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The *European Journal of Management and Public Policy* publishes original scholarly papers across the whole spectrum of disciplines encompassing Management and/or Public Policy (widely defined). The areas of interest include Accounting, Finance, Human Resource Management, Organisational Behaviour, Industrial Organisation, Marketing, Public Administration, Public Policy, Transformation and Transition Studies, etc. but this list is by no means exhaustive. The Journal aims to be eclectic and pluralistic and, consequently, multidisciplinary work and work endorsing different (even conflicting) schools of thought is welcome. The Journal desires to be an influential policy forum and therefore the submissions must be primarily policy oriented and capable of influencing the policy processes at both the micro and macro levels. However, good quality theoretical papers, which may also be considered for publication, should clearly demonstrate the potential for replication and further extension by the professionals and policy-oriented scholars. Each paper submitted for publication will be judged, based on its own merit and international standards of excellence. The editors and referees will pay particular attention to the originality of the topic, the quality of the methodological approach, the paper's relevance for future developments of and within the discipline and the overall quality of exposition. Although the Journal promotes high quality, original empirical and theoretical work, high quality review articles are also welcome, especially if they demonstrate excellence to the extent that they may influence the directions of further research on the particular topic or in the focus area. All published papers must be accessible to both academics and practitioners, who should be able to understand papers published without being experts on the particular topic or area of research. All papers submitted will be judged in the first place by the Editor. If the paper is initially judged to be suitable for publication in the Journal, the Editor will send the paper to *at least* two anonymous referees. The referees can recommend a paper for publication without revision, publication with minor revisions, publications with major revisions and to reject publication of a submitted paper. In all cases where they recommend some changes to be made, the referees must provide a detailed report listing all the changes that are recommended. Based on the referee reports, the Editor will decide on the status of the submitted paper. The decision of the Editor is final and cannot be disputed.

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Editorial Board

VERICA GBURČIK

Climate Change and Sustainable Development

Abstract

The objective of this paper is to review contemporary knowledge on global and local climate changes caused by anthropogenic influences and interactions with sustainable development. The facts on presented knowledge have been completed on the basis of international and national sources such as: official documents of the United Nations Environment Programme (UNEP), World Meteorological Organization (WMO), Intergovernmental Panel on Climate Change (IPCC), World Health Organization (WHO), EU Commission documents, European Environment Agency and other relevant international centers and scientific articles and studies.

The aim is to raise knowledge and public awareness about anthropogenic impacts on atmospheric processes such as global warming, climate change and variability, and ozone layer depletion.

The core conclusions are:

The global warming (caused by high emissions of greenhouse gases) of the Earth and high concentrations of ozone depleting substances have the consequences, such as climate change, and have been attributed to human activities (anthropogenic influences);

The solution of the climate crisis and achieving sustainable development lies in the world's orientation towards the use of climate resources, especially renewable energy resources (solar, wind, biomass, geothermal, etc.) and energy efficiency technologies.

Key words: Climate change, Global warming, Sustainability *JEL Codes*: Q51, Q54, Q56

1. Introduction

Two global atmospheric processes and their effects on the Earth were dominant in the last century and are also dominant in the current one: global warming and ozone layer depletion. Both processes are caused by anthropogenic influences. However, the general public does not have enough knowledge and understanding because it is most often informed by the media.

Journalists like to make interviews (particularly in Serbia) with people having opposite opinions, thus causing confusion (Jovanovic, D. 2000). It would be better to make some popular journals devoted to climate themes in understandable form and with exact data for the general public (Nikolic, Z., 2010 and 2011).

The aim of this paper (as a review of contemporary knowledge on global and local climate changes) is to raise knowledge and public awareness about anthropogenic impacts on atmospheric processes such as global warming,

climate change and variability, and ozone layer depletion. The facts on the presented knowledge have been completed on the basis of relevant international and national sources and have been verified on the competent levels.

The following chapter presents and describes: the structure of the climate system, climate change and variability processes, atmospheric ozone and ozone layer depletion process, adaptation and mitigation of climate change and causality of sustainable development and climate resources. At the end, some general conclusions are presented.

2. Climate System

The Earth's unique climate system nurtures and protects the mankind and whole living world on our planet. At the same time, it is never constant and keeps changing in space and time.

At the simplest level, weather is something that happens in the atmosphere at any given time. In a narrow sense, climate is usually defined as the "average weather" or more exactly, as the statistical description in terms of the mean and variability of relevant quantities over a period of time. In a broader sense, climate is the status of the climate system, which comprises the atmosphere, hydrosphere, cryosphere, surface lithosphere and biosphere. These elements determine the state and dynamics of the Earth's climate (Fig. 2.1), (WMO 2003).

Climate is defined as the average state of the atmosphere over a given period of time (months to years) for a particular geographical location. The climate is characterized by a wide range of meteorological parameters; the most common are temperature, precipitation, atmospheric pressure, duration of sunshine and wind. Other elements may include humidity, cloudiness, extreme weather such as thunderstorms, and even the type of soil (dry, arid, desert), (WMO 2008).

The Earth's climate system includes the atmosphere, ocean, land, cryosphere (snow and ice) and biosphere. The descriptors of this complex system include temperature, precipitation, atmospheric and soil moisture, snow cover, cloud cover, extent of land and sea ice, sea level, extreme weather and climate events, atmospheric and oceanic large-scale circulation, and plant and animal habitat. The science of describing climate must take into account the measurements and interrelationships among these descriptors.

So, the climate system is a complex, interactive system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water. The atmospheric component of the climate system most obviously characterizes climate, which is often defined as the average weather over time.

It must be underlined that each locality has its own climate (topoclimate) and this climate is in interaction with the global climate structure. One of the local effects in big cities (heat island) is presented in Fig. 2.2 (Gburcik V. and Tosovic S., 2005).

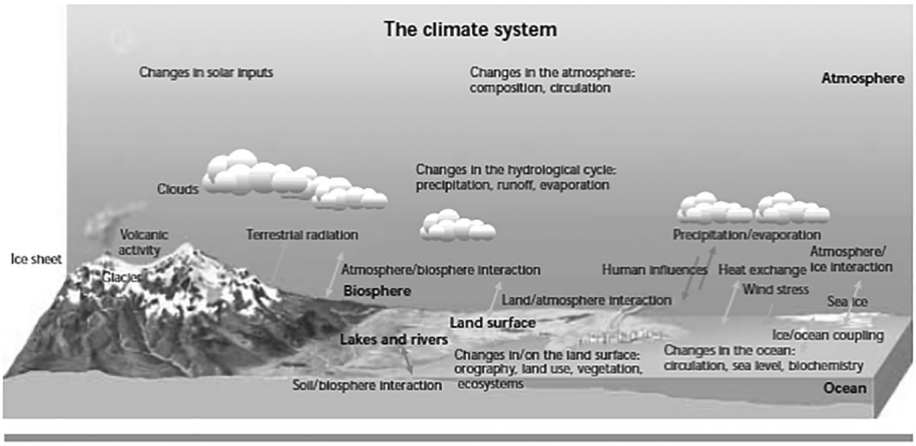

FIGURE 2.1. – Climate system (*Source*: WMO 2003)

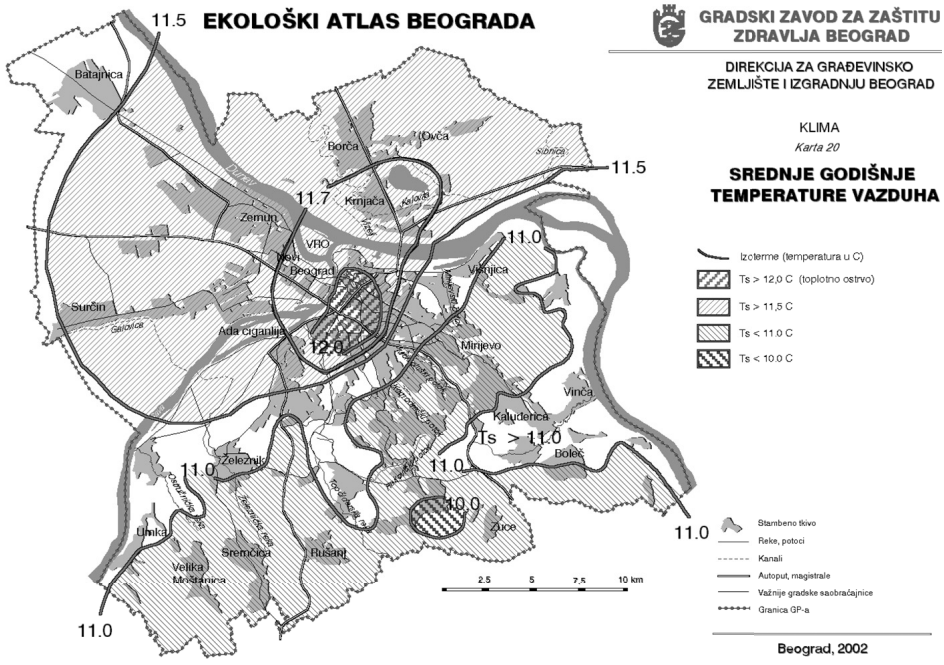

FIGURE 2.2. – Mean annual air temperatures in Belgrade with a significant heat island in the center of the city (*Source*: Gburcik V. and Tosovic S., 2005).

Life on Earth is sustained by the energy radiated by the sun. A phenomenon known as the greenhouse effect, in which gases such as water vapor and carbon dioxide contribute to retaining some of the energy radiated back from the Earth's surface, allowing the temperatures close to the Earth's surface to remain within bearable limits for human beings. Without the greenhouse effect, global mean surface temperature would have been about – 19°C instead of 14°C that prevails at present (WMO 2011). However, this is the theme of the next chapter.

3. Climate Change and Variability

Studies have shown that the Earth's climate has never been static. It is dynamic, subject to variations on all timescales ranging from decades to millennia, to millions of years. Among the most prominent variations is the cycle, over 100 000 years, of glacial periods when the Earth's climate was mostly cooler than at present, followed by warmer interglacial periods. These cycles occurred as a result of natural factors.

Since the industrial revolution (started in 1750), a change in climate has been occurring at an accelerated rate as a result of human activities. This change, which is superimposed on natural climate variability, is directly or indirectly attributed to human activity that alters the composition of the atmosphere.

In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in order to take stock of scientific knowledge on the threat of human-induced climate change. The IPCC is now recognized as the authoritative international, scientific and technical voice on climate change. The WMO hosts the IPCC Secretariat.

Experts generally agree that the Earth is warming up. What is clear is that, globally, 1998 was the warmest year ever recorded and eighth of the 10 other top annual mean temperatures occurred during the decade in the twentieth century (IPCC 2001). Fig. 3.1 illustrates the air temperatures in the period of 1000-2000 years.

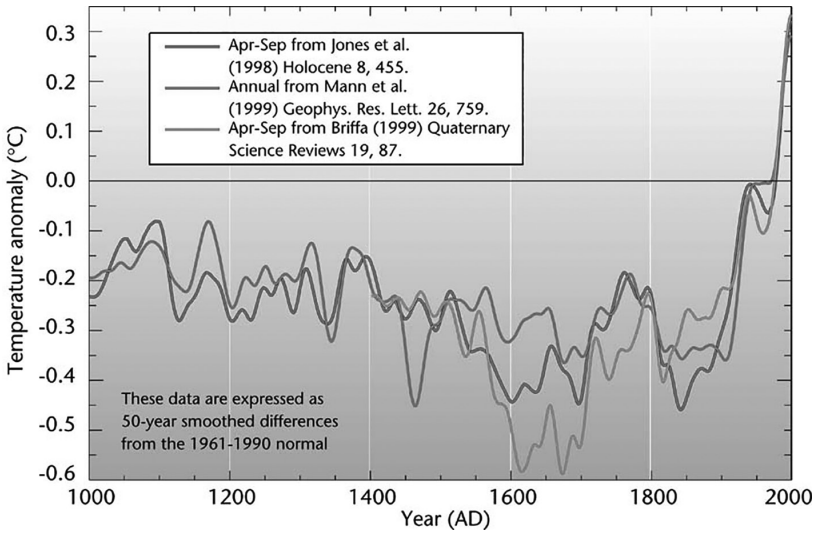

FIGURE 3.1. – Temperature anomalies in the period of 1000–2000 years, analyzed in three international centers (*Source*: IPCC 2001)

The WMO statement on global climate in 2010 (WMO 2011) shows that 2010 tied for the warmest year on record beginning in 1880. The 2010 nominal value of +0.53°C ranks just ahead of those in 2005 (+0.52°C) and 1998

(+0.51°C), although the differences between the three years are not statistically significant, due to uncertainties mainly associated with sampling the Earth's land and sea surface temperatures using only a finite number of observation sites, and the way estimates are interpolated between those sites (Fig. 3.2).

The decade 2001–2010 was also the warmest on record. Temperatures over the decade averaged 0.46°C above the 1961–1990 mean, 0.21°C warmer than the previous record decade 1991–2000. In turn, 1991–2000 was warmer than the previous decades, consistent with a long-term warming trend.

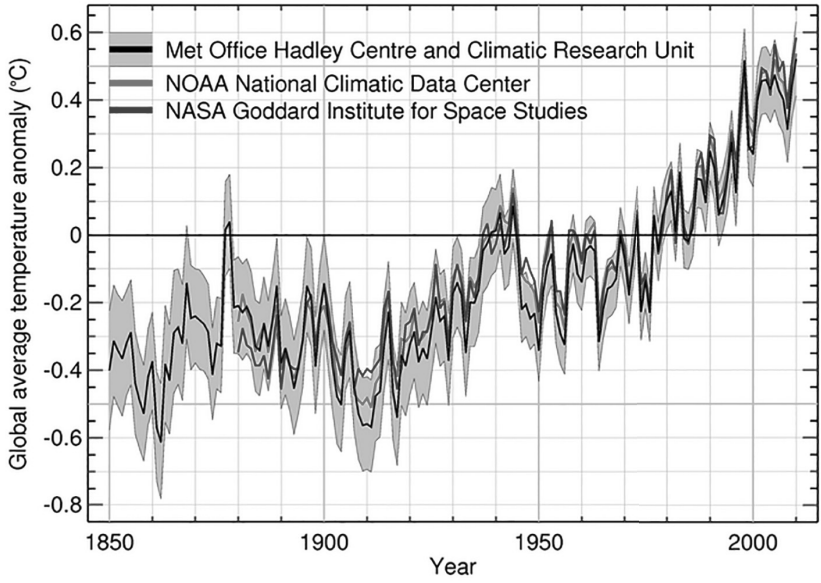

Figure 3.2. – Global temperature anomalies in the period 1850-2010 (*Source*: WMO 2011)

This temperature rise is responsible for the melting of ice sheets in both polar regions. Mountain glaciers around the world are on the wane as well. A rise in the global mean sea level of between 0.09 and 0.88 meters by 2100 has been projected, mainly due to the thermal expansion of sea-water and loss of mass from ice caps and glaciers.

The Intergovernmental Panel for Climate Change (IPCC) Fourth Assessment Report (2007) projects an increase in the globally averaged surface temperatures of 2.1 to 6.1 degrees Celsius, compared to the mid–20th century, by 2100. Nearly all land areas are projected to experience more hot days and heat waves and fewer cold days and cold waves. In a warmer world, the hydrological cycle becomes more intense, with heavier and more frequent precipitation and flooding in many areas. An increased summer drying and the associated risk of drought over most mid-latitude continental interiors are also predicted. A schematic framework presenting anthropogenic drivers are presented in Fig. 3.3.

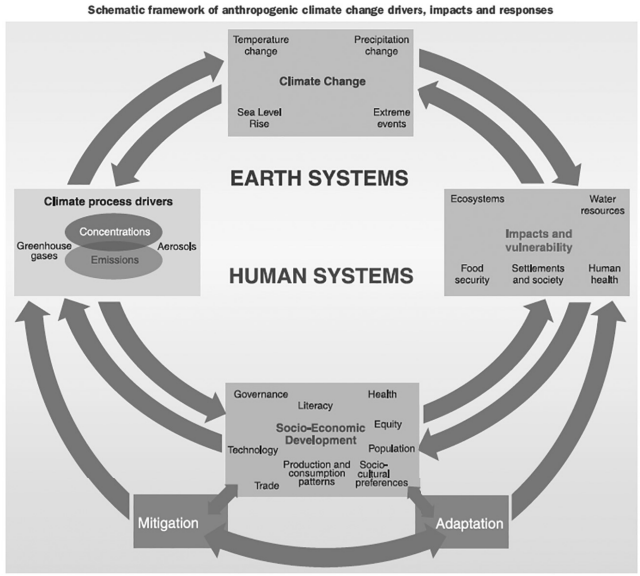

FIGURE. 3.3. – Schematic framework representing anthropogenic drivers, impacts of and responses to climate change, and their linkages (*Source*: IPCC 2007)

Climate change is expected to decrease water availability in arid and semi-arid regions, which could lead to the doubling of the population living with water scarcity over the next 30 years. Areas affected by diseases such as malaria (and waterborne illnesses) could well expand, while crop models indicate a decrease in yields for tropical and sub-tropical areas. It has also been calculated that a rise of more than a few degrees would trigger a fall in plant productivity throughout most regions of the world. IPCC has started work on its Fifth Assessment Report, aimed at refining a number of the previous conclusions, but the whole report, which requires the coordinated work of about 2000 scientists, will not be completed before 2014.

Some diagnostic illustrations from the Intergovernmental Panel for Climate Change (IPCC) Fourth Assessment Report 2007 are presented in Figures 3.4 and 3.5. (IPCC 2007).

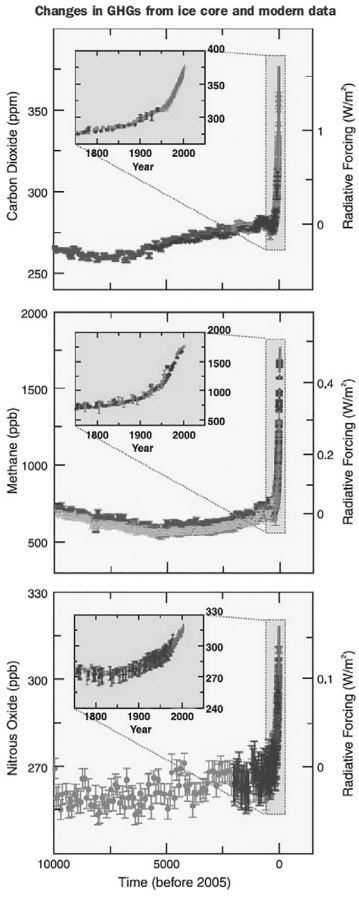

FIGURE 3.4 Atmospheric concentrations of CO2, CH4 and N2O over the last 10,000 years (large panels) and since 1750 (inset panels). (*Source*: IPCC, 2007)

European environment priority areas (EEA 2010) are shown in Figure 3.6.

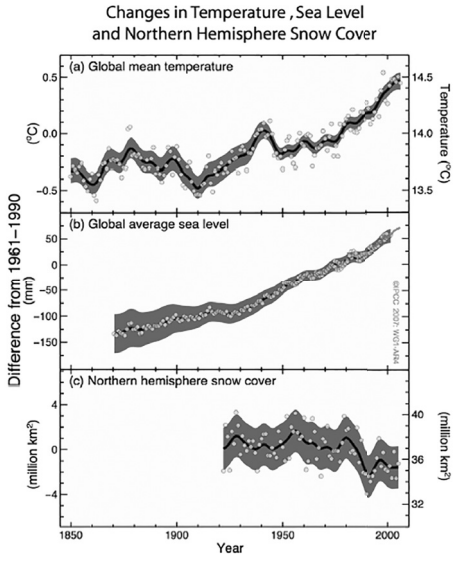

FIGURE 3.5. – Observed changes in (A) Global average surface temperature; (B) Global average sea level from tide gauge (blue) and satellite (red) data; (C) Northern hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961–1990. (*Source*: IPCC, 2007)

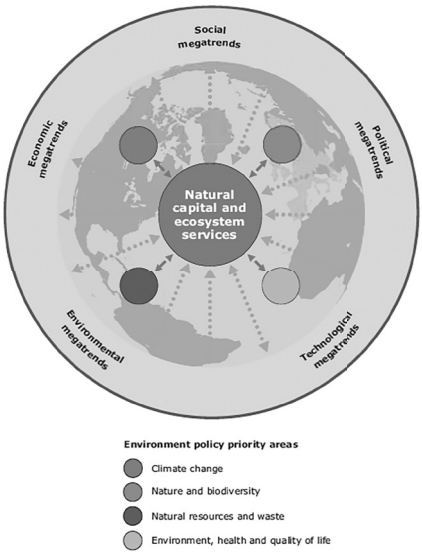

FIGURE 3.6. – European environment priority areas (*Source*: EEA 2010)

3.1. The Difference Between Climate Change And Climate Variability

Climate variability is the term used to describe a range of weather conditions which, averaged together, describe the "climate" of a region. In some parts of the world, or in any region for certain time periods or parts of the year, this variability can be weak, i.e. there is not much difference in the conditions within that time period. However, in other places or time periods, conditions can swing across a large range, from freezing to very warm, or from very wet to very dry, thereby exhibiting strong variability.

A certain amount of this is understood and accepted by the region's inhabitants. Occasionally, an event or sequence of events occurs that has never been witnessed or recorded before, such as the exceptional hurricane season in the Atlantic in 2005 (though even that could be part of natural climate variability). If such a season does not recur within say, the next 30 years, we would look back and call it an exceptional year, but not a harbinger of change. For the scientific community to recognize a change in climate, a shift has to occur and persist for quite a long time.

The Intergovernmental Panel on Climate Change (IPCC) is making considerable efforts in trying to determine, for various hydro meteorological hazards (e.g. tropical cyclones and tornadoes) and related events (e.g. flash floods), whether their occurrence is affected by human-induced climate change. The IPCC Fourth Assessment Report provides evidence that climate change affects the frequency and (or) intensity of some of those events, but further work is under way to refine those findings and prepare a more comprehensive assessment as part of a Special Report to be published in 2011.

The United Nations Climate Change Conference in Cancún, Mexico, ended on 11 December 2010 with the adoption of a balanced package of decisions that set all governments more firmly on the path towards a low emissions future and support enhanced action on climate change in the developing world (UN 2010).

3.2 El Niño and la Niña Weather Type

El Niño, which is Spanish for " the boy child" (because of the tendency of the phenomenon to arrive around Christmas), is an abnormal warming of water in the Equatorial Pacific Ocean every three to five years and can last up to 18 months. Severe cases of El Niño, as in 1997/98, are responsible for drought, flooding, as well as the areas of formation for tropical cyclones and severe winter storms. The 1997/98 El Niño and its associated impacts have been blamed for the deaths of hundreds of people and damage amounting to billions of dollars in 15 countries, especially in the Panama Canal region, but also as far away as the east coast of Africa.

La Niña means "the little girl", the opposite of El Niño, and refers to the abnormal cooling of the ocean temperatures in the same Pacific region.

El Niño and La Niña weather types are acting with global climate change and cause the opposite (La Niña) or superposed effect (El Niño) and so have influenced climate variability.

4. Atmospheric Ozone

Ozone is a form of oxygen whose molecule carries three atoms instead of two. Ozone is found both in the troposphere, i.e. the lower 10 km of the atmosphere and in the stratosphere (10-50 km above the ground). Ozone is our shield against harmful ultraviolet radiation from the sun, so we need ozone in the atmosphere to protect us. However, ozone at ground level is a pollutant. It can cause respiratory problems in human beings and damage to plants and crops, and is one of the major ingredients of smog. Accordingly, whether ozone is "good" (stratosphere ozone) or "bad" (troposphere) depends on its altitude in the atmosphere.

What is happening to the ozone layer?

The ozone layer has been under attack from chlorine (chlorofluorocarbon, CFC) and bromine (halon) compounds abundantly used in the past in products such as sprey aerosol, can propellants, refrigerants, pesticides, solvents and fire extinguishers. When these substances reach the stratosphere, the ultraviolet radiation from the sun causes them to break apart and release chlorine and bromine atoms, which react with ozone. These reactions trigger chemical cycles of ozone destruction that deplete the protective ozone layer (Gburcik V. et al 2006).

Countries have been adhering to the international agreements currently being in force, such as the Vienna Convention and the Montreal Protocol and its Amendments. After peaking recently, the total amount of chlorine and bromine containing compounds in the stratosphere is now slowly going down, but it will probably take 50 years before the amount of chlorine and bromine is back where it was before 1980 (roughly when the first Antarctic ozone hole was observed). Recent scientific reports show that ozone reduction has been less rapid in some regions of the globe, but it could take years before ozone starts to increase again.

The processes of global warming and ozone layer depletion are in an interaction. Global warming and climate change cause changes in the vertical gradient of air temperature and further cause the cooling of the stratosphere, which is conductive to ozone destruction.

Due to the above causes, the World Health Organization and other UN agencies (World Meteorological Organization, United Nations Environment Programme and International Commission on Non-Ionizing Radiation Protection) formulated the Global Solar UVI (Ultraviolet index) using the International Commission on Illumination (CIE) , the reference action spectrum for UV-induced erythema on the human skin -ISO 17166:1999/CIE, (WHO 2002).

5. Sustainability and Climate Resources

The protection of the Earth's climate is possible only by achieving sustainable development. The feedback effect (it seems to be paradoxical) is that only by using the climate resources the human can realize sustainable development (WMO 2002).

The climate resources are: solar energy, wind energy, biomass energy, hydro energy, etc. How much energy we need at the global level is illustrated in the Fig. 5.1. (Greenpeace 2010).

The above cited resources are naturally available. Of course, they are not technically usable, but the technological conditions enable at least 10 per cent of natural resources (on the average). This means: we have (the world) about 300 times more available and technically usable renewable energies than the current energy needs.

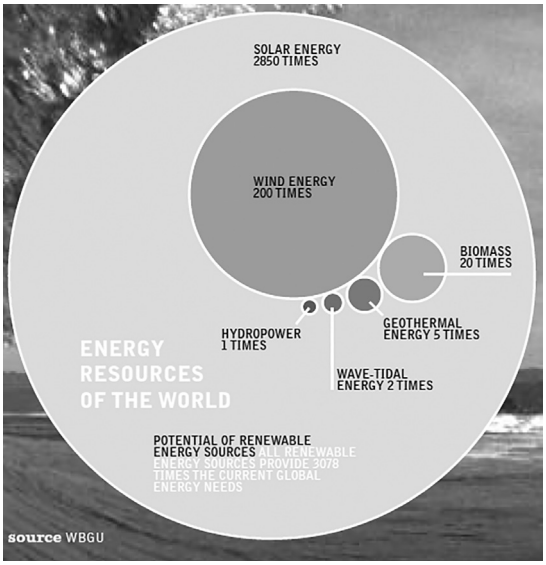

FIGURE 5.1. – Energy resources of the world (*Source*: Greenpeace)

In accordance with EWEA 2010 the annual installations in 2009 were as follows:

- 10.163 megawatts (MW) of wind power capacity installed in the EU during 2009, up 23 per cent more than in the previous years
- A total of 74.767 megawatts is now installed in the European Union with Germany remaining the EU country with the largest installed capacity, followed by Spain, Italy, France and the UK.

What are the renewable energy potentials in Serbia?

The available solar energy potential in Serbia is high (30% above the EU average) and suitable for utilization by active and passive conversion systems (Fig. 5.2).

