN projects.

Alongside its work on specific projects the Wuppertal Institute also engages in long-term cooperation and academic exchange with national and international universities and research institutions. It is, for example, involved in cooperation projects with the university and the Centre for Environment and Energy Research and Studies (CEERS) in Tehran to create a sustainable energy system. It also cooperates regularly on projects with the Japanese Institute for Global Environmental Strategies (IGES) and The Energy and Resources Institute (TERI) in India.

RESEARCH PARTNERSHIPS WITH THE INDUSTRY

Ever since it was founded the Wuppertal Institute has been successfully collaborating with economic actors. The Institute provides advice to small and medium-sized companies as well as global players. Researchers always maintain an independent position, bringing their research findings into collaborative projects and providing their clients with customised methods and instruments for achieving sustainability goals in daily practice. In addition the client benefits from the researchers' national and international scientific networks.

Companies bear responsibility for their products and production conditions. Nowadays production is usually organised on a global scale, so sustainability management must embrace manufacturing facilities and suppliers all over the world as well as the entire product cycle from the extraction of raw materials to waste disposal. Companies that produce in a sustainable manner are rewarded with a positive image and commercial success. The Wuppertal Institute maps out paths to achieve these goals. It initiates dialogues with stakeholders, together with suppliers and clients, develops innovative management strategies, customised instruments and branch-specific solutions for global sustainability management.

Innovative technologies and materials open up new areas of business. It usually takes a high level of investment to develop these, however, along with a good deal of patience and staying power. But once the breakthrough has been achieved, sustainability can unfold its full economic power. For then eco-efficient products and services can conquer the domestic market, create jobs and reduce production costs. And, on top of that, innovations can become export “hits”. In joint projects with partners from industry the Wuppertal Institute investigates how to accelerate and facilitate the market launch of eco-efficient technologies and renewables. Research focuses on nano- and biotechnology as well as renewable energy and hydrogen as fuels of the future.

Scientific Advice to the Project "Sustainable Development" of the Autostadt: The project aims at the conception of an interactive and target group specific exhibition about the subject area sustainability. In two phases the Wuppertal Institute provides academic support and monitors the development of a content-related exhibition concept in the sectors of sustainable consumption, sustainable mobility as well as the ecological and social consequences of resource consumption and climate change. In the first phase, two workshops have been held to provide an academic foundation for the concept and to develop exhibits for the following sectors:

- Sustainable consumption including the exhibits "Data-sculpture virtual water", "Ecological Rucksack", "Ecological Footprint";
- Sustainable mobility including the exhibits "Data-sculpture mobility", "Utopia check mobility";
- Consequences of climate change including the exhibits "Data-sculpture climate change", "Multi-media wall of climate interaction".

Perspectives of local infrastructures in the context of competition, climate change and quality of service (INFRAFUTUR): Over the past years, conditions for municipal companies active in the fields of energy, water, sewage, waste and public transport changed in a fundamental way. Both, liberalisation of EU and national competition legislation and the poor financial situation of the municipalities put companies under pressure. They have to face stronger competition while, at the same time, they have to fulfil their tasks of providing public service for improved quality of life in the cities and contributing to the mitigation of climate change. Which perspectives for sustainable public service can be developed in this context? This is the objective of the research partnership between 13 municipal companies of the supply, sewage, and waste sectors with the Wuppertal Institute, the association of municipal companies (vku) and the vku's working group for rational use of energy and water (asew). Studies are to provide scientific support to the partners in preparing strategies and measures for the sustainable development of their local infrastructures. This concerns business areas of energy supply, water supply and sewage, as well as domestic waste treatment and recycling of consumer goods. An eco-efficient and quality-focussed paths for development has to be drafted, harnessing the comparative strengths of local infrastructures in the competition. This must be closely tied to the objectives of regional development (e.g. those related to quality of life, attractiveness for business, regional labour market).

SELECTED FURTHER RESEARCH FIELDS

ENERGY AND RESOURCE EFFICIENCY

This new concept changed our view of the World and ushered in a change of paradigm. Whereas previously most people had associated environmental protection with doing without and with constraints on their lifestyle, the Wuppertal Institute now espoused a broader mode of environmental thinking, introducing a new focus on efficient use of resources. Peter Hennicke, president of the Wuppertal Institute for many years and an internationally respected scientist, identified energy as the key resource for global climate protection and sustainable development. He showed early on that consumption of fossil fuels would have to be reduced if renewable energies were to become marketable alternatives. In other words, energy efficiency is the intelligent way forward for climate-friendly renewables. What is more, this concept can be applied to the entire spectrum of resource efficiency. For companies it is an ideal way to reduce costs and to bring about rationalisation in a period of rising energy and commodity prices.

Studies on resource efficiency are a further important branch of research at the Wuppertal Institute. Inspired by the conviction that raising energy and material efficiency are ecologically essential, technically feasible and make socio-economic sense, the Institute's researchers are analysing "material flows". This is a way of measuring the volume of raw materials we consume for each product we make, use and dispose of, what volume of waste and emissions we leave behind, and how much energy and land we use up in the process.

Our research teams are continually questioning their own findings and working to improve their knowledge and skills. As a "learning" research facility the Wuppertal Institute has established numerous procedures for quality management and is continually bringing its knowledge up to date via intensive exchanges with research partners all over the World.

SUSTAINABILITY IN A GLOBALISED WORLD

Applied sustainability research and the viable instruments it offers for decoupling the use of natural resources from prosperity are today more in demand than ever before. Since the World Summit on Sustainable Development, held in Johannesburg in September 2002, sustainable production and consumption have risen to the top of the international community's agenda – an agenda in the setting of which the Wuppertal Institute plays an active role. Researchers at the Wuppertal Institute pursue unconventional lines of thought, thus opening perspectives from which alternative options can evolve. This casts the Wuppertal Institute in the role of a "think tank producing responsible knowledge for the future", as the Institute's founder Johannes Rau once put it, alluding to its unique capacity to solve problems.

Researchers at the Wuppertal Institute are devising strategies for a climate protection policy for the future. Their point of reference is the Kyoto protocol, which came into force on 16th February 2005 and for the first time committed its signatories (the industrialised states) in a legally binding way to limiting their emissions of greenhouse gases. "Kyoto Plus" embraces a number of different dimensions: perpetuating the Kyoto protocol beyond 2012, for which the Wuppertal Institute is providing scientific support; implementing concrete measures for emission reductions (mainly carbon dioxide, CO_2) at national and European level; and strengthening "renewables", in other words, making the utilisation of renewable energy sources commercially viable.

SELECTED FURTHER RESEARCH PROJECTS

The Consequences of Using Biomass

Biomass is a renewable resource that can be used as food, raw material or fuel. But it also has drawbacks. Cultivating plants for energy purposes means increasing the amount of land devoted to agriculture, often at the expense of natural eco-systems, of savannah, grazing land and forests. A number of projects are analysing both the potential of biomass and the ecological, economic and social conflicts that using biomass may engender. On this basis we will propose concepts for an incentive based political funding structure and, where necessary, suggest how false incentives might be corrected.

Climate Risks and Chances in the Finance Sector

Global climate change also presents a major challenge for the finance sector. Climate change causes harm running into billions of Euros, threatening the value of investments and companies. If we manage to respond to this situation quickly and comprehensively, we will have a chance not only to ensure effective climate protection but also added social and economic value. We aim to develop instruments, processes and methods that give climate change and climate protection a firm place in the calculations of financial analysts, fund managers, insurers and investors.

Sustainable Germany in a Globalised World

Friends of the Earth Germany, Evangelischer Entwicklungsdienst (the Church Development Service) and Brot für die Welt (Bread for the World) launched a campaign in 2008 to stimulate public discussion of globally sustainable development. To ensure thorough preparation for such an initiative, the Wuppertal Institute was commissioned to outline a book project, the study ”Sustainable Germany in a Globalised World“. The challenges were to evaluate progress in sustainability in Germany, to outline German and European responsibility in the emerging world society, to link the domestic social agenda to the environmental agenda and to provide a civil society perspective on sustainability now that climate concerns have entered the mainstream debate. The project was highly interdisciplinary. Its findings were published in a 656-page book in October 2008.

Hychain-Minitrans

In four regions of Europe small, lightweight vehicles are being used to demonstrate innovative fuel cell technology and test its suitability for everyday use. This project involves 25 research institutes all over Europe. The aim of the project is to optimise the prototypes for commercial use and to construct hydrogen logistics systems. Within this European research network the Wuppertal Institute has been assigned the task of carrying out a socio-economic and ecological evaluation of the technologies and infrastructures and of their commercial potential. Its findings will be used to derive conclusions for research and energy policy.

FIRTST IDEAS FOR POSSIBLE CONTENT FOR TEACHING AND RESEARCH FIELDS IN HUNGARY

- Low Carbon Mitigation strategies (overview on relevant technologies their characteristics and potentials etc.)
- Low Carbon Mitigation Pathways (energy and climate protection scenarios:
- Methodological background for scenario analysis, system behaviour and interdependencies, social and cultural impacts)
- Integrative (dynamic) technology assessment (LCA-methodologies, net import/ export balances, ecological backpack/footprint)
- Energy and climate concepts (local and regional level)
- Energy, Climate and Resource policy instruments (overview of options, experience, advantages, disadvantages)
- Dynamic market development (promising future technologies) and sustainable entrepreneurship
- Technology scouting
- Resource flow and land-use balances/management

SUMMARY

Ever since it was founded the Wuppertal Institute has been building unique competencies in applied sustainability research. Our inter-disciplinary approach, our links with actors from practice and our wealth of experience make our researchers highly sought-after partners in national and international networks, research associations and project consortiums. The Wuppertal Institute regards itself as an independent research enterprise that works flexibly with a great variety of partners in science.
For many years now the Wuppertal Institute has been collaborating successfully with partners in politics, industry and society. Its close contacts with actors and practice are a special qualification that it brings to the research consortiums and that complements its fundamental research. These special qualities make it the ideal organisation to conduct scientifically sound feasibility studies and to develop instruments to translate research findings into policy and management. With its wealth of experience in coordinating and managing work within the consortiums the Wuppertal Institute can always guarantee professional project management.

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Renewable Energy Clusters (through the example of the Archenerg Cluster)

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ABSTRACT

Clusters are geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated organisations in a particular field linked by commonalities and complementarities. There is competition as well as cooperation.

WHAT IS A CLUSTER?

A cluster is such a group of enterprises and institutions that depend on each other mutually co-operate and compete with each other at the same time. They are concentrated in one or more region; they are specialized in one determined field of economy and bound together by common technologies and capacities.

The cooperation provided by a cluster is really important as the economic competition is getting more and more severe and the growing interest of customers can be observed as well. The demand on new solutions shows an upward tendency and the work of researchers and innovators is considerable. In the course of economic competition, the concentration of capital and knowledge takes place and the lack of the required response results in the shortfall of small and medium sized enterprises.

Consequently, those SMSs and institutions are interested in clusterisation that have no significant capital but they are innovative and willing to give up a part of their sovereignty in order to create a greater value-added product or service in co-operation with other enterprises. This would result in real competitive advantage in long-term.

SHORT HISTORY

The ArchEnerg Cluster was established on 21st March 2007 with the aim of creating an economic and social model based on renewable energy sources and energy awareness that carries ahead the enterprises in green economy and the society towards a more sustainable future.

The ArchEnerg Regional Renewable Energy and Building Trade Cluster won the certificate of „Accredited Innovation Cluster" on 28th November 2008. As a result of the continuous increase and development, the Cluster was re-accredited in 2009. The membership of the Cluster mostly consists of small and medium sized enterprises.

ACTIVITIES AND RESULTS

During the 3 years operation of the Cluster, it has developed an extensive activity network. Its primary task is the strengthening of cluster members and strategic industrial sectors. This includes infrastructure development, lobbying, market and demand generation.
The Cluster is active on other fields as well, it has organised two successful professional conferences (REMEK'08 and RE¬MEK'09). In relation to this, it aims to form the attitude of people regarding renewable energy as well, thus the Cluster promotes energy aware life style on different expos and family programmes, for example Earth Day.

International business relations play also a crucial role in the life of the ArchEnerg Cluster. The central office in Szeged is favourable in terms of cross-border co-operations (DKMT Euro region). On the basis of this advantage, the Cluster is looking for cooperation opportunities on both sides of the border. The already existing business relations are capitalized by grants co-ordinated directly from Brussels (e.g.: Cross-border Co-operation Programme 2007-2013).

The Cluster works on regional pilot projects too. A tangible example for this is a pyrolysis initiative for energy recovery from waste that is realized within the framework of the Economic Development Operational Programme (EDOP). This would present a good example for a more environmental friendly way of elimination of communal waste. A 1MW capacity solar farm is under planning in Szeged district which would be the largest photovoltaic power plant in Hungary, according to the present conditions.

Complex services of the ArchEnerg Cluster
- Generation of projects
- Cluster marketing
- Searching for financial solutions
- Tender watch, Partner search
- Demand assessment
- Organization of professional courses, presentations, lectures

Services provided by the members of the ArchEnerg Cluster
- Solar energy utilization: installation of photovoltaic and solar systems for the production of domestic hot water including water needed for the heating system or for producing domestic solar electricity
- Geothermal energy utilization: installation of heat pump systems
- Biomass utilization: compact biomass utilization (furnace, wood, brick, pellet), planning and building of plants based on biogas
- Prefabricated and passive houses: planning and implementation of energy efficient houses
- Building industry, engineering: planning, implementation, heat insulation, renovation
- Consulting, preparing feasibility studies, organizing audits, tender consultations

Results of Experiments Related to Stump Lifting

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Keywords: stump lifting, stump harvesting, power needed for stump extraction, machine development, bioenergy

ABSTRACT

In cutting areas soil preparation is necessary occasionally before reforestation. The aim of the action is a land-use planning that enables the performing of further measures without problems. Removal, collection and transportation of stumps from the soil are part of this. Issues related to climate change and the shortcoming of fossil energy resources call attention to increasing the rate of renewable energy resources. Using stumps removed from the soil as fuel is a significant resource within the biomass potential. For lifting a part of the stump and the roots generally a special holding device mounted on a bagger is used. Utilization of the lifted stumps for energy purposes increases worldwide (especially in the Scandinavian countries) (KÄRHÄ, K., AND MUTIKAINEN, A. 2009). In order to rationalize the work operation of stump lifting time analyses have been carried out (LAITIKA, J., RANTA, T. AND ASIKAINEN, A. 2008). Results of Hungarian experiments are presented below.

INTRODUCTION

As a long-term aim the European Union determines 20 percentage of renewable energies in the total energy consumption for the member states. Various directives and measures related to climate protection put issues related to the effective utilization of resources forward. The renewable energy utilization action plan of Hungary sets the effective utilization of the biomass potential as an important target. According to certain calculations the total biomass reserve of Hungary is around 350-360 million tons the majority of which is based on wood. Utilization of forestry side products for energy purposes means additional income, improving profitability. These serve also regional political goals offering development possibilities for underdeveloped regions. Technological and technical development of wood based biomass production may influence significantly the change of the theoretical potential. Detailed analysis of the effects and mechanization development are important research fields.