The available wind energy potential in Serbia is very good, comparable with Germany in energy potential, and suitable for electricity production (Fig. 5.3).

It is necessary to point to the complementarities of solar and wind energy in temporal distribution in Serbia. Maximal wind energy occurs in winter and maximal solar energy in summer. This characteristic is very suitable for hybrid conversion systems (solar +wind).

There are some countries with more modest climatic resources than Serbia, where solar and wind energy is converted into electric energy end fed into the public grid, thus increasing the system's capacity and efficiency.

An inherent problem with climatic resources is that of periodic and non-periodic fluctuations. We have demonstrated in this study (Gburcik V. et al 2008) how the effects of these fluctuations can be significantly reduced by cumulative and complementing use of both solar and wind energy.

Naturally, every locality has some specific conditions, different from the macro scales (due to local climate characteristics), which is illustrated on the above maps (Gburcik V. 2010).

Europe has committed itself to obtaining 20% of its energy from renewable sources by 2020. An analysis of 27 EU member state action plans shows that renewable energy output is projected to grow by 6 % per year on average. Wind power, solar electricity and bio fuels are foreseen to contribute with the highest growth rates. If all member states follow the trajectory outlined in their plans, the EU will exceed its 20 % renewable energy target by 0.7 (EEA 2011).

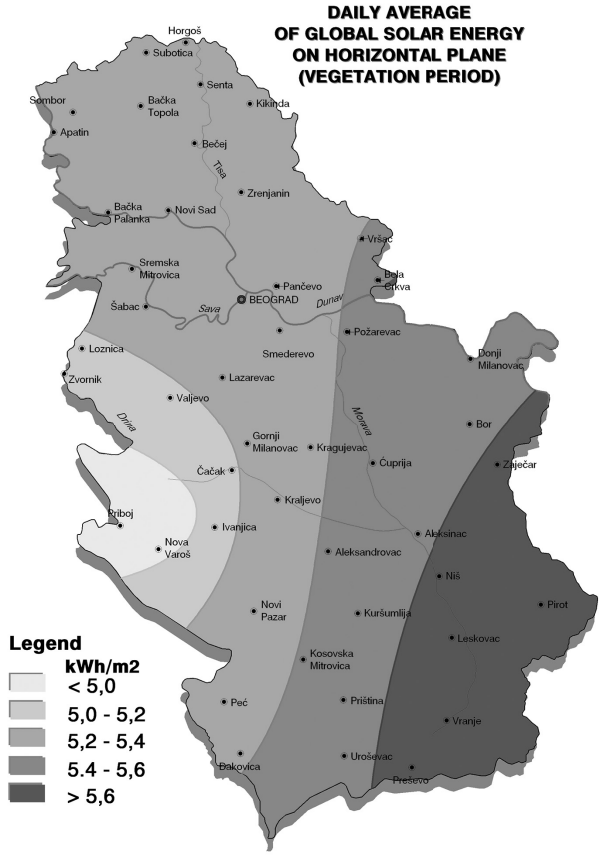

FIGURE 5.2. – Map of the daily average of global solar energy on the horizontal plane in Serbia for vegetation period (April – September), (*Source*: Gburcik V. et al., 2008)

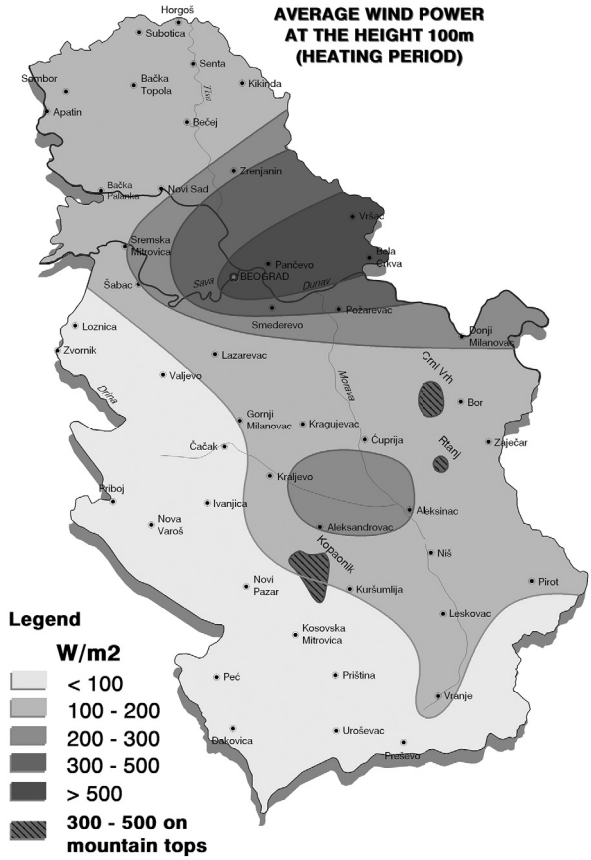

FIGURE 5.3. – Average wind powers at the height of 100m in Serbia for heating period (October – April) (*Source*: Gburcik V. et al., 2008)

6. Conclusions

The global climate change is a reality. There is a consensus of climate scientists.

The global warming (caused by high greenhouse gases emissions) of the Earth and high concentrations of ozone depleting substances have consequences such as climate change, and are attributed to human activity (anthropogenic influences).

The main solution to the climate crisis and achieving sustainable development lies in the world's orientation towards the utilization the climate resources, especially renewable energy resources (solar, wind, biomass, geothermal, etc.) and energy efficiency technologies.

There is no doubt that the amount of energy available from renewable (climatic) sources is large enough to completely substitute fossil and nuclear energy fuels. It is open for discussion as to what strategy and tactics would best

pave the way for returning to the use of climatic energy resources, which are the only warrant of the long-term sustainable development and survival of life on Earth. There is both a long-term and immediate strong motivation for countries with no fossil fuel resources of their own to secure their energy independence from extra import energies.

National strategies have to be directed to the analyses of sensibility, vulnerability, adaptations and mitigations concerning global and local climate change.

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UROŠ RAKIĆ

Planet Earth Is Crying

Almost every day we hear or read news about climate change. Climate change is related to any significant changes in climate (such as temperature, precipitation or wind) for a long time (several decades or longer). Climate change could result from natural factors and processes, or from human activity.

The term "climate change" is often used as a synonym for global warming. Global warming refers to an increase in the average temperature of the atmosphere near the Earth's surface, which may contribute to changes in global weather patterns. However, the temperature rise is only one aspect of climate change.

The collection and interpretation of environmental indicators play a critical role in understanding climate change and causes. An indicator of climate change is the state of certain environmental conditions in a given area and at an appropriate time. The indicators of climate change are temperature, precipitation, sea level and concentrations of greenhouse gases in the atmosphere. The impact of climate change is evident by the following:

Ozone Layer (BBC, 5 April 2011)

By the end of March, 40% of ozone in the stratosphere was destroyed, compared to the previous record of 30%. The ozone layer protects against skin cancer, but the ozone layer has been destroyed by industrial chemicals. The discharge of industrial chemicals into the atmosphere is limited by the UN Montreal Protocol, but due to their slow decay, damage may continue for decades. "The Montreal Protocol actually works, the amount of gases that deplete the ozone layer is falling, but rather slowly," said Geir Braathen, a senior scientist with the World Meteorological Organization (WMO), which coordinates ozone data on a global scale. "Meanwhile, we have a much colder winter than before, and cold periods lasting longer in the spring; therefore, it is a combination of gases and low temperature, and then the sun, and then you get loss of ozone". Dr Braathen presented the findings at the Geosciences European Union (EGU) annual meeting, in Vienna.

The World Meteorological Organization says that this winter in the Arctic was unusually warm at ground level, while the temperature 15-20 km above the Earth fell and remained low. "Low temperatures did not differ from other

years, but the ozone hole has expanded much more in March and April – in fact it is still happening," said Farahnaz Khosravi, ozone expert at the Meteorological Institute of the University of Stockholm, Sweden.

"Usually in cold winters (2010-2011) we observe that about 25% of the ozone disappears, but this winter was really a record – 40% of the column has disappeared," said Dr. Florence Goutail from the French National Centre for Scientific Research (CNRS).

Longer and colder winters in the Antarctic often cause the ozone levels to fall to 55%. The Antarctic ozone hole was discovered by Dr. Joe C. Farman and his colleagues from the British Antarctic Survey. They have been observing the ozone level in the area since 1957. It was also found that the ozone content gradually falls each October, showing a tendency of continuous decline since the late 1970s. The period from September to December in the Southern Hemisphere spring, which corresponds to following the 24-hour cold polar winter night. However, this has no impact on human health, since the region is largely uninhabited – only the southern tip of South America sometimes comes under the ozone hole. Projections indicate that the Antarctic ozone hole will not fully recover until 2045-60.

But, the situation in the Arctic is different. During the past month, the ozone hole was seen over Scandinavia, Greenland, Canada and parts of Russia. The World Meteorological Organization (WMO) advised people in the Nordic countries and Greenland to track information about living conditions in order to prevent any damage to their health. The loss of ozone allows more harmful ultraviolet rays from the Sun to penetrate into the atmosphere. This is associated with the increased rates of skin cancer, cataracts and damage to the immune system.

Ozone is often viewed as an environmental problem that has been solved. The Montreal Protocol, adopted in 1987, and subsequent agreements gradually reduce the amount of many chemicals depleting the ozone layer, such as chlor-fluor-charcoal (CFCs), which were once widely used as refrigerants. In addition, research conducted by Markus Rex from the Alfred Wegener Institute in Germany suggests that winters that stand out as being cold in the stratosphere in the Arctic are even cooler.

Floods (Australia, AAP, January 11, 2011 10:27am)

Thousands of people were invited to leave parts of Brisbane, Australia's third largest city, which is facing its worst floods in decades. Officials say that between 6,500 and 9,000 homes and businesses were flooded in Queensland. The floods in Queensland left 10 dead and more than 70 missing. About 200,000 people were affected by floods. Brisbane is facing a combined wave of water from the flooded Valley Lockyer and the Wivenhoe Dam, which was

so full, but was always under control. Authorities fear that the level of the Brisbane River will reach 5.45m (17.9ft), which is the peak reached during the devastating floods of 1974.

Drought (Associated Foreign Press Wednesday, 10 February 2010)

Scientists have linked a serious decade-long drought in Australia with increasing snow in East Antarctica, reported the Associated Press.

Anthropogenic global warming may play a role in changing extreme precipitations said researchers Tas D. van Ommen and Vin Morgan. This is the so-called "seesaw of precipitation" which links the Australian drought and Antarctic snowfall. Relatively cold, dry air flows to southwest Australia, providing little rain, while warm, moist air flows to east Antarctica, providing plenty of snow. This link explains why the rainfall level was so low in southwest Australia and snow was so high in East Antarctica. It also clarifies the drought's severity in historical terms. In South Australia, a 15 to 20 per cent decline in rainfall occurs in winter, thus the drought that began in 1970 has a devastating impact on agriculture, industry and citizens in the region.

The exact cause of the drought and the extent of human impact remain unclear. Changes in land use, ocean temperature, air circulation and natural variability are also contributing factors. Researchers from Australia and Antarctica have found that high snowfall over the last three decades in East Antarctica is thicker than in any other period in the past 750 years. A major snow precipitation in East Antarctica is expected only once every 5400 years.

An analysis of historical trends can help to determine human impact. Scientists believe that droughts are direct consequences of such climate change and can have an impact on water supplies. United Nations experts told Reuters that the main impact of climate change is on the water supplies, and competition for water resources can lead to conflict. "The main event of temperature rise will affect water supplies," said Adel Grasso, Chair to UN-Water. "This has an impact on all parts of our lives, society, natural systems and habitats."

The year 2010 was the year of extreme weather events

The Earth's atmosphere experienced extreme weather events in 2010. Along the East Coast of the United States in the first week of February snowfall blanketed big cities in the Mid-Atlantic region, from Wilmington to Washington. In the spring, heavy rains brought flooding across the Southeast, including Oklahoma and Arkansas and especially Tennessee, where 33 people died and damages only in Nashville were estimated at about $ 2 billion.

And then came summer, with heat waves in the northern hemisphere. Nineteen nations recorded new record high temperatures – including 53.3° C (128.3 degrees Fahrenheit) in Pakistan, the warmest ever recorded in Asia, reported meteorologist Jeff Masters. Russia suffered its hottest year in 1000 years of history. In Moscow, the hottest temperature ever recorded, turned Russia's capital city into the smoky cauldron. At least 10 000 people died from the heat. The wheat crop was badly damaged and fires spread underground. Peat lands burned and threatened to release toxic amounts of carbon compounds, which already overburdened the atmosphere. One quarter of large glaciers in Greenland slipped into the Arctic Sea. You may also observe other problems. Large chunks of ice that go to oil rigs. High temperatures and fires in Russia will certainly affect food supply in the current and following year.

Floods and landslides have been recorded in China and Pakistan.

In the United States, the second season of intense heat spread from Maine to Pennsylvania in July and throughout the southeast in August. The southwest drought reduced Lake Mead's water level.

In Pakistan, monsoon rains brought a flood of incredible proportions, destroying bridges, roads and dams, and leaving thousands dead and millions homeless. Scientists are beginning to wonder whether the climate system is showing signs of instability caused by a change in its chemical composition, which would add heat and water vapor, and a change in circulation leads to the loss of Arctic Sea ice. More frequent extreme weather is a feature that is common to most simulation models of global climate change in the future. If the models are correct, 2010 could mark an early phase of a longer trend of dangerous times.

(Published 6, January 2010 foxnews.com)

Mother Nature is in a very, very bad mood. Much of the northern hemisphere is in the grip of Arctic air and snowfall is causing hardship and devastation from China to Russia, western Europe and the American plains. In Northeast Asia, the worst winter was recorded for the last six decades. More than 10 inches of snow fell in Seoul, the South Korean capital – the heaviest fall since record keeping began in 1937. Meanwhile, summer in the southern hemisphere is warmer than average. Around the globe, it has become extremely unpredictable.

There are several precedents for the global sweep of extreme cold and ice that has killed dozens in India, paralyzed life in Beijing and threatened crops in Florida. The residents of Chicago sweltered from a potentially killer freeze, Paris endured Siberian cold and Poland counted at least 13 deaths due to a record low temperature of about minus 250°C (–13 F). A series of deadly avalanches in the Alps, in northern Italy caused seven deaths.

2009

The year 2009 was the warmest year in history in most parts of South Asia and Central Africa. The National Oceanic and Atmospheric Administration reported in September that the ocean surface temperature was the warmest in August, according to a preliminary analysis based on records dating back to 1880.

On the second day of the Copenhagen Climate Change Conference, the United Nations weather agency, the World Meteorological Organization (WMO), reported that the last decade was the hottest since records began in 1985 and 2009 could rank among the top five warmest years.

Meteorologists are trying to find the form of heavy rain that hit the equatorial region and southern hemisphere in the past week. At least 20 people died in floods in Kenya, after the rain left thousands homeless (December 2009).

In Australia, the authorities declared a natural disaster along the Castlereagh River, forcing 1,200 residents to abandon their homes for high ground. In Brazil, the number of victims of flooding and landslides over the past four days reached 80 (December 2009).

NASA satellite images: Recordings of land and water changes during the past decade (Wednesday, 6 January 2010 09:14)

Images show the annual variability of Arctic sea ice, droughts in Australia and the decline of the Aral Sea, among others. As part of its 10-year monitoring of climate change, NASA's Earth Observatory presented a gallery showing annual changes in the Earth's land, water and atmosphere in places like Central Asia, Australia, Iraq and the Amazon.

Photos of the Aral Sea reveal the near complete evaporation of what was once the world's fourth-largest inland water body. The southern part now has a slight amount of water at the western margin of its former boundary. Dams built in 2005 cut off the flow of water. The Amu Darya River is used for navigation in the southern part, but its entire flow is diverted before it can reach the sea.

Different types of drought appear in satellite images of Australia. The series of photographs show how the decade-long drought has affected on vegetation in the southeastern states of Victoria and New South Wales. Above average growing conditions in the early 2000s have given way to large, almost degraded areas in agricultural areas along the Murray River.

The marshes of southern Iraq in the valley of the Tigris and Euphrates were once an area with rich biodiversity. In the second half of the twentieth century, due to the construction of engineering projects, the wetlands almost disappeared. After the U.S. invasion in 2003 the marshes were flooded and the

ecosystem was restored. The United Nations Environmental Program study in 2006 concluded that 58 per cent of the wetlands had been restored. But restoration is not the case in the Amazon. Satellite photos show the patterns of deforestation in the Brazilian state of Rondonia. Illegal roads extend deep into the forest. Farmers clear land on both sides of the road, creating a herringbone pattern. When the land becomes too degraded for agriculture, the crops give way to grazing livestock.

Over the past few decades, the evidence of the human influence on climate change has become ever clearer and more convincing. There is irrefutable evidence that human activities, such as electricity and transport, have contributed to a multiple increase in the concentrations of greenhouse gases that are already naturally present in the atmosphere. These gases are now at record high levels in comparison with the recent and distant past. The warming of the climate system is well documented. Satellite images, time records in meteorological services and other records going back to the late 1800s tell us about the warming of the planet. Moreover, there is evidence in geological records, ice, near shore marine waters. Altogether, this shows that our planet is changing. Ice around Antarctica and Greenland is melting. The sea level is rising by 3 millimeters each year. But, there is a possibility that it may rise even more.

Reducing emissions is something that anyone can do in order to help protect the planet and climate. Climate experts show that reducing carbon dioxide and other gases that are discharged into the atmosphere from cars, power plants and other fossil fuels, whether from industrial or residential sources, must be significantly reduced. Fires produce harmful air pollution which far exceeds local regions. Fires generate carbon monoxide which can pose various health problems on the ground. Carbon monoxide is also an ingredient in the production of ground-level ozone, which causes many respiratory problems. The accumulation of greenhouse gases in the atmosphere contributes to climate change and other problems.

The collection and interpretation of environmental indicators has played the crucial role in understanding climate change and the reasons for change. Indicators are defined as the state of certain environmental conditions in a given area over a certain time period. Scientists, analysts, policy makers and others use indicators in order to protect the environment, including those related to climate, and assist in monitoring trends in the state of the environment, key factors having an impact on the environment and the impact on ecosystems and society over time.

Is it sufficient just to understand the problems causing climate change? Will we keep silent and observe calmly how our planet is suffering and crying?

JUGOSLAV NIKOLIĆ

Weather And Climate – Global And Regional Governance

Abstract

Potential possibilities of weather and climate governance have strong economic, environmental, military, health, demographic, social and psychological significance. Modern climatology includes fundamental research problems related to the cycle of energy and water circulation in the *Earth-atmosphere* system. The process of urbanization and the increasing needs for energy cause significant changes in the natural characteristics of the soil and atmosphere. Energy and water balance, among other things, depend on the anthropogenic impacts that can be directly controlled by human decisions. The bad weather can be artificially influenced. The global pollution of the atmosphere due to burning of fossil fuels can be significantly reduced by using climate resources of renewable energy sources. The modern concept of governance and protection, at all levels and in all phases of planning, means defining an acceptable level of risk from the consequences of natural disasters and pollution of the atmosphere due to anthropogenic impacts. Then the intervention may be conducted through the system of preventive, organizational, legislative and other measures with an aim of removing the causes and preventing, or reducing, the consequences to an acceptable level. In order to have favorable outcome of global actions, modern technology and human resources of appropriate expertise are needed, as well as good organization and consistency of interdisciplinary methodological approaches.

Key words: weather, climate, water balance, energy balance, renewable energy sources

Introductory Remarks

Weather and climate have always been the factors in the focus of interest of mankind. Since the very beginning of civilization, mankind has been primarily dependent on weather and climate. Their impact in the distant past have often been interpreted by the supernatural. Seasonal flooding of the Nile River was the main environmental factor that influenced the civilization of ancient Egyptians. Written records of the study of the atmosphere can be found in Aristotle's book Meteorologica from the fourth century BC. This Greek book was saved by the Arabs through whom it reached Europe. Scientists, priests and prophets of Mesopotamia, India and China were very interested in weather and climate. Special deities from ancient religions dealt with the control and artificial influence on weather. Weather and climate have become increasingly significant factors with the development of society.

In recent years, there have been frequent misunderstandings in the scientific and professional public concerning the concepts of weather and climate,

leading to controversy and dispute about the conclusions, regardless of their relevance.

One must bear in mind that weather represents the state of meteorological elements and meteorological phenomena that define the state of the atmosphere over a short time interval, in an observed area. Complex meteorological elements and weather phenomena are mutually closely related and interdependent. Numerous values of meteorological parameters that define the weather in an area refer to the time interval ranging from several minutes to an hour, day, decade, month, season, or vegetation period. The basic meteorological elements and weather phenomena that cause the weather comprise the balance of radiation in the Earth-atmosphere system, air pressure, air temperatures, humidity, precipitation, insolation, cloudiness, evaporation, wind, optical and electrical phenomena in the atmosphere and the like. The mentioned elements and phenomena are the result of the corresponding processes in the atmosphere, the Earth's surface and shallow layer of the Earth (Milosavljević, 1963).

On the other hand, climate is a set of weather phenomena, that is, atmospheric processes, characterized by the mean physical state of the atmosphere over a place or larger area of the Earth's surface in a relatively longer time interval. The mean physical state of the atmosphere is obtained by the statistical analysis of perennial series of measured or observed weather elements and phenomena. In this way not only the mean values of meteorological elements are obtained, which are then called climatic elements, but also the mean and extreme deviations of some elements from the average values, as well as the frequency of their occurrence are determined. The number of climate elements is a variable category that depends on the locality, the climate of which is studied, as some elements are more important than others for particular climatic zones. In addition to meteorological ones, the climatic factors also, include, geological, geomorphologic, hydro-geological, geographical, cosmic and other factors. Climate represents the resultant of astronomical, geophysical and many other factors. It is a reflection of the state of the geophysical system on the planetary scales and its changes are caused by the changes in the geophysical system. The weather and climate of a place, or a larger area of the Earth's surface, have primarily been the reflection of the characteristic of the general atmospheric circulation over the observed area. Climate changes, from the distant past to the present, are reconstructed on the basis of palaeographic data, historical indicators and the available instrumental measurements. Climatic variability by intensity, duration and prevalence can have very different scales. The shortest climatic variability is seasonal, but inter-annual and longer climatic variability are of special scientific and practical significance.

A large number of factors affect the climate and climatic variability, so that the study of climate and climate changes is quite complicated. Two or more processes, which primarily affect the climate, can be superimposed or they

can occasionally act in opposite directions, which additionally complicates the balanced 'adjustment' of the climate system and climate research. In addition, the influence of different factors on climate change depends on the previous and current state of climate. It is conditioned due to a relatively long and different time in which the corresponding processes occur in the oceans, biomass, lithosphere, ice cover and the like.

In recent years, special attention has been paid to the study of anthropogenic factors on changes of the natural characteristics of the soil and atmosphere. Anthropogenic impacts on energy and water balance can be directly controlled by human decisions.

The consequences of natural and anthropogenic atmospheric disasters are numerous and can be seen through several aspects: ecological, economic, military, health, demographic, social and psychological. Hence, one of the most topical problems has been weather and climate management, that is, weather disasters and climatic variability management.

International cooperation with the aim of managing the processes in the atmosphere is of special importance at the global level, as well as the management of hazardous weather conditions at the local level. The phenomena called weather or climate have a universal meaning. This results from the fact that the atmosphere knows no national boundaries. Awareness of global and universal nature of meteorology has long been present. Since man has existentially been dependent on weather and climate, the first international cooperation began to develop just in the field of meteorology.

The first international congress of meteorologists was held in 1873 in Vienna and was attended by 32 representatives of 20 governments. All governments, attending the Congress, delegated their representatives except France. The Congress was a turning point in highlighting the needs of international cooperation in the field of meteorology. It also emphasized the need to establish an international fund for weather projects (World Meteorological Organization, 1973), which was practically realized eight decades later. The non-governmental organization, managing international cooperation in the field of meteorology since the Congress in Vienna ceased to exist in 1951. It was replaced by an intergovernmental organization, a specialized UN agency called the World Meteorological Organization.

As for the issue of management, that is, human influence on the phenomenon of weather, great interest refers to the artificial influence on the storms, precipitation stimulation, fog dispersal, the effect of creating conditions for the masked aircraft flights and the like. As for climate control, special significance is attached to managing the emissions of pollutants from the combustion of fossil fuels, which directly contributes to the development and practical application of alternative, renewable energy sources. General circulation of the atmosphere and the insignificance of borders imply the interaction and global interdependence of renewable energy sources and weather and climate.

There are at least three significant reasons for insisting on renewable energy sources:

- Depletion of non-renewable energy sources;
- Harmful effect of atmospheric pollutants on human health;
- The influence of fossil fuel combustion on weather and climate through the impact on microphysical processes in the troposphere and greenhouse effect.

Among other things the aim of the paper, was to establish the universal character of weather and climate, causes of climate change and natural disasters, possibilities of weather and climate control, as well as the global significance of climate resources of renewable energy sources and their global return importance on weather and climate. One of the aims was to make a practical contribution to the method of using small, unstudied water flows as a significant hydro-potential, that is, potentially significant renewable energy source for a large number of countries.

Genesis of Global Changes and Climatic Variability on Earth

Researches indicate that planet Earth is about five billion years old. The evolution of climate on Earth is closely related to the evolution of Earth, because the atmosphere is part of this geophysical system. Three main sources of data are used to study the evolution of climate on Earth: instrumental measurements, historical records and palaeographic data. Instrumental measurements on a global level existed for a period of one century, and only at a few places for the last two or three centuries. Historical records can be found for the period of two or three thousand years, at a few places, mainly in old cultural centers. The most significant for the long evolution of climate on Earth are palaeographic data from different parts of the world.

There are not many scientific facts for the first four billion years of the evolution of planet Earth. Yet, there is a convincing hypothesis that Earth went through its red-hot state and was covered by thick crust during that period. Thus a geophysical system was created, with the atmosphere as its part. In such a system, the red-hot interior could no longer affect the heat balance of the Earth's surface and its atmosphere. The sun then practically became the only source of energy of the *Earth's surface-atmosphere* system.

Paleoclimatologic studies of fossil plants, animals and minerals have shown that the climate on Earth was constantly changing, from the prehistoric geological epoch to our time, during very long as well as shorter periods.

From about 600 million to one billion years ago, the climate was torrid in all areas of planet Earth. The first ice age appeared at the beginning of the Paleozoic era, 600 to 500 million years ago, after which there was a period of

warm climate; the second ice age appeared at the end of the Paleozoic epoch, from 250 to 300 million years ago. The third ice age appeared at the end of the Tertiary geologic period, about 10 million years ago. At the beginning of the Quaternary period, about two million years ago, the temperature at the poles in winter was descending below zero, and then an ice cover began to form which has been preserved to the present day.

There was a whole series of ice ages during the past 700 000 years. The last ice age occurred in the Pleistocene epoch, from 20 to 12 thousand years backwards. There was warming thereafter, with a maximum of 5 to 7 thousand years backwards. In this period there was a warm humid belt in the North, Sahara was green and abounded in flora and fauna. In such a pleasant climate, cultural centres were developing in Egypt and Nubia.