In Hungary stump excavation is carried out in greater continuous areas in the Great Hungarian Plain prior to reforestation with complete soil preparation. The Kiskunság Forestry and Timber Industrial cInc. carries out stump excavation over an average area of 700-800 hectares per year of naturally non renewable woodlands. For this stumping machines lifting by grabbing the stumps are used currently. In the course of our research the theoretical background of stump lifting has been studied.

EXPERIMENTAL METHODS

Lifting stumps left in the soil is one of the most energy demanding task. Due to the great weight below the cut plane, the branching roots and the various soil heaviness the power required for stumping was estimated by SZEPESI (1966) to several hundred thousand Newtons.

At the beginning of the 1970s PIRKHOFFER (1974) carried out measurements in order to determine the power input for stumping using the lifting forked stumping machines widespread at that time. He set a hydraulic power measurer into one branch of the rope system of the winch moving the lifting fork that closes an angle of 30° with the horizontal. His results revealed that the extracting power increased exponentially with the diameter of the stump. This was the consequence of the significant horizontal power component that occurred when the stump was lifted.

Stumping technology applied today, however, differs significantly from the above (Horváth B. 2003). The power required by this method has not been investigated yet. No data were found in the literature considering the magnitude of vertical stumping power. We performed measurements on a hydraulic grabbing stumping machine used nowadays during operation in the case of various tree types. Pressure values for the lifting of the jib during the lifting were measured and recorded by a pressure measurer device connected to the hydraulic system of the stumping machine. After this the extracting power in vertical direction was determined based on the geometric size and mechanical characteristics of the machine. According to our investigations the stumping machine with one grab is capable to lift stumps of 40 cm diameter at the cut plain. In the case of diameters above this value several grabs or the cutting of the side roots are required for lifting. For the measurements tree types widespread in the Great Hungarian Plain (Scotch pine, robinia, poplar) were chosen as the removal of their stumps is required most often. Investigations were carried out in sand soils with 20% average production site water capacity. Soil compactness and moisture content were determined using a 3T System type soil compactness measuring device.

RESULTS AND DISCUSSION

Roughly the same time elapsed between the lifting of the given stumps and the cutting of the trees therefore this parameter was not indicated as a variable during the experiments. Diameter of the stumps at the cutting plain was measured with 1 cm accuracy while the extracting power related to them was determined with 100 N accuracy. Results are shown in Figure 1.

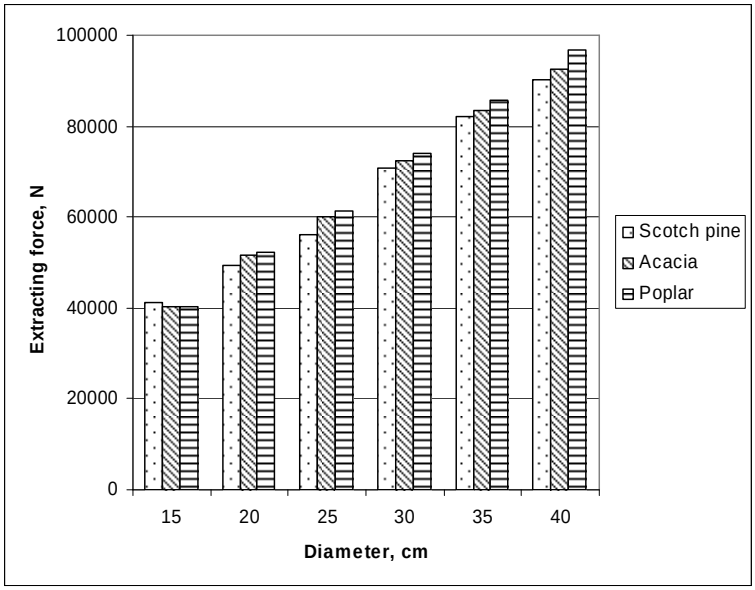

Figure 1: Magnitude of extraction power as a function of stump diameter at the cutting plain

Extracting power shown in Figure 1 was compared to the lifting fork data of Pirkhoffer published for Austrian oak, robinia and hornbeam (Figure 2). Based on Figure 2 it can be stated that the power required to extract stumps with diameter greater than 25 cm is significantly less when the grabbing stump extraction is applied than in the case of using the lifting fork. This can be explained by the lack of the so called bowl effect in the soil in the case of lifting the stump vertically as no horizontal forces occur (SITKEI GY. 2001).

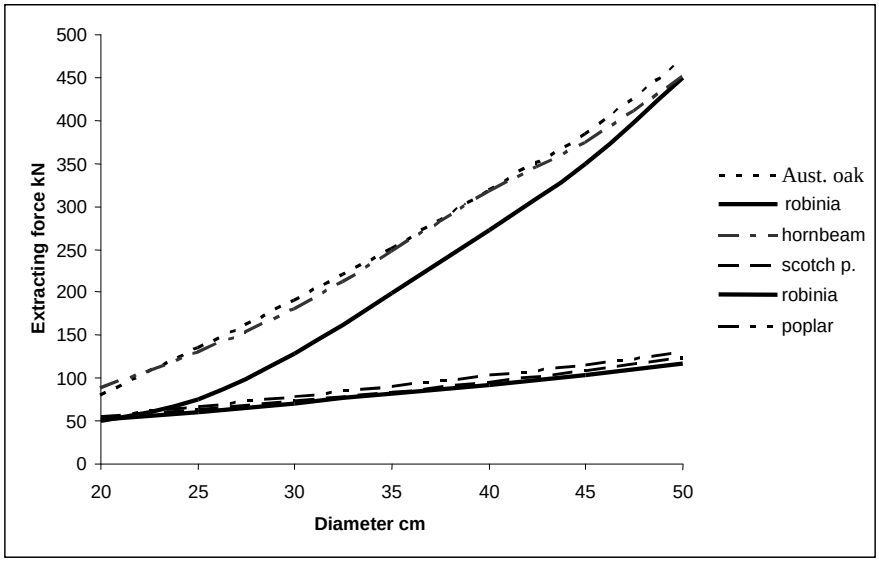

Figure 2 Comparison of extracting powers in the case of various methods

ed on the collected data and measurement results, correlations between stump diameter and extracting power were studied. More than 150 data were available for each tree type, however, standard deviation of these data was great occasionally (Figure 3). For easier statistic analysis moving average of 3-3 neighbouring data was calculated.

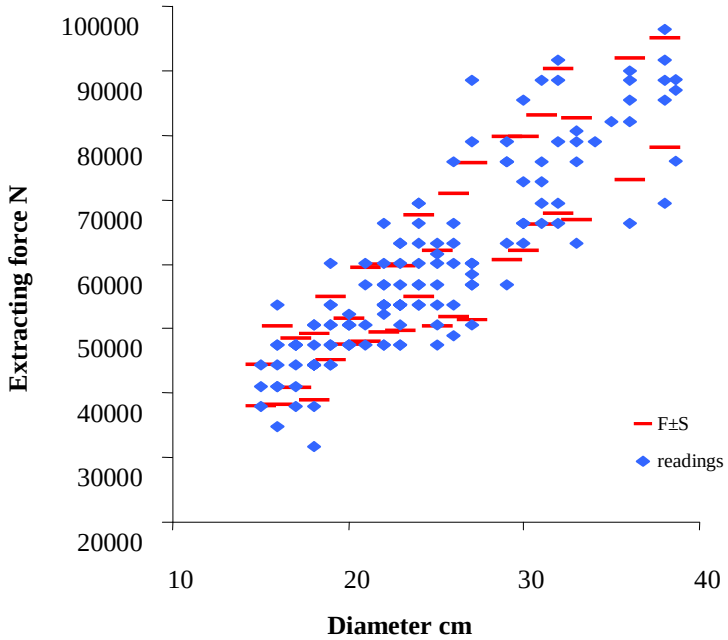

Figure 3 Measurement results

The regression function describing the correlation between the extraction power and stump diameter based on logical factors (e.g. fulfilment of the clauses that $f(0)=0$ and $\lim_{x\to+\infty} f(x)=+\infty$) and statistic factors (unfitting analysis e.g. with F-test, reliability analysis) we assumed to be like the following after determining several possible equations:

$$f(x)=a\cdot(x^b+e^{c\cdot x}-1), \tag{1}$$

where: x is stump diameter in cm;
f(x) is the power necessary for stump lifting in N;
a, b, c are unknown parameters yet to be determined.

The function fits on the measurement data best if the difference between the square extraction powers measured and calculated from the regression function is the smallest (*smallest squares principle*). Function (1) is a non linearizable function with two unknown parameters, the equation system composed of normal equations cannot be solved in an exact way therefore method of continual approaches has to be applied (CZUPY I. AND HORVÁTH-SZOVÁTI E. 2005). Such method of continual approaches is for example the *iteration procedure* performed by the *Taylor series expansion*. In the course of this, function (1) is approached linearly by Taylor series expansion. (A function can be written by linear approach only if the residue ε in the Taylor series keeps to zero. This is true if the secondary mixed partial derivates are equal. Function (1) fulfils this clause.)

First step of iteration: value of the unknown parameters is estimated: a_0, b_0 and c_0. Then the $f(x_i,a,b,c)$ function with three variables is solved by Taylor series expansion around the (x_i, a_0, b_0, c_0) place until the linear members:

$$\begin{aligned} f(x_i,a,b,c)=f(x_i,a_0,b_0,c_0)+f'_a(x_i,a_0,b_0,c_0)\cdot(a-a_0)+f'_b(x_i,a_0,b_0,c_0)\cdot(b-b_0)+\\ +f'_c(x_i,a_0,b_0,c_0)\cdot(c-c_0)+\varepsilon, \end{aligned} \tag{2}$$

where ε is the residue and i=1,2,…n (number of the measurement result).

Restructuring:

$$\begin{aligned} \hat{y}_{i_0}=f(x_i,a,b,c)-f(x_i,a_0,b_0,c_0)=f'_a(x_i,a_0,b_0,c_0)\cdot(a-a_0)+f'_b(x_i,a_0,b_0,c_0)\cdot(b-b_0)+\\ +f'_c(x_i,a_0,b_0,c_0)\cdot(c-c_0)+\varepsilon\ . \end{aligned} \tag{3}$$

This formula is placed for the sum of squares applied in the smallest squares principle and the minimum of the function with three variables obtained in this way is searched. Primary partial derivates according to a, b and c of the sum of squares to be minimized are equalled to zero (*normal equations*). Let us introduce the (4)-(6) matrix algebra indications where index 0 marks the vectors or matrixes related to the starting, estimated parameter values.

$$\bar{y}_0=\begin{pmatrix}\hat{y}_{1_0}\\ \hat{y}_{2_0}\\ \vdots\\ \hat{y}_{n_0}\end{pmatrix},\ Z_0=\begin{pmatrix} f'_a(x_1,a_0,b_0,c_0) & f'_b(x_1,a_0,b_0,c_0) & f'_c(x_1,a_0,b_0,c_0)\\ f'_a(x_2,a_0,b_0,c_0) & f'_b(x_2,a_0,b_0,c_0) & f'_c(x_2,a_0,b_0,c_0)\\ \vdots & \vdots & \vdots\\ f'_a(x_n,a_0,b_0,c_0) & f'_b(x_n,a_0,b_0,c_0) & f'_c(x_n,a_0,b_0,c_0)\end{pmatrix},\ \bar{x}_0=\begin{pmatrix}a-a_0\\ b-b_0\\ c-c_0\end{pmatrix}, \tag{4}-(6)$$

With these the normal equations can be written by matrix equations (7) in which Z^T is the transposed of matrix Z.

$$Z_0^T \cdot \bar{y}_0 = Z_0^T \cdot Z_0 \cdot \bar{x}_0, \quad (7)$$

From this multiplying from left by the inverse of the $Z_0^T \cdot Z_0$ matrix the difference of the real parameters and the starting values ($\bar{x}_0$) can be estimated as follows:

$$\bar{x}_0 = \left(Z_0^T \cdot Z_0\right)^{-1} \cdot Z_0^T \cdot \bar{y}_0, \quad (8)$$

Where T marks the transposed of the matrix, the (–1) exponent indicates the inverse of the matrix. With the appropriate coordinates of the obtained $\bar{x}_0$ vector the starting values of the parameters are modified and in this way the new refined values of parameters a_1, b_1 and c_1 are obtained.

Second step of iteration: the procedure is repeated using the new starting values (all vectors and matrixes have index 1):

$$\bar{x}_1 = \left(Z_1^T \cdot Z_1\right)^{-1} \cdot Z_1^T \cdot \bar{y}_1. \quad (9)$$

With the appropriate coordinates of vector $\bar{x}_1$ the starting values of the parameters are modified again. The iteration is continued until the parameters show striking convergence. The convergence of the method was proved by Hartley (1961). For analysing the 150 measurement data for each tree types the MAPLE computer algebra system was applied due to the complexity of the calculation. For the tree types the following extracting power – stump diameter functions were obtained:

Scotch pine:

$f(x) = 6541{,}6226 \cdot (x^{0{,}6369} + e^{0{,}041189 \cdot x} - 1)$; r^2=0.9987; mean standard deviation: 6317 N

Robinia:

$f(x) = 6288{,}8911 \cdot (x^{0{,}6526} + e^{0{,}038167 \cdot x} - 1)$; r^2=0.9985; mean standard deviation: 6041 N

Poplar:

$f(x) = 5432{,}1293 \cdot (x^{0{,}7399} + e^{0{,}038392 \cdot x} - 1)$; r^2=0.9978; mean standard deviation 5879 N

(x marks the diameter of the stump at the cutting plain in cm).

Based on the equations the vertical power required for lifting the stumps of the above tree types can be determined for any diameter. Based on the presented method the correlations can be determined easily in the case of different soil types or tree types as well.

CONCLUSIONS

Energy utilization of stumps extracted in cutting areas is expected to increase in Hungary in the near future. Power demand of removing the stumps left in the soil depends on the following factors according to our experiments:

- Method of stumping;
- Tree type (roots);
- Diameter of the stump;
- Time elapsed from the cutting of the tree;
- Soil type and
- Moisture content of the soil.

It can be stated that the power demand of the vertical stump lifting is the smallest among various stumping methods. Extracting power – stump diameter functions determined for the given tree types based on our experiments can be applied to select the appropriate power machine and determine the costs of the operations.

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Child Education and Environmental and Climate Protection

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Keywords: kindergarten teachers' training, environmental education, professional teachers' training, climate change

ABSTRACT

Environmental knowledge has a significant role in the trainings of the Benedek Elek Faculty of Pedagogy as developing environmental conscious behaviour interweave with our life from infancy to the end of our life. Trainings and courses of the Faculty of Pedagogy give a glance into the pedagogic approach to environmental protection and climate change.

INTRODUCTION

Development of loving the environment surrounding us starts as early as the childhood as part of bringing up children. Significance of environmental education, realization and development of the love of the environment is respected more-and-more in kindergarten pedagogy as well. This is the basis for the connection of the education module, unit mentioned in the title to the educational programme..

A BRIEF HISTORY OF THE FACULTY

The Kindergarten Association in Sopron, predecessor of the Benedek Elek Faculty of Pedagogy was opened in 1874 under the leadership of Vilma Petrik. The first kindergarten teachers' training was started in 1875. The association had two-year trainings and two kindergartens for the practical courses in 1879. Operation of the first kindergarten training institute was started parallel to the teachers' training school in the building of the Hospitaller Order in the academic year of 1899/1900. The building in which middle level kindergarten teachers' training was carried out was owned by the congregation of the monk women named after the saviour until nationalization.