A cold spell set in thereafter, with a maximum from 1000 do 500 BC, when the general circulation of the atmosphere and climate on Earth were approaching the present ones. Sahara became a desert and due to poor climate conditions the cultural centres moved from Egypt and Nubia to Italy, Greece and Persia.

In the 10th century AD, an appreciable warming occurred, when Greenland was green, Vikings settled there and then came to the shores of North America.

From the mid 14th century to the mid 19th century, a new cold spell set in, known as the Little Ice Age. The warming followed thereafter with the maximum in 1930/1940, when the levels of the Caspian and Aral Lakes dropped to a few tens of meters.

The causes of these big climate changes were different. The climate changes were influenced by astronomical factors due to changes in the position of Earth in relation to the Sun, changes in the atmospheric composition due to strong volcanic activities, movement of the continents, change in plant and ice covers, as well as human activities. Of all these factors, only the astronomical factors were precisely explained by Milankovic's theory (Milankovith, 1941; reprint 1997). All other factors have remained at the level of a hypothesis.

Anthropogenic Factors

The influence of anthropogenic factors on the climate in the past could practically be ignored, because people did not have significant sources of energy. Recently, the influence of anthropogenic factors on the environment and processes in the atmosphere has become dominant. That requires international action in order to put certain human activities under control. An important global strategic goal could certainly be an integrated management of weather disasters and climate variability with the aim of preserving human lives, properties and sustainable development. Policy weather disaster

protection implies planning and continuous monitoring and forecasting, as well as giving announcements and warnings and realizing operational activities in their modification and control. An artificial weather modification is based on the approach to achieve great effects with small efforts. Meteorological science found this mode in the relevant scientific principles that are used through the operational methodology and procedures with the aim of exerting an artificial influence on microphysical processes. In this regard, well organized and equipped services are of particular importance, with teams of experts from different fields who will be able to successfully manage of these disasters.

The knowledge of global and regional factors of atmospheric natural disasters is important for management and planning, particularly in agriculture, water development, electrical industry, construction, health and tourism, as well as for military aims.

The great importance of meteorological factors of atmospheric natural disasters results from their limiting influence on the development of all economic and non-economic activities. Huge, often irreparable, damages to agricultural crops, properties and food production are caused by storm-hail disasters, droughts and frost. Therefore, there is a need for an analysis and of artificial effect on stormy disasters over an area with an aim of defending against harmful effects, through artificial influences on microphysical processes in storms. Weather modification can have different forms. It may refer to the defence against hail and mitigation of the effects of different types of storm processes, defence against frost, fog dispersal, the stimulation of precipitation, etc. An analysis of the possibility of stimulating precipitation is important in the strategy of minimizing the impact of drought, especially in terms of agriculture and power production. In addition, a partial analysis of the meteorological elements and phenomena is significant, especially the impact of wind, extreme temperatures, insolation, rainfall, snow and ice, and evapotranspiration.

It is known that plant species adapt to climatic conditions. In certain conditions, some plants thrive better and have a dominant influence. On the other hand, plants influence a change in local climatic conditions through a direct impact on the albedo (energy transfer), temperature regime, air flow (wind), humidity and other weather elements. The influence of forests, for example, on certain climatic elements depends on the morphological characteristics of the terrain, height and density of the stand, season and plant species in the ecosystem. Climatic conditions are limiting basis for planning and dimensioning of water resources and building facilities, dimensioning of field irrigation and drainage and water supply systems. Climatic factors, particularly the duration of insolation, number of rainy and foggy days, as well as extremely low/high temperatures, are limiting the development of tourism, spa and climatic centres, planning and building of infrastructure, planning of plantations for agricultural purposes (farming), forestry, urban areas (parks), etc.

The management of atmospheric processes fundamentally affects planning and development.

Meteorological parameters such as wind speed, turbulence and atmospheric stability (temperature inversions) influence, among other things, the transport of pollutants, their expansion, concentration, transformation and deposition (the ecological aspect and environmental protection).

The artificial effect aimed at providing masked aircraft flights is significant for military purposes. It is achieved by 'seeding' (ejecting) the substances that act as the reflectors of the wavelengths waves that the radar systems use for tracking. There are other potential application possibilities for using modern technology and know-how for military goals, which are not the subject of this paper.

The Possibility of an Artificial Impact on Atmospheric Stormy Disasters

Many countries, from the most developed to less developed ones, deal with the problem of modification of atmospheric processes. One of the common goals of an artificial impact on atmospheric weather processes is hail control. This effect is illustrated on the example of Serbia.

The previous development of the defense system against hail in Serbia has been based on the radar tracking of hail clouds and insertion of reagents with anti-hail rockets in certain areas of the clouds.

Researches have shown that according to its climatologic characteristics, the Republic of Serbia belongs to regions where the phenomenon of hailstorm is a common meteorological phenomenon, with all its negative consequences. According to financial indicators, hail is, after drought, a natural disaster that can cause the greatest damage to agricultural production in Serbia.

Hail is produced by a stormy mass of clouds called cumulonimbus. The occurrence of these clouds in the temperate continental climate zone, to which the territory of the Republic of Serbia belongs, is linked to the warmer half of the year in 99% of cases. An artificial impact on weather with the aim of defending against hail in Serbia began in 1953, in a smaller part of its territory, but the conditions for an artificial impact on weather over a wider area in Serbia were provided in 1969, when the first meteorological radar was installed and put into operation.

The defense system against hail must be based on relevant scientific principles, defined operational methodology and operational procedures. In Serbia's defended area, about 100 days of cumulonimbus cloudiness per year is observed on the average, whereof 30–50 per cent refers to days with solid precipitation – atmospheric phenomena of ice pellets or hailstones.

The first problem with the effect of modification of cumulonimbus is enormous energy released by these clouds, which is comparable to the energy of a one megaton thermonuclear bomb. This means that the natural process of hail formation cannot be countered by artificially produced energy, such as heat energy; instead, it is necessary to find a way to achieve large effects with small efforts. Meteorological science found a way in the possibility of artificial impact on microphysical processes in the cloud.

The principle of modification of stormy and precipitation processes has been based on the hypothesis of artificial competition by natural processes in cloud systems. The principle refers to the insertion of artificial crystallization nuclei in precisely defined, radar detected parts of the cloud with the aim of redistributing the water potential of the cloud on as many smaller ice balls as possible, thus reducing their size and kinetic energy when falling to the ground.

Crystallization nuclei are needed for the creation of hail in the cloud, that is, tiny particles of an appropriate structure by creation which the creation of hailstones begins. These particles can always be found in the atmosphere, but in limited amounts, so that natural conditions work in favour of the creation of a smaller number of larger hailstones. The idea of artificial effect is to increase the number of embryo hailstones in relation to the natural state and encourage the process of 'stalling' the storm by inserting the reagent (crystallization nuclei) into certain cloud zones. An increase in the concentration of embryo hailstones leads to competition for the available liquid water in the cloud, which prevents ice particles from growing too much. In this way, instead of creating a smaller number of large hailstones by natural processes, influence is exerted on the formation of a sufficient number of smaller hailstones that thaw before reaching the ground.

Defence methodology is based on the use of meteorological radars and rocket systems in order to determine the appropriate cloud zones and insert into them the reagent by the combustion of which releases a sufficiently large number of crystallization nuclei. The procedure consists of permanent observation, using a weather radar system, of the entire defended area, as well as parts of the territory up to 200 km away from the boundaries of the defended area. Two or three weather radars are always on duty which, under normal circumstances, monitor the cloud system over the whole country. In case of observed development of potentially dangerous clouds, the relevant radar centre is put into operation, measuring precisely the microphysical processes within the cloud from minute to minute. If the radar criteria for cloud seeding are satisfied, the radar centre seeks approval for action of a rocket system from launching stations (Fig. 1). Pyrotechnic mixture based on silver-iodide is stored in rockets, which has proved to be the best crystallized reagent. However, harmful effects on the environment of seeding clouds with silver iodide have not been sufficiently explored. Each rocket carries 400 g of this reagent being fired in the rocket and seeded in the cloud zones that are strictly determined by radar, in the temperature zones from –4° to –12°C.

Statistical and physical approaches are the two most important approaches towards proving the efficacy in hail suppression. The weakness of the efficacy assess of the defence system against hail in Serbia lies in the use of mainly statistical methods. By statistical analysis (Radinovic, 1989; Radinovic, 1993), the effectiveness of the defence system against hail is 63 to 74 per cent, and this is not a percentage reduction in damages from hail, but the statistical evaluation of effectiveness of modifying the process of creating hailstones. Researches have shown that during the operation of the hail defence system, a reduction in hail frequency ranges from 15 to 20 per cent (Mesinger F. and N. Mesinger, 1992). The representation of hail damage (per cent), in the target and control areas in Serbia (1971–2006) is graphically illustrated in Fig. 2 (source: the archives of the Republic Hydrometeorological Institute of Serbia).

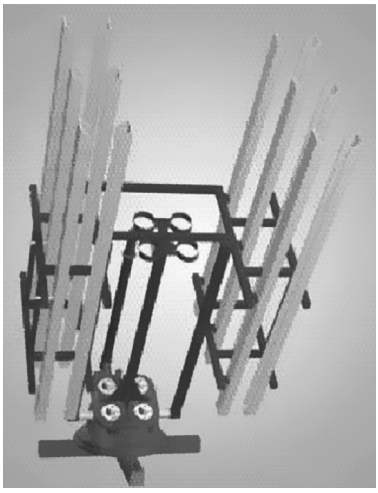

FIGURE 1. – Appearance of launchers for anti-hail rocket launching

A high percentage of hail damage in 1999 is explained as a consequence of war and the lack of a hail defence system against that year. The method of cloud seeding from planes has been an alternative to the rocket system.

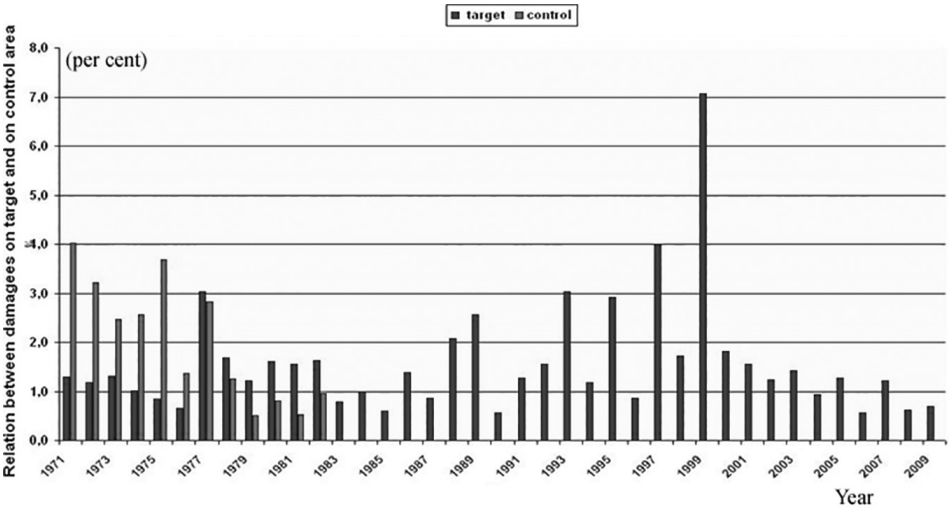

FIGURE 2. – Representation of damage caused by hail in the undefended/defended territory (1971–1982) and defended territory of the Republic of Serbia (1983–2009).

Climate Resources of Renewable Energy Sources

Climate can be defined as a phenomenon and a resource. It is a renewable natural source: energy (sun and wind), material (precipitation) and the basics of the biomass (with geological/morphological base). Climate, as a phenomenon, is defined on the basis of experience with weather phenomena, manifested by atmospheric processes. The classical definition includes mean values, extremes and other statistical parameters of meteorological conditions.

The use of the sun as a clean renewable climatic energy source is of great potential significance. Massive use of this form of energy in the world has not yet come fully to life due to the high costs of solar panels, the problem of accumulation and efficiency of collecting solar energy during cloudy weather. This form of renewable energy source has a huge potential in solving the appropriate technological problems related to the efficiency and cost of solar power plants, as well as problems of intercontinental transport of this form of energy from the climatically most favourable areas to other parts of the world.

As a climatic resource of clean energy, wind is now widely used in the world, primarily due to lower prices of wind generators in recent years. However, wind as a climatic factor relatively rarely meets the optimal requirements for the economic feasibility of wind generators construction and wind electricity generation. Only a small number of sites satisfy the conditions for the construction of windmill farms. Such sites require the presence of wind throughout the year, with speeds above a critical value. On the other hand, high speeds and heavy gusts are not favorable because they may damage the propellers, and wind generators are shut down during strong winds.

The use of biomass energy potential also depends on the site, that is, potential options for biomass production.

One of the potentially most important sources of clean energy is the hydro potential of a large number of smaller rivers. The basins of these rivers mostly fall into the category of so-called unstudied basins. Two out of three basic elements of water balance are related to precipitation and evaporation as climatic elements, and their determination is of strategic importance for practical applications.

Contribution to Solving Practical Problems Related to the use of Hydro Power of Unstudied Basins

On planet Earth, water is in the atmosphere, on its surface and in its crust, forming the hydrosphere of the planet. The upper limit of the hydrosphere is usually defined by the tropopause height as the upper limit of the troposphere. The thickness of the troposphere is not constant; it changes the most at moderate latitudes and is several kilometers lower in cyclones than in anticyclones. The tropopause height is up to about 18 km over the equator.

Approaching the poles, the thickness of the troposphere reduces on the average and is 6-8 km at the poles. Its most common value is 10-12 km in the temperate latitudes.

The lower limit of the hydrosphere is not defined. It can be conditionally defined by the depth of the Earth's crust up to which groundwater's appear in different forms. There are two zones of the groundwater distribution in the profile of the lithosphere: upper and lower. The upper zone includes all waters in a liquid, solid or gaseous state, physical and most of chemically bound water. The lower zone refers to waters in a supercritical state and the part of chemically bound water in minerals. The thickness of the upper zone is 10-25 km on the continents, while it is usually less than 10 km in the area of the oceans.

Under the influence of solar energy and gravity, a continuous process of circular motion of waters is developing in nature. A hydrological cycle includes the process of water circulation in the *troposphere-upper zone of the Earth's crust* system. The cycle is described by precipitation, evaporation and surface/underground runoff through the water balance equation, without taking into account waters in the deep parts of the Earth's crust, in the lower zone, with slow and very slow water movement.

Out of the total precipitation over some basin, one part creates surface runoff (effective or net precipitation). The rest of precipitation mostly infiltrates, partially evaporates, partly retains by interception and then evaporates, and partly retains on the surface in the local depressions of the basin wherefrom it sinks or evaporates. The runoff process includes surface, subsurface and underground runoff, forming the total runoff through direct and basic runoff. The genesis of total runoff (Nikolic, 2010-b) is schematically illustrated (Fig. 3).

Measurements of both water levels and discharges at hydrological unstudied basins are missing, so that runoff cannot be directly determined. Hence, it is especially important to determine the precipitation and evapotranspiration with sufficient accuracy, on the basis of developed models. Thereafter runoff can be indirectly determined, on the basis of the water balance equation.

The determination of precipitation is a lesser problem that can be solved by using the developed models (Nikolic, 2010b). The best are the three-dimensional numerical models for mesoscaled processes that include orographic and dynamic effects based on a physical manner (Frenzen, *et al.,* 1987). Orographic effects increase precipitation with altitude, and dynamic effects cause the size of this increase, as well as decrease of precipitation with a further increase in the height, above the critical value.

The most complex and crucial issue in determining the water balance refers to the problem of determining total evaporation. Evapotranspiration, as integrated water evaporation under natural conditions, represents a complex and hard to measure process, which depends on many factors. Precise direct measurements are possible by using electronic weighting lysimeters, but

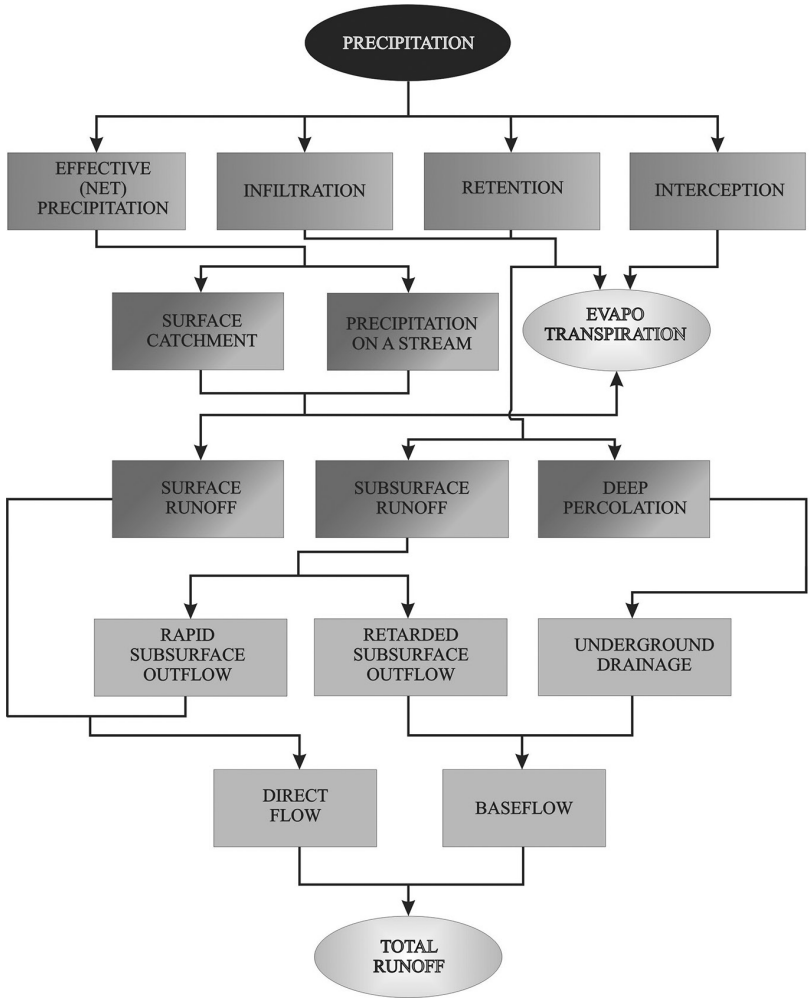

FIGURE 3. – Schematic representation of total runoff

these instruments are relatively expensive, bulky, immobile and rare in practice. Therefore, numerical methods of indirect determination of integral water evaporation are of special interest. The development of models for determining evapotranspiration is important for certain scientific disciplines to the extent to which the water balance is significant, because water evaporation is its main element, in addition to precipitation and runoff.

One of the developed and verified models (Nikolić, 2010-a) has a good physical basis that integrates energy and dynamic effects, as well as the effect of plant physiology. On the other hand, the model does not require special measurements; it is based on the available initial data, which are usually measured in practice. This is of particular importance for the practical application of the models.

Major parameters determining the process of evapotranspiration are modularly established and integrated into the model through its basic equation.

The basic developed equation of the model, derived from using the developed models (Nikolić, 2010-a), is the following:

$$E_T = \frac{0{,}9 \cdot \Delta \cdot G \cdot (1 - A)}{\Delta + \gamma \cdot \left(1 + \frac{r_s}{r_a}\right)} - \frac{0{,}9 \cdot \Delta \cdot R_{ED}}{\Delta + \gamma \cdot \left(1 + \frac{r_s}{r_a}\right)} + \frac{86400 \cdot \xi \cdot \gamma \cdot \frac{\rho_w \cdot (e_w(T) - e)}{p \cdot r_a}}{\Delta + \gamma \cdot \left(1 + \frac{r_s}{r_a}\right)}$$

The list of symbols of the model`s essential equation means the following:

E_T –actual evapotranspiration ($mm \cdot day^{-1}$);
Δ – slope of the saturation of vapor pressure curve at the air temperature ($hPa \cdot K^{-1}$);
G_A –Solar radiation reaching the top of the atmosphere ($mm \cdot day^{-1}$);
A – albedo of the surface;
n – actual observed sunshine duration (hours);
N – maximum possible sunshine duration (hours);
ε – emissivity of the active surface;
σ – Stefan–Boltzmann constant ($\sigma = 5.6686 \cdot 10^{-8}\ W \cdot m^{-2} \cdot K^{-4}$)
T – air temperature (K);
$\varepsilon \cdot \sigma \cdot T^{-4}$ – long wave radiation of the active surface ($mm \cdot day^{-1}$);
γ – psychrometric constant ($\gamma = 0.66\ hPa \cdot K^{-1}$);
ρ_w – density of moist air ($kg \cdot m^{-3}$);
ξ – water/air molecular ratio ($\xi = 0.622$);
P – atmospheric pressure (hPa);
$e_w(T)$ – saturated vapor pressure at air temperature $T(hPa)$;
e – actual vapor pressure in the air (hPA);
r_a – aerodynamic resistance ($s \cdot m^{-1}$);
r_s – crop cover resistance ($s \cdot m^{-1}$);
a_n, b_n – constants determined from measurements, calculated on the basis of relative sunshine duration;
a, b – constants for effective irradiation, empiricaly determined.

The methodology of application includes a digitized relief and spatial-temporal analysis of input parameters obtained by current measurements. The domain of the model is defined in relation to the surface of the observed basin. Resolution of the model, with spatial step $k = \Delta x = \Delta y = 1\ km$ ($k = 100\ m$ around watersheds), provides sufficient accuracy of the calculated values of evapotranspiration in heterogeneous geological conditions of natural environments, which determine its spatial variability. The model includes a module for calculating the surface and aerodynamic resistance, as well as spatial-temporal dependence of albedo, through the parameters available in practice, while the specific impact of geological bases is being parameterized.

The model includes significant energy balance components that primarily influence the process of evapotranspiration, such as the radiation balance of

the *earth-atmosphere* system, latent heat flux, sensible heat flux and heat flux in the base. The methods of indirect determination of appropriate short-wave and long-wave radiation balance components have also been developed on the basis of the parameters on which the radiations mostly depend, which are available to a wider range of researchers. For example, global radiation is calculated on the basis of relative insolation, or cloudiness, with the coefficients adjusted to the concrete conditions of the terrain. For the calculation of long-wave effective radiation, the corrected coefficients are also used. Thus, one comes to a specific approach towards calculating total water evaporation, which is tested and calibrated using direct measurements by electronic lysimeters and measurements from the relevant meteorological station (Nikolić, 2010-a).

Under natural conditions, the evapotranspiration process can significantly be affected by the physical characteristics of the base. Researches have shown (Nikolić and Prohaska, 2005), that the geological base can significantly modify the process of evapotranspiration, which can range from 30 to 80 per cent in relation to the water extracted by precipitation, depending on the geology of the terrain. The model does not explicitly include the influences of different geological bases, but a specific approach to their parameterizations is worked out (Nikolic, 2010-b).

Conclusion

Human activities can initiate the occurrence of atmospheric disasters or climate variability with a different scope of effects on humans, other living beings and material goods. The growing need for energy causes significant changes in the atmosphere and soil, which directly affects the energy and water balance. Global consequences of pollution in the atmosphere caused by burning fossil fuels can significantly be reduced by the global and regional management of weather and climate phenomena and use of climate resources of renewable energy sources.

Strategic priorities in defining the policy of weather and climate management are the harmonization of relevant regulations at the global, regional and local levels, efficient utilization of appropriate human resources through the stimulation of experts with appropriate scientific and specialized references and relevant experience, as well as a consistent interdisciplinary approach.

The paper is a contribution to the understanding of weather and climate, which have been a frequent source of misunderstandings and disputes about conclusions regardless of their relevance in scientific and professional circles in recent times. The irrelevance of borders is emphasized and the interaction, importance and global interdependence of renewable energy sources and weather and climate are implied. The paper is also a contribution to the study of the genesis of global climate change and climate variability, and the

possibility of artificial impact on storm-hail weather disasters is illustrated on the example of the Republic of Serbia.

The depletion of non-renewable energy sources, the impact of pollution in the atmosphere on health and influence of combustion products of fossil fuels on weather and climate are the main reasons for insisting on the global and regional management of the processes in the atmosphere and imposition of renewable energy sources. Precipitation and the evapotranspiration, as the basic elements of water balance and solar and wind energy, represent climate resources. Hence, the phenomena of weather and climate are very relevant and have strategic importance, both at global and regional and local levels.

Measurements are a very significant components of renewable energy sources. A large number of small watercourses, usually unstudied basins without discharge or water level. In these basins, runoff can be indirectly determined by calculating or measuring the other two basic elements of water balance equation: evaporation and precipitation. Precipitation can be easily measured, but the precise measurement of evapotranspiration is complicated and carried out by electronic weighting lysimeters, bulky, expensive, immobile and rare instruments. Hence, indirect determination of evapotranspiration is significant. One possibility is to apply a verified numerical model of evapotranspiration, which is physically well-based and relatively easily applicable in practice.

Evapotranspiration is one of the most important processes of water circulation in nature, and the assessment of water balance is important for science and the practice of many scientific disciplines. The presented model of determining evapotranspiration is applied in almost all industries, especially in water management, power industry, forestry, agriculture, construction and tourism. The described model represents a good physically-based tool to effectively solve many problems: water balance analysis, construction of mini hydro-power plants, planning and control of water resources, solving problems of water supply, irrigation and drainage, designing water projects and numerous other applications in hydrological, meteorological and hydro-geological practice and environmental protection.

From the aspect of sustainable development, the paper includes a practical contribution to the methodology of using a large number of smaller, unstudied watercourses as potentially important resources of renewable energy sources of many countries of the world. On the other hand, the attempt was made to systematize the various aspects of weather and climate, and stress the importance of global and regional actions in terms of control and management. The strategic objective is the integrated management of relevant processes in the Earth's atmosphere as a basis for providing conditions for efficient spatial development, the preservation of human lives and properties and the implementation in the broader contemporary model of risk management of any disaster.

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BRANKO MICEV AND LUKA MITROVIĆ

Warming and Climate Change in Montenegro

Abstract

Does a global climate change have a reflection on the local level? This paper will demonstrate the existence of a local climate change and local warming. Warming identification in the territory of Montenegro will be done for three reference locations with different climate types, from maritime, through continental, to mountainous climate type. None of these highly different climate types representing the Montenegrin climatic regions is spared from warming and climate change, which will be shown here in an exact way. Warming identification will be proved using three procedures. The first procedure through the acting of normalized air temperatures. The second is through climate indicators, which are defined by the World Meteorological Organization. The third procedure is a test of series homogeneity.

Introduction

Over the past 20 years, the territory of Montenegro has experienced climate anomalies and extreme values of meteorological parameters, which can be considered a consequence of global warming and climate change. Climate anomalies can be observered: in a distinct temperature increase, expressive dry periods, heat waves and increase in the number of tropical days, increased index of fire hazards, change in the precipitations regime, heavy rain series, storms, etc. All this has a significant impact on the economic situation. These climate anomalies have mostly been reflected in the most vulnerable sectors such as food production, water sector, energy sector, tourism, transport, etc.

In this paper, an attempt will be made to demonstrate that something that is happening in Montenegro is associated global warming and global climate change using mathematic and statistical methods. The warming process, as a trigger for all further processes, is most important; therefore, focus of our research will be on warming-temperature increase. Three reference locations in Montenegro have been chosen for analyzing the processes of warming and climate change: Bar for the coastal area, Podgorica for the central part and Žabljak for the northern, mountain area of Montenegro.