The new higher education institute of Sopron, the kindergarten teachers' training college was opened in September 1959. From the 1989/1990 academic year students started learning according to a new college syllabus of six semesters. The college took up the name of Elek Benedek in 1991. The college was listed among the state higher educational institutes acknowledged by the Higher Educational Act as the Benedek Elek Pedagogy College. Since 1st January 2000 the institute training almost 2000 students has been operating as the Benedek Elek College Faculty of Pedagogy in the University of West Hungary that is comprised of seven faculties. From September 2006 the new name of the faculty is Benedek Elek Faculty of Pedagogy, University of West Hungary.

TRAININGS AT THE BENEDEK ELEK FACULTY OF PEDAGOGY

BACHELOR OF ARTS AGRICULTURAL TRAINER BA:

- Technical trainer BA
- Kindergarten teacher BA
- Kindergarten teacher – ethnic specialization BA
- Social educator BA
- Social studies BA
- Infant and child care BA

MASTER OF ARTS:

- Agricultural engineer teacher
- Engineer teacher

DOCTORAL SCHOOL

POST-SECONDARY VOCATIONAL EDUCATION:

- Infant and child care
- Press technician
- Practice teacher

Kindergarten teacher:

Aim of training: The aim of the training is realizing the syllabus targets prepared on the basis of the qualification requirements. As a result of training kindergarten teachers capable of modern and diverse kindergarten education diplomas are given to students capable of applying firm theoretical knowledge in variable conditions, having special knowledge in certain fields and capable of self-education and self-development.

Main part of the professional training:

- pedagogy and methodology of play,
- native and literature education and its methodology,
- mathematic education and its methodology,
- environmental education and its methodology,
- music education and its methodology,
- visual education and its methodology, physical training and its methodology

Ecology and environmental protection course

Aim of course:

Introduces students to the basic terminology and investigation methods of ecology. It also presents the formation and development of environmental protection, the global problems in detail, topics of international conferences, characteristics of sustainable development and economy and students receive a glance into the work of Hungarian environmental and nature protection via the operation of Hungarian national parks.

Topics:

- Basic terms of an investigation field of ecology
- Principles, international and national history of environmental protection
- Global problems I-II.

Climate protection in theory

- Renewable energies
- Passive houses, eco-villages
- Principles of nature protection
- National parks of Hungary I.-II.

Nature studies course

Aim of the course:

To introduce students to the calendar, cycle, phenomena and law of Nature from January to December.

Topics:

- History of the calendar
- Development of the calendar
- Seasons, months, weeks
- Natural laws and features of every month from January to December (from meteorological characteristics through the fauna of the month to applications in practice)

Climate protection in practice

Environmental education course

Aim of the course:

In the course of environmental education students get acquainted with possibilities, advantages and pedagogy methods of education in the environment and with the realization of sustainability in practice.

Topics:

- History of environmental education
- Stages and methods of environmental education I.-III.
- Fundamentals of bio-ethics
- History of the development of scouting, forest school and study trails
- Construction of a selected study trail in group/individually
- Presentation
- Construction of one week forest kindergarten programme in group/individually
- Presentation

Competencies:

- Thinking in system networks
- Critical thinking
- Creative thinking
- Knowledge related to sustainable development
- Solidarity and responsibility between and within generations
- Knowing global, regional, national and local environmental problems
- Knowing the economic, ecological and social consequences of environmental problems

We would like to contribute to the programme with this knowledge.

SUMMARY

In its trainings the Benedek Elek Faculty of Pedagogy in conformity with its traditions focuses on studying and teaching the changes and relationship of the environment, nature and the natural environment together with developing environmental conscious attitude from infancy.

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Teacher's teaching at the Faculty Apáczai Csere János

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Keywords: Educational structure of the Apáczai Faculty, PhD course of Environmental Pedagogy, Forest Pedagogy in Ravazd, environmental conscious attitude

ABSTRACT

The first part of the study is about the history and educational structure of the Apáczai Csere János Faculty of the University of West Hungary. At this university students can get degrees both in BA and MA levels.
Researches of the Institution of Pedagogy are also introduced here. In the centre of these researches is the environmental attitude. The scenes of this education are extended from forest schools to PhD courses.
The Institution of Pedagogy has a wide range of national and international relationships.

HISTORY OF THE FACULTY

The Apáczai Csere János Faculty of the University of West Hungary operates in Győr. The city is the capital of Győr-Moson-Sopron county. It is a fast developing city and it patronizes the institutions of higher education in the city. Győr counts on the skills and professional abilities of the graduated students.

Apáczai Csere János, whose name was adopted by the faculty, was a scholarly pedagogue in the 17th century. In the middle of the century he wrote about the importance of having schools. As a reaction to these thoughts, during the rule of Maria Theresia, the chronology of teachers' training in Győr began since, based on the decrees of Ratio Educationis, the second master training course of historical Hungary started at the National School of Győr on the 1st of July 1778.

There has been a long way leading to the presence when the University of West Hungary Apáczai Csere János Faculty has started its 231st academic year. For more than two hundred years teachers training and their further trainings have been the main activities of the institution. Though, our faculty adopted the name of Apáczai Csere János by no mistake. This scholarly pedagogue proved with his life-long work that we always have to be open to any changes in life. Being loyal to this thought our faculty has been keeping the values of its predecessors by maintaining the high quality of education, but at the same time it is ready to get renewed and react to the new expectations of our speeded up world.

STRUCTURE OF WORK

At the moment there are seven BA courses, one MA course and two higher professional trainings at our faculty. In 1990 beyond the teacher training we introduced the andragogy and social pedagogy trainings. At present, in addition to the previously listed courses the students of the faculty can study special needs education, tourism and recreation organisation and also receive a qualification of a business trainer.
From the academic year 2008/2009 we offer an MA course in Human Resources Advisor for the students. The higher professional training of tourism and catering relieves the problems of the lack of professionals on this field in the West-Transdanubian region.

Apart from the wide variety of our courses we can say that they are also very similar: in all of them it is the human being who is in the centre, their education, assistance, the organisation of different services, so the high quality teaching of how to deal with people professionally.

The experiences gained by the trainers of the institution in teachers training are used efficiently in further trainings for teachers at our faculty. The aim of our institution is to be the workshop of teachers' further trainings in Győr and its region. Our faculty offers many different courses – e.g. media communication, drama pedagogy, teacher of adapted physical education, pedagogue specializing in Romany studies, specialist examination of pedagogy – for the teachers who want to refresh and improve their knowledge.

The main characteristic of the BA courses of the new, multi-level education is the importance of practice. This is why we created the practice bases of these courses. Our students taking part in the teachers training course can practice their future profession in a well operating system. Both the Kálmán Öveges Demonstration Primary School and the other primary schools of the city welcomes our students for practice teaching. The students of our other faculties can also gain practice with the help of very good professionals. It is very true for our most popular training of tourism and catering. Since September 2007 our tourism students spend a term at the model hotel called Hotel Famulus. The students can learn all practical knowledge from the masters of the profession at this successful four-star hotel and its restaurant.

We can tell, that the number of our students does not decrease, and there is a significant over-application for most of our courses. The following thought was heard at the 230th Jubilee Anniversary of the faculty: "One can be faithful to the past if one can be always different" (by Géza Hegedűs).

At present the faculty has 68 full time teachers and about 4200 students. The pie chart below demonstrates the different majors and the number of students at them.

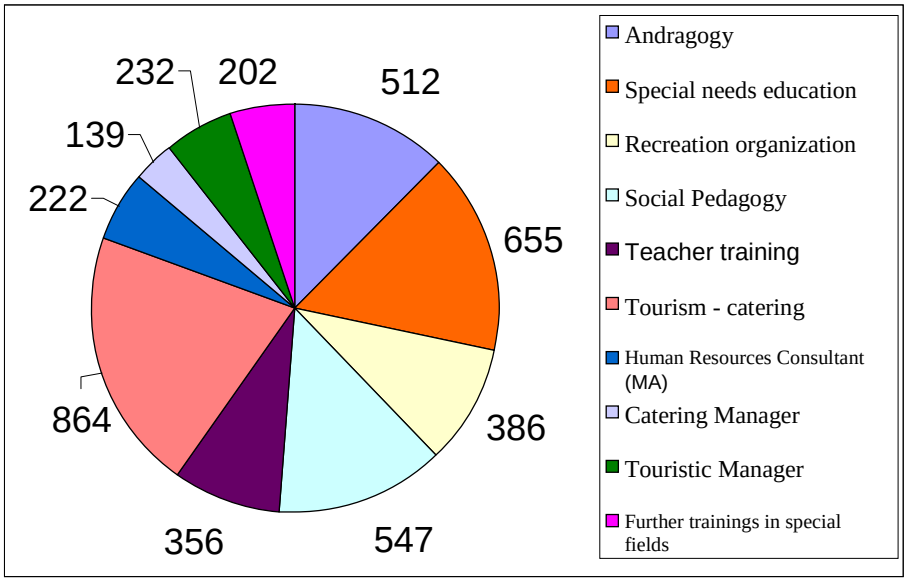

Figure 1: Structure of work at Apáczai Faculty

We can join the project with the following trainings: teachers training, further trainings for teachers and our 'forest school' programme running successfully for years.

POSSIBILITIES OF COOPERATION

Some possibilities which can assure the cooperation.
At the Institute of Pedagogy of the University of West Hungary Apáczai Csere János Faculty there is an Environmental Pedagogy workshop operating.

One of the most important elements of the University of West Hungary is the formation of environmental conscious attitude of the students. The University has recognised that the education for reservation can only be achieved with social union. This is why our university – as an institution traditionally taking responsibility for the protection of the environment - has undertaken the task to integrate the results of different science areas. It is represented by the fact that University of West Hungary Faculty of Forestry offers a PHD course of Environmental Pedagogy with the leadership of Professor Dr.Mária Németh Mrs Kováts, dr. habil, the head of our institute and the leader of the workshop operating at our faculty.

OBJECTIVES OF THE RESEARCHES

The creation of the theoretical and practical action plan system for the formation of the environment conscious attitude which can maintain and improve the quality of human life. To find solution for the global challenges in the given natural and social environment. To stimulate the environmental conscious improving and experimenting activities in the practice of Hungarian pedagogy. To affirm the environmental conscious intensions of the Hungarian state education policy.

The Institute of Pedagogy has been an active participant in the national environmental education in state education and higher education for one and a half decades. One of the major results of the faculty's environmental education activities – apart from its PHD course – is the Forest School Educational Centre in Ravazd, which has been operating together with the "Kisalföldi Forestry Company". This centre can provide a perfect theoretical and practical unit for research and school development.

The theoretical base of the work being done at the Educational Centre is the project created by Professor Dr.Mária Németh Mrs Kováts, dr. habil with the title of "Forest Pedagogy as Life Strategy". The practice orientated programmes of the project can be grouped in three major categories: Nature, Health and Education. This grouping is theoretical though, since the programmes form a complex unity. All programmes contain elements of the three groups. The forest and climate programme can be found in the Nature group, since its main aim is to make the students understood how important role the forest plays in the protection of the climate of our close environment and the World. The aim of the health programme is to draw an attention to the health protection effects of the forest (e.g. recreation). The educational content of the programme is to form an environment conscious attitude, to teach how to save the forests, how to behave properly in a forest and to respect all living creatures.

Many primary schools and families from different parts of the country have taken part in the programmes of the Educational Centre and we also have had groups from Austria, Germany, Slovakia and Transylvania. 2500 – 2800 children join the Forest Pedagogy project annually. With the help of the professional leaders and the wide range of different instruments the participating children can gain knowledge and experience which would be difficult to gain in classroom environment.

Due to the consistent hard work during the last one and a half decade the Educational centre and the Forest Pedagogy project have become well-known and well-respected nationally and internationally, too. The Hungarian UNESCO Committee pronounced it as a model school for the education of reservation in 2006.

It is an important task for the Institute of Pedagogy to organise further trainings for teachers. Since 2001 many Hungarian and foreign colleagues have taken part in our accredited training called "Forest Pedagogy, planning and developing forest school projects".

NATURE STUDIES SPECIALITY

The other possible area for the cooperation is the education of the teacher training students with nature studies specialty.

Subjects dealing with environment protection and climate changing can be introduced in the educational programme of this course.

There are a few possibilities below:

- The introduction of some 'C' subjects can be suggested which deal with the above mentioned topics.
- The programme of the three-day field trip in year 2 and 3 can fulfil this objective.
- It would be necessary to provide students with some essay titles in this area which could be further developed into a scholarly essay.
- The University of West Hungary Apáczai Csere János Faculty has a botanical research team who deals with the research of areas with drought vegetation. It can be resolved that the students with nature studies specialty, who are interested in the topic could take part in the work of the research team.
- It would be worth carrying out biomonitoring researches in areas where there are several environment harming factors.
- The industrial parks and the rubbish dumps around Győr would be suitable for this purpose. The students could carry out measuring at these places operating biomonitoring. Students could write their thesis and scholarly essays with using the data. With the help of the local press the subject could be made commonly known in the region.
- It would be useful to create a meteorological station – equipped with the basic meteorological instruments – in the courtyard of building I. or II. We would regularly summarise the recorded data. From the data of the micro region a survey could be made. The results could be published on the homepage of our faculty showing the micro climate around the buildings the faculty.
- 'Rubbish patrols' could be organized finding the illegal rubbish dumps in the area or finding out the locals' selective rubbish collecting habits.

POSSIBILITIES OF ENVIRONMENT PROTECTION

The introduction of selective rubbish collection in the buildings of the institution. (Estimation of the quantity of different types of rubbish, economical calculations, formation of social consciousness. KOMSZOL)

The examination of the efficiency of the model hotel and the model restaurants and making them 'green'. The development of ISO 14001 environmental control system with special consideration of the exhaustion gases causing green house effect.

Observation of the micro climate and noise in different areas of Győr. The frequency of stress situations caused by extreme weather conditions. (OMSZ, Likócs station)

Botanic monitoring of flooded (restored) meadows in the Hanság. (Fertő-Hanság National Park)

The micro climatic, botanical and soil comparison of the effects of different forest cultivation in the Sokoró or Szigetköz. (Kisalföldi Erdészeti Zrt.)

The possible usage of waste water mud and its familiarization and acceptance by the society. (Pannon-Víz, KOMSZOL)

The following lecturers of the faculty have been taking part in the above listed researches: Professor Dr. Mária Németh Mrs Kováts, dr. habil, the head of our institute, Viktória Gősy Mrs Kövecses PhD assistant lecturer, Bálint Lampert assistant lecturer, dr. Péter Szabó docent and dr. András Halbritter.

SUMMARY

The Apáczai Csere János Faculty of University of West Hungary has over two hundred years experience and tradition in teachers' training. In the current educational system, both in BA and MA levels, the environmental attitude is placed in the centre. The educational work is helped by the research made by the Apáczai Faculty directed and organized by the Institution of Pedagogy. The achievements of the research can be seen in practice in forest schools, PhD courses, selective rubbish collection and all the other type of protecting the environment.

Brief Introduction of the Faculty of Natural Sciences, University of West Hungary, Savaria University Centre

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Keywords: biology teacher, geography teacher, environmental science teacher

ABSTRACT

Previously, the institute was a successful independent teachers' training college for many decades. Following the establishment of the University of West Hungary (January 2008), our major field is still education, but we are heavily investing in scientific and collaborative research. Faculty of Natural Sciences is divided into four institutions: Biological Sciences, Geography and Environmental Sciences, Technology, Information and Economy, Mathematics and Physics. Four MSc programmes, which could be involved in the international collaboration: Biology, Geography, Geographer, Environmental Scientist.

INTRODUCTION

The Faculty of Natural Sciences and Technology has belonged to the 10 faculties of the University of West Hungary since 1st January 2008. History of the Faculty of Natural Sciences dates back to the times of the Berzsenyi Dániel College. The aculty was founded in 2002. Its predecessor, the Institute of Natural Sciences was founded in 1992, however, most trainings were performed in the united college that was not subdivided into faculties.

Figure 1: The buildings of the Faculty of Natural Sciences

In the college mathematics teacher training was started first in 1972 than in 1983 the technology, physics teacher training was started. After this, in 1984 biology, geography and chemistry teachers training was started as well. In the 1990s and in recent years the range of trainings in the Faculty was expanded. In this process the environmental sciences, economic management, industrial product and shape designer and engineering manager trainings were developed. Currently the Faculty has 9 bachelor, 4 teacher training and one none teacher training master trainings are offered, completed by 8 higher educational professional trainings.

Education and research are carried out in four institutions and in 12 institutional departments in the Faculty where active research and education and student life have been developed. As an example various professional days and evening fests, study trips, field-trips and astronomical observations organized by students can be mentioned. Research activity of the teachers of the faulty is intense that is proved by several conferences and other professional events organized at the faculty.
Wide range of higher professional education is carried out at our faculty. These include the following: web-programmer, general system administrator, tourism professional manager, information statistician and economic designer, technical informatics engineer assistant, product designer technical manager assistant, waste management technologist.

INSTITUTIONS

Infrastructural background essential for the Hungarian-German TéT co-operation is considered in the form of two institutions of the faculty:

INSTITUTE OF BIOLOGY

Our institution joined the University of West Hungary in 2008 operating since then as a new, independent university. This new institution as the fifth largest university of Hungary places trainings in Szombathely into an even more effective and valuable position in the Hungarian higher educational structure.

Attraction of the college has been its organization, stable and simultaneously advancing training structure, favourable regional position, educational and scientific experience of the lecturers and the excellent cooperation of the students so far. Biology teacher training was started in 1984. The Institute of Biology is currently composed of two departments as the Department of Zoology and the Department of Botany teach the professional courses. Departments are not only educational units, they are significant scientific research units of the Alps–Adria region having international co-operations.

INSTITUTE OF GEOGRAPHY AND ENVIRONMENTAL SCIENCES

The institute was formed in 2006. It consists of the following three departments: Department of Physical Geography, Department of Social Geography and Department of Chemistry and Environmental Sciences. Staff of the departments involves 9 people at the Physical Geography, 5 people at the Social Geography and 5 people at the Chemistry and Environmental Sciences departments. Four non lecturers help the education and research in the institute. The institute has its own library, it also has four laboratories (computer, general and physical chemical, inorganic and organic and environmental analytical laboratories), moreover a research room, a petrological and mineralogical collection, one drawing and one preparatory rooms together with a map-room.

MASTER TRAININGS AT THE FACULTY

BIOLOGY TEACHER

Based on knowledge acquired at bachelor level or on other higher educational training biological professional knowledge is expanded and deepened together with expanding pedagogical knowledge and abilities. Preparation of the student for solving successfully and innovatively educational, pedagogical research, planning and development tasks characteristic for public education, professional education and adult education. Preparation of students is also aimed for continuing education at PhD level. In the case of student graduated from BSc in the first four semesters complex infraindividual and supraindividual biological, laboratory and field knowledge together with methodological and educational practice knowledge of biology teaching and skill development are included in the training. In the fifth semester students take part in public education practice.

Difference is found in training time and in training-development contents according to the BSc and higher educational professional training of the students. Following graduation from biology teacher training and successful admission students may carry on with their training in the accredited Environmental Sciences PhD school of the University of West Hungary or in similar PhD schools of any other institution. They can be employed in educational institutes, educational servicing or advisory institutes or in other fields requiring or preferring teacher qualification.

GEOGRAPHY TEACHER

Based on knowledge acquired at bachelor level or on other higher educational training geographical professional knowledge is expanded and deepened together with expanding pedagogical knowledge and abilities. Preparation of the student for solving successfully and innovatively educational, pedagogical research, planning and development tasks characteristic for public education, professional education and adult education. Preparation of students is also aimed for continuing education at PhD level.

In the case of student graduated from BSc in the first four semesters complex physical and social geographical, regional geographical, research methodological knowledge together with methodological and educational practice knowledge of geography teaching and skill development are included in the training. In the fifth semester students take part in public education practice. Difference is found in training time and in training-development contents according to the BSc and higher educational professional training of the students.

GEOGRAPHER

Basic modules of the first year include mapping, methodology and social knowledge courses. Choosing the specialization is taking place from the second semester completed by 1 week field-trip and 3 weeks of professional practice. Students are free to choose from 14 courses according to their interest. Geographer training of the institute starts with the specializations of geomorphology and regional and settlement development starting at the second semester. Specialization in geomorphology following mapping and mathematical basics focuses on applied geomorphology emphasizing the importance of practical and field education. Specialization in settlement and regional development focuses on handling regional and district differences and on development using tender founds complemented by detailed settlement geographical knowledge.

ENVIRONMENTAL SCIENCE TEACHER

The aim of the training is to prepare the student for solving successfully and innovatively educational, pedagogical research, planning and development tasks characteristic for public education, professional education and adult education based on qualification and knowledge acquired at bachelor level or on other higher educational training. Preparation of students is also aimed for continuing education at PhD level. Certified environmental science teacher has to possess complex way of looking at things including the natural, built, social and economic environment together with local, regional and global environmental thinking. The teacher has to be able to present a topic or issue and the thinking by integrated and interdisciplinary views. The teacher also shall have environmental intelligence and the ability to recognise and categorise environmental elements and to explore the relationship among environmental elements. Specialized secondary schools train secondary professionals specialized in environmental protection in increasing number. This will increase demand for environmental science teachers in the following years.

Environmental science teachers are also prepared to teach natural science in elementary schools due to their biology, chemistry, geography, physics basic knowledge and special environmental knowledge. Curriculum of the training is as follows:

- Main forms of physical pollutions to the environment. Advancement of pollution. Process of flow and drift. Global circulation phenomena (atmosphere, oceans).
- Noise as a factor deteriorating the environment, environmental problems related to noise and their treatment. Energy budget of the Earth, global climatic change and its possible consequences. Natural and social causes of the green-house effect.
- Main benchmarks of the development of the Carpathian-Pannonian Basin (in time and space).
- Climate and climatic changes. Factors determining the climate. Anthropogenic changes of the physical properties of soils, factors triggering and influencing soil erosion, issues of soil protection.
- Environmental protection, nature protection, environmental management, sustainable development. History of nature protection and environment protection. Environmental protectional activities. Possibilities of harmonizing environmental and economic interests and developing responsible environmental behaviour. Ways of activity for pupils, schools, families and residential areas in protecting their own environment, reducing locally environmental problems

SUMMARY

The Faculty of Natural Sciences has belonged to the 10 faculties of the University of West Hungary since 1st January 2008. The Faculty has 9 bachelor, 4 teacher training and one none teacher training master trainings are offered, completed by 8 higher educational professional trainings. Infrastructural background essential for the Hungarian-German TéT co-operation is considered in the form of two institutions of the faculty: The Institute of Biology is currently composed of two departments as the Department of Zoology and the Department of Botany teach the professional courses. The Institute of Geography and Environmental Sciences consists of the following three departments: Department of Physical Geography, Department of Social Geography and Department of Chemistry and Environmental Sciences. The master trainings at the faculty: biology teacher, geography teacher, geographer, environmental science teacher.

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Densification of Poplar Wood for Sustainable Flooring Material

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Keywords: poplar, thermo-mechanical densification, colour, hardness, shrinking

ABSTRACT

The main aim of the presented research work was to enhance the technical performance of the poplar wood (*Populus x euramericana* cv. 'Pannonia'). Poplar plantations with high growing rates deliver valuable raw material for different sectors in the wood industry (plywood, WPC's, construction wood, and even solid wood for different applications). However there are some disadvantageous properties like low mechanical strength, low surface hardness, and nevertheless the unexciting texture and appearance. The last mentioned properties restrict the use of poplar in many fields of applications, e.g. the furniture and the flooring industry. By upgrading the unfavourable properties of poplar wood new and very promising applications could be defined.
The idea of our research was to enhance the surface hardness, and the colour of poplar wood in order to make it suitable for furniture industry (fronts) and flooring (parquet).

Thermo-mechanical densification schedules using different temperatures (160°C, 180°C, 200°C), densification grades (20%, 30%, 40%), and durations (15 min, 30 min, 45 min) were applied to poplar wood.

After the treatments the colour, the average density, the density profile, moisture related properties, modulus of rupture and the surface hardness were analysed.

The colour of the surface became more and more vivid by longer durations and higher temperatures. The well visible changes are reflected in the CIELab colour coordinate as it follows: Δa^* (0 -+6), Δb^* (+3 -+11), ΔL^* (-2 - -22). The total colour change ΔE reached values ranging from 4 to 25.

The density of the surface could be enhanced significantly, whilst the density in the core of the boards changed only small extent. The higher densification rate resulted in higher swelling, but no clear influence of temperature and duration of densification could be proved. A major positive result is the upgrading of the surface hardness, as the values could be raised by 60-130% (ca. 9 MPa for control and ca. 22 MPa for densified wood). The MOE could be increased by 15-60%, and MOR by 10-45%.

INTRODUCTION

Poplars play an important role in the plantation forestry in Hungary. Nowadays the share of poplars in the afforestations amounts to ca. 30%, the fellings come to 1 Million m^3/year. However the utilisation of poplar timber shows many difficulties. Top quality logs are processed in the plywood industry, while sawlogs deliver the raw material for pallets and

boxes. The short logs are utilised in the particle board and fibreboard mills. Recently poplar species are grown on energy plantations as well. The major problem is that even quality sawlogs are processed to low price pallets, thus the technology is uneconomical. In spite of some positive examples (e.g. in the building sector), the utilisation of poplar timber in Hungary is still an unsolved challenge.

Possible outbreak from this situation could be the production of furniture and other interior products. Unfavourable properties of poplar, such as low strength and stiffness, low durability, inexpressive colour and texture are a clear hindrance for widespread utilisation of the material in the furniture industry.

In order to surmount the obstacles we focussed our research work to enhance the relevant physical, mechanical and esthetical properties of poplar wood. The specific aim of our work was to establish the scientific background for a thermo-mechanical modification method. The process should enhance the surface hardness, the strength and the appearance of this low density wood with thin fibre walls.

Studying the literature there is a lack of scientific results concerning thermo-mechanical densification of poplar wood. Basically conifers were studied as reported by WELZBACHER et al 2008, UNSALA et al 2009, NAVI AND GIRARDET 2000, UNSALA ET AL 2009. Recently results were published concerning hardwoods by RAUTKARI ET AL 2009, AND GONG ET AL 2010. A good summary about the densification of wood was given by KUATNAR AND SERNEK 2007. The future potential in Europe of poplar is justified e.g. by the work of DE BOEVER (2010).

MATERIAL AND METHODS

Poplar boards for the investigations were delivered by the KAEG Zrt. The freshly cut boards were dried in a conventional dryer down to 12% MC. The boards were then cut into laths. The laths were densified in hot press across the grain at 3 different temperatures. 160°C, 180°C and 200°C. Three different starting thicknesses (25.0mm, 28.5mm and 33.3mm) were used. The final thickness of the laths was set to 20mm from all laths. Thus the grade of the densification was 20%, 30% and 40%. After the densification under heat, the wood material was kept for 10, 20 and 30 minutes in the hot press at the corresponding temperature.

After the treatment the change in different material properties were studied. The investigated properties were: the colour change, moisture related shrinking and swelling, surface hardness, MOR and the grade of densification across the thickness.

The colour properties were measures by a CM-2600d spectrophotometer working in the CIELab system. The device calculated and delivered directly the required colour coordinates L*, a* and b*. A CIE D65 xenon lamp served as light source, the window for measurements had a diameter of 10mm. The colour coordinates were measured prior and after the treatments (thermal densification). The chroma (C) and the total colour change (ΔE) were calculated regarding Eq. 1 and Eq. 2.

$$C^* = \sqrt{a^{*2} + b^{*2}} \quad (1)$$

$$\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}} \quad (2)$$

The ovendry density was determined according to MSZ 6786-3:1988 using specimen with the dimension of 20mmx20mmx30mm (RxTxL).

The shrinking properties were measured following the standard MSZ 6786-18:1989, with the deviation that the directions across the grain were defined as directions parallel and perpendicular to the pressing force rather than radial and tangential anatomical directions. The density and shrinking were determined on the same samples. Shrinking values were determined during drying from ca. 10% MC to ovendry state. The shrinking coefficient were than calculated as the ratio of the measured swelling (%) and the MC change (10%).

The surface hardness (Brinell-Mörath) was determined according to MSZ 6786-11:1982. A ball with the diameter (D) of 10mm penetrated the surface of the specimen with a maximum force (F) of 500N, the penetration depth (h in mm) was measured as well. The Brinell-Mörath hardness value (N/mm^2) was calculated using Eq. 3.

$$H_{BM} = \frac{F}{D \cdot \pi \cdot h} \tag{3}$$

The hardness was determined prior and after the densification, so the change in percentage caused by the treatment could be calculated.

The modulus of rupture was measured following the standard MSZ 6786-5:1976. The dimension of specimen was 20mmx20mmx300mm (RxTxL). The distance between the supports was 240mm. The tests were carried out by using one force, where the direction of the testing force corresponded to the treating force (pressure). .

After the treatment the degree of the densification was determined across the thickness. In order to be able to detect the deformations in different depths, liens in 45°to the pressing direction were drawn onto the side surface of the laths. The curving of the straight lines (Figure 10) deliver data on the deformations of the material. The lines were photographed after the treatment and analysed by sectioning them into 20 parts.

RESULTS AND DISCUSSION

RESULTS – COLOUR

The change of red hue (Δa*) was for all treatments positive, which means that the colour of the surface turned to red. Figure 1 shows a clear that higher temperatures and longer treatments resulted in more pronounced changes, while the densification grade did not influence the red hue changes significantly.