The periods from 1991 to 2010 were compared to the reference climatic period 1961–1990. Both the summer part, and winter part of the year were observed.

Research, that is, the identification of warming will be conducted in three phases. The first phase will be identification through the acting of normalized temperatures in relation to the basic climatic state for the period 1961-1990. The second phase will be identification through the indicators of climate change, defined by the World Meteorological Organization, and the third phase is an analysis of series homogeneity that is, the comparison of the period 1991–2010 with the climatic period 1961–1990.

1. Normalized Average Monthly And Maximal Three-Month Daily Temperatures

Normalized temperatures show a deviation from the corresponding climatic normal for the period 1961–1990, in relation to the standard deviation for the climatic period 1961–1990. The equation is given below:

$$T^{i}_{nor} = \frac{T^{i}_{god} - T_{kp}}{\sigma_{kp}}$$

where: T^{i}_{nor} – normalized temperature for ith year in series; T^{i}_{god} – temperature for *i* th year in series, T_{kp} – is the temperature for climatic period (kp) 1961–1990 and σ_{kp} – is a standard deviation related to the climatic period 1961–1990.

By using the method of normalized temperatures, we reach the conclusion that in the last 20 year, the area of Montenegro has experienced climate change, which is reflected in extremely distinct warming. In the figures showing long-year series of normalized temperatures, one can easily see the extreme warming trend in the last 20 years and that there was almost no year when the normalized temperature was below zero, which means that there was no year with the temperature below the climatic normal.

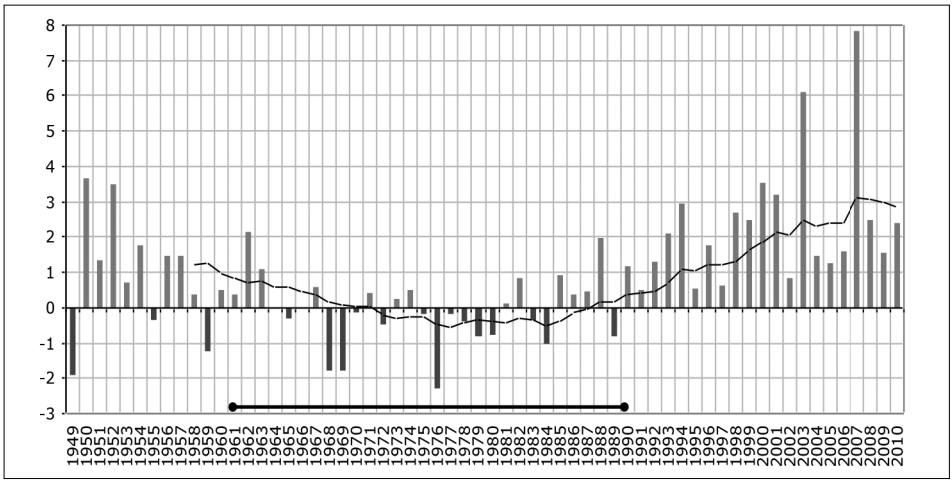

FIGURE 1.1. – Normalized temperature for Podgorica, summer period June–July–August

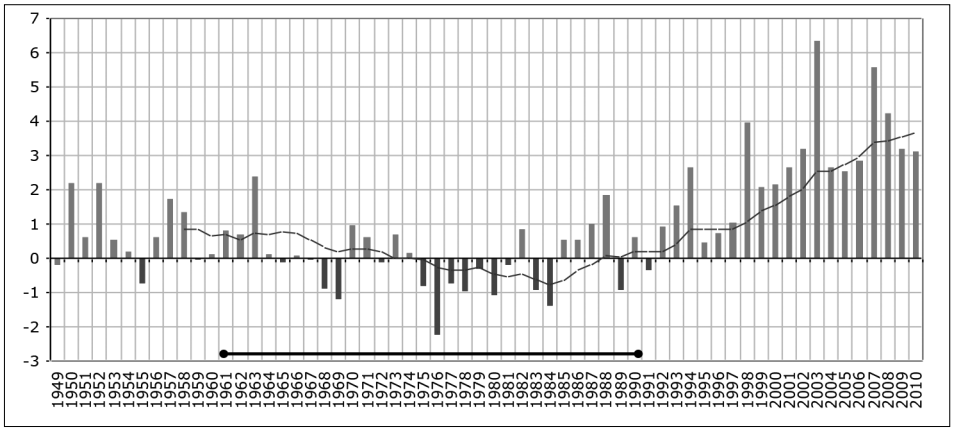

FIGURE 1.2. – Normalized temperatures for Bar, summer period June–July–August

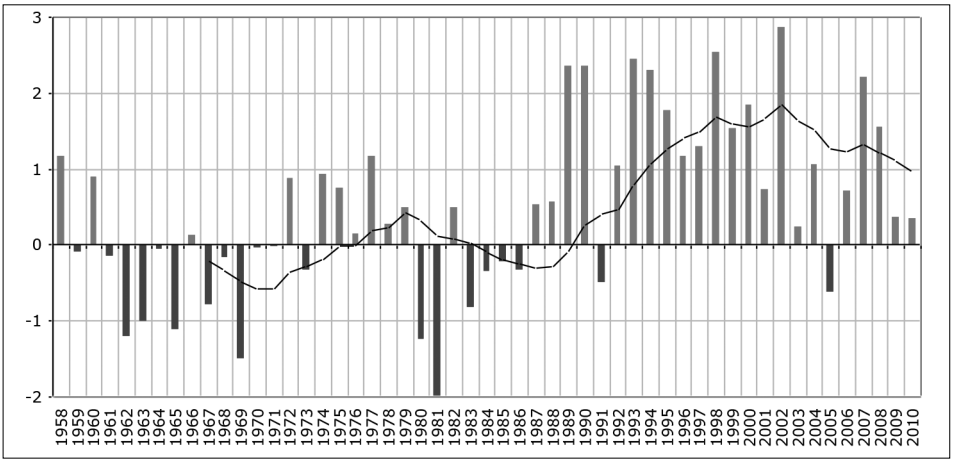

FIGURE 1.3. – Normalized temperatures in Žabljak for winter period December–January–February

2. Climatic Indicators

In accordance with the need for a unique identification of climate change in different parts of the world, the WMO[1] has defined the criteria known as "climatic indicators". There are 27 climatic indicators with the established units – IDU[2]

Here we will present the climatic indicators for Bar and Žabljak, which undoubtedly show the existence of climate change, i.e. air temperature rising trend.

Just three indicators, shown in the following figures, are sufficient to get a clear picture of the level of climate change and climate warming.

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[1] WMO-World Meteorological Organization

[2] Indicator definition unit

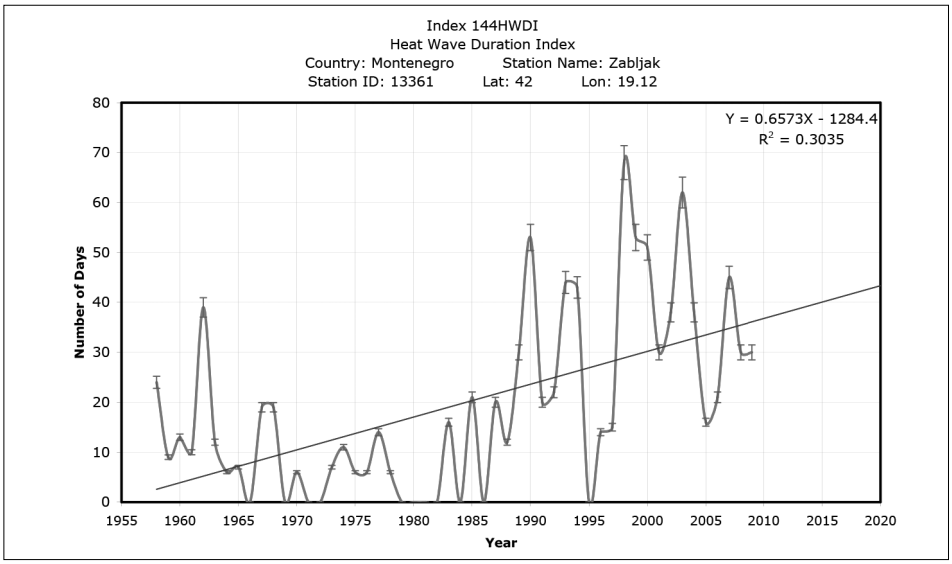

FIGURE 2.1. – Indicator of heat wave duration for Žabljak with the trend line

Due to this upward trend in heat wave duration, we can expect an increase in the duration of heat waves from 35 days at present to the statistically projected 44 days until 2020.

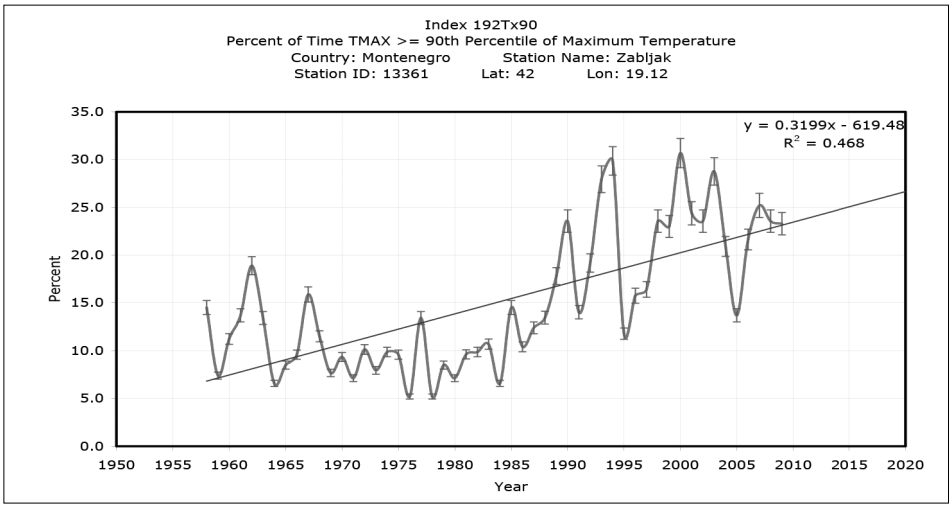

FIGURE 2.2. – Indicator of 90% percentile of maximum daily temperatures with the trend line for Žabljak

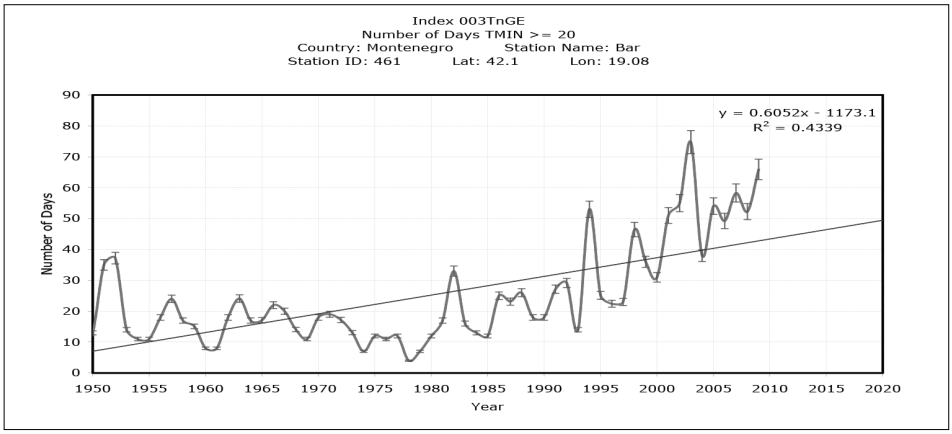

FIGURE 2.3. – Indicator of the number of tropical days in Bar with the line trend

3. Analysis of Series Homogeneity for the Period 1991–2010 in Relation to the Basic Period 1961–1990

3.1. Testing of Maximal Daily Temperatures for January in Zabljak

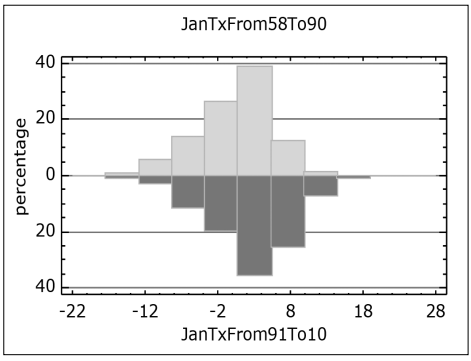

FIGURE 3.1.1. – Comparison histograms of maximum daily temperatures in Zabljak for January (upper part – green, for period 1958–1990., lower part – red, for period 1991–2010.)

Comparison of the Means

95.0% confidence bound for the mean of JanTxFrom58To90: 0.254936 + 0.259015 [0.513951]

95.0% confidence bound for the mean of JanTxFrom91To10: 2.46299 + 0.361492 [2.82448]

95.0% confidence bound for the difference between the means

assuming equal variances: –2.20805 + 0.43763 [–1.77042]

TABLE. 3.1.1. – **Summary Statistics for Zabljak**

	Tmax daily for January from 1958 to 1990	**Tmax daily for January from 1991 to 2010**
Count	1023	589
Average	0.254936	2.46299
Standard deviation	5.03656	5.32529
Coeff. of variation	1975.62%	216.213%
Minimum	–19.9	–15.2
Maximum	13.5	17.7
Range	33.4	32.9
Stnd. Skewness	–8.32585	–3.81222
Stnd. kurtosis	2.09898	0.107749

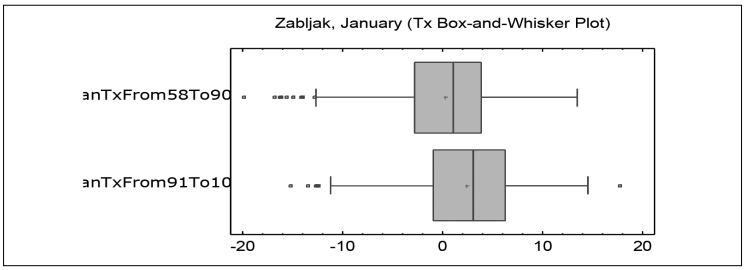

FIGURE 3.1.2. – Statistical review of maximal daily temperatures for January in Zabljak for two periods, first 1958–1990, (upper part of the figure) and second 1991–2010 (lower part of the figure)

TABLE 3.1.2. – **Comparison of Standard Deviations for Zabljak for January (period 1958–1990, first column, and period 1991–2010, second column)**

	JanTxFrom58To90	JanTxFrom91To10
Standard deviation	5.03656	5.32529
Variance	25.367	28.3588
Df	1022	588

Ratio of Variances = 0.894502

95.0% Confidence Bounds
– Standard deviation of JanTxFrom58To90: [4.86027]
– Standard deviation of JanTxFrom91To10: [5.0825]
– Ratio of Variances: [0.792069]

For the Žabljak area it can be said that there is disturbed homogeneity related to maximal daily temperatures during January. Certain statistics are above the permitted values. The graph clearly shows the movement towards higher temperatures in the period 1991-2010.

3.2. Homogeneity Testing of Average Daily Temperatures for June, for Podgorica

TABLE 3.2.1. – **Summary Statistics for Podgorica**

	Tmax daily for June from 1949 to 1990	Tmax daily June from 1991 to 2010
	PGJunFrom49To90Tavd	PGJunFrom91To10Tavd
Count	1230	600
Average	23.0284	24.6655
Standard deviation	3.24165	3.68697
Coeff. of variation	14.0767%	14.9479%
Minimum	13.2	12.5
Maximum	31.3	34.0
Range	18.1	21.5
Stnd. skewness	–3.87825	–3.03079
Stnd. Kurtosis	–2.00984	–0.497539

Comparison of the Means
95.0% confidence bound for the mean of PGJunFrom49To90Tavd: 23.0284 + 0.152034 [23.1804]

95.0% confidence bound for the mean of PGJunFrom91To10Tavd: 24.6655 + 0.247967 [24.9135]
95.0% confidence bound for the difference between the means assuming equal variances: –1.63713 + 0.277996 [–1.35913]

t test to compare the means
Null hypothesis: mean1 = mean2
Alt. hypothesis: mean1 < mean2
assuming equal variances: t = –9.6866 P-value = 0.0
Reject the null hypothesis for alpha = 0.05.

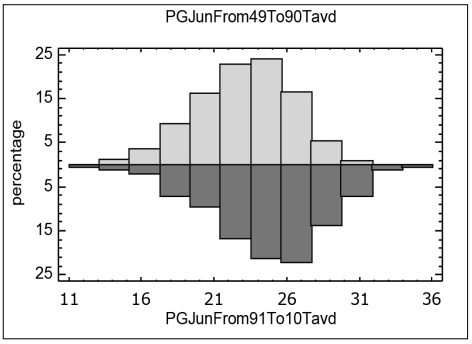

FIGURE 3.2.1. – Histogram of average daily temperatures for June, for Podgorica (upper part of the figure / period 1949–1990, lower part of the figure part / period 1991–2010)

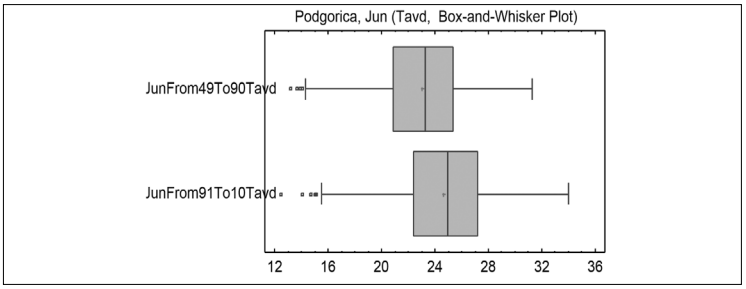

FIGURE 3.2.2. – Statistical review of the average daily temperature in June for Podgorica for two periods, first 1949–1990 (upper part of the figure) and second 1991–2010. (lower part of the figure)

TABLE 3.2.2. – **Comparison of Standard Deviations for Podgorica for June**

	Period 1949-1990.	**Period 1991-2010.**
	PGJunFrom49To90Tavd	**PGJunFrom91To10Tavd**
Standard deviation	3.24165	3.68697
Variance	10.5083	13.5937
Df	1229	599

Ratio of Variances = 0.773024
95.0% Confidence Intervals
Standard deviation of PGJunFrom49To90Tavd: [3.11841, 3.37509]
Standard deviation of PGJunFrom91To10Tavd: [3.48949, 3.90831]
Ratio of Variances: [0.672104, 0.886135]

For the Podgorica area a disturbed series of homogeneity is also evident. The period 1991-2010 is acting as "not belonging to the population" 1949-1990. The basic statistic parameters exceeded the permissible limits. By using certain tests[3] of series homogeneity, one obtains a series that is related to the period 1991-2010 and is not homogeneous with the series 1961–1990.

[3] t-test i F-test

Conclusion

The existence of climate change, i.e. a significant temperature rise in the Montenegro area was determined using mathematical-statistical methods.

The values of the statistic parameters for the period 1991-2010 exceed the statistically permissible ranges, i.e. deviate from the statistical parameters for the population before 1991.

These drastic changes have strongly implicated numerous unfavorable weather conditions. Very distinct heat waves followed with extreme high temperatures directly favoring mass fires with huge material damages to forest complexes and human goods. Losses in human lives are also a direct consequence of heat waves and fires, in addition to a long water deficit, and water supply restrictions, especially during summer months when the demand for water increases manifold. The unfavorable situation with water in the middle of the tourist season has a negative impact on tourist circulation. The absence of snow cover during some winter periods, had a negative impact on the operation of winter tourist centers with developed infrastructure facilities. Water scarcity has an impact on the normal functioning of hydro-power plants and agricultural production. December and January were characterized by heavy precipitation and unusually high temperatures, lack of snow, precipitation in the mountain areas and severe floods as a direct consequence. The lack of snow cover during heavy rains directly contributed to a sudden increase in water levels of water courses and Lake Skadar. Absolute record water levels were observed in water courses and Lake Skadar with severe-unprecedented floods resulting in great damages and losses. Bridges and roads were demolished or damaged. People's goods were damaged, agriculture and agricultural land could not be prepared for production, etc.

In this paper the existence of climatic anomalies, which can be related to global climate change was described in an explicit and exact way on the basis of three points. Local[4] warming is evident and during the same period we could witness a huge correlation level between evident warming and area vulnerability.

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[4] Local in terms of the Montenegro area.

NIGEL CARTER

Is a Carbon Footprint a Personal Issue?

Introduction

The global community is confronting serious challenges as it enters the second decade of the twenty first century. The economic problems affecting many states, within and without the European Community, are relatively minor when measured against a growing population, food shortages and diminishing access to natural resources.

The world's population is scheduled to surpass 7 billion people during 2011, with India scheduled soon to overtake China as the most populous country, each with communities well in excess of 1 billion people. Communities are increasingly becoming urban communities with severe pressure on the supply of clean water, as well as the loss of cultivable land to burgeoning industrial and residential development.

The world is also currently enduring a shortage of wheat. Drought and then floods in Australia and further climatic disasters in the US and Russia have conspired to reduce yields significantly. The 'feedstock' for bread, spaghetti and other basics is increasingly expensive, putting these products beyond the purse of many households.

The recent turmoil in the Middle East has seen the spot price for crude oil (Brent) pass through the US$110 per barrel. Investors seeking security bought gold, sending the price through US$1400 per ounce and the price of copper, a base metal, is threatening to pass through the US$10000 barrier. All of these price movements, indicative of potential short and long term scarcity, threaten the more fragile economies and the potential for growth in developing countries.

However, the threat which outstrips these is that of climate change and global warming. Damage to the ozone layer and the consequential loss of atmospheric strata, which previously protected the Earth from excessive warming, is permitting rising temperatures. Changing weather patterns are blamed for excessive periods of drought, increasingly violent storms, glacial and polar ice-melt and, in the longer run, significant changes to regional climates. These changes are likely to influence agricultural activities, change river flows and dry up lakes and bring desertification to previously fertile regions of the world. Climate change threatens rising sea levels and the potential loss of vulnerable land in locations such as the Maldives, Bangladesh and

Mediterranean countries. Accompanying this land loss will be the loss of species, both flora and fauna.

Blame for this climatic change is being placed on two hundred and fifty years of industrial (anthropogenic) activity which demanded the burning of millions of, initially, coal and, latter, crude oil products and natural gas for energy and power generation. It is the oxidation of fossilised carbon, released into the atmosphere as carbon dioxide (CO_2), which is the fundamental cause of the problem. To the negative impacts of this release has been added the destruction of the tropical hardwood rain forests – a natural 'sink' for carbon dioxide, as the vegetation takes it up in the process of photosynthesis. Huge swathes of rainforest in Equatorial Africa, South America and the Asia Pacific Rim have been destroyed for the exploitation of tropical hardwoods and to make way for indigenous tribes seeking more land to exploit for agricultural purposes. Most recently, the demand for palm oil has prompted further destruction of rainforest in some countries to enable industrial levels of production to be achieved, although rigorous efforts are being made to justify this.

A schematic below shows the carbon cycle and the typical flux and flows of carbon dioxide.

The United Nations Framework Convention on Climate Change (UNFCC, http://unfccc.int) has promoted the Kyoto Protocol to seek government-level agreement to reductions in the emission of CO_2 and other greenhouse gases (GHGs) – methane (CH_4), oxides of nitrogen (NO_x), sulphur hexafluoride

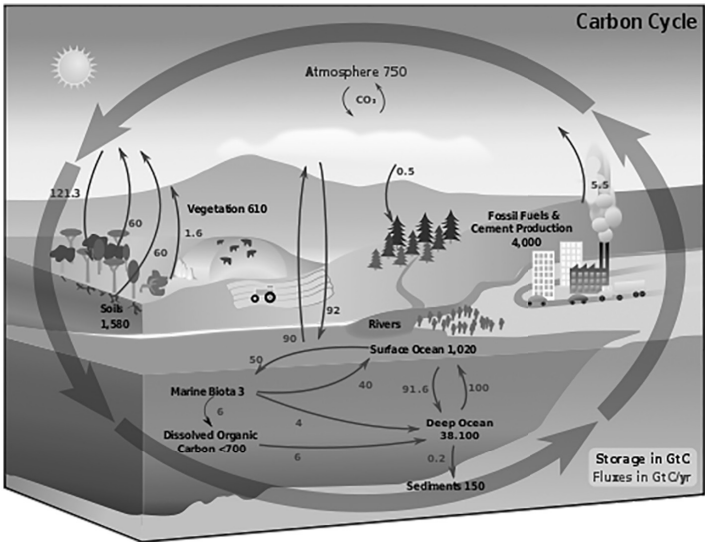


FIGURE 1. – Diagram of the carbon cycle. The black numbers indicate how much carbon is stored in various reservoirs, in billions of tons ("GtC" stands for GigaTons of Carbon and figures are circa 2004). The dark blue numbers indicate how much carbon moves between reservoirs each year. The sediments, as defined in this diagram, do not include the ~70 million GtC of carbonate rock and kerogen. *Courtesy of Wikipedia*

(SF_6), hydroflurocarbons (HFCs) and perfluorocarbons (PFCs) – from a variety of industrial processes, as well as seeking additional reductions in emissions arising from the domestic consumption of energy, from transportation and through better waste management. Currently, 191 countries have signed and ratified the Protocol and the full text and details can be obtained from http://unfccc.int/cop6_2/convkp/index.html.

The identification of the opportunity for the reduction of GHGs is increasingly known as 'carbon footprinting' and this paper is primarily dedicated to the discussion on the emerging processes for identifying the carbon footprinting of products and organizations, and discussing the role of the individual in reducing GHG emissions.

Background to the Carbon Footprint

With the realisation that climate change represented a major challenge to the global community, many governments set about addressing the challenge in various ways. Prominent among these was the United Kingdom, which developed the first national emissions trading scheme (UK ETS, http://www.decc.gov.uk/en/content/cms/what_we_do/ lc_uk/ccas/uk_ets/uk_ets.aspx). It depended upon an 'emissions cap' and encouraged companies reducing their emissions to win financial credits, with which they were expected to trade with companies failing to meet their targets, at a price of about US$20 per tonne of CO_2. A lack of initial rigour in setting the caps enabled companies to readily meet their targets and the few ensuing trades depressed the price of the tradeble certificates given for credits. The scheme failed to meet its initial objectives but recovered sufficiently to be largely mimicked by the European Community's emissions trading scheme (EU ETS, http://ec.europa.eu/clima/policies/ets/index_en.htm.

Few locations in the rest of the world had such regulation in place, but industry still wanted to be able to measure and possibly trade its CO_2 savings and also to take advantage of the Intergovernmental Panel on Climate Change's (IPCC) proposals for creating removal projects through the Joint Implementation (JI) and Clean Development Mechanisms (CDM). *JI and CDM are the two project-based mechanisms which feed the carbon market. JI enables industrialized countries to carry out joint implementation projects with other developed countries, while the CDM involves investment in sustainable development projects that reduce emissions in developing countries* (http://unfccc.int/kyoto_protocol/mechanisms/items/1673.php).