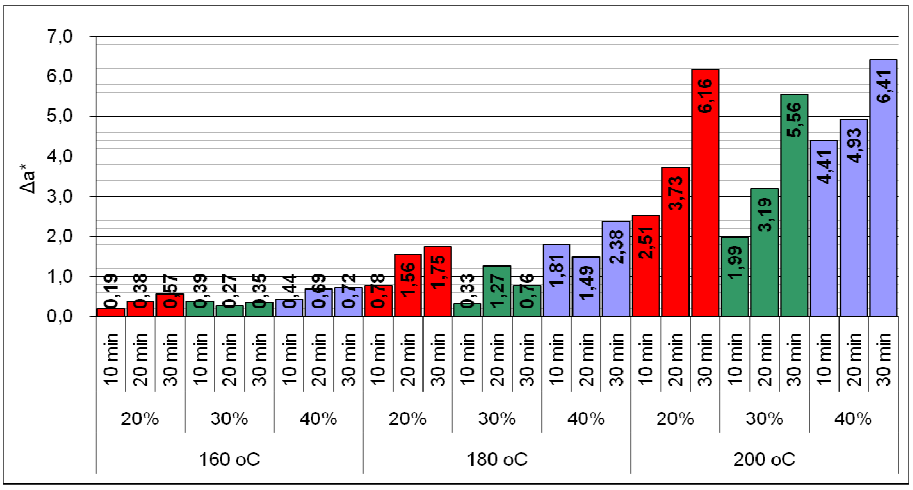

Figure 1: The effect of treatment parameters on Δa*

The yellow hue values changed in positive direction (Δb*), thus the surfaces became more yellowish (Figure 2). Compared to red hue values similar tendencies could be found concerning the effect of temperature and duration, but the changes showed higher values.

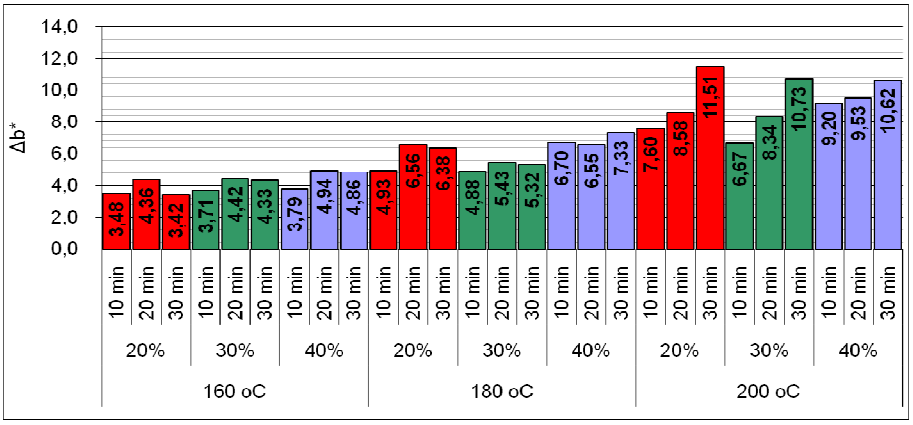

Figure 2: The effect of treatment parameters on Δb*

The treatments caused reduction of lightness, thus the ΔL* values are negative (Figure 3.), the colour became darker. Minor changes could be proved by the lowest temperature (160°C), but the darkening became more significant as temperature and duration increased.

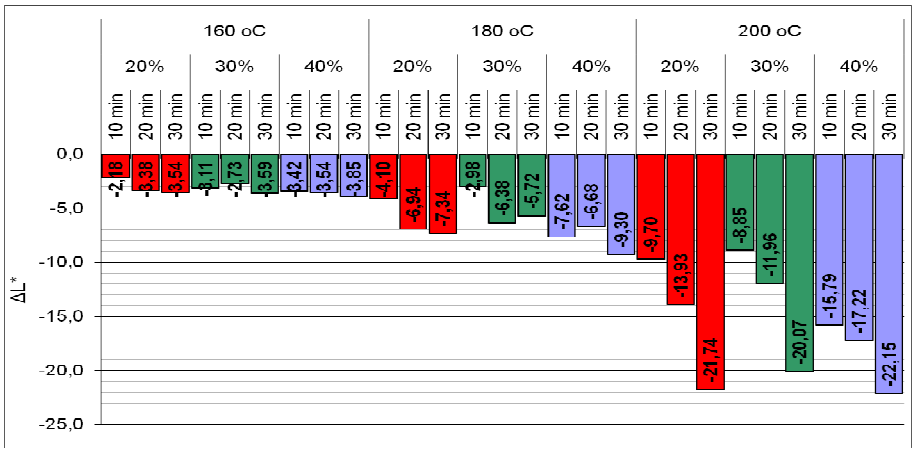

Figure 3: The effect of treatment parameters on ΔL*

Studying the total colour change, values over 3 can be found by all treatments. Thus the colour change is visible even at the lowest duration, temperature and densification grade to the naked eye (Figure 4.). As for all the three investigated colour coordinates (a*, b*, L*) showed similar changes, the ΔE* is influenced particularly by the temperature (highest changes at 200°C, 30% and 30 min.). The longer duration of the pressing treatment did not resulted in significantly higher total colour changes at 160°C and 180°C. The densification grade did not influence the colour change.

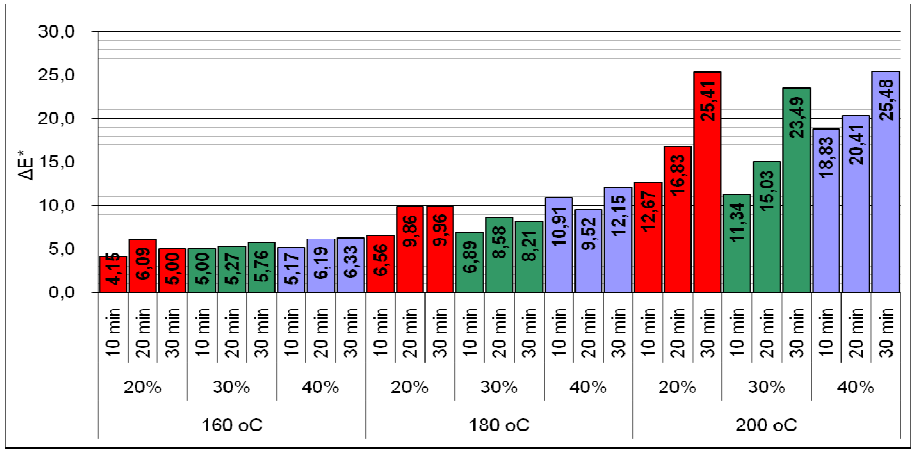

Figure 4: The effect of treatment parameters on ΔE*

Similar tendencies for colour changes were reported by BAK ET AL (2008) for different plantation grown timbers, and by NEMETH ET AL (2009) for Poplar and Robinia using hot vegetable. In their studies the duration of the treatments were longer, therefore the achieved total colour changes were superior to the values reported here.

RESULTS – HARDNESS

One of the main targets of this research work was to enhance the surface hardness of poplar wood. The corresponding values for untreated timber were in the range of 8-11 MPa. The relative low values could be increased by the applied thermal densification method up to the range of 15-22 MPa. Figure 5 shows a clear positive effect of the treatment in terms of hardness change. From the results we can conclude that the densification grade is the most prevailing among the treatment parameters.

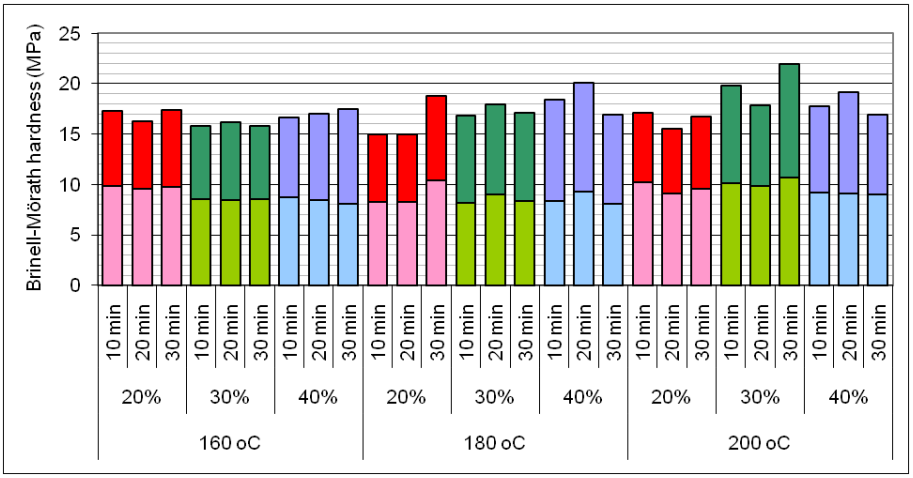

Figure 5: The effect of treatment parameters on the Brinell-Mörath hardness (light column before and dark column after the treatment respectively)

RESULTS – MOR

The average MOE of control material amounted to 79,85 MPa. These values could be increased to the range of 87-116 MPa. As it is shown on Figure 6 the treatments enhanced the MOE of the material. No clear influence could be proved for single treatment parameters (temperature, duration and densification grade). It has to be mentioned that the coefficient of variation (20-25% cv) for treated MOR values increased compared to the cv of the controls.

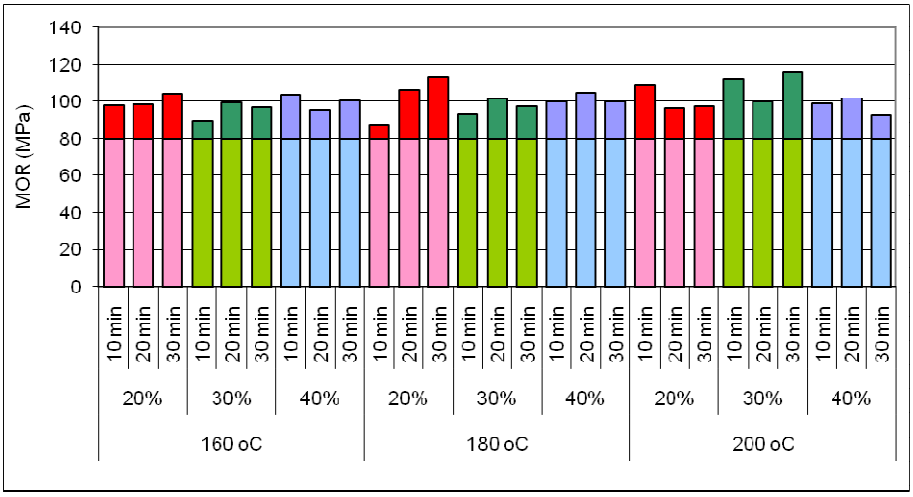

Figure 6: The effect of treatment parameters on the MOR (light column before and dark column after the treatment respectively)

RESULTS – MOE

The control poplar material showed an average MOE of 8,2 GPa, while the treated material's values ranged between 9,3-13,3 GPa. Thus the treatment resulted in higher MOEs compared to the control as it is shown on Figure 7. Similar to MOR, no clear effect of the single treatment parameters could be proved.

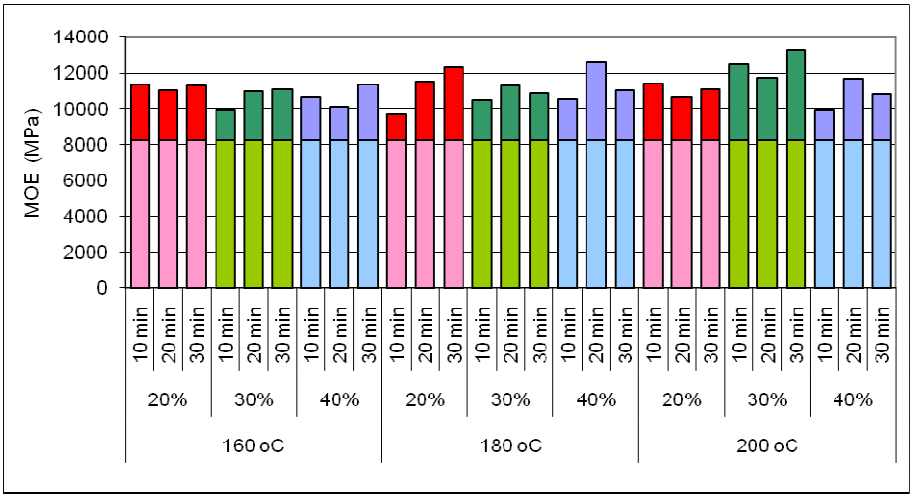

Figure 7: The effect of treatment parameters on the MOE (light column before and dark column after the treatment respectively)

RESULTS – SHRINKING

The shrinking ability was determined in three directions: parallel to the grain, across the grain and parallel to the pressing force (thickness), across the grain and perpendicular to the pressing force (width). The shrinking coefficients (treated and control) in thickness and width are shown on Figure 8. No differences could be found for shrinking parallel to the grain and in width, while in thickness considerable increase in shrinkage could be proved. At all investigated temperatures the higher densification grade resulted in higher shrinkage. Because of the relative short treatment time, the thermal treatment modified the surface only, even at the highest value (200°C). Thus no thermal degradation occurred in the inner layers; therefore no stabilisation effect could be aimed.

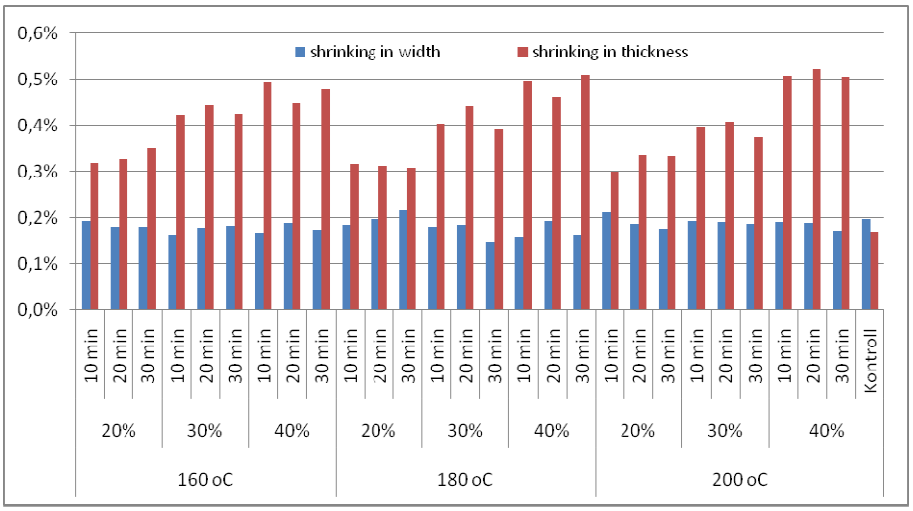

Figure 8: The effect of treatment parameters on the shrinking coefficient in width and in thickness

RESULTS – OVENDRY DENSITY

Studying the data shown on Figure 9, it can be seen that there is a positive correlation between the densification grade and the ovendry density. The final density value is determined by the initial density of the laths.

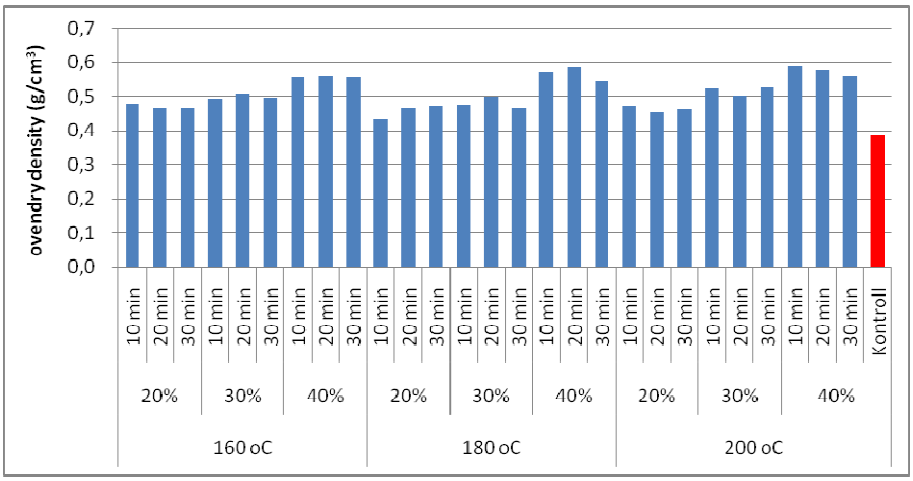

Figure 9: The effect of treatment parameters on the ovendry density

RESULTS – DENSIFICATION GRADE ACROSS THE THICKNESS

It should be mentioned that the densification grade is not evenly distributed across the whole thickness. Studying the deformations of the straight lines which were drawn on the side surface of the laths prior to the treatment we can get information concerning the distribution of the densification across the (half)thickness (Figure 10). Applying the lowest bulk densification grade of 20% the local densification of the upper 1/3 layer amounts to 40%, while the inner parts show rather slow 0-10% local densifications. Applying the moderate densification grade of 30% the local densification of the upper 1/3 layer amounts to 45-50%, the second 1/3 layer shows 30% densification, while the inner part densifies ca. 10-15%. Applying the highest densification grade of 40% the local densification of the upper 1/3 layer amounts to 50-55%, the second 1/3 layer shows ca. 30%-40% densification, while the inner part densifies about 20-25%.

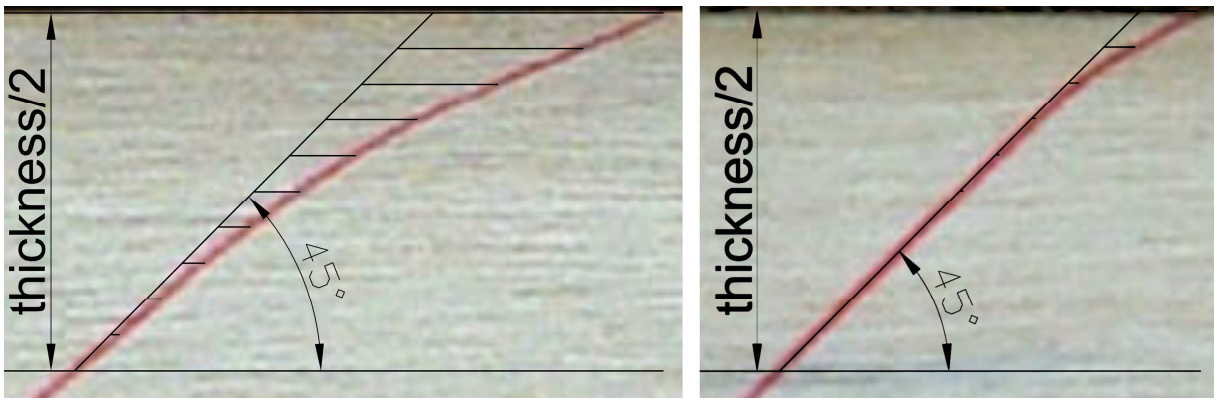

Figure 10: The densification of different layers due to densification values of 40% (left) and 20% (right)

CONCLUSIONS

The specific aim of our research work was to enhance the surface hardness, and the colour of poplar wood (*Populus x euramericana cv.* 'Pannonia') in order to make it suitable for utilisation in the furniture industry (fronts) and flooring industry (parquet).
Thermo-mechanical densification schedules using different temperatures (160°C, 180°C, 200°C), densification grades (20%, 30%, 40%), and durations (15 min, 30 min, 45 min) were applied to poplar wood.

After the treatments the colour, the average density, the density profile, moisture related properties, modulus of rupture and the surface hardness were analysed.

The colour of the surface became more and more vivid by longer durations and higher temperatures. The well visible changes are reflected in the CIELab colour coordinate as it follows: Δa* (0 -+6), Δb* (+3 -+11), ΔL* (-2 - -22). The total colour change ΔE reached values between from 4 to 25, thus the treatment caused well visible changes.
A major positive result is the upgrading of the surface hardness, as the values could be raised by 60-130% (ca. 9 MPa for control and ca. 22 MPa for densyfied wood). The MOE could be increased by 15-60%, and MOR by 10-45%.

The density of the surface could be enhanced significantly, whilst the density in the core of the boards changed only small extent. The higher densification rate resulted in higher swelling, but no clear influence of temperature and duration of densification could be proved. Because of the relative short treatment time, the thermal treatment modified the surface only, even at the highest value (200°C). Thus no thermal degradation occurred in the inner layers; therefore no stabilisation effect could be aimed.

Further research is needed to enhance the water-related properties of the densified poplar wood. Different starting MCs and higher temperatures are subject for future investigations.

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Macroeconomic Sustainability from Ecology Point of View

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Keywords: sustainable development, ecology, environmental elements

ABSTRACT

"Sustainable development is a development that meets today's demands without endangering the prospect of future generations to meet their own needs" (NFFT, 2009). Sustainability means therefore a relationship, approach and culture in which the relationship among people and with their environment establishes the possibility of present and future harmony.

Sustainability can be interpreted in three dimensions with economic, social and ecological relations. Considering ecological aspects, great challenge of our age is to establish the balance between sub-interests diverging from the decision makers and each other at the current level of social and economic division of labour, science and technology. Especially concentrated forces can operate relatively free producing significant and diverse as often as not harmful effects even in a sort time while they do not face all consequences of their operation (externalities). Prevention of disadvantageous effects is hardly or not effectively possible individually.

EXPENDITURE ASSOCIATED WITH ENVIRONMENTAL PROTECTION IN THE GDP

At macro level environmental protection expenses can be regarded as costs of preventing environmental damages. The magnitude of these costs is apparently much lower than the reconstruction costs of subsequent environmental damages if reconstruction is possible at all.
Environmental protection expenditures can be interpreted from microeconomic (company level) and macroeconomic points of view. At company (branch) level this expenditure includes tax and fees on environmentally strategic goods. In the favourable case this environmental product tax is used for covering state expenditure associated with environmental protection. If this is not the case environmental taxes can still have advantageous effects as raising the price of the given product artificially limits the consumption loading the environment significantly.

For a long time the strict enforcement of the standpoints of environmental protection was rejected referring to competitiveness reasons. By today it was proved that it is possible to support environmental sustainability in a way providing profit for the economy as well (Fig. 1). On the one hand, stricter norms resulted in savings in production expenditures, on the other hand a partially new market based on the demand of environmental protection was established. Tasks, targets in the field of environmental protection usually generate jobs that resulted in the formation of the environmental protection industry. Environmental protection industry is the engine of innovations and generates employment (CEDEFOP, 2010). Environmental protection aspects transformed education as well developing new trades. Establishing green jobs holds enormous employment potential.

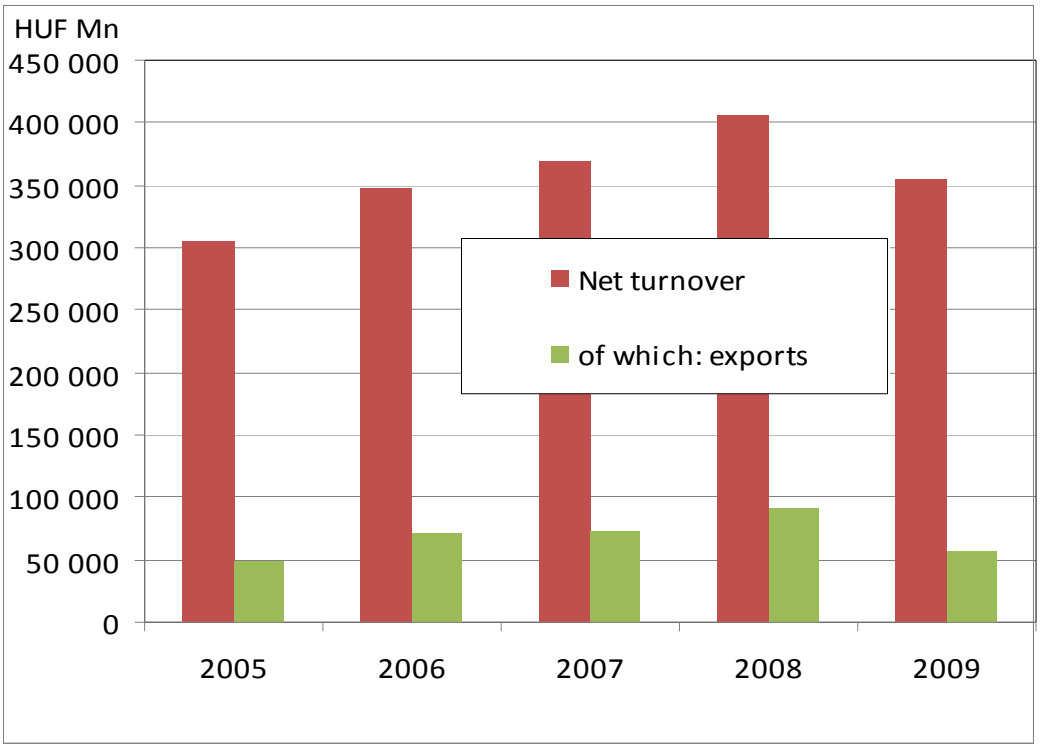

Fig 1: Turnover of environment industries in Hungary (HUF Mn)
Source: Statistical Mirror, CSO, Budapest, Dec 2010

Environmental protection investments give an increasing ratio in the investments of the national economy. Interventions related to sewage treatment, air pollution, waste management and soils give most of these investments (Fig. 2).

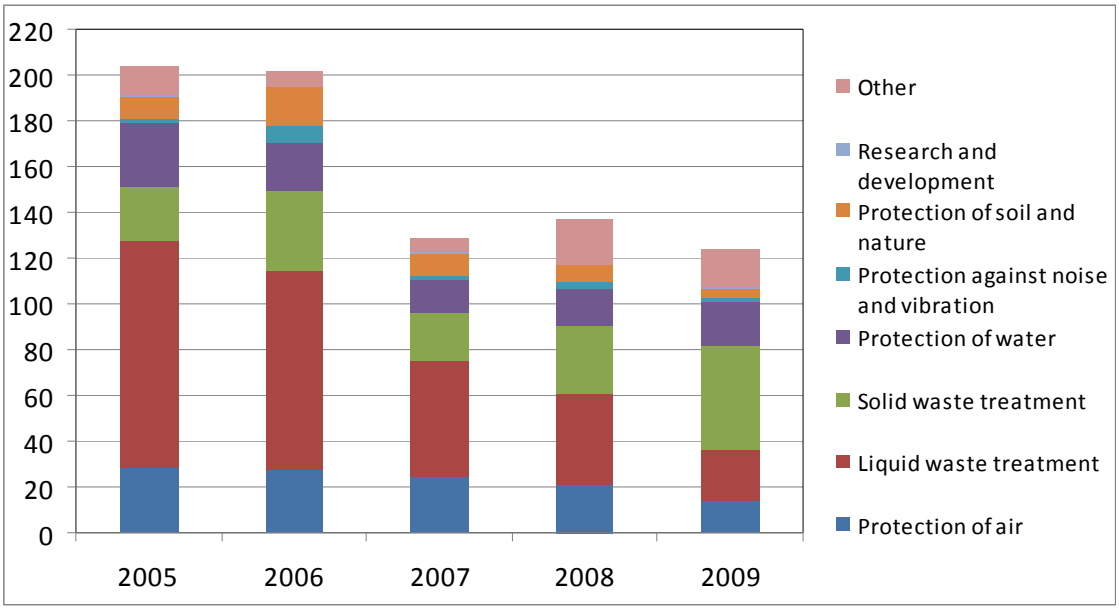

Fig 2: Investments in environment protection, HUF Bn
Source: Central Statistical Office (CSO), HU

Environmental protection activities would require co-operation between the state and the competitive sector. The state can be either active investor or regulator. Members of the competitive sector often regard the enforcement of environmental aspects as a compulsory cost that are forced on them by the regulators. There are an increasing number of examples, however, showing that environmental consciousness plays an important role in the image of certain companies on the market.

"Europe 2020" strategy on sustainable increasing and employment of the European Union placed innovation and green increasing in the centre of the competitiveness strategy. This is also the result of the European Economic Recovery Plan that allocated 200 billion Euros for supporting clean technologies and infrastructure in 2008.

ENVIRONMENTAL ELEMENTS

Considering macroeconomic processes the quantity and quality conditions of the most important environmental elements are fundamental. Environmental elements are on the one hand resources and on the other hand, they are the receivers of pollutions, potentials and limits at the same time of economic and social processes. No synthesized parameters are available today that would give a simple overview of the characteristics therefore measuring environmental data is separate in different regions (Fig. 3).

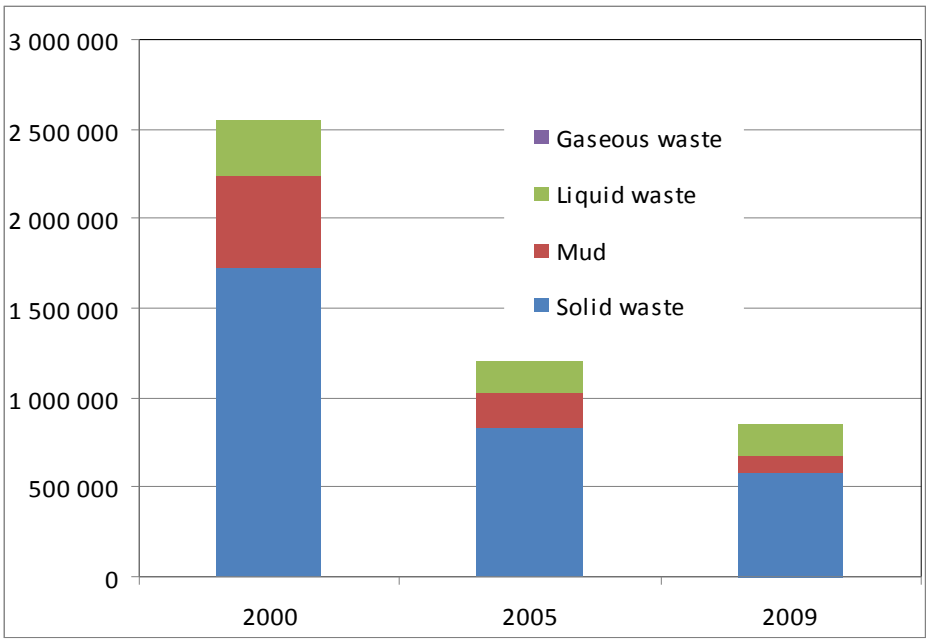

Fig 3: Output of hazardous waste in Hungary (tons)
Source: Central Statistical Office (CSO), HU

Air: cleanliness of the atmosphere as its pollutants endanger human health, vegetation and the rest of the environmental elements, moreover they damage the built environment. The air is the main carrier of global environmental problems. In the case of air pollution settling environmental damages maybe the most difficult (identifying those responsible, restoration).
Water: Among our natural resources water is essential regarding biological vital conditions, everyday life of the society and the operation of the economy as well. Its renewing ability is significant. It is relatively well adjusted into the financial accounting systems.