Two initiatives were undertaken to assist. The first was the ***Green House Gas Protocol***, a collaborative effort, prepared and published in 2001 by the World Business Council for Sustainable Development (WBCSD) and the World Resource Institute (WRI). It consists of two volumes – the *Corporate Reporting and Accounting Standard*, introducing guidance on methodologies for

business and other organizations to inventory and report all of the GHG emissions they produce, and the *Project Accounting Protocol and Guidelines*, calculating reductions in GHG emissions from specific GHG-reduction projects. The Corporate reporting and Accounting Standard is a guideline standard which does not offer the opportunity for verified transactions. It identifies emissions typically as Scope 1, that is direct GHG emissions from operator-owned or controlled boilers, furnaces and vehicles; Scope 2, or electricity indirect emissions from the purchase of electricity consumed within an organisation, and Scope 3, or other indirect emissions produced as a result of the organisation's activities, but not immediately attributable to them. Accounting for Scope 3 emissions was optional when the standard was initially published. WBCSD/WRI subsequently published a Project Protocol, a policy-neutral accounting tool for quantifying the greenhouse gas benefits of climate change mitigation projects.

The second initiative was that undertaken by a technical sub-committee (Sub Committee 7, GHG management and related matters) of the International Organisation for Standardisation's (ISO, www.iso.ch) Technical Committee 207 (ISO TC 207), Environmental Management. In 2006, the sub committee completed work on a suite of three standards, ISO 14064.1-3, which embraced GHG quantification and reporting, project monitoring and reporting and the verification of the assertions which arose from the quantification processes. These standards were particularly welcomed by countries seeking to establish trades in CO_2 as they were 'requirements' standards, against which an accredited verification could be achieved. They were supplemented in 2007 by a further standard, ISO 14065, which specifies the requirements for bodies undertaking verification. Further work in progress will see the publication, later in 2011, of a standard – ISO 14066 – confirming the requirements for the competence of GHG verifiers.

These standards, of course, addressed emissions and removals from within carefully defined facilities and organisations. In the period of development of the WBCSD/WRI and ISO standards, further thought was being given to the issue of energy intensity in the provision of goods and services and the concept grew of 'embedded carbon', i.e. the energy consumed throughout the life cycle of a good or service.

The Carbon Footprint

The carbon footprint is established through the application of life cycle principles derived, in particular from ISO's suite of life cycle documents, designated *ISO 1404X*. Principles among these are ISO 14040*, Environmental management – Life Cycle Assessment – Principles and Framework* and ISO 14044*, Environmental management – Life Cycle Assessment – Requirements and Guidelines.* The full life cycle assessment process requires the identification of environmental impacts from all elements of a product's life, including

its application and disposal at the end of its life. In the case of a carbon footprint, the assessment is undertaken exclusively against the impact of climate change.

The first publicly available standard which attempted to address this challenge was the British Standard Institute's Publicly Available Specification 2050 published in 2008 (PAS 2050:2008, www.bsi.com). The standard, supported by the UK government's Department of Environment, Farming and Regional Affairs (DEFRA) and freely downloadable from the BSI web-site

http://www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050, has been available to companies for more than three years, has been widely downloaded and used outside the UK by commercial organisations and has been trialled officially in China. The standard, while intended primarily to make companies more aware of the energy intensity of their activities, has been used to communicate carbon footprint labels.

FIGURE 2. – Example of a carbon footprint applied to a drinks carton

WBCSD/WRI are poised to publish a GHG Protocol module providing expanded guidance on the quantification of scope 3 emissions (http://www.ghgprotocol.org/standards/product-and-supply-chain-standard), enabling companies to understand their supply chain emissions.

Finally, ISO is engaged in the development of ISO 14067 – based on LCA standards from the ISO 1404X series and labelling standards in the ISO 1402X series, a 'requirements' standard addressing the quantification and communication of a carbon footprint on both a business-to-business and business-to-consumer basis.

What's The Point?

Carbon footprinting primarily enables two things – the strategic identification of carbon 'hotspots' in industrial processes, enabling supply chain co-operation – typically, buyer-to-supplier pressure, to reduce these, and the

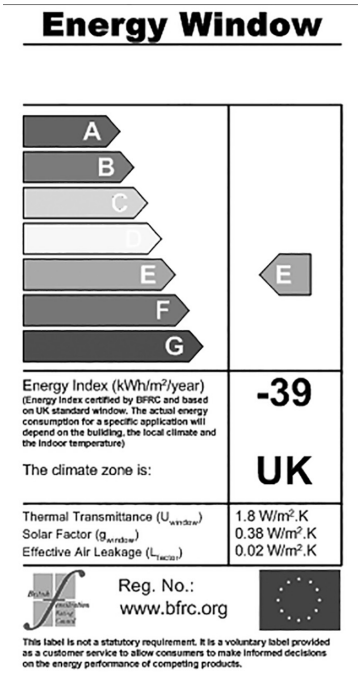
communication to consumers of the carbon embedded in the products they elect to purchase. It is to be hoped that informed consumers will elect to buy products which have been produced in energy efficient circumstances and that the supply lines are kept short, encouraging producers to work to reduce their emissions.

How Can I Help?

The individual has, as employer, employee and as a private citizen, many options to consider in helping reduce their individual carbon footprint.

As an employer – owner/manager or senior board member – you have the capacity to invest in an in-house culture of energy efficient working, supported by investment in energy efficient equipment. This might include everything from a building with a good thermal efficiency, through low energy pumps and modern compressors, to low PC monitors and energy light bulbs, supported, of course, by good maintenance. The opportunity for developing renewable energy resources might also arise. Outside the plant, investment in low emission vehicles for distribution and for essential business car users would be a further initiative, followed by consideration for the need for travel and whether, in future, video-conferencing and similar tools might not be an option. Relationships with suppliers become increasingly important with the opportunity to co-operate on the development of energy efficient components and better logistics.

Some governments are now offering tax incentives to encourage industrial organisations to invest in low energy equipment.



As an employee, there are probably limits to those initiatives which might be undertaken personally. However, ensuring that lights, PC's and PC monitors, printers and other electrical equipment are switched 'off' is an immediate opportunity. The management of heating and/or air conditioning is another consideration. Working in shirtsleeves in an overly heated office in winter and having to pull on a jumper to work in an overly cool office in summer seems illogical when adjusting thermostats by one or two degrees might help reduce energy consumption in quite a big way. As a driver of delivery vehicle, do you switch off the engine during deliveries? This has the helpful action of reducing fuel consumption and reducing emissions!

As an individual at home, many of the actions discussed earlier are relevant. Is walking or cycling to work an alternative to taking the car? The choices of domestic equipment – refrigerators, televisions, washing machines – offer low energy options. Renewable energy purchased from national grids remains an option for most consumers seeking to use renewable resources, although the use of photovoltaic cells (subject to their price!!) as a local source is a growing alternative.

An example of the energy rating label now in regular use across the European Union is given below. A green, 'A'-rated appliance is the most desirable in any category.

So, can the individual help reduce our global carbon footprint? Yes, of course, at a personal and professional level and, by encouraging others, make their action LOCAL!

MATJAŽ MULEJ

Survival: Climate Change and Innovation of Habits Toward More Social Responsibility of Humans

Abstract

The European Union's definition of innovation is broader in its basic document than in its statistics, which reflects the technological innovation only. Thus, the practical decision making has a one-sided and therefore misinforming basis. This has lasted for the entire industrial and information society periods. The dangerous climate change results from this absence, or lack, of requisite holism. The recent decade has seen official awareness of this dangerous absence of holism: the United Nations and European Union launched documents supportive of social responsibility. In 2010 the ISO 26000 went a crucial step further: it calls (1) holism and (2) interdependence the two common denominators of social responsibility. Thus, these documents are asking for innovation of habits for humankind to overcome its dangerous economic theory of so far – the neo-liberalistic abuse of Adam Smith's liberalism. Climate change can be addressed, once this innovation of habit, not technology only, has been attained by promoting social responsibility.

Key words: climate change, innovation, neo-liberalism, requisite holism, social responsibility

The Selected Problem and Viewpoint of Dealing with it here

Climate change that humankind is facing today results from the radically changed conditions of life due to changes in production over the past two centuries. Innovation of the prevailing habits, not technology alone, toward more social responsibility replacing the one-sidedness so far is unavoidable for the current civilization to survive. We will leave the possible untouchable natural processes aside and concentrate on possible human activities.

Some Data Summarizing Climate Change as a Consequence of Human Habits so far

One must take into account the radically changed conditions:

- Since 1820, after the 3 (three) % per-millennium growth before industrialization, growth has reached 5500% (fifty five times) in less than two centuries; humankind is now facing three bombs – population, ecology, and resources, but is nevertheless using shallow information versus deep knowledge and versus wisdom available (Targowski, 2009).

Since 1945, in six decades only, humankind has grown 2.5 times, and its economy and consumption of natural resources have grown 7 (seven) times. But the Planet Earth has not grown and is becoming critically depleted (Bozicnik et al., 2008; Brown, 2008; Dyck, Mulej et al, 1998; Ecimovic et al., 2002; Ecimovic et al., 2007; Korten, 2009; Plut, 2009; Stern, 2006, 2007; Taylor, 2008; Wilby, ed., 2009; etc.).

- Due to human habits resulting from the above reflected development, humankind now emits each hour (!) four million tons of CO_2 into the atmosphere and 1.7 million tons of nitrogen in to arable soil, while cutting 1.500 hectares of woods; this makes 13 million hectares a year, according to Reuters, which is one size of Slovenia (or New Jersey, USA, M. M.) every month (Trstenjak, 2010), on average in 2000-2010 and even 16 million hectares a year earlier (Keršič Svetel, 2010); thus we face a very dangerous growth of air temperature that is visible in melting of icebergs etc. (See: Mulej, Hrast, editors, 2010, for details). This causes very dangerous climate change (Hamman, Ecimovic, Mulej, 2010). Many kinds of innovation are badly needed (See Table 1 for types of innovation).
- We are all on the same – sinking – boat (James, 2007), but on different decks. The poor are not organized enough and cannot change the current trend, while the rich are well off and not willing to change it. In order for humankind of the current civilization to survive climatologists warn of the need to reduce emissions in the air, water, and soil by 80%, which can be attained with the given technologies, but not without critical changes in the current consumption patterns and big structural changes in production and use of energy (but: the point is not in any change, but the innovative ones, providing new benefit to their users!). – Only the renewal of natural preconditions for our civilization to survive, after decades of competition by destruction of nature, would cost more than both world wars, in a best case scenario, if the action is immediately undertaken; postponing the action may increase the cost to beyond 20% of the worldwide GDP (Stern, 2006, 2007). The current affluence (James, 2008; Porter, 1990) makes GDP an obsolete, or insufficient (at least) measure of success, because it disregards crucial aspects of human well-being and happiness. They only started to work on new measures (see: Mulej, Hrast, editors, 2010, and references in it; Stiglitz, 2009a, b).
- The theory that economic growth is unavoidable at any price (Baumol et al. 2007) is equally leading to a blind alley as is the neglection of humans' natural environment and happiness; it is related to the above cited piling up of a tremendous cost threatening to cause poverty and no well-being for the generations to come, due to the lack of social responsibility (SR); see ISO 26000 (ISO, 2010). What leads to poverty without SR and well-being is the usual combination of current actions showing in synergy that only 15-20% of humankind benefit from an innovative society that ruins natural preconditions living 100% (only 15% of humankind live on more

than six USD a day (Nixon, 2004), but this data covers situation before the 2008–crisis.). The data that the income level of poorer people, making people unhappy (and poor purchasers) in the entire worlds population, are higher than ever before in history, and are exact only in bookkeeping terms, rather than in real economic terms (references above). A good picture is only a monetary one. Satisfaction with it is similar to satisfaction with being alive when falling from a high skyscraper and passing the second floor alive. Data are not requisitely holistic (RH) enough for the theory backing it in order to show the way out from the current blind alley. (See Table 2 for the concept of requisite holism.)

- A similar blind alley is the destruction of ambition by affluence (Table 3); it is reflected in drug abuse and the like rather than having motivation growth, while creativity is the central human attribute (Mulej and Prosenak 2007a, b; Skafar, 2009; etc.) Such findings put questions that do not tackle only knowledge, but also human values, culture, ethics, and norms, in interdependence (VCEN). VCEN direct acquisition and use of knowledge in interdependence with VCEN (Mulej 1974 and later, also: Mulej et al. 2008; Mulej, Hrast, editors, 2010; Potocan, Mulej 2007; etc.).
- Unemployment is growing because technological innovations replace human labour with technical equipment and because economists, business persons, and governments have wrongly predicted that market growth will last forever; they disregarded the data that only 15% of humankind live on more than six USD/day (Nixon, 2004), while the other live in poverty, or modestly, or in a saving rather than consuming life-style (James, 2007; Mulej and Hrast, editors, 2010; Prosenak, Mulej, 2008; etc.). Countries' debts have a negative impact on financial markets, as a visible sign of feelings of the most lively, speculative, and influential parts of businesses, around the world. The United States expect a new crisis; Greece and Ireland received EU's support to survive; Portugal is expected to be the next needing help, while Spain's debt is bigger than the debts of Greece, Ireland, and Portugal combined, and this situation also affects China (Nicolaci da Costa, 2010). Most countries of the world are now showing their data, according to which their liabilities exceed any acceptable limit, because they have been using a short-term and narrow-minded strategy, as the public media reported on a daily basis in 2010 and 2011.
- In Europe, which is quite rich and wanted to become the world's strongest economy, every 6th person has a hard time paying his or her bills; three out of four of them think that poverty has grown and they worry about keeping their jobs; more than 50% of them fear that they will not find another job in six months, if they lose the current, and do not trust their pensions will enable them to live a decent life in their old age; the Lisbon strategy failed, the new strategy with the same aim is called Europe 2020 (Vidic, 2010).

Nearly a billion people in the world today suffer from hunger. Every six seconds a child dies due to illness related to hunger and poverty. In sub-Saharan Africa, 30% of the entire population suffers from hunger (data are quoted in: Vidic, 2010.).

- The current pace of work and 'bombing' with data aimed at becoming information, i.e. influential messages, are too much for most humans (Zgonik, 2011a). In pre-industrial agricultural society, European farmers had a much shorter work-time per year, because they were not making a living from growing rice like in southern China (Gladwell, 2009). In essence, we all depend on history and genesis over several generations (ibid.); this is in line with Mulej's 'Law of 2-generation cycles' (Mulej, Ursic, 1991). After WWII the market required enterprises to supply anything for a few years only, then they had to compete with lower costs (in the 1960s), and add high quality to low prices (in 1970s), and a broad range of choices to both of them (in the 1980s), then uniqueness to all of them (in 1990s), and environmental care to all of them (in 2000s), and SR to all of them (in 2010s). All additional requirements have demanded more and more innovation in order match something we call 'systemic quality' (Mulej et al., in press). The system here means a complex feature and complex picture of this complex feature. Though, innovation alone did not enable humankind to avoid a crisis in 2008, because it stressed technological innovation only, or much more than non-technological ones (Table 1).
- The above data do not show the essence of the problem, but only its visible consequences. The problem did not grow on a tree; it results from human behaviour that lacks social responsibility for humans to be less selfish for selfish reasons, i.e. less short-term and narrowly oriented in their behaviour than so far – in order for the current human civilization to survive, including themselves. The Planet Earth can live without humans (again, like millennia ago), but humans cannot live without a healthy Planet Earth, including a healthy climate) and therefore without a healthy economy (Hrast, Mulej, editors, 2010; Mulej, Hrast, editors, 2010; Mulej, 2010; references quoted above; etc.).
- No influence over multinational companies is possible, because international law cannot be enforced, thus being no real law, and the world-democracy including a world government has never so far been accepted, although efforts have been made for decades (Martin, 2008; Martin, Murphy, editors, 2009). Thus, the most crucial sources of one-sided rather than requisitely holistic and socially responsible behaviour cannot be off.
- In sum: the neo-liberal concept that *one must diminish the cost at any cost* is too costly to be acceptable and viable any longer (if it has ever been): it costs lives of the entire humankind. The danger is also reflected in climate change; it requires innovations altering the basic human habits over the past two centuries. Greed should no longer replace need.

Thus, for very economic reasons, the invention-innovation-diffusion process (IIDP) and innovation, as its outcome, need a broader definition than a technology related one only. The EU's definition (EU, 1995, and later) is broad enough, in principle, but not elaborated in any detail, and only technological innovation is measured. This causes misinformation in statistics, which provides the basis for governments', businesses', and individuals' decisions. To reach SR and thus to find a new way out from the current socio-economic crises, a broader definition is needed.

The Breadth of Perceiving Innovation Under the Current Conditions

Forty years ago the OECD provided its broad and rather realistic official definition of innovation (in 1971); but many still tend to limit this term to technological innovation, including official international statistics. But, does technology alone create the future, as it seems to be since the times of industrial, post-industrial, information revolutions, etc., or is it a tool of decisive humans and their followers (Collins, 2001; Collins, Porras, 1994)? If it is a tool, which it certainly is, does either one-sidedness or RH in humans' behavior show the way out of the current long-term crisis? The data on the results of the recent decades reveal the dangerous impact of one-sided decision makers and the need for RH (Bambaren 2010; Bozicnik, 2007; Bozicnik et al., 2008; Harris, 2008; Stern, 2006; Stern, 2007; etc.). SR reflects RH and wholeness of outcomes based on a RH approach to work.

The official international definition of innovation does not cover only technology, but statistical guidelines in the related Oslo Manual cover technology also:

> »Innovation is the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organization, and the working conditions and skills of the workforce« (EU, 2000a: 4).

It is well meant, but superficial and limited to enterprises, unless the word "management" also covers societal management, i.e. government. Hopefully, the word "workforce" includes governors and managers, besides lower ranks. The same word applies, hopefully, to public servants as well. In addition, the word "changes", in daily usage, is not limited to beneficial changes, which innovations are, both for their users and, later on, their owners and authors; it covers all changes, including detrimental ones. Last but not least, this definition says nothing about the human attitudes, habits, VCEN, which have turned out to be the most necessary types of innovation, as soon as the quoted data are accepted that say that the neo-liberalistic VCEN have prompted the need for innovation.

In the current trends, innovation may not be reduced to IIDP of products and services; rather it must also cover the non-technological issues, or be above all else. Technology is an important tool, but only a tool of humans (see Table 1).

Innovation of VCEN tends toward SR, ethics of interdependence, sustainable future, and RH of approach leading to requisite wholeness of outcomes of human behavior (see Table 2). Management style–and VCEN-related innovation is the most influential: by the switch from 'I think and decide, you work only under my orders' to 'We all think, we all work, we all listen to each other to attain the RH' principle, this double innovation enables other types to show up (and survive via innovation of habits). Management, governance, and governing must become crucially more holistic than the concept of the Chicago School of neo-liberal economy opposing and disabling Adam Smith's liberalism and its invisible hand, i.e. market with no monopolies and no separation of rights from obligations, no lack of transparency, personal responsibility of enterprise owners, and their honesty (Gorenak, Mulej, 2010; Smith, 2010; Toth, 2008).

The 2008 crisis was not caused in 2008; it only surfaced at that time, as a consequence of a neo-liberal fictitious, rather than realistic, model of an omnipotent market, causing also fictitious innovations by bank–and finance–people and the break of a fictitiously working real-estate market in the USA (e.g.:

TABLE 1. – **40 basic types of inventions, suggestions, potential innovation and innovations**

'Innovation is every (!) novelty, once its users (!) find it beneficial (!) in practice (!)'.				
Three networked criteria of inventions, suggestions, potential innovations, and innovations	**(2) Consequences of innovations**		**(3) On-job-duty to create inventions, suggestions, potential innovations, and innovations**	
(1) Content of inventions, suggestions, potential innovations, and innovations	**1. Radical**	**2. Inc-remental**	**1. Duty exists**	**2. No duty**
1. Business programme items	1.1.	1.2.	1.3.	1.4.
2. Technology (products, work processes)	2.1.	2.2.	2.3.	2.4.
3. Organization (process-based rather than subordination-based)	3.1.	3.2.	3.3.	3.4.
4. Managerial style (co-operative rather than one-way commanding)	4.1.	4.2.	4.3.	4.4.
5. Methods of leading, working and co-working (supportive of co-operation)	5.1.	5.2.	5.3.	5.4.
6. Business style (co-operation with business partners)	6.1	6.2	6.3	6.4
7. Governance & management process (supportive of co-operation)	7.1	7.2	7.3	7.4
8. VCEN (supportive of co-operation and reflecting interdependence)	8.1	8.2	8.3	8.4
9. Our habits (realizing contemporary VCEN in our practice)	9.1	9.2	9.3	9.4
10. Habits of others (realizing contemporary VCEN in their practice)	10.1	10.2	10.3	10.4

Rop, 2011). This crisis is obviously much deeper: the market cannot be relied upon because the 'limited competition', i.e. monopolistic market, does not work as predefined by A. Smith (Smith, 2010). It does not prevent the abuse of those with less bargaining power. It does make the three notions of the French revolution – freedom, equality, and brotherhood – survive. Neither can goverments be realiable, if they are biased and one-sided due to one-sided monopolisation and outvoting by the winning parties rather than requisitely, or even totally holistic in their approach. Thus, they can hardly attain the requisite wholeness of their insights and other outcomes. See Figures 2a and 2b.

The problem lies in mentality very much – in human thinking and worldview as well as other VCEN's parts. This mentality is expressed in companies' one-sided and short-term thinking patterns expressed in their marketing and public relations messages (Prosenak, Mulej, 2008; Prosenak, Mulej, Snoj,

TABLE 2A. – **The selected level of holism and realism of considerating of the selected topic between a fictitious, requisite, and total holism and realism**

←----------		----------→
Fictitious holism/realism (inside a single (subjectively selected) viewpoint)	*Requisite holism/realism (a dialectical system of all (subjectively selected) essential viewpoints)*	Total = real holism/realism (a system of all (objective rather than selected) viewpoints)

TABLE 2B. – **Law of requisite holism (Table 2a) in some details**

APPROACH TO DEALING WITH AN OBJECT AS A TOPIC OF BEHAVIOR	One-sidedness by a single viewpoint	*Requisite holism by co-operation of all essential professionals and only them*	Total holism by consideration of totally all viewpoints, insights from all of them and synergies of all of them
TYPE OF APPROACH	(Too) simple	*Requisitely simple*	Very or too entangled
TYPE OF SYSTEM AS A MENTAL PICTURE OF THE OBJECT DEALT WITH	Single-viewpoint based system	*Dialectical system*	Total system
THE CONSIDERED ATTRIBUTES OF OBJECT	(Very) few	*All essential*	Totally all
RESULT OF APPROACH	Fictitious holism (in most cases)	*Requisite holism (good in most cases)*	Total holism (ideal)
FOCUS MADE POSSIBLE	(Too) Narrow focus (in most cases)	*Requisitely holistic focus*	Lack of focus
NUMBER OF PROFESSIONS	One single	*Requisitely many*	Literally all
TYPE OF WORK	Individual	*Mixed team of requisite different experts*	All humankind in cooperation/ synergy
CONSEQUENCES	Complex due to crucial oversights, dangerous	*No problem due to no crucial oversights, hopefully*	Simple due to no oversights
AVAILABILITY	(Too)Frequent in real life	*Possible in real life*	Not possible in real life

2008). One-sidedness results in a lack of contemporary excellence, which requires more RH of observation, thinking, decision-making, and action for the future of humankind. Baumol et al (2007) fail to see this need of entrepreneurs. The current climate change reflects all these dangerous processes.

Climate Change Requires Social Responsibility as a Way to Requisite Holism of Human Behavior

We are viewing SR here in the perspective of systems theory as a science on attainment of RH behavior aimed at requisite wholeness of insights and outcomes. We use the latter also to deal with innovation and we see a practical connecting point of them and SR in daily experience – VCEN need innovation toward more holism meaning less selfishness for selfish reasons ('our benefit depends on benefit of other due to mutual interdependence'; it demands 'ethics of interdependence' to be prevailing VCEN). Narrow selfishness does not protect us from envy and protests all way to terrorism on the part of those who feel that decision makers do not decide with SR, but with a narrow and short-term responsibility, if any, except a fictitious one, etc.

SR does not ask whether or not there are, for example, entrepreneurs and more or less high and even questionable awards for managers, but it asks about the criteria that should be felt among people and, at the same time:

- Requisitely honest and based on real achievements, hence acceptable without envy, i.e. as ethically correct;
- Achievements enabling economic and social advancement including the RH quality of a requisitely big majority; and
- Attained by methods/products that do not ruin natural conditions for the life of humans and other living beings without which humans cannot live such as bees, etc.

People, time and conditions define differently what is socially acceptable, i.e. SR behavior. Criteria have always depended on VCEN of the most influential ones, that is power holders. Their values became culture, ethics, and norms, when attracting people as followers by appeal or force (Potocan, Mulej, 2007). Their VCEN were expressed in ideologies, e.g. religions and similar tools of power providing ownership and joy to the most influential ones. These VCEN, according to official definition of SR tackle manners of influential ones in the treatment of (EU, 2000b, 2001, 2006 a, b):

- Their co-workers;
- Other business partners;
- Their government, non-governmental organizations, etc., that is, broader social environments; and
- Their natural environment as the natural precondition of survival.

In all four aspects, influential ones must attain more RH behavior than before, that is, to innovate their practice toward SR.

The rather new ISO 26000 (ISO, 2010) adds some crucial attributes to the just quoted definition of SR:

1. Governance and management;
2. Human rights;
3. Customers.

What is even more crucial is that ISO 26000 defines two crucial common denominators for all seven topics:

a) Holism and
b) Interdependence.

Thus, SR is a process of social-economic IIDP/innovation and its objective for humankind is to find its way out of the current dead end. The success of this process depends on humans, especially influential ones.

Influential people can use their influence to define the criteria for what is wrong or right, sometimes with too narrow and short-sighted egoism. In such cases, they do not prove their SR and lose their power, ownership and joy, at least gradually. During the latter process, the SR and legal responsibility tend to mix up, but they can differ: the power-holders are influential enough to be able to adapt legal rules to their interests, including their narrow, one-sided, biased, and short-term interests. They often do so more easily than accept VCEN with SR, based on broader defined and perceived RH. This may get them in trouble, too, not only those subordinated to them. Thus, Friedman's famous definition that SR is unacceptable is wrong: companies must care for their profit and benefit of their owners, but they do not do a good job with narrow and short-sighted criteria (Goerner et al. 2008; Toth, 2008; etc.). Friedman became a Nobel Laureate in Economics in 1970 for his theory of conservative neoliberalism, which now proves to be out-dated and detrimental to enterprises and society at large. It does not match the old proverb that 'The first profit does not go into the pocket' – a short-term benefit based on narrow and short-sighted criteria often costs much over a longer term. The climate change is a visible sign, so are the related illnesses and other avoidable costs.

People seem to have tended not to understand this general need for SR. For millennia, people have also used many religions to foster SR, and they do so today. There has always been a mixing, networking, and fighting of the concepts of more narrow and short-term interests, on one hand (read: interests concerning now and here), and of longer-term and broader interests, on the other, reaching beyond now and here (Rudel, 2008; Wu, 2004).

Slave-owning and feudal societies clearly enforced narrow and short-term interests, as their opponents said. This practice led both long periods of human history in a life that – according to the criteria for the quality of life today

– has experienced poor economic efficiency and the quality of life of a great majority of people, and in extreme differences between rulers and subordinates around the world. Before the Western Industrial Revolution, China and India supplied 80% of global production, but recently they have come close to 10 % (Boskovic, 2006). Industrial and post-industrial/entrepreneurial society differs from previous ones by its principle of equal chance for everybody to display his or her skills and interests and contribute to the quality of life of themselves and others. Experience has shown that in terms of bookkeeping data entrepreneurial society seems successful in raising the standard of living, but differences in the quality of life are again very similar to those in feudal times: if only good two hundred richest individuals donated less than five per cent of their property, four million children would not die of hunger and illness every year (Crowther et al., 2004b). Other data are similar (Nixon, 2004; Toth, 2008; etc.). Private owners enforce their interests, so do governmental ones, although formally legally there are no owners. Ownership is no problem, but the short-sighted and narrow definition of interests of influential ones, who forget about SR's longer-term and broader effects, or failure to use SR concepts.

Thus, the crucial issue of SR reads: do the influential ones abuse/misuse – rather than use, with RH behavior – their chances hidden behind legal responsibility and protection; abuse/misuse fails to lead to SR, but to its opposite – and opposition, all the way to wars, etc. Hence, in our view, the essence of SR in practice is the prevention of misuses/abuses of legal, economic and natural laws, and enforcement of replacement of the narrow and short-sighted criteria of right and wrong for broader or even RH criteria. Actually, this is what A. Smith stood for, although today they attribute the opposite opinion to him.

Rare authors (such as Walker, 1978) say that in their research Adam Smith and Karl Marx have aimed at a way to preserve the village solidarity of earlier times, after transition from village to entrepreneurial society. They did not succeed. Nobody did. Therefore the effort called SR is showing up today to help influential people adapt longer-term and broader criteria. No wonder, SR has hard times to become a general VCEN. The short-term and narrow views of decision-makers make obstacles all the time, and there is no thinking of a theory to replace the current neoliberal economics, although it leads humankind to a dead end.

People who abuse the label of liberalism to cover huge modern differences in richness, health, famine, etc. and destruction of humans' natural environment, fail to see that A. Smith does not favor narrow and short-term interests (See the citation above). The invisible hand expresses the logic of economic interdependence rather than independence and dependence: you must delight your customer to have him/her return and make you happy as a supplier (Quinn, 2006; etc.). The fact that people enforce, under the label of A. Smith, economic thoughts and interests opposing his ideas, is visible under

conditions of human care for the natural preconditions of life and survival of the current civilization: this 'care' is worrying even in global official data (Hrast, Mulej, editors, 2009; Hamman, Ecimovic, Mulej, 2010, etc.).

These data express the abuse of the law of external economics (Stern, 2006, 2007). This law can often be beneficial, but has been applied to nature with expensive consequences of abuse. They will obviously damage the coming generations soon – our children and grandchildren already. Influential ones act as if they hate their offsprings, when they act on a narrow basis and with no SR (Mulej, 2010, and references therein).

Thus, SR enforces own benefits/interests of people, but not merely narrow and short-term ones, but also or even primarily the long-term and broad ones. People need to reinforce them in the form of local, national, international, and supra-national legislation and VCEN of their enterprises and other organizations for the present human civilization to survive. Market – as an institution aimed at reinforcing the invisible hand – needs support. Not all private or governmental owners should be off, but those without SR. They make too much damage to the coming and their own generations.

Let us hence be less selfish for selfish reasons. We are not independent, rather, we are an interdependent part of nature on the planet Earth.

Climate Change Requires Adam Smith to Replace Neoliberalism

Those of us who have ever dealt with the major theorist of liberal economics A. Smith from the viewpoint of systems theory as the theory of (requisitely) holistic human behavior (consisting of monitoring, perception, thinking, emotional and spiritual life, decision making, communication, and action, rather than a superficial input-output relationship only) (François, 2004; Mulej et al., 2008 and earlier, since Mulej, 1974; Mulej, 2007 a, b; Mulej et al, in press), might expose some other A. Smith's thoughts. Toth (2008: 100-102; 132; 147) points out:

- Older socio-economic systems practiced no more justice than capitalism – a free market economy. But justice was often valued more highly than profit, in their times. Still, modern capitalism is the best version so far, although its blessings do not reach all people, and differences are big and growing. The advantage of capitalism seems to have reached its peak and not to grow any more. It should be improved so as to develop into something better which will keep the current benefits and correct mistakes.
- A. Smith attacked the notion of limited responsibility. What is known today as limited liability or joint-stock-company used to be forbidden in the UK from 1720 to 1862. Smith considered the existence of joint-stock companies as an obstacle to making competitive markets; one's own interests are harmless only if realized in small local communities and at a local lev-

el. Thus, enterprises are under control for honesty in community and under the full judicial, moral, and economic responsibility of the owners/manager.

- Although capitalism fortifies the tendency toward moral relativism, it practically erases the idea of justice from economic thinking. In its economic theory 'homo oeconomicus', i.e. the human increasing profit, is elevated to the central position; besides, every human being is also a consumer, therefore benefit always wins over justice.
- 'Shared benefit is no matter of generosity of the butcher, brewer, or bakcer, for us to get our dinner, but it is part of their own interest …. In directing his diligence in a direction in which the yield presents the highest possible value, the entrepreneur thinks of his own revenue only; in this effort the entrepreneur, like in all other cases, is led by an invisible hand leading to a goal that has not been a part of his aim.' (A. Smith).

How should these summaries be read from the viewpoint of economy versus social responsibility (SR)?

1. It is obviously the market which acts as an invisible hand. On the market the highest benefit belongs to the supplier attracting customers best of all; now, this is attained by innovation, i.e. creation of new benefit for users (Table 1). If entrepreneurs' self-interest is their revenue/profit, they cannot succeed, if they are so very selfish that they do not care for their customers and think that the customers do not see their abuses and have no alternative. Therefore, the market must allow no monopolies. Monopolies create relations and ethics of dependence and independence instead of interdependence, which is reality due to the natural and professional specialization of humans, organizations, and regions. Interdependence requires entrepreneurs holism reaching at least the level of requisite holism (RH) of behaviour for requisite wholeness of insight and outcomes; RH means the consideration of everything essential in networking and synergy (Mulej, Kajzer, 1998 a, b). (Table 2). So does SR (ISO, 2010).
2. Free market is more than a place in which supply and demand show up and prices are formed. It is first of all a relation in which nobody has a predominant bargaining power, including abuse of his or her impact, like slave-owners, civil and clergy feudalists, and other monopolists used to, and still do, either governments or entrepreneurs, including the contemporary ones. The advice 'laisser-faire' reflects this with its demand for no monopolies to exist: all market participants are small, all available products and services are transparent and easy to understand, etc. This is no longer completely true. Thus, there is anti-monopoly legislation, but it is obviously weak at least, on the global market. Despite this, people and companies innovate much more than they ever used to, and do so all the time today, in order to be competitive or even temporary monopolists. This competition causes both progress and problems: the permanent

effort is stressful, and side-effects on nature and humans and peace etc. ruin motivation, lives, and the like. (Mulej, Hrast, editors, 2010; Treven, Potocan, 2006; Udovicic, 2007, 2008).

3. The entrepreneur's profit results, as we know, from the difference between cost and price of the product or service sold. This puts an essential question: what is calculated in the cost and what is instead left aside as an uncovered cost (for the time being, at least). The postponement of costs to later times or their transfer to other people might mean also abuse, of the law of external economics and especially, the law of supply and demand. The abuse of the law of external economics causes the accumulation of the uncovered cost of maintaining natural conditions for survival of the current human civilization to grow over 5.500 billion euros; this amount exceeds the cost of both World Wars combined; if humankind keeps postponing the necessary action, GDN may fall for 20% (Stern, 2006, 2007). If these sums are included in calculation, GDP has grown fictitiously only over the recent decades (Bozicnik, 2007). The abuse of the law of supply and demand e.g. concerning labor causes strikes and other forms of trade unions' costly fight against employers, etc.; as for products, it leads to falsification, grey and black markets, very high prices of energy sources, extremely low pay in Africa etc., refugees travelling to Europe and the USA, etc. The predominant bargaining power simply tends to lead people to morally questionable behavior, based on short-term and narrow-sighted criteria. Consequences are very costly.
4. Walker (1978) found that A. Smith and K. Marx had tried, first of all, to create a model enabling the pre-industrial village-solidarity to survive in an industrial/entrepreneurial economy. Big capital, growing independently from humans, multinational enterprises outside the real impact of any government and with a big impact over governments, finds solidarity expense rather than an investment over a longer term, they are not necessarily right: consequences might be very costly. Dyck (2008) and Goerner et al. (2008) speak against such short-sightedness and abuse; they quote and use similar arguments as A. Smith used to: an enterprise may not be an independent legal entity, but a tool of humans, also in legal terms, for humans to assume full responsibility for it as private persons. Otherwise, feudal capitalism arises, as a practice against which capitalism has been created.
5. A. Smith wrote first his book 'Moral Sentiments' (Smith, 2000), and only later 'The Wealth of Nations' (Smith, 2010); the first one provides a crucial basis for the second one: values of interdependence. Thus, SR is a new attempt to innovate the values/culture/ethics/norms (VCEN) in order to prevent abuses and introduce a real liberal economy replacing the farce ruling under its name now. In the current economic practice, the role of government is limited to weapons etc. trade instead of the role foreseen by Keynes – the role of additional market regulator for the free

market to survive (Dyck, 2008; Goerner et al., 2008) (if we now do not tackle medical care and similar less market-prone societal needs).

6. If A. Smith spoke of an invisible hand meaning interdependence, like Petzinger (2000), then A. Smith introduced into theory a new effort to realize interdependence. The latter pointed out (see Mulej et al., 2000) as an essential attribute to be considered necessary, already in ancient Chinese philosophy – by the notion of yin-yang as a synergy of interdependent opposites. Engels (1953) states that interdependence as an attribute of all parts of nature, including humans, has been a topic of the ancient Greeks and Hegel's philosophy of the 19th century – under the label of dialectics. It is thus very unnatural if the top people in enterprises and countries and other organizations oversee that only interdependence is a natural attribute, while dependence and independence are crucial legal and political notions. Legally, independence prevents the abuse of humans, while dependence provides for abuse. History demonstrates that those who had been forced in dependence by others, have always rebelled, and have put in trouble the persons/nations who failed to admit interdependence. The same is true of nature and humans who have subordinated nature, after the times of living on gathering and hunting, by switching to production, first to agriculture, etc. Now nature seeks revenge by climate change. How badly has interdependence been forgotten about in industrialization times, is shown by the big echo of two authors exposing on interdependence after WWII: (1) Bertalanffy (1950 and 1968, edition 1979, foreword) made interdependence the basis of his General Systems Teaching/Theory; (2) Lovelock launched his hypothesis Gaia (Crowther and Ortiz Martinez, 2004: 104; Myers, 1991), saying that organisms are interdependent in nature and influence each other therefore, although they are not necessarily visibly and directly linked. Crowther and Ortiz Martinez (2004) explain that interdependence includes organizations and should be taken into account in governance and management. They find even more: 'Recently the selfish tendency toward monopolies of 1990s has been replaced by the care for SR; thus, RS is again on the agenda of enterprises, government, and citizens around the world'. And they state: 'EU defined corporate SR (2002, 347 final, p. 5) as follows: corporate SR is a concept with which enterprises incorporate their care for society and environment in their business activities and in their interactions with their stakeholders.' In 2010, this concept was fortified with ISO 26000 (after many years of preparation, but anyway).

7. Thus, the current, so called financial crisis of the world economy is not simply a financial crisis, as the crisis may look like on surface, but it is a crisis of the basic economic concept, especially of the abuse of A. Smith (who they unfortunately take as their cover). The contemporary circumstances differ essentially from his times. Nixon (2004: 193) belongs to authors who warn that 'the contemporary world is certainly full of

opportunities and life has improved a lot in it, especially in the West, if compared to previous generations. But globalization does not work, at least not in its current form. It works for a small minority of very rich and influential people, but not for six billions people the masses of: 85% of them live (according to World Bank data) on less than six US$ a day and one billion even on less than one US$ a day. On the other hand, one billion humans are too fat to be healthy. This is not caused by globalization and its failure to work; globalization has existed for centuries and has yielded big benefits to humankind. Trouble is caused by the economic system with its doctrine of – fictitiously – free market capitalism, greed-rather-need-based consumerism and permanent economic growth (limited to GDP growth and disregarding happiness and well-being); some call this a global power of money (global monetocracy), which does not work for people. Good two centuries ago A. Smith who is called the father of this doctrine, warned that 'an unbridled market is dangerous'. The human nature causes market to permanently tend to commit suicide in the form of dominance of monopolies over competition, which influential people value less than their own monopoly (from home onwards) yielding their benefit.

8. Where are the limits of benefit? If one views them with a too narrow and short-term perspective, one tends not to perceive long-term and indirect benefits. This fact makes VCEN, skills and viewpoints of individuals and their conditions critical. Awareness is important, so that one can think and act more broadly and thus attain benefit therefore.
9. Is the invisible hand an incident, or a synergy of conditions? Or is it made of all what individuals are unaware of and brings them to unexpected outcomes? Today, there is a lot of indirectly visible hands of influential ones (Estulin, 2008; Martin, 2008; Martin and Murphy, editors, 2009).
10. What is also nearly invisible is the fact that accountancy covers the very essential attribute of social responsibility, which is its capability to diminish or even prevent costs. The current accountancy includes visible costs, but does not consider opportunity costs. If influential persons apply social responsibility, they prevent, say, the costs resulting from strikes, lost suppliers and customers, social riots, destroyed nature and health.
11. The current dangerous climate change is no topic of its own, but a consequence of the human practice of combining broad consequences of individual actions of company and government people and their narrow, one-sided and short-term, bases of behaviour. Thus, solving the crucial problems that are called the current climate change in the industrial and post-industrial period can hardly be solved, unless one starts from innovating of the prevailing habits by promoting of social responsibility.
12. This is a revolutionary looking evolution. Customers (Gerzema, 2010; Zgonik, 2011a, 2011b) started making this evolution happen by

supporting much more suppliers with the image of social responsibility and by reducing the percentage of shopping-addicted population below six per cent in the USA and close to one percent in Germany.

13. In development-economics terms one may say that the current climate change problems result from human ambitions. As long as managers are rewarded on a short-term basis and with rather narrow and one-sided criteria of success, no legislation or promotion of social responsibility reaching beyond legislation in terms of honesty and requisite holism can be successful (for details see: Mulej and Hrast, editors, 2010).
14. The issue of ambitions is more influential than it may look like in considering climate change. As pointed out by Porter (1990; let us leave his important texts about SR aside now), competition-based economy has experienced the evolution of the basis of competitiveness; it includes four phases:
    a) Natural resources, when people had a bad life for millennia;
    b) Investment, when people live better, but mostly foreigners/investors;
    c) Innovation, i.e. the creation of beneficial novelties for users, when people live on their own RH creativity and therefore inbetter and better;
    d) Affluence, which is at the same time the highest level of human desires and a blind alley; when you have everything you no longer feel motivated to work hard in order to have even more, hence you cherish laziness and need support. A new motivation is needed to create a new ambition (James, 2007); personal and economic survival must be deemed, and believed, to depend on social responsibility including interdependence – as the background/basis – and holism as the top aspiration.
15. In terms of climate change this means: environmental problems are first of all mental problems, (Ecimovic, Mulej, Mayur, 2002).

We (Mulej et al., 2007a, b, 2008a, b; Mulej, Hrast, editors, 2010; Prosenak, Mulej, 2008; Prosenak, Mulej, Snoj, 2008; etc.) see a way out of this blind alley in the fifth phase to be created. It should be based on synergetic networking of (1) SR as a way of RH behaviour of people, (2) ethics of interdependence, (3) creation and innovation including general purposes, (4) dominance of the creative class (Florida, 2005) – for in their research humankind to come closer to Fromm's transition from owner to creator (James, 2007), and (5) replacing the cult of laziness and free time with no content so far with creative contents, (6) shorter working time, along with many creative contents of leisure time, etc.

Some Conclusions

In brief as individuals and as humankind we must decide: whether we will continue our way to a blind alley in we which we do innovate a lot, but much more in technological terms than with RH; first of all, we must innovate the

managerial and business style for more RH by SR, hence the related VCEN – for more democracy and creation instead of blindly obeying orders lacking RH/SR (e.g. IBM, 2006; Potocan, Mulej, 2006, 2007). Dilemma reads: either we as humankind and individuals innovate, that is,. beneficially renew, our VCEN toward SR/RH behaviour to attain requisite wholeness of our insights and outcome, or we will soon ruin our natural preconditions for existence. Innovation to which the current generation has condemned itself leads unavoidably to either affluence as a blind alley, or to another direction that is offered by the SR concept. Technological progress does diminish material consumption and the destruction of the natural environment per unit of product/service, but at the same time the total amount of production, specialization, trade and traffic is growing so much that both consumption and destruction grow less rapidly, but they do grow all the time. Over the past two centuries, the entire energy consumption on the planet Earth has grown 40 times (Kajfez Bogataj, 2008, quoted in Mulej, Hrast, 2008).

There are also promising signs: in the USA only six per cent of women and 5.5 per cent of men are still shopping-addicted (Zgonik, 2011b); the number of consumers preferring the SR suppliers was growing rapidly even before the current crisis, making companies innovate their habits (Gerzema, 2010); many new technologies reducing the need for energy are being created all the time; many political documents are addressing the issue, etc.

Still, economic practice rewards managers, governors and owners of banks and multinational corporations and the like. on a too short-term basis for them to support SR and RH in VCEN of themselves and other humans under their influence. Still, there is no supranational law, while international law is not obligatory and hence there is no real law to control multinational companies. Hopefully, the visible consequences as expressed in climate change will encourage influential humans and their organizations to accept SR and RH as their predominant VCEN and strategies.

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VLADIMIR KENDROVSKI, DONCHO DONEV, MARGARITA SPASENOVSKA, AND MARIJA KISMAN – HRISTOVSKA

Climate Change and Human Health in the Republic of Macedonia: Impacts, Vulnerability and Adaptation in Heat Wave Mortality

Abstract

Delineating where human health vulnerability to climate change is likely to occur is the key to formulating effective adaptation strategies. By defining where increased health vulnerability due to a climate-change is likely to occur allows health officials, planners, and decision-makers to develop and focus research adaptation strategies. We take a quantitative approach in determining health vulnerability due to climate change, at the national level and the level of Skopje as the biggest urban conglomerate in the country. We analyzed heat-related mortality to determine first where climate-sensitive health vulnerabilities occur and secondly to assess the potential effects of climate change. Key areas for the Strategy in adapting to climate change include: adapting health care infrastructure (hospitals, nursing homes) to be more resilient to climate change effects. In 2010, a 'Heat-Health Watch' system started to operate in Macedonia during the summer months, with four levels of response and appropriate advice. The health care system in the Republic of Macedonia has an important role in establishing adaptation, health promotion, prevention and response measures against health risks related to climate change and, particular strengthening of existing public health capacities for early detection and adequate response to heat waves.

Key words: climate change, health impact, health vulnerability, adaptation, heat waves

Introduction

Climate change is perhaps the most significant environmental problem which mankind will face in the coming century. Efforts to reduce the extent of climate change at global and local levels are of course important, but it is likely that we will also have to deal with at least some impacts on health.

The global atmospheric concentrations of greenhouse gases have markedly increased all around the world as a result of human activities since the pre-industrial period, and that most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. The mean temperature on the Earth's surface has increased. The 100-year linear trend (1906–2005) in global average surface temperature is 0.74°C (0.56 °C to 0.92°C). An increase of 2.3–6°C may reasonably be expected within the next 100 years, depending on the scenario in place (Bates et al. 2008). Due to industrialization and population growth, the emissions of greenhouse gases as a result of combustion of fossil fuels, deforestation and clearing land for agricultural use

are increasing. Over the past 150 years, greenhouse gases have been released into the atmosphere faster than the natural processes' capacity to remove them. In addition, new synthetic gases have begun emerging in the atmosphere which, as it has been found, also contributes to the greenhouse effect. The concentration of such gases has been constantly increasing in recent times and it is assumed that such growth will persist parallel to the growth of the global economy. These emissions have begun to disturb the delicate natural balance, significantly increasing the quantity of greenhouse gases in the atmosphere and their isolating effect. The global atmospheric CO_2 concentration has increased from its pre-industrial value of about 280 parts per million (ppm) in 1750 to 386.3 ppm in 2009 (Tans, 2010).

Between 1971 and 2000 the annual mean temperature in the Republic of Macedonia changed by –0.1° to 0.2°C in comparison to the period 1961–1991. The values recorded for the period 1996-2005 are 1.3°C higher for Demir Kapija and Prilep, 1.4°C higher for Stip and Bitola and 1.5°C higher for Skopje. Climate change projections for Macedonia of the main climate elements (temperature and precipitation) have been made up to 2100. To describe the relationship between large-scale climate variability across South-East Europe and local-climate variability in Macedonia were used as the simulations of future climate with Global Circulation Models, based on a limited number of emission scenarios, usually SRES A2 and B2, the local climate change projection, developed for the first time, was additionally scaled to other marker SRES emission scenarios (A1T, A1b, A1Fl, B1) using the pattern scaling method (Bargant, 2006). The region of central Macedonia, which is under a combination of continental and sub-Mediterranean climate impacts (represented by the stations at Veles, Skopje-Petrovec, Strumica and Štip), shows a more intensive temperature change in winter than in summer and autumn, compared to the region of south-east Macedonia. The highest increase in air temperature by 5.4°C for 2100 is expected in summer. No change in precipitation is practically expected in the winter season and decrease in precipitation in all other seasons, reaching the maximum value in summer (-23% compared with the reference year 2000), (Alcinova, et al, 2011).

Climate change associated diseases are already estimated to comprise 4.6% of all environmental risks related diseases. It has been estimated that climate change in 2000 contributed to about 2.4% of all diarrhoea outbreaks in the world, 6% of malaria outbreaks in certain developing countries and 7% of the episodes of dengue fever in some industrial countries. In total, the estimates show that mortality due to climate change has been 0.3%, whereas the related burden of disease has been 0.4% (WHO, 2002).

There are several mechanisms by which climate can affect health. The extremes of temperature and rainfall, e.g., heat waves, floods, and drought-have direct immediate effects on mortality as well as longer-term effects. For example, populations that have experienced flooding may suffer from sustained increases in common mental disorders (Ahern, et al, 2005).

Research on the health impacts of climate change addresses three main topics: current associations between climate and disease, the effect of recent climate changes, and the evidence base for projecting the future impacts of climate change on health. Temperatures have been globaly increasing for the past two to three decades. The detection and attribution of health effects to these changes has become a key research challenge (Kovats, et al, 2001). Climate warming is projected to continue and accelerate, so that by the end of this century the global mean temperature will increase while the effects on health at the upper end of the range are more difficult to predict and are likely to be more seriously adverse.

In meteorological terms, a heat wave is defined as a prolonged period of unusually hot weather. To date, a standard definition of heat wave has not been agreed upon and different definitions have been used to evaluate its impact on health (Michelozzi, et al, 2004). Climate change projections for Europe show that, over the next century, heat waves will become more frequent and intense, and will last longer. In addition, these changes could contribute much more to the burden of disease and premature deaths, particularly in vulnerable populations with limited adaptation resources (IPCC, 2007). Considering this latest IPCC Assessment Report, climate change predictions for Europe show an increase in the frequency and intensity of heat waves, especially in central, southern and eastern areas and, as a consequence, heat-related mortality will become a relevant threat even in cities usually not exposed to extreme hot temperatures.

Direct Effects of Rising Temperatures on Population Mortality in the Republic of Macedonia

Studying the impact of weather events and climate variability on human health requires appropriate specification of the meteorological "exposure". Weather and climate can each be summarized over various spatial and temporal scales. The appropriate scale of analysis and choice of any lag period between exposure and effect, will depend on the anticipated nature of the relationship. Much of the research requires long-term data sets with information about weather/climate and health outcome on the same spatial and temporal scales. In all such research, there is a need to accommodate several types of uncertainty that are inherent in these studies. Predictions about how complex systems such as regional climate systems and climate-dependent ecosystems will respond when pushed beyond critical limits are necessarily uncertain. Likewise, there are uncertainties about the future characteristics, behaviours and coping capacity of human populations (WHO, UNEP, WMO, 2003).

Weather can have a profound impact on mortality. During unusual weather events, deaths from all causes can increase as much as 50 per cent above the

normal. Certain fatal illnesses appear to be closely related to weather variations, especially those associated with cardiovascular, cerebrovascular, and respiratory systems. Asthma is closely linked to air pollution, which worsens during hot weather. Hot weather can cause illness and kill. The normal body temperature range (36.1–37.8 °C) is maintained by the hypothalamus, which constantly regulates the production and loss of heat. When the outdoor temperature is higher than the skin temperature, the only heat loss mechanism available is evaporation (sweating). Therefore, any factors that hamper evaporation, such as high ambient humidity, reduced cardiac output, reduced air currents (no breeze, tight-fitting clothes) or drugs with anticholinergic mechanisms, can result in a rise in the body temperature that may culminate in life-threatening heat stroke. There is growing evidence that the effects of heat-wave days on mortality are larger when levels of ozone or PM10 are high, particularly among the elderly (75–84 years). A wide range of factors – such as chronic diseases, social isolation, being confined to bed, certain medical treatments and some types of occupation – increase the individual risk of heat stress (WHO, 2010).

For each population there is an optimum temperature at which the (daily or weekly) death rate is the lowest. Studies published between 1993 and 2003 from several European cities attribute a change of between 0.7% and 3.6% in all-cause mortality to a 1°C increase in temperature above a certain threshold. A more recent assessment in 15 European cities in the period 1990–2001 has estimated an increase in mortality for every 1°C increase in apparent temperature above thresholds of 2% (95% confidence interval (CI): 0.06–3.64) in northern cities and 3% (95% CI: 0.60–5.72) in southern cities. The heat-wave of 2003 in western Europe caused more than 70 000 excess deaths in 12 European countries. The EuroHEAT project estimated a 7.6% to 33.6% increase in mortality during heat-wave episodes in nine European cities. The results showed a high heterogeneity of the effect between cities and populations. The impact of heat-waves of longer duration (over four days) was 1.5–5 times higher than for short heat-waves. Heat-waves put at risk the elderly, children and people with chronic diseases (WHO, 2009). The role of housing and socioeconomic conditions varies greatly. The elderly suffer the greatest effects of heat-waves, with women bearing a higher burden of mortality than men. The ultimate health effects will depend on the level of exposure (the timing, frequency, intensity and duration of the heat-wave), the size, structure or demographic profile of the exposed population, population sensitivity (such as through chronic diseases or drug treatment) and the prevention measures in place. Climate change is expected to lead to an increase in global average temperatures and the number and intensity of heat waves. The Macedonian city of Skopje is the only urban agglomeration that has the effect of "urban heat island" in the country and where statistical representative surveys of mortality in the function of weather variables can be carried out (Kendrovski et al, 2009).

In the territory of Macedonia 241,451 deaths were reported for the period 1994-2007. The highest number (19,594) has been reported in 2007. For the whole period the average monthly deaths were 1437.21. The highest values for the Seasonal Index of total deaths distributed by months and years (1994-2007) for the Republic of Macedonia were registered in January with 116.9%, March with 108.9% and December with 107.2%. The lowest values were registered in September (86.9%) and August 90.3%, respectively (Fig. 1).