Ground, soils: Soil is a non renewable or conditionally renewable resource. It has several functions regarding human activities and the survival of ecosystems including among others: biomass production, storing, filtering and transforming nutrients and water, moreover, soil is an essential element of biodiversity, the place of most human activities, it supplies raw-materials, operates as a carbon source and bears geological and archaeological heritage. This is also integrated well into the traditional financial accounting systems.

Soil deterioration is a serious problem in Europe and in all continents. One reason for soil deterioration is human activities, like industrial activity, mining, urban and industrial expansion, built-in areas, applying inappropriate agricultural and forestry methods, tourism, etc.

Further factors related to ground is the green surface supply of towns that is influenced by the practice of permitting the selling of ground plots and the building up of areas.

Waste management: Waste management is one of the most neuralgic area of sustainable development as explicit shortfall can be found between waste production and treatment solutions ideal from environmental protection point of view (reducing production, increasing re-cycling in its material if possible).

SUMMARY

The major challenge of future economic development is how the triangle of targets can be maintained and harmonized. The three – economic, social and environmental – goals are, however, not controversial. The coherent way of treatment of these challenges needs only a new way of thinking. Environmental industries may create several new jobs, contributing to higher rate of employment. Rapid technological change leads to important shifts in labour markets and skills needs. Public policies and enterprise strategies in many areas follow calls for innovative, clean and greener economies. Availability of skills for green jobs plays a crucial role in triggering change.

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Effect of Traffic on Climate change

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Keywords: traffic, climate change, air pollution, GHB

ABSTARCT

Effects of the economy on the climate change are studied frequently while the effects of climate change on the economy are researched by only a few scientists even though this direction of the relationship is also significant. Climate change and its effects set up numerous new conditions for man to face therefore it is important for us to know extreme weather, unbalanced alternation of seasons and extreme weather phenomena.

BRIEF DESCRIPTION OF THE PROBLEM OF CLIMATE CHANGE

Lasting years of drought are replaced suddenly by years of extreme amount of precipitation. Periods of drought and heavy rain alternate extremely even within one year.Today's economy is not prepared to these effects of climate change. This is verified by the increasing problem of floods and by that the effects of sudden and lasting droughts cannot be treated by irrigation. As a result of these effects, the quality of the productive soil is deteriorating continuously and the soil is not able to adjust to climate change. Agricultural works have been delayed in numerous occasions and the crop is decimated by various diseases. Harvesting crop of appropriate quality is more-and-more expensive. Furthermore, crop can be stored more-and-more expensive than in normal weather.

Analysing economic effects is of key importance – especially when future technologies and preventive measures are determined. Effects experienced today have to be analysed not only to reduce momentary detrimental effects but to support scientifically the selection of future measures. Experiences obtained in this way can be used in the course of making strategic and operative decisions.

In order to draw correct conclusions it is highly important to involve experts from the fields of ecology and public economy as well!
To solve problems associated with today's climate change experts representing only one field of profession is not enough as phenomena accompanying climate change have very complex effects. Just think only to the environmental and economic effects of handling the increasing number of floods! In such situations strongly founded economic decisions have to be made within a relatively short period of time that shall not result in harms to the environment either in the short- or in the long-term. Therefore conscious harmonization of ecological and economical interests is necessary.

Results of research have to be published as soon as possible in order to encourage further research and to help the complete understanding of the processes!

Recognized and thoroughly verified correlations have to be presented to representatives of all fields of science in order to make scientific results required for further research available with as little time as possible. This is necessary primarily in the case of handling catastrophes.

PROBLEMS OF RESEARCH

Data collection related explicitly to the climate change, global warming applying a united methodology dates back only a few years, maximum a decade, therefore conclusions drawn solely from the data have to be treated cautiously!

Thorough scientific research requires enormous data sets with the help of which even natural phenomena can be described accurately. Unfortunately scientific fields dealing with climate change started their studies relatively late – unfortunately there are so called climate sceptics who deny the role of human activities in climate change. According to their opinion, climate change is a solely natural process influenced only slightly or not at all by human activities.
Related data had been collected using different methods in the last decade therefore they have to be assessed cautiously.

Considering that climate change dates back only a decade, methods of scientific research are not uniform yet. This is accompanied by an inconvenient side effect that data collected so far cannot be compared in certain cases. Conversions are required to draw comprehensible conclusions from the data collected by various methods these conversions, however, may distort original data.

Data collection requires appropriate profoundness – this primary research also requires significant amount of time! Even most recent data are frequently 3-5 years old, thus their analysis by statistic methods is difficult! Therefore it is highly important for the researchers of the given scientific fields to work on the basis of a uniform method. Regarding the above I consider the harmonized education of environmental science and economic science necessary to achieve the target. Therefore I recommend to call ecolonomy the new field of science created by mixing knowledge of ecology and economy (NAGY, 2010).

DESCRIBING CLIMATE CHANGE

According to the present way of approach of science, the effects of not only CO_2 but those of the other green-house gases (GHG) have to be considered. Based on this we have to count on methane (14%), nitrogen oxides (8%), chlorine and fluorine derivatives and sulphur hexafluoride (1%) emission as well.

Although the applied dimension is CO_2 equivalent as 77% of the total GHG emission is given by carbon dioxide, other gases giving 23% of GHG emission and solid air pollutant material (PM) shall not be forgotten!

According to recent research, gases – emitted by human activities – influencing climate change are released typically (61.4%) as a result of energetic processes therefore this field should be unloaded first to minimize effects (BAUMERT et al. 2005).

AIR POLLUTION AS THE PRIMARY FACTOR INDUCING CLIMATE CHANGE

Science associates the increasing intensity of climate change with the increasing emission of green-house gases related to human activities. Although the scale of their significance is debated by scientists it can be clearly detected that the climate change is in correlation to the pollution of the environment and the air within it.

DYNAMISM OF GHG EMISSION

GHG emission originated from fossil fuels has been increasing dynamically and monotonously over the last century as shown by Figure 1.

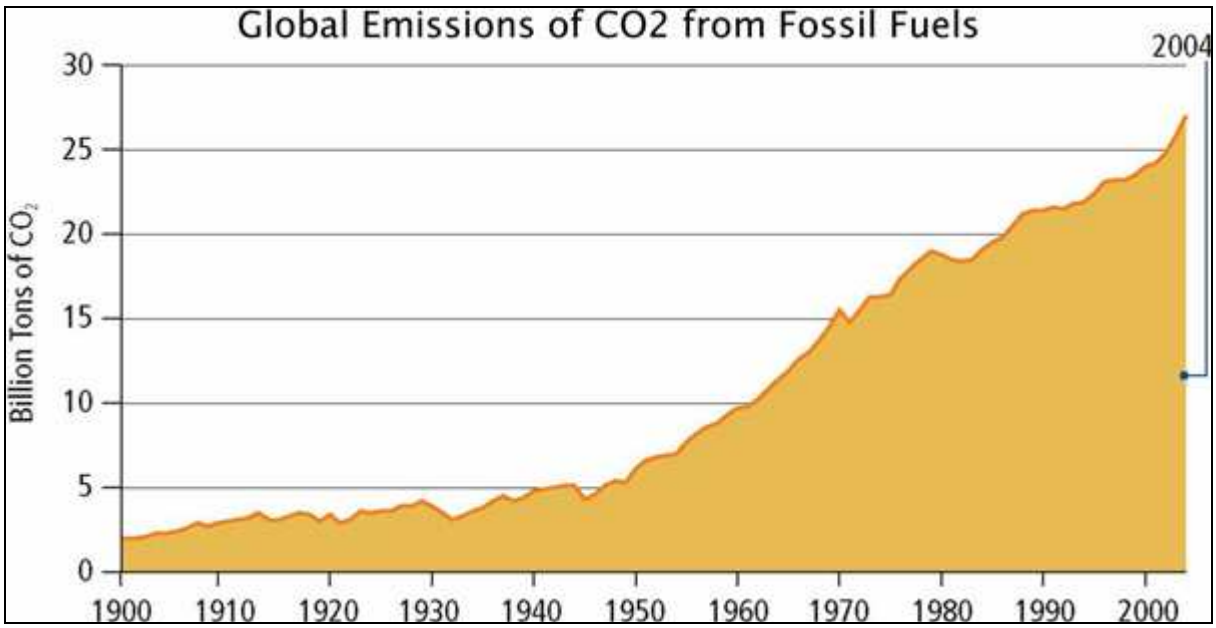

Figure 1: Dynamism of CO_2 emission originated from burning fossil fuel (source: http://www.wri.org)

This tendency has not change since 2004, even so, due to the effects of developing states in the Far East further strong increase can be prognosticated.

ROLE OF TRAFFIC IN AIR POLLUTION

According to the research carried out by the Intergovernmental Panel on Climate Change (IPCC) 13.5% of GHG emission is originated from traffic. Furthermore, a significant ratio of traffic emission could be improved by optimalization. The paper focuses on this in the following.

Significance and efficiency of optimalization is enlighten by the example of two metropolises. Traffic development case-studies of the Brazilian Porto Alegre and the capital of Vietnam, Hanoi justifies clearly that with the help of optimalization and technological innovation significant results can be achieved.

BRASIL: PORTO ALEGRE PROJECT

In Porto Alegre by traffic management (route optimalization, creating fast services) and using alternative fuel the project wishes to stop the increase of GHG emission despite increasing passenger kilometre in the next 15 years.

The project studied four possible scenarios in which the common characteristic is the application of various fee discounts to get passengers to use mass transport. Probable direction of development is the supplement of public transport by fast services ensuring discount change from one to another. These fast services would connect the city centre to the suburbs.

The report discusses the effects of the fuel of busses used in the city mass transport. Introducing alternative fuel could produce significant decrease in pollutant emission. Using diesel oil of low sulphur content would reduce solid pollutant, CO and Nox emission by 56%, 10% and 5% respectively in the case of busses with Euro3 engines (CORDEIRO M. AND FOCANTE, 2005).

Success of the project depends on whether inhabitants can be convinced of the advantages of using public transport and whether they will be willing to use public transport services.

VIETNAM: HANOI PROJECT

In Hanoi, the capital of Vietnam problem of air pollution originated from traffic is totally different.

Hanoi experiences significant demographic and economic development nowadays that can be characterise by among others, the major increase of the number of passengers. The 60% share of motorcycles in vehicles is a local speciality. Such motorcycles are present in 84% of households in Hanoi and their number is increasing rapidly.

While bicycles had a ratio of more than 70% in 1995 their share decreased to 24% by 2005. In contrast, the share of 21% of motorcycles in 1995 increased to 62% over 10 years. Despite the fact that the public bus service network develops rapidly its share in the city traffic is only 5% (TUAN AND ORN, 2008).

Based on the above, solution can be brought about by the development of mass transport and by increasing its ratio in urban traffic. The set target is increasing the ratio of mass transport to 30% by 2020.

Figure 2 presents the expected result by showing carbon monoxide emission tendencies. Decreasing CO emission caused by technological development can be sees.

COMPARING THE TWO CASE-STUDIES

It is apparent that the common conclusion in the two case-studies is that the solution can be found in increasing the ratio of mass transport, in modernizing vehicles and in applying environmentally sound fuel. Firstly by eliminating journeys not absolutely necessary, secondly by shifting necessary journeys to mass transport major results can be achieved.

One of the main consequences of the above results is the reduction of air pollution and the conservation of depleted energy resource reserves by using them in more conscious and responsible ways.

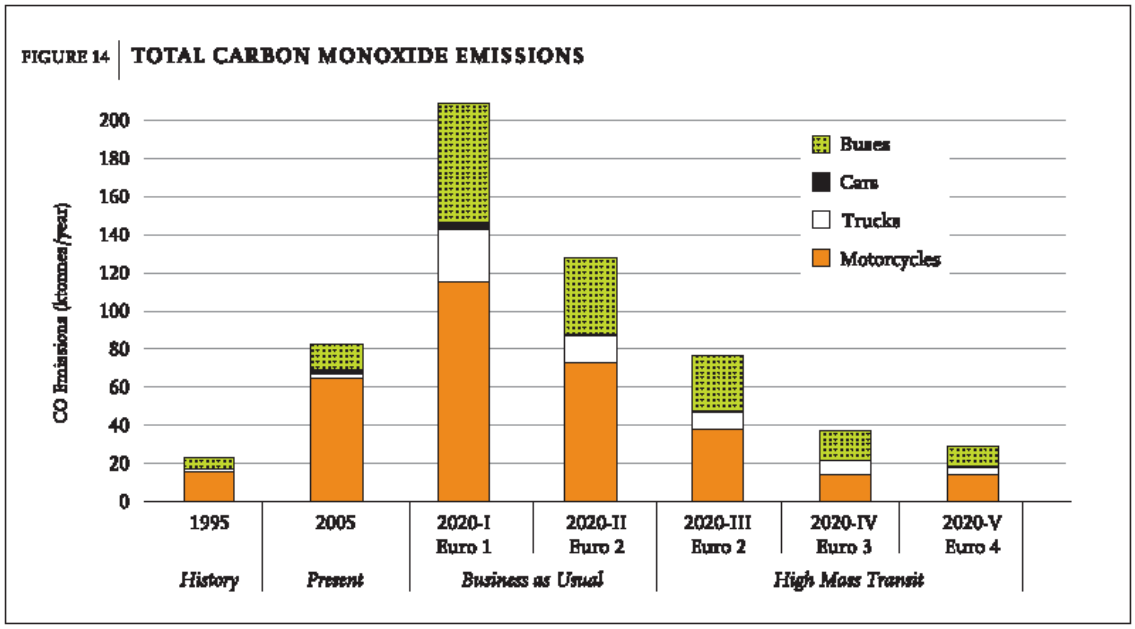

Figure 2: Expected tendency of carbon monoxide emission

CONCLUSIONS

Considering the above presented reports it can be admitted that the future of traffic cannot be imagined only by methods based on the modernizing of vehicles – using mass transport is also desirable due to its lower specific air polluting effects.

The other conclusion is that significant results can be achieved by traffic management based on route optimalization and by applying preferable tariffs.

I recommend to apply the example of the two metropolises in Hungary as well as nowadays presence of air polluting material originated from traffic exceeding the health limit is getting to be more-and-more frequent not only in Budapest but in other county centres and large towns as well. Adaptation of the solutions presented in the reports may bring success in Hungary as well.

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http://www.wri.org/chart/global-emissions-co2-from-fossil-fuels-1900-2004

Closing remarks of Prof. Dr. Csaba Mátyás, Member of the Hungarian Academy of Sciences*

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Ladies and Gentlemen,
I take the liberty to express my thoughts about the conference in the language of Wilhelm and Alexander von Humboldt. Some of the facts I want to tell about the venue of the conference – the University of West Hungary – might be of special interest for the German-speaking participants.

In a World where the significance of German in the fields of culture and science gradually diminishes to our regret it might be surprising that half of the students of the Faculty of Forestry take the language examination required for the diploma in German even today. Primary reason for this lies in the surviving tradition supported by the continuing economic, scientific and cultural connections.