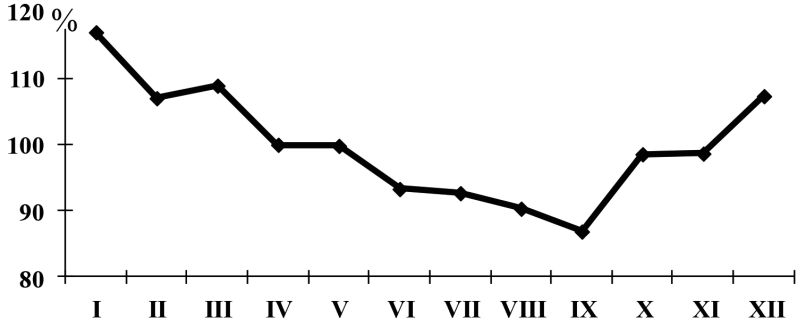

FIGURE 1. – The Seasonal Index (%) for deaths in the Republic of Macedonia for the period 1994–2007 – distribution by months

The difference between total average monthly mortality in absolute numbers is 30% (from +17 to –13) for January (month with highest mortality) and September (with lowest).

The results demonstrate that climatic variables such as the mean winter ambient temperature are found to be positively associated with the levels of relative excess winter mortality in Macedonia. A highly significant regression coefficient of 0.27 is found ($p<0.001$) with regard to environmental temperature for total deaths, i.e. 0.23 ($p=0.02$). for males deaths and 0.54, ($p<0.001$) for females deaths, respectively. This result indicates that the typical, inverse relation normally found between cold exposure and rates of (all year) mortality does not hold for excess winter mortality (Kendrovski et al., 2010).

According to the Second National Communication Report to UNFCCC the decrease of several per cent in some colder months is expected regarding the total annual monthly mortality (January 4%, October 4%, November 2%) due to climate change in the next decades. On the other hand, in warmer months the increase of 4-11% of the total annual monthly mortality is expected (mostly in April, May and June, and will be higher than in the period 1996-2000 by 10% on the average), (MoEPP, 2008).

There are two causal pathways connecting housing, climate and health: a) modification of the health effects of weather extremes (predominantly a local, short-term effect) and b) burning of fossil fuels for home heating and cooling leads to the emissions of greenhouse gases (principally CO2) which has a long-term effect on global climate. Housing especially provides protection from temperature related illnesses and deaths. As energy use in housing

contributes to climate change, improvements in energy efficiency had two potential benefits – 1) by avoiding extremes of temperature, it protects the health of the occupiers for affordable costs; and 2) by reducing energy use it reduces the housing sector's contribution to climate change (WHO, 2007).

Material and Methods

We take a quantitative approach in determining health vulnerability due to climate change at the national level and the level of Skopje as the biggest urban conglomerate in the country. We analyzed heat-related mortality to determine, first, where climate-sensitive health vulnerabilities occur and, second, to assess the potential effects of climate change.

Available data for daily mortality, meteorological and air pollution were provided for the city of Skopje for 2007 and only summer months (May-September) were included in the study. The summer of 2007 was analyzed separately in order to assess the impact of this exceptional heat wave episode that affected most of the Balkan cities, and results were compared to heat waves in other years included in the study period. Mortality data were daily counts of total deaths for all causes and meteorological data including the maximum air temperature, retrospectively. To investigate potential confounding by air pollution, data were also collected for the following variables: particulate matter with a diameter of 10 micrometers (PM_{10}) (24-hour mean) and O_3 (maximum 1 hour, maximum 8-hour moving average). Daily mortality series was examined in relation to daily temperature using the Poisson generalised linear models allowing for over-dispersion. Daily levels of PM_{10} and O_3 were incorporated into the regression model as possible confounding variables, regardless of statistical significance. Indicator variables for the days of the week and public holidays were included. To establish the general relationship between mortality and temperature, natural cubic splines of the temperature series (df = 3) were regressed against the model residuals after controlling for the confounding factors noted above. By means of logistic regression we determined the relationship between the days when there were heat waves (the definition of heat waves is taken the days when the maximum temperature was 90 percentile of average monthly value of the maximum temperature for at least two consecutive days). All days during the period May-September for 2007 were marked "1" and "0" for heat waves for all months separately. Thus, the heat effect is the log-linear increase in risk above a heat cut-point defined as the 95th percentile of the daily mean temperature.

RESULTS AND DISCUSSION

The 2007 Summer Impact

The absolute highest air temperatures in RM were measured in July 2007, 43,5 °C in Štip, 45,3°C in Gevgelija and 45,7°C in Demir Kapija. The temperature of 45,7°C measured on 24 July 2007 in Demir Kapija was the highest

measured temperature in RM since the conducted continual meteorological measures and surveillances in its territory havebeen established. The year 2007 is a specific year in terms of the extreme, in other words absolute maximum air temperatures in the months in January, June and July, measured almost in the whole territory of the country. It is generally ascertained that during the last fifteen years the number of days with maximum temperatures higher or equal to 30°C (tropical days), days with maximum temperatures higher or equal to 35°C (hot days), as well as the number of days with minimal air temperatures higher or equal to 20°C (tropical nights) has evidently increased. The Government of the Republic of Macedonia declared a nationwide heat-wave emergency in 2007. During July, daily temperatures reached 43°C and caused more than 200 fires, destroying more than 2,000 hectares of forests, and almost 1000 excess deaths (compared to the averages of 1994–2007). (IPHRM, 2010)

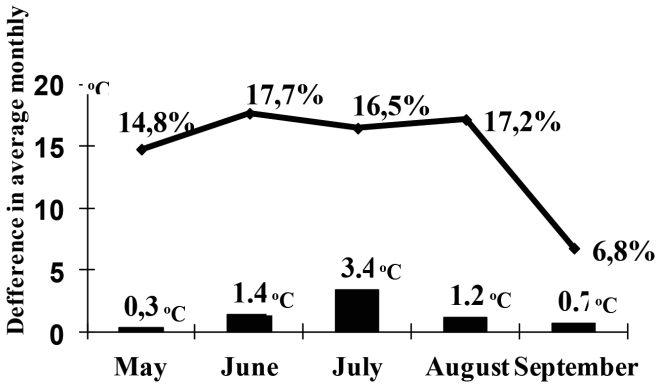

FIGURE 2. – Number of deaths (%) and difference between months (°C) during the summer of 2007 in comparison to the average for the period 1994–2008.

The number of deaths during the summer of 2007 increased for all summer months in comparison to the average monthly counts for the period 1994 – 2008, i.e. June with 17.7%, August with 17.2%, July with 16.5% and May with 14.8%, respectively (Fig. 2). The differences in the mean monthly temperature between the period 1994–2008 and 2007 shows that a higher increase was detected for July with 3.4°C, June (1,4 ^{0}C) and August with 1.2°C, respectively.

Europe has experienced warmer summers in the past two decades and there is a need to describe the determinants of heat-related mortality to perform public health activities in a better way during hot weather, (Kovats, Ebi, 2006). We investigated the effect of high temperatures on daily mortality for Skopje in 2007. We included in our investigation all days during the period May-September for this particular year. We collected data for the daily distribution of number of deaths for all causes, both male and female counts as well as daily distribution of the maximum temperature and values of pollutants: PM_{10} and ozone as follows.

TABLE 1. – **Relations of the daily maximum temperature and daily mortality in Skopje for the period May–September in 2007**

Health, environmental and climate indicators	Values for the period May-September 2007 (No. of days 153)			
	Mean	Minimum	Maximum	Std. Deviation
Total mortality*	11,76	4	29	3,8
Females mortality *	6,5	1	15	2,68
Males mortality *	5,25	1	14	2,44
Max. temperature	29,85	16	43,4	6,12
PM_{10}	94,44	24,7	179,4	27,33
O_3	64,66	22,6	211,6	30,63

**Source*: State Statistical Office (on request)

Series of daily mean temperature (°C) were generated. Air pollution may confound the effects of high temperature on mortality, and so daily ambient levels of PM_{10} (μg/m^3) and ozone (μg/m^3) were obtained, too.

The output in Figure 3 shows the results fitting the Poisson regression model to describe the relationship between daily total mortality in Skopje during the period May-September 2007 and the daily maximum temperature for the some period. Since the P-value for the model in the Analysis of Deviance Table is 0.011 or less than 0.05 there is a statistically significant relationship between the variables at the 95.0% confidence level.

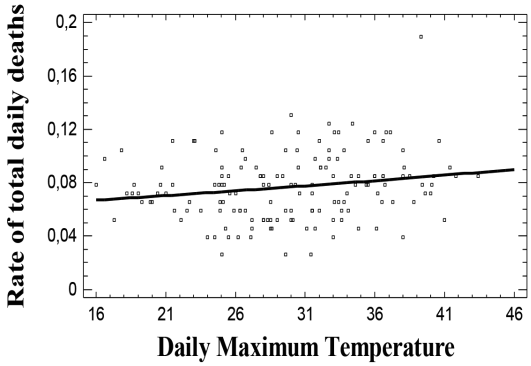

FIGURE 3. – Poisson distribution of daily deaths as function of the maximum daily temperature

The "heat cut-point" used in this analysis was 30.8 °C (95th percentile daily mean temperature). The observed mean daily values for PM_{10} and ozone were 94,43 (90,06-98,8) μg/m^3 as well as 64,66 (59,77–69,55) for 8 hr Ozone concentration μg/m^3 95%CI, respectively. The odds ratio for the variable: maximum temperatures in terms of deaths of people during the heat wave in Skopje for the summer of 2007 is 1.048, which means that under conditions of heat waves by increasing the temperature by 1^{0}C above the "heat cut-point" (30.8 °C), mortality increases by 4.8%.

Hot weather has a stronger impact on human mortality than cold weather. Although daily winter mortality is generally higher than that in summer,

much of this is due to transmitted illnesses, such as influenza, which are related to indoor confinement. Summer mortality is characterized by sharp daily increases during stressful conditions – a situation not found in winter. There is no standard definition of a heat-wave. EuroHEAT, a project coordinated by the WHO Regional Office for Europe and co-funded by the European Commission Directorate-General for Health and Consumers, defines a heat-wave as a period in which the maximum and minimum apparent temperatures are over the ninetieth percentile of the monthly distribution for at least two days. In our National Heat Health Action Plan we adopted the same definition (Kendrovski, et al., 2011). The rates of heat-related mortality are substantial throughout Europe, but the hot summers in Southern Europe cause little more mortality than the milder summers of more northerly regions. People in Southern Europe achieve this largely by simple traditional measures, such as use of shade, fans, and avoidance of exercise at hot times of day, rather than by air conditioning as in the United States. The time needed for people to adopt effective responses to hotter weather is not known. There are particular grounds for concern about mortality from occasional heat waves of unprecedented severity. In 2003, an exceptional heat wave in central France caused mean daily temperatures of around 28^0C for 10 days with 14,000 deaths (Pirard et al., 2005). Further south, where people were more accustomed to high temperatures, the heat wave caused less mortality.

Adaptation and Action to be Taken to Reduce Heat Wave Mortality and Health Sector Preparedness as Summers Become Hotter

Climate change adaptation comprises all spontaneous responses and planned action taken to cope with the impacts of, or reduce vulnerability to, a changing climate. Such adaptation is needed to tackle current problems or anticipate possible future changes, with the aim of reducing risk and damage cost effectively, and perhaps even exploiting potential benefits. Moreover, in responding to other health pressures or as a result of precautionary policy, the adaptive capacity of health systems has often been implicitly increased. A combination of adaptation and mitigation measures can reduce the health risks associated with climate change (Adger et al., 2007).

Increasingly, therefore, society and policy-makers are making preparations to counter adverse impacts and initiating dedicated adaptation action. Such adaptation action, which may be anticipatory, autonomous or planned, includes both national and regional adaptation strategies as well as practical steps taken at the community level or by individuals.

Adaptation for health means that a number of current measures, policies and strategies need to be revised or strengthened under the current levels of risks from climate change. Current threats have already led to the introduction of new measures and policies, such as heat health action plans. As long as

the increase in global warming is less than 2°C from pre-industrial levels (and not too rapid), many of the projected effects on health are likely to be controllable by strengthening well-known, well-tested public health interventions, such as public education, disease surveillance, disaster preparedness, food hygiene and inspection, nutritional supplementation, primary care, and training. Nevertheless, the effectiveness of these actions will need to be further evaluated and assessed over time. Existing actions, policies and measures might become insufficient at higher levels of risks or in the face of more frequent and intense events, or more rapid climate change.

Where capacities are weak, health systems will need strengthening. The capacities of health systems to respond vary greatly in the European Region. Health systems will need to assess potential climate-related health impacts, review existing capacities for addressing them, strengthen their functions where needed and consider the need to review some legislation, in order rapidly to detect and take action against current and future climate-related risks. The strengthening of health security includes the following activities:

- maximizing synergy with already existing instruments, such as the International Health Regulation (IHR), preparing health workforce to respond to health-related consequences of climate change and strengthening of health services to address climate-related events in a timely manner;
- Advocating health with other sectors;
- Building capacity in health workforce;
- Providing intelligence; and
- Setting the example by "greening" the health services.

Reducing Greenhouse gas (GHG) emissions, i.e., their mitigation, can have direct and immediate health, environmental and economic benefits. Employing cleaner fuels and shifting to more active transport (walking and cycling), for example, will lower carbon emissions, increase physical activity, reduce traffic-related casualties and result in less air pollution and noise. For example, money saved from not having to cover the health-care costs of air pollution and lost productivity will often match or exceed the costs of climate mitigation measures.

The need for developing a Climate Change Health Adaptation Strategy for Macedonia arose from the relevance of this issue on a global, regional and national level, the necessity to prepare and respond to climate-change-associated health risks and the need for interdisciplinary cooperation and exchange of relevant data with other sectors that could contribute to improving the health status of the population in the Republic of Macedonia. The Strategy has been developed by the Climate Change and Health Commission of the Ministry of Health, comprising representatives from various sectors and endorsed by the Government in 2011 (MoH, 2011). The National Climate Change Health Adaptation Strategy of the Republic of Macedonia envisages the objectives and activities that will be carried out by the health

sector in cooperation with the other relevant sectors in the country. Its goal is to interlink with other strategies in this area developed by other sectors and to form part of the chain/scope of activities aimed at reducing the impact of climate change on people's health in the country. In particular, Macedonia has experienced warmer summers in the past two decades and there is a need to describe the determinants of heat-related mortality to better inform public health activities during hot weather. One of the effects of climate change already encountered in this country is the increased frequency of heat waves. There is evidence that it is possible to reduce morbidity and mortality through a variety of heat-wave preparedness and response activities: strengthening and conducting a heat-wave announcements and warnings system (heat-wave early warning system), strengthening preparedness and the health services response, informing the public about the possible effects of heat-waves and how to deal with them, as well as adequate civil engineering planning and housing (WHO, 2008).

The Heat-Health Action Plan of the Republic of Macedonia has been developed in order to implement adaptation measures and prevent health consequences of extreme heat caused by changing weather conditions as a result of climate change. The primary goal of the Plan is to reduce heat-related morbidity and deaths through issuing heat health warnings, with particular emphasis on the most vulnerable population groups, provide timely advice and announcements of upcoming heat-waves, raise awareness amongst the public and health workers, and coordinate and mobilize all available resources in a timely manner to prevent the health consequences of heat waves (www.toplotnibranovi.mk). The Plan consists of activities that will be conducted by governmental representatives and institutions from the health sector as well as other relevant sectors. The aim of the Plan is to provide a multisectoral approach in the response to extreme heat, through prompt action by all institutions designated as responsible within this Plan. This document is in line with the National Platform for Disaster Risk Reduction of the country. The heat-health warning system of the Hydro-Meteorological Institute provides 48 hours advanced information to selected health authorities as part of the National Heat-Health Action Plan. This 'Heat-Health Watch' system operates in Macedonia during the summer months, with four levels of response and appropriate advices from the National Institute for Public Health and the Ministry of Health.

Conclusion

In the Republic of Macedonia over 60% of the population lives in cities. Direct hazards to human health as a consequence of global warming can represent a significant health problem in the context of further urbanization, primarly due to the retention of the sun's heat by concrete and asphalt even after the sun has set ('heat island' effect).

The National Climate Change Health Adaptation Strategy has been endorsement by the Government for its envisages the objectives and activities that will be conducted by the health sector in cooperation with other relevant sectors in the country. The general goal of the strategy is to foresee climate change adaptation measures for the health system in order to prevent and/or overcome the existing and new risks and to timely respond to the risks and problems that are expected to occur as a result of climate change on the people's health and well being. It involves activities on building an integrated, efficient and effective approach for prevention, early warning, managing and overcoming the climate change consequences as a result of heat waves, floods, increased air pollution, UV radiation, communicable diseases, etc.

Global climate change will have different consequences on health in Europe in the coming decades. Over the past few years, there has been a noticeable increase in the frequency of hot weather in many European countries. The Mediterranean and Balkan countries are especially vulnerable to heat waves.

There is evidence that it is possible to reduce morbidity and mortality through a variety of heat-wave preparedness and response activities.

In order to prevent and combat potential heat-wave health threats, the Ministry of Health, in cooperation with the World Health Organization, has prepared a national Heat-Health Action Plan, including an early warning system implemented in cooperation with the Hydro-meteorological Institute.

The goal of this plan is:

Early prediction of heat-waves and warning to all responsible public health and other institutions, which will contribute to timely information and taking of appropriate measures;

Reduction of heat-wave-related morbidity and mortality through issuing heat health warnings, especially for those most vulnerable to the effects of heat waves: the elderly, infants and children up to five years old, the chronically ill, people who are overweight, people in certain professions who work outdoors, people whose socio-economic status makes them more vulnerable and those who are more vulnerable to the effects of heat-waves because of certain social factors (nationality, profession, education, social isolation, etc.);

Timely coordination of currently available measures and resources for response to heat waves;

Raising awareness amongst the public and health workers of the effects of heat waves on people's health.

The national Heat-Health Action Plan encompasses existing and defined activities which will be conducted by Government representatives and institutions, from the health sector as well as from other sectors.

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ELIZABETA RISTANOVIĆ AND UROŠ RAKIĆ

Impact of Climate Change on Microorganisms

Abstract

There are about 2–3 million various microorganisms naturally existing around us. The infectious diseases cause about 15 million human deaths per year. Microorganisms provoke about 15 percent of all malignant disorders. The development of genetic engineering and biotechnology and their misuse as well the present bioterrorist threat increase the problem of infectious diseases. The appearance and development of infectious diseases depend on various factors including weather and climate changes. The global warming process associated with air and water pollution and lack of food and emergent's rapid disturbance of natural habitats and cycles, and have an important influence on the development of infectious diseases. Climate changes particularly influence each part of the infectious disease transmission pathway: microorganisms, vectors, reservoirs and humans presenting important factors in the development of infectious diseases and their incidence in human population (malaria, hemorrhagic fevers, viral encephalitis, etc.) Considering the influence of climate change on infective diseases different models for the prediction of disease. Spread among the population was developed.

Key words: climate change, microorganisms, infectious diseases, infectious agents

Microorganisms – The Scourge of Modern Times

According to scientific estimates, there are about 2-3 million various microorganisms and potential pathogens and only about 5% has been identified to date.

According to the World Health Organization (WHO), diseases caused by microorganisms are classified as the top ten leading causes of death in the world. Every year, about 15 million people on the planet and more than 50 per cent of children under the age of five die of infectious diseases. The first place among infectious diseases is held by respiratory infections of which about 4 million people die every year; they are followed by HIV/ AIDS (about 3 million deaths per year), diarrhea (annual mortality rate: approximately 2 million people), tuberculosis (1.6 million) and malaria (1.3 million); the percentage of deaths from viral hepatitis, other sexually transmitted diseases, hemorrhagic fever, and the like should not be neglected either. It is believed that more than 15 per cent of all malignant diseases is of infectious etiology.

The highest rates of infectious diseases are recorded in developing countries (in Africa 62% and South East Asia 31%) while in developed countries, despite progress in the eradication of traditional infectious diseases, there

emerge new diseases, with entirely new clinical manifestations and causes such as, for example, avian (H5N1), and (H1N1) swine influenza, SARS (corona virus), high percentage of HIV infections associated with frequent infections, tuberculosis, hepatitis C (as estimated by the WHO, hepatitis C has infected about 3% of people in the world) and syphilis, in addition to new types of viral encephalitis, viral diarrhea, hemorrhagic fever and rickettsioses.

The emergence and development of infectious diseases, and change bio-epidemiologic, pathogenic and clinical characteristics are actively influenced by the following factors: the characteristics of pathogens, emergence of antibiotic resistance and mechanisms that lead to it, ecological characteristics of endemic areas, characteristics and distribution of reservoirs and vectors, routes of transmission, immune status of an individual, and population, weather and climate conditions, as well as today's current climate change and urbanization and globalization, including all negative impacts on human health and ecological balance.

TABLE 1 – **Incidence of some infectious diseases in the Republic of Serbia in the period 2003–2008.**

Years / Disease	Incidence per 100,000 population		
	Tularemia	HIV	Lyme disease
2003	0.79	0.81	11.05
2004	0.49	0.77	8.88
2005	0.75	0.72	5.51
2006	0.49	0.70	6.85
2007	0.09	0.57	8.78
2008	0.34	0.51	11.7

Source: "Dr Milan Jovanovic Batut" Institute of Public Health of Serbia

Throughout the history of mankind, from the Bible to the present day, infectious diseases have always had a great impact on humanity and have greatly changed the geopolitical picture of the world (plague, Spanish flu, Hong Kong flu, etc.). They still have such an impact because, despite great scientific progress, there is still no solution or appropriate response to many diseases caused by microorganisms. Due to the development and abuse of genetic engineering and biotechnology, infectious agents can become more dangerous killers.

As already stated, the process of globalization with all subsequent consequences necessarily increases the risk of threatening microorganisms, given the fact that today's air transport carries people and material resources to any part of the world within 24 hours, that population migrations are frequent and that a rapid transmission of infectious agents and the development of epidemics and pandemics are the reality of modern times (e.g. the current pandemic of swine flu, spread of HIV/AIDS, antimicrobial resistance). Since

the incubation period for most infectious diseases is longer than a trip to the most remote part of the world, it virtually ensures that the epidemic spreads quietly through only one infected tourist. If we add that, according to the WHO, 800 million people travel every year, the actual extent of the spread of infectious agents could be identified. The spread of microorganisms was significantly influenced by the globalization of production and food supply, because hundreds of known bacteria, viruses, parasites, and prions are transferred to food, and new ones are being constantly discovered.

The growing threat of bioterrorism in the third millennium is also a significant problem and major global challenge facing modern civilization. Taking into account all the above, it is clear that today almost every microorganism can now be used as a biological weapon. In this sense, it is very difficult to implement preventive epidemiologic measures.

So, although it was believed for 50 years of the twentieth century that the battle with infectious agents was finally won thanks to vaccines and powerful antibiotics (MacFarlane, "One can think of the middle of the 20th century as the end of one of the most important social revolutions in history – the virtual elimination of the infectious disease as a significant factor in social life" – diseases caused by microorganisms (new or old in the changed format – emerging vs. re-emerging) and it now forms the world and significantly affects the geopolitical circumstances in it, and is still in the focus of medical and social attention.

Climate Change and Health

The climate on Earth is gradually changing under the influence of natural factors (sun, volcanic activity, astronomical parameters). Since these changes are not dramatic, the relative stability of the climate was one of the main reasons for the continuous growth and development of mankind. However, over the past hundred years, one has begun to ruthlessly exploit and destroy our planet. The rapid development of technology and industrial production has brought many benefits to mankind, but is adversely affecting the climate balance to a significant extent. Thus, the fact that the climate on Earth is rapidly changing has become an unavoidable and painful truth – not only for scientists dealing with this topic, but also for the political establishment faced with the problems that until a few years ago were contemplated, while the world's largest forces, like the United States, now treat drastic climate change as a serious threat to national security.

Due to the effect of global warming, the average temperature increased by 1.3°C (+ / –0.3°C), only in the 20th century and it is estimated that it will (increase by 1–3.5°C) by the end of this century. Large ice surface melts (in the last 30 years at the average annual rate of melting. Arctic sea ice has been 8%), sea level increases, water and air pollution is increasing, and the lack of drinking water, food and energy (this is especially favorable for the

development of various infectious diseases), all of which inevitably leads to the violation of natural habitats and the natural cycle of life. Increased deforestation increases the level of CO_2 produced by greenhouse gases; natural disasters are also more frequent (heat, floods, hurricanes, tsunami, etc.).

Scientists predict that around the 2030th there will be around 8.3 billion people on the planet, which will inevitably lead to mass migration of populations from the already impoverished areas and cause a further increase in the population in urban areas, where about 60% of world population already lives. This will lead to the creation of new megacities and future generation of political and economic problems and tensions between different social groups within the same society. The struggle for natural resources, especially drinking water, food, fertile land and energy resources will become a matter of survival not only for the ruling elite, but also for entire nations and societies. Pandemic and infectious diseases are regular companions in such situations, as well as the possibility of terrorist acts, including bioterrorism.

Climate change certainly has the strongest hold on the health of people who definitely fall into the most vulnerable category. Otherwise, climate and atmospheric changes can have positive and negative, direct and indirect impacts on human health. The direct impact refers to meteorotrophic diseases such as vascular diseases, asthma, skin diseases or skin cancer, while the indirect effect is generated through the transmission of infectious diseases, impact on food production, availability of drinking water, etc. A global rise in temperature results in a higher frequency of hot summer waves, but also reduced the number of episodes of cold winter, which led to increased mortality rates in the summer due to heat stroke, as well as to an increased incidence of neuron-vegetative disturbances. A significant reduction in mortality in winter due to cardiovascular disease and asthma also occurs. Increased UV radiation, due to the depletion of the ozone layer, and greenhouse effect significantly increase the risk of skin cancer.

Global warming is a pervasive phenomenon, which is primarily caused by man who will, inevitably face more serious consequences, dangerous diseases and increased mortality rates (due to natural disasters, pollution, food and water by microorganisms, changes in the geographic distribution of some infectious diseases and air pollution, etc.) if the present trends continue.

Climate Change and Infectious Agents

Taking into account the transmission routes of infectious diseases and zoonosis *anthroponotic* (Figure 1), it may be logical to conclude that these diseases are particularly susceptible to the influence of weather and climate, since climate change is affecting all participants in the cycle of transmission: pathogens, vectors, reservoirs and people, and thus represent a significant factor in the development of various infectious diseases and their effect an human life.

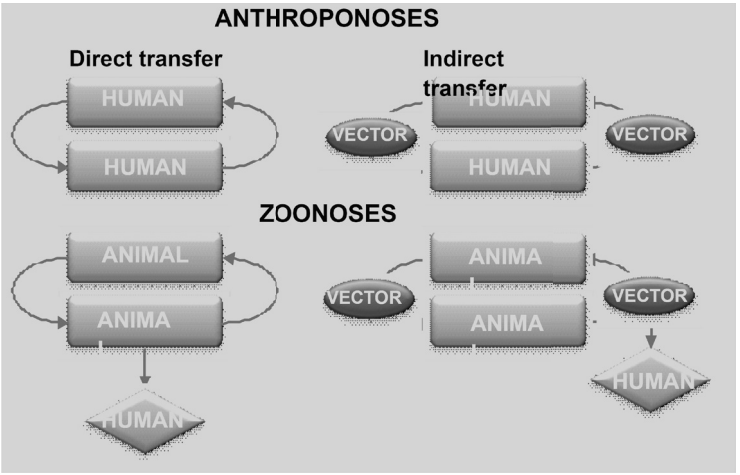

FIGURE 1. – Transmission routes of infectious diseases

Source: McMichael, D.H. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Sheraga, A. Woodward. Climate Change and Human Health, Risks and Responses, WHO, Geneva, 2003.

About 75% of blood infections caused by microorganisms became one of the drivers of zoonoses, and as the result of a complex of transmission cycle and the fact that all participants in the process of transfer are subject to weather conditions; climate change has the greatest impact precisely on this category of infectious diseases.

An increase in temperature leads to changes in bio-epidemiologic vectors of infectious diseases: rodents, birds, insects, just like globalization, migration and natural disasters, leading to the spread of endemic areas for many infectious diseases, for example, malaria, ***leptospirosis***, leishmaniosa, ***hemorrhagic*** fevers, viral encephalitis, cholera, etc..

Namely, temperature increases metabolism vectors, which implies more food, so that their contact with the reservoir and higher risk of infection are more common. An increase in temperature also increases the fecundity of the vector and reduces the incubation time, resulting in a tick population growth, changes in the season of occurrence and activity, changes in geographical distribution thereof, and increased incidence of associated diseases (such as highland malaria in Africa). Temperature can also lead to changes in vector susceptibility to certain pathogens, and can act on pathogens (e.g. those which are spread by water; also, the extension of their season-high temperature distribution creates favorable conditions for marine mucilage).

As a climatic factor, precipitation also influences infectious diseases. The influence of rainfall might be twofold; due to high humidity during the period of high precipitation, this may lead to increased vector population due to the creation of new litters, while too heavy precipitation and snow cover can destroy the nest. Low humidity can lead to dehydration, whose vectors are compensated by more frequent feeding, which enhances the possibility

of infection. The lack of rainfall leads to the drying up of rivers and creation of pools of standing water, which are suitable for the propagation of different vectors (e.g. mosquitoes that transmit malaria). Precipitation had a positive impact on vegetation and food availability, leading to an increase in the number of rodents, which are the carriers of various infectious diseases. On the other hand, flooding can significantly reduce rodent population in the area, while its flight from flooded areas brings them into more frequent contact with people, thus increasing the possibility of human infection.

Wind may also affect the distribution of vectors, while sea level rise leads to a reduction in the destruction of their habitats.

A detailed study of the perceived influence of weather on infectious diseases has led to the development of several models for predicting the spread of infectious diseases under the influence of climate change (statistical, mathematical, models based on habitat models for an early warning system, etc.).

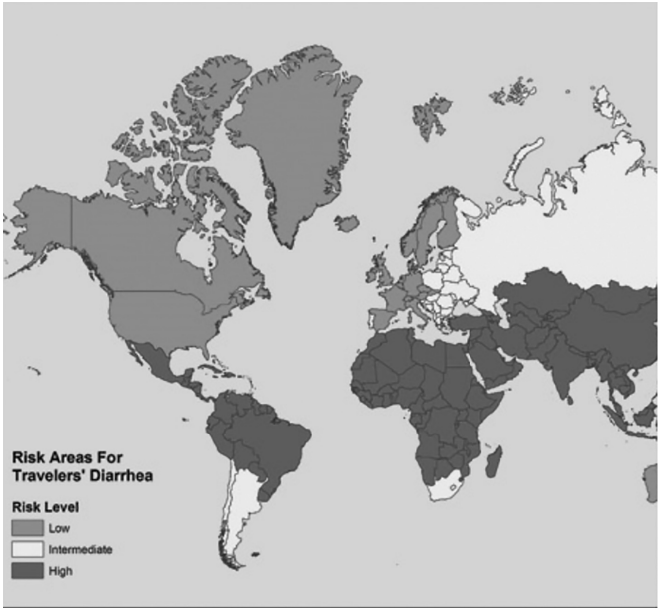

FIGURE 2. – Zone risk for traveler's diarrhea (WHO, 2007)

Taking into account all these facts, it is not surprising that many diseases caused by microorganisms, which are thought to have been previously eliminated, once again pose a threat to humans, such as: malaria, tuberculosis, streptococcal diseases, certain sexually-transmitted diseases and diarrhea (Figure 2). Thus, for example, climate change, as noted above, can help spread the litter of mosquitoes and their infection by parasites, and contribute to the re-emergence of autochthonous malaria in Europe, which was thought to be eradicated 40 years ago. Naturally, one must take into account other diseases transmitted by mosquitoes such as, for example, West Nile virus or Dengue virus (Fig. 3), and other zoonotic diseases.

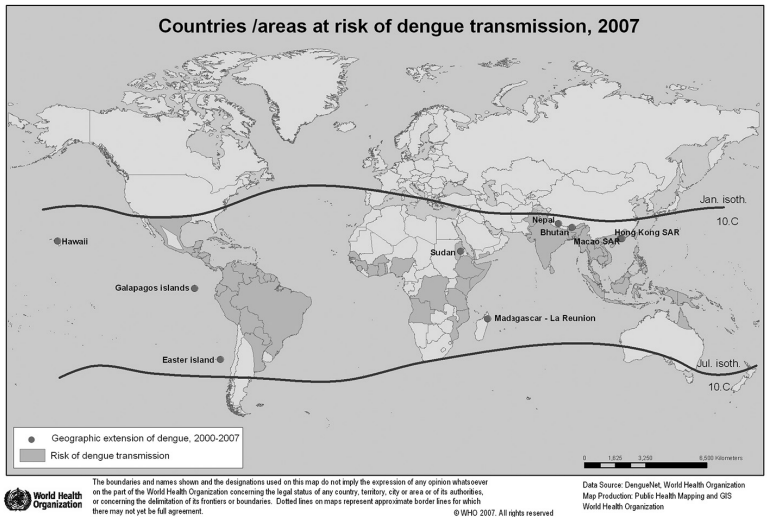

FIGURE 3. – The risk of transmission of dengue haemorrhagic fever (WHO, 2007).

Considering all this, it is unambiguously clear that we should introduce the permanent monitoring of infectious diseases movement at the national and international levels, and establish adequate and timely links among experts at all levels.

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http://www.epa.gov/climatechange/effects/health.html

Institute of Public Health of Serbia http://www.batut.org.rs/statistika.html

MILUTIN A. LJEŠEVIĆ, GORAN TRBIĆ AND MIROSLAV DODEROVIĆ

Geoecological Factors of Global Climate Change

Abstract

The climate is a very old area of human concern. Back in the Epic of Gilgamesh it is mentioned that weather caused the flood. In ancient Egyptian papyrus weather as a "gift from the gods" . In the Old Testament climate is mentioned at several places as something that defines human life. First Plato and then Hippocrates, as well as Aesculapius pointed to the importance of climate to human lives. Today it is clear that the environment is not only an integral part of human life, but also an element of spiritual culture and human development.

The problem of climate change is one of the major current problems. Specifically, increased climatic fluctuations and the consequences of these fluctuations have led to numerous changes in the quality of life of many people. Frequent droughts have led to reduced yields in large areas on all continents, which led to increasing poverty and hunger. The food problem is one of the acute problems of modern times. Millions of people, especially children, are exposed to alimentary genocide. There are different opinions on whether the climate is warming or cooling, but. all agree that climate change is present.

Disagreements arise over the cause of this change. Some say that it is a natural process of the geological history of repeated cycles. Others are of the opinion that this was a consequence of anthropogenic influence, or incineration of large amounts of fossil fuels and emissions into the atmosphere. We have observed changes in the ozone layer related to the emissions of large amounts of greenhouse gases that deplete the ozone layer (photo oxidants).

Key Words*:* climate change, temperature ranges, natural factors, anthropogenic factors, development of geoecological factors

Introduction

In order to seriously deal with this issue it is necessary to clarify the two above mentioned terms "geoecological factors" and "climate change". Both terms have not been fully determined or defined. There are scientific and technical discussions about both terms. We will try to make a modest contribution to this issue.

The processes that form the climate are taking place under specific geographical conditions of the Earth's surface. At low–and -high latitudes, over the land and over the sea, and over the mountains and plains there are processes that form the climate, taking place in a different way and having their geographical specificity. Climate characteristics and their distribution depend on

these same climate related geographical factors. The multi-year regime of radiation, temperature, humidity and wind are the results of geographical conditions and their daily and annual flows. The main climate related geographical factors are latitude, elevation, land and sea distribution, land orography, sea movement (current), vegetation, snow and ice cover to some extent. People's work affects the processes of climate formation, and thus the climate through changes of these or other geographical factors.

Geoecological factors represent a set of phenomena and processes on the ground, and are the bearers of different global and local changes. They can be of natural and anthropogenic origin. Natural geoecological factors include a variety of energy sources on the planet Earth (gravitational, electromagnetic, rotary, etc.), while cosmic energy is primarily generated by the sun spots and protuberance, and the influences of other heavenly bodies, especially the pull of the moon. Regional and local natural geoecological factors related to the morphology of the terrain (hypsometrical, slope aspect, slope angle), geomorphologic factors (wind and water erosion, landslides, etc.) and especially geophysical factors (volcanism, seismic, etc.). In addition, there are very significant hydrological factors (fluctuation of sea level, groundwater level, discharge and water level of rivers, distribution and thickness of snow and ice on the surface of the Earth). We should not forget biogenic factors such as the covered territories, courts overgrown with grass and biological burden of that area.

The impact of soil (thickness and type of solum, devastation, mineral composition, etc.) is also significant. The regional character of the territory (land and sea distribution, continentality of that area, as well as activities and zonal and a-zonal factors is certainly an important factor in climate change.

As for anthropogenic factors, we will stress the importance of economic production (agriculture and industry), transportation, building settlements and communal economy. The basic tendency in the world today and in our science and practice is reduced to anthropogenic activities and processes.

But, the facts indicate that the complex natural phenomena and processes at the time when there was no industry, led to significant climate change that have changed the situation on Earth, made significant geomorphologic changes, changes in hydrological terms (level fluctuation of the world's oceans, river water level, etc.), changes in the structure of the planet biogenic (changes of biodiversity, changes in the quantity of biomass, certain genetic variations, etc.). The influence of geoecological factors is undeniable. The circulation of heat and humidity, as well as the circulation of the atmosphere in general are the main factors that form the climate. All three processes are inter connected. The soil thermal regime as well as the atmosphere affect cloudiness, which keeps the flow of solar radiation. The formation of clouds is one of the elements of the moisture circulation. But, it depends, above all, on thermal conditions of the Earth's surface and atmosphere, which in turn

depend on a certain degree of advective heat, i.e. general atmospheric circulation. Apart from transferring water vapor and clouds, general circulation affects moisture movement through it and heat conditions. The mode of each climate heading is the result of the interaction of all three processes, which form the climate. For example, rainfall distribution is a direct cause of moisture circulation as precipitation is one of these links. Consequently, it depends on the distribution of moisture sources (especially marine ones) or a specific location and other components of moisture circulation, such as evaporation, and turbulent diffusion of water vapor condensation. But, the precipitation regimes also affect thermal conditions, which depends on evaporation. They determine the maximum saturation of air and moisture in the air in relation to saturation, as well as the presence of water in the clouds that determine the position and level of cloud formation and rainfall.

The next question is whether there is climate change, and if so, how it manifests itself? It is certainly a fact that climate change is present. We are witnessing the increased number and intensity of climate disasters (tornadoes, droughts, large fluctuations in temperature, etc.). On the other hand, observations made over more than 100 years show changes in the weather and climate, which has significant consequences for the economy, energy and, in particular, people's everyday life. One of the central issues when it comes to climate change is what causes these changes and whether these changes can be mitigated. Is it possible to stop these changes and minimize their consequences? In the opinion of some authors, such changes occurred in the past so that this is nothing new. On the other hand, there are various apocalyptic versions of religious scientific claiming that this is a new problem caused by people due to their irresponsible and sinful behavior. They argue that this is the main reason for climate change and a rapidly warming atmosphere and, along with it the hydrosphere, biosphere and geosphere. They think that the main cause of this sudden change in the locations of the magnetic poles where lies in the inclination of the Earth's axis to the ecliptic.

What Exactly Happens When it Comes to Climate Change?

It is obvious that the weather has been very unstable in recent years. Many media outlets in the world bombard us with stories about global warming and the upcoming major climate change. According to them, the cause of the "greenhouse" effect is the result of excessive and uncontrolled emissions, of carbon dioxide, methane and chlor-fluor-carbon (HFC) in particular. Some researchers believe that the blame for this should be put on world's major industrial countries and excessive burning of fossil fuels.

Some politicians, most notably Al Gore and Hillary Clinton, act as environmental lobbyists advocating reductions in emissions from burning fossil

fuels, thus putting them under control. Hillary Clinton especially attacked on China and India, saying that these two countries, due to their rapid development and energy needs, were using large amounts of fossil fuels, especially coal and oil. Whether it is the question of global geopolitics or it is a fact? Many skilled researchers, climatologists and geophysicists, who know the power of nature, are of the opinion, thanks to space research, that the cause of climate change events should be attributed to the sun. According to these scientists, the Earth also experienced similar changes in the past.

Politicians and environmental lobbyists, especially Al Gore, are actually lobbyists for big multinational capital, willing to take advantage of these natural processes and profit from transnational capital through their paid politicians and international institutions concerned with environmental protection and ensuring global monitoring and control over the industrial development in the entire world, especially in the East (China and India) and developing countries in Africa, as well as in Europe. So, they have divided scientists into those who support Al Gore's efforts, and those who see only natural force in everything. Where is the truth? Ordinary people do not know the real state of affairs because they have neither time nor knowledge to talk about the conclusions.

Contemporary and impending climate changes on the Earth are indisputable, but it is only part of the change in the energy field in the solar system and the Sun. These changes are not only related to climate but also to the Earth's magnetic field and, along with it, significant changes in the biosphere. It is known that the Earth's magnetic field strongly affects the life on the planet and climate change causes significant life's changes and changes in the quality of life. This is reflected in the health of the population, particularly those chronically ill including those having mental illness. Life requires a balance of chemical and electromagnetic factors, which the living world on the planet has adjusted. If some of factors change, all forms of life must readapt to new circumstances. The adaptation is the basis of the evolution of living beings, and the species that cannot adapt, to disappear from the biosphere. As a result, many species will disappear but new ones will be created. This is the essence of the universal principles of cosmic creation and extinction. Thus, the undeniable fact is that climate change is happening, at least when the observations carried out in the historical period are considered. Yet, when it comes to natural phenomena, this is a matter of climatic variability, and changes occur in cycles. Climate and weather have cyclical turns. We witnessed dry years and very rainy summers in the recent past. Paleontological, archaeological and geomorphological research tells us that today is dominated by the green Sahara, that the river flowed through it, that Europe was wetter and cooler. In short, the climate on Earth was changing in the past. We are witnessing a variety of natural disasters that are documented in historical annals. If we follow the nature of the creator of all changes and even climate.

Climate change is an intensive process oven the course of geologic time. Such changes are related to changes in the Earth's surface structure and air composition as well as various astrofactors, such as, for example, changes in the orbit and speed of rotation of the Earth around its axis and the speed of rotation around the Sun, changing the density of matter in interplanetary space, solar activity changes, as well as changes in the Earth's magnetic field and position of magnetic poles.

There is now unequivocal evidence that climate change is happening. It is likely that increasing atmospheric concentrations of greenhouse gases due to human activities cause global warming. Eleven of the last twelve years are among the warmest recorded since global surface temperature measurements in 1850. Over the past 100 years, the beginning of global surface temperature has risen by 0.74° C. Sea level increased by 17 cm in the 20th century. In recent years, we have witnessed more frequent extreme weather conditions and changing ice cover on the mountains and in polar regions. The Intergovernmental Panel on Climate Change (IPCC) has developed climate change projections bases on complex mainstream models.

It seems that consensus reached has been with regard to the anthropogenic causes of climate change, but there is uncertainty as to how to reduce their impact. We will be increasingly faced with the consequences of climate change. Climate change will come gradually by increasing the average temperature and rainfall volume. The main impact of these changes will be felt in the long run. However, the effects of an increasing frequency of extreme events will already be felt over the short term, and will be the main short-term challenge.

However, the fact is that the intensity of climate change is now greater than ever, that these changes are frequent and associated with more casualties. The climatic change of modern times is the result of natural factors, and anthropogenic factors are modifying the change at the local and regional levels. We are witnessing the spread of deserts (desertification), sometimes dried-up mighty rivers and lakes, some reduction of forest cover, etc. This suggests that we all experience different negative consequences of climate change. We think that global climate change is a result of the global impact of the space activities, especially the Sun, and that local and regional climate change and climate disasters can be a result of human impacts. Within our framework, we cannot significantly affect global climate change; we can only take care not to increase the effects of economic and other activities. Developed countries expert more influence on changes in the temperature and gas composition and developing countries less, since they use less energy than developed ones. Climate change mitigation at the local level is in the hands of citizens and states. We cannot move and prevent sun spots or changes in the geomagnetic field, but we can exert influence on forest cover, air pollution reduction and local climate changes.

Consequences of Climate Change

Climate change results in more negative consequences for the lives of people and thus for the economy, transport, settlements and geopolitical relations in the world. Those consequences are:

- Frequent occurrence of natural disasters in the form of floods and strong winds;
- melting of glaciers and the resulting rise in the sea level;
- winters without snow;
- extremely hot or rainy and chilly summers;
- long-lasting drought periods;

Planetary physical changes are manifested by explicit and implicit consequences. Explicit ones include frequent floods, hurricanes, periodic droughts and frosts, severe storms, epidemics, earthquakes, landslides and the extinction of various species. All of these catastrophic events are carefully monitored in order to their cycles and study the possibility of their mitigation.

Floods and hurricane winds are accompanied by major human casualties and material losses. Only in the last ten years there were thousands of flood and hurricane victims, while damage property is estimated at over $ 100 billion. The world's famous El Nino is not just a hurricane, but a global phenomenon which, in one part of world, causes a huge flood and drought and hunger in the other.

Glacial melting and glacioeustatic sea levels lead to changes in the world. Sea ports will change their functions and the coastal area will be attacked with new tidal waves or sea transgression. This will affect more than 2/3 of mankind. Namely, damage to ports and their submersion may be prevented by construction work. Land cover changes most fertile parts of the coast as a result of marine transgression and can hardly be recovered by more serious repair. Local ventures to protect the sea, as is currently the case in the Netherlands, have only a local character. And control procedures are very expensive and involve generations of settlers. The Republic of Srpska is not affected by climate change consequences, but the impact on its climate must take place. These effects may include increased humidity, more rain and the lowering of the average annual temperature.

On a world scale, glacial melting, especially in the Arctic, may result in changing the course of warm ocean currents (Gulf Stream and Kuroshio in the Pacific), which will affect the climate (and life) in Western Europe, Scandinavia and northern Russia. It would also cause changes in the movements of air masses and the direction of global and regional winds, accompanied by the changing humidity of the continents. It is certain that these changes affect the quality of people's lives and the economy, civilization and culture. In turn, this can lead to change in the temperature regime, as well as to climatic disaster.

We are witnessing more frequent winters without snow, or with a thin snow cover. Some tourist seasons in ski resorts are thus unsuccessful or very short. When it comes to the Republic of Srpska, this relates primarily to of the Jahorina, but also to other resorts. The consequences of this phenomenon on agriculture and energy in the Republic of Srpska are even more important. Namely, the snow cover is the regulator of soil moisture; it protects winter crops from frost and handles the flow of water courses, which reflects the potential for irrigation. Hydroelectricity pumps significant resources from snow. As a regulator of stream flow regime snow cover enables the unique energy potential of the rivers, and also produces "greater quantity" of electricity at the time of its demand in the market.

Extremely hot or rainy and chilly summers affect people's lives in a special way. Excessive heat requires cooling and power consumption. In addition, increased heat requires intensive irrigation and thus increased investment. Dry and hot summers are followed by reduced crop yields, which is reflected in more expensive food production and thus an increase in the cost of living. Rainy and chilly summers affect the summer tourist season, especially in coastal countries. Thus the losses in Croatia, Montenegro and Italy, caused by greater rainfall and chilly time in the summers of 2010 were estimated at billions of dollars. On the other hand, greater rainfall is reflected in an increase in the moisture content of the soil, lack of plowing fruits picking. The sowing season is late and thus yields are lower. Sometimes it is impossible to pick a fruit, because one cannot enter the field. This is especially present in the Popovo Polje area (long flood season), Posavina, Semberija and funnels. Lower temperatures cause the later emergence and tillering of winter crops, thus reducing the yields.

Long-lasting drought periods affect all nations of the world. Drought is one of major natural disasters. It causes lower crop yields and thus the occurrence of hunger. In the Republic of Srpska, Montenegro, southern Serbia and, in particular in eastern Macedonia; drought is especially pronounced in lying parts of Herzegovina, but also affects the parts of Serbian Posavina, Semberija, Vojvodina and especially southern Banat and Negotinska Krajina.

This problem is even more pronounced in the world. Namely, the regions south of the Sahara, Central Asia and the Middle East are confronted with the problem of famine and desertification, which is precisely the cause of prolonged droughts.

Anthropogenic Factors of Climate Change

The main "contribution" to global climate change is associated with greenhouse gases which disrupt the balance of gases in the atmosphere. The atmosphere envelopes the entire Earth and provides a connection between the oceans and continents. Air masses forming the lower atmosphere are in a constant state of circulation. Certain gaseous components of the diffusion

process are moving through air. The composition of the atmosphere affects life processes on the Earth's surface. Carbon dioxide, oxygen and nitrogen levels depend on the life processes. Therefore, the effects of pollution on ecosystems can, at least in theory, affect the operation of these processes globally and thus change the composition of the atmosphere.

If you look at things this way, the effects of pollution on living organisms can be direct or indirect. Photosynthesis inhibitors are the examples of pollution that directly affect plants, slowing the use of CO_2 and release of O_2. The effect of chlor–flour-carbon gases (CFC) is indirect. Due to the depletion of the ozone layer, more ultraviolet radiation reaches the Earth's surface causing damage to animals and plants. Carbon dioxide levels in the atmosphere have been in the focus of much debate. Over the past 40 years, they have increased by about 10%. It is held that most of this increase is caused by the burning of fossil fuels (coal, oil, etc.). It is also held that the reduced areas of forest cover have also contributed to this, since trees tie up significant amounts of CO_2. Concerns over arise in atmospheric CO_2 are caused by the fact that it influences the effect of greenhouse gases, keeping more heat on the Earth's surface and, thus, creating global warming. The questions regarding this problem are long term ones and tend to be constant. The effects of pollution on a global scale can affect the planet's entire ecosystem and are likely to enhance concerns in the 21st century. Apart from CO_2, and CH_4, N_2O and water vapor, greenhouse gases are followed by hydrocarbons and their derivatives, sulfur compounds and other products of fossil fuel combustion.

The biggest sources of air pollution are power plants (thermal and electric power plants), various industries and traffic. A significant indirect contribution is also made by agriculture and forestry. Large carbon-dioxide emissions, deforestation and reduction of green space in rural and urban areas have resulted in an increase in carbon dioxide emissions. Plants use carbon dioxide (CO_2) for photosynthesis and thus absorb carbon into biomass and reduce the greenhouse effect. The burning or decomposition of average trees re-released carbon into the atmosphere in the form of CO_2 or CH_4 (methane). Reductions in emissions produced by human activities would ensure the natural balance, and greenhouse gases would be reduced to their levels before the Industrial Revolution. Green space reduction irrigation – drainage of certain areas, construction of artificial lakes, as well as the development of cities, industry and transport are significantly influenced by climate change on Earth. Greenhouse gases produced by human activities are released into the atmosphere and disturb the balance between the energy coming to Earth and the energy going with it.

In the Republic of Srpska, air pollution is global, even at the regional scale. However, this does not mean that one should work on reducing pollution. Namely, power plants in the Republic of Serbia (TPP and Gacko, and heating in large cities, if you can talk here about big cities) increased air pollution, because they are in recesses where it encourages the production of local

greenhouse gas emissions due to the thermal inversion phenomenon. In Serbia, TNT are in Obrenovac, Kostolac (Drmno) and the Kosovo Power Plant. The problem lies the fact that those are technologically obsolete power plants which emit much more pollution per unit of output than similar plants in developed countries.

Industry in the Republic of Srpska is not developed at the local level, so that one cannot say that and it pollutes air. In Serbia, of paramount influence are the Pancevo Chemical Works, Trepca, Sartid in Smederevo and Bor Mining and Smelting Complex. Due to obsolete technology power plants emit far more pollutants than plants with the same volume of production in developed countries.

During the 1990s, intensive logging was continued, which was reflected thein climate change in this region. This especially refers to region of important Herzegovina. Namely, deforestation and forest degradation expose on surface area, which is then prone to erosion that has the lasting effect on the area. Karstification and denudation, in particular, increase surface temperatures (hotter summers and colder winters).

In the Western Balkans and other European countries road traffic has sharply increased.. There are more and more cars on roads and streets. It is known that internal combustion engines produce large emissions of CO_2, CO, NOx, SO_2 and hydrocarbons; all these gases are on the list of greenhouse gases. The problems in these areas are posed by old cars that emit up to four times more pollutants than modern ones. Roads are in bad condition, with many bends and slopes which further increases fuel consumption and thus air pollution.

Recently, a serious debate about the impact of wastes (municipal and industrial, and agricultural) on greenhouse gas emissions has been held. There is a particular increase in methane emissions. Methane is a significant factor in the development of greenhouse gases. In this region it is estimated that there are over 150 illegal dump sites in one municipality with the deposit of about 6,000 m^3 of wastes. It must be borne in mind that about 20% of the organic component is expected to produce significant methane and CO_2 and CO emissions. In addition, ash dumped during the winter tends to burn waste, thus emitting significant amounts of dioxin from burning plastics, Styrofoam and other PVC materials. Dioxan is treated as a mutagenic and carcinogenic substance and its production is not only harmful, but also has a lasting impact.

Wastes from power plants and heating plants (sludge and ash) are significant water and air polluters. The main problem is posed by very small ash particles that the slightest breeze raises above the ground level, thus blurring air, reducing solar radiation and thus photosynthesis, managing are decrease in CO_2 consumption. Nitrogen oxides emitted from these dump sites are photo-oxidants that deplete atmospheric ozone. The true "contribution" of the Western Balkans is not great, but is still present and must be taken into account. An additional problem is also posed by ionizing radiation.

In recent years, various "benefactors" from the West have appeared wishing to "help" the Balkans and install municipal waste incinerators. It must be borne in mind that these wastes contain plastics, which will certainly emit significant amounts of dioxan. This means that such "assistance" should not by any means be accepted.

What to do in Order to Optimize the Climate Change Problem?

There is growing awareness that the choice and implementation of climate change mitigation options in several sectors will realize synergies and prevent conflict with other dimensions of sustainable development. Apart from impact mitigation measures, adaptation measures are also necessary. Attention to climate change can be considered as an integral element of sustainable development. A power institution in the RS determines the impact of development policies on greenhouse gas emissions and photo-oxidants. Change directions of development and interaction of public and private decision makers, including government, business and civil society, although many of them did not believe that environmental policy is in their domain. This process is most effective when all stakeholders participate and when the coordination of decentralized decision-making climate change and other sustainable development policies are often, but not always, synergic. There is growing evidence that decisions about macroeconomic policy, agricultural policy, development banks, insurance practices, electricity market reform, energy and conservation