I would like to remind you that the language of education at the former Mining Academy was German until the Austro-Hungarian Compromise (1867) and renowned German-speaking professors ensured the high level of education amongst whom Christian J. Doppler is probably the most widely known. Until the end of World War I the seat of this first college of technology one the continent founded as early as 1735 was Selmeczbánya, a former mining town (now Banska Stiavnica in Slovakia).

New borders of the new national states resulted in the relocation of the Academy to the town of Sopron/Ödenburg, its current seat. The return of this bilingual town to Hungary was eventually supported and decided by the newly arrived – a romantic story.

As a consequence of renewed cataclysms following World War II, the town lost the majority of its German-speaking inhabitants due to forced expulsion and got the status of isolation in the security zone of the "iron curtain". Apart from the numerous losses associated with this state that included the separation and relocation of mining, metallurgy and earth sciences from the college, the town and its university gained a role in World history which proved to become significant in recent German history as well. The academic staff of the university had a decisive role in organising the so called Pan-European Picnic which led to the breakthrough of the "iron curtain" in August 1989 in Sopron. This brave initiative led to unexpected major political changes in Europe finally to the historical collapse of the Berlin wall. The memorial at the place of the breakthrough unveiled by Federal Chancellor Angela Merkel on its 20th anniversary reminds even today of that the efforts to divide Europe by force can be impeded by civil courage and confidence.

It is a special pleasure for me that the Humboldt Foundation supports the co-operation in Europe also in the fields of environmental sciences and climate protection. It would be hard to find a topics in which co-operation and the vision of common future envisage would have greater significance. Therefore the importance of the conference cannot be overemphasized. The modern history of Sopron/Ödenburg and its university reminds us of this.

*The address was presented in German

Prof. Dr. Mátyás Csabának a Magyar Tudományos Akadémia rendes tagjának zárószava*

Mélyen tisztelt Hölgyeim és Uraim!
Engedjék meg, hogy a konferenciához csatlakozó gondolataimat Wilhelm és Alexander von Humboldt nyelvén mondjam el. A következőkben kifejtett okok a konferencia helyszínét - a Nyugat-magyarországi Egyetemet - a német nyelvű résztvevők szemében bizonyára érdekesebbé varázsolják.

Egy olyan világban, amelyben a német nyelv jelentősége a kultúra és a tudományok terén egyaránt, sajnálatos módon folyamatosan csökken, meglepőnek tűnhet, hogy pl. az erdőmérnök hallgatóink csaknem fele a diplomához szükséges nyelvvizsgát még ma is német nyelvből teszi le. Ennek az elsődleges okát a tradíciók ápolásában kereshetjük, amelynek jogosságát a már régóta meglévő gazdasági, tudományos és kulturális kapcsolatok folyamatossága mindig újra és újra bebizonyított.

Emlékeztetni szeretnék arra, hogy az Osztrák-Magyar Kiegyezésig (1867) az oktatás nyelve a hajdani Bányászati Akadémián német volt és a professzorok között olyan jelentős német nyelvű tudósok is voltak, akik közül minden bizonnyal Christian J. Doppler a legismertebb az Önök számára. Ennek, a már 1735-ben a kontinensen elsőként megalapított műszaki oktatóintézménynek a székhelye az I. világháború végéig az egykori bányászváros Selmecbánya volt, melynek a mai neve Szlovákiában Banska Stiavnica. Az új nemzeti államok újonnan keletkezett határai az Akadémia jelenlegi helyszínére, Sopron/Ödenburg városába történő áttelepüléséhez vezetett. Ez egy kétnyelvű város volt, amelynek Magyarországhoz történő tartozását jelentős mértékben az újonnan érkezettek erősítették meg és döntötték el - egy romantikus történet.

A II. világháború utáni politikai változások következtében a város, amely a német ajkú lakosainak nagy részét a kényszer-kitelepítések révén éppen elvesztette, a kiközösítés státuszába került a”vasfüggöny” biztonsági zónájában. Az ezzel együtt járó számtalan veszteség mellett, amely többek között a bányászat, a fémkohászat és a földmérés leválasztását és áttelepítését jelentette a főiskoláról, a város és egyeteme egy világtörténeti szerepre tett szert, amely az újabb német történelem számára is jelentős lett. Az egyetem tanári kara az 1989-ben Sopronban rendezett ún. Páneurópai Piknik szervezésében döntő szerepet játszott, amelynek során a „vasfüggöny” áttörésére került sor. Ez a bátor kezdeményezés nem várt hatalmas politikai változásokhoz vezetett Európában, végül pedig a berlini fal történelmi leomlásáig. Az áttörés helyén emelt emlékmű, amelyet az áttörés 20-dik évfordulóján Angela Merkel szövetségi kancellár avatott fel, még ma is arra emlékeztet, hogy azok a szándékok, amelyek Európát erőszakkal akarják megosztani, polgári bátorsággal és áldozatkészséggel meghiúsíthatók.

Különösen örömmel tölt el, hogy a Humboldt Alapítvány Európa összenövését a környezeti tudományok és a klímavédelem terén támogatja. Alig van olyan témakör, amelyben az együttműködés és a közös jövőbeli elképzelések nagyobb jelentőséggel bírnának, mint e téren. A konferencia jelentőségét ezért nem lehet eléggé hangsúlyozni. Sopron/Ödenburg város és egyeteme újabb kori története is erre emlékeztet minket.

*A zárszó német nyelven hangzott el.

Schlusswort von Prof. Dr. Csaba Mátyás, Mitglied der Ungarischen Akademie der Wissenschaften

Sehr geehrte Damen und Herren,
gestatten sie mir dass ich meine Gedanken zu dieser Konferenz in der Sprache von Wilhelm und Alexander von Humboldt vortrage. Die im Weiteren ausgeführten Gründe hierfür werden diesen Austragungsort, die Universität Westungarn, in den Augen der deutschsprachigen Teilnehmer sicherlich interessanter machen.

In einer Welt, in der die Bedeutung der deutschen Sprache sowohl in der Kultur als auch in der Wissenschaft zu unserem gemeinsamen Bedauern stetig abnimmt, erscheint es zumindest sonderbar, dass z.B. bald die Hälfte der Studenten an der Fakultät für Forstwirtschaft die für den Diplomabschluss erforderliche Sprachprüfung auch heute noch aus Deutsch ablegt. Der primäre Grund dafür ist in der Traditionspflege zu suchen, die durch die Fortführung lange bestehender wirtschaftlicher, wissenschaftlicher und kultureller Beziehungen seine Daseinsberechtigung immer wieder beweisen konnte.

Es sollte daran erinnert werden, dass bis zum österreich-ungarischen Ausgleich (1867) die Unterrichtssprache der einstigen Bergakademie Deutsch war und unter den Professoren auch bedeutende deutschsprachige Wissenschaftler waren, unter ihnen ist wohl Christian J. Doppler der bekannteste. Diese bereits 1735 gegründete, erste technische Lehranstalt am Kontinent hatte seinen Sitz bis zum Ende des ersten Weltkrieges in der einst wichtigen Bergmannsstadt Schemnitz (heute: Banska Stiavnica in der Slowakei).

Die entstandenen neuen Grenzen der jungen Nationalstaaten führten zur Umsiedlung der Akademie auf ihren jetzigen Standort Sopron/Ödenburg, eine zweisprachige Stadt, dessen Zugehörigkeit zu Ungarn durch die Neuankömmlinge bestärkt und entschieden wurde – eine romantische Geschichte.

Die Umwälzungen nach dem zweiten Weltkrieg brachten der Stadt, die gerade den Großteil seiner deutschsprachigen Bürger auf Grund der gewaltsamen Aussiedlungen verloren hatte, den Status der Ausgrenzung in die Sicherheitszone am „Eisernen Vorhang“. Trotz der damit einhergehenden, zahlreichen Verluste (unter anderem die gewaltvolle Abtrennung und Umsiedlung der Bereiche Bergbau, Metallurgie und Geowissenschaften der Hochschule) hat dieser Zustand die Stadt und seine Universität zu einer weltgeschichtlichen Rolle erkoren, die auch für die jüngere deutsche Geschichte bedeutsam wurde. Der Lehrkörper der Universität hat eine entscheidende Rolle in der Organisation des sog. „Paneuropäischen Picknicks“ in Sopron gespielt, bei dem Ende August 1989 zum Durchbruch des Eisernen Vorhanges kam. Diese mutige Initiative führte unerwartet zu gewaltigen politischen Veränderungen in Europa, schließlich zum historischen Fall der Mauer in Berlin. Ein Denkmal am Ort des Durchbruchs, das zum 20. Jahrestag von Bundeskanzlerin Angela Merkel eingeweiht wurde, erinnert uns auch heute daran, dass Bestrebungen, Europa gewaltsam zu teilen, durch Zivilcourage und Opferbereitschaft vereitelt werden können.

Es freut mich besonders, dass die Humboldt-Gesellschaft durch ihre Unterstützung das Zusammenwachsen Europas auch auf dem Gebiet der Umweltwissenschaften und des Klimaschutzes fördert. Es gibt kaum Themenbereiche, wo Zusammenarbeit und gemeinsame Zukunftsvisionen mehr Geltung hätten. Die Bedeutung dieser Konferenz kann deshalb nicht genug unterstrichen werden. Die jüngere Geschichte von Sopron/Ödenburg und ihrer Universität erinnern daran.

Closing Remarks of the Rector of the University of West Hungary

Dear Mr Mayor,
Dear Mr Kengyel President of the Humboldt Society Hungary,
Dear Employees in the TÁMOP project,
Dear Humblodt Scientists,
Dear Ladies and Gentlemen!

The direct aim of the conference was to establish a scientific consultation that helps at international level the followings:

- promoting collaboration among leading researchers of the environmental and climate protection
- publishing scientific knowledge in relation to the most important research fields as sustainable development, climate change, raw-material and energy utilization
- determining join Hungarian – German education and research themes in the above fields.

Various presentations in the scientific fields of adaptation and mitigation were heard during the meeting.

Presentations in the conference gave information that will help the recognition of the fields and activity of scientific co-operation between institutes and universities. This high level scientific activity contributed to the foundation of joint education as well.

Further aim of the conference was to include industrial professionals into the project. This would give the basis for later industrial work. Taking a glance on the list of the participants this aim was realized successfully.

In the long term it is necessary to structure a widely based interrelationship between Hungarian and German environmental and climate protection that connects the partnerships of science and industry. The following steps of the project will enable the establishment of an international network including the surrounding countries together with active cooperation between existing research groups in the region in the fields of sustainability, environmental and climate protection.

The highly educated specialists for sustainable development, environmental and climate protection will support the accomplishment of the increased level of challenges from the industry in the region.

For all who kindly participated the meeting I wish success in future projects and activity!

Prof. Dr. Sándor Faragó
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A Nyugat-magyarországi Egyetem Rektorának záró szavai

Tisztelt Polgármester úr!
Tisztelt Kengyel elnök úr!
Tisztel Támop dolgozók!
Tisttelt Humboldt tudósok!
Tisztelt vendégeink

A találkozó elsődleges célja egy olyan tudományos tanácskozás létrehozása volt, amely nemzetközi szinten segíti

- a környezet és klímavédelmi szakemberek közötti kooperációt
- tudományos ismereteket közöl a legfontosabb kutatási területekröl, mint a fenntartható fejlödésröl, az éghajlatváltozásról, a nyersanyag- és az energiagazdálkodásról
- a fenti szakterületeken közös magyar-német oktatási és kutatási témakörök meghatározását.

Az összejövetel során sokféle elöadást hallottunk az adaptáció és a mitigáció kutatás szakterületén.

A konferencia keretében elhangzott elöadások olyan témaköröket ismertettek, amelyek a jövöben elősegítik az intézetek és az egyetemek közötti tudományos kapcsolódási pontok felismerését és a közös tevékenység kialakítását. Ez a színvonalas tudományos tevékenység aktívan járult hozzá a közös oktatás megalapításához is.

A konferencia további célja az ipari szakemberek bevonása volt a munkába. Ez a későbbi gazdasági tevékenység alapjait szolgálja. A résztvevök névsorát figyelve ezt a célt a konferencia sikeresen teljesítette.

Hosszú távon szükséges a magyar-német környezet.-és klímavédelemben egy széles alapokon nyugvó kapcsolatrendszer létrehozása, amely összefogja a szakterület tudományos és ipari résztvevőit. A konferencia folytatásaként lehetővé válik egy nemzetközi hálózatnak a kiépítése a környékbeli országokban is, valamint egy szorosabb együttműködés létrehozása a már meglévő szakmai csoportokkal a fenntarthatóság, a környezet és a klímavédelem területén.

A fenntartható fejlödés, a környezet- és a klímavédelmi oktatás során képzett szakemberek a jövőben segíteni fogják az ipar egyre fokozódó kihívásainak a teljesítését.

Minden kedves résztvevönek sok sikert kívánok a további alkotó munkában!

Prof. Dr. Sándor Faragó
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Schlussworte des Rektors der Westungarischen Universität

Sehr geehrter Herr Bürgermeister!
Sehr geehrter Herr Präsident Kengyel!
Sehr geehrte Mitarbeiterinnen und Mitarbeiter des TÀMOP Projektes!
Sehr geehrte Humboldt Wissenschaftler!
Werte Gäste!

Das vorrangige Ziel der gegenwärtigen Tagung war die Schaffung eines Forums, die folgende Aktivitäten auf internationalem Niveau unterstützt

- die Kooperation zwischen den Fachleuten des Umwelt- und des Klimaschutzes
- die Vermittlung von Kenntnissen von den wichtigsten Fachgebieten, wie die nachhaltige Entwicklung, die Klimawandlung und die Rohstoff - und Energiewirtschaft
- Bestimmung der bedeutendsten wissenschaftlichen Fachrichtungen auf dem Gebiet der gemeinsamen ungarisch-deutschen Lehre und Forschung.

Im Laufe der gegenwärtigen Konferenz haben wir eine Vielzahl von Vorträgen im Bereich der Adaptation und der Mitigation gehört.

Die im Rahmen der Tagung vorgetragenen Fachgebiete können dazu beitragen, die wissenschaftlichen Anknüpfungspunkte für die Zusammenarbeit der fachlich betroffenen Institutionen und Universitäten zu stärken und die Schaffung gemeinsamer Projekte zu ermöglichen.

Das weitere Ziel der Konferenz bestand die Einbeziehung von Fachleuten aus den interessierten Industrieunternehmen in die gemeinsame Arbeit.

Längerfristig ist es notwendig, ein internationales Netzwerk zu knüpfen, das die Teilnehmer der Fachgebiete in den Bereichen der Wissenschaft und der Industrie zusammen bindet. In der Fortführung des Treffens kann eine engere Zusammenarbeit zwischen den bereits bestehenden fachlichen Gruppierungen für den Umwelt- und Klimaschutz sowie für die nachhaltige Ressourcenwirtschaft geschaffen werden.

Die Erziehung vielseitig gebildeter Fachleute für die nahhaltige Entwicklung, für den Umwelt – und Klimaschutz wird die Erfüllung der Aufgaben auf diesen Gebieten weiter unterstützen.

Ich wünsche allen Teilnehmerinnen und Teilnehmern eine weitere erfolgreiche Tätigkeit!

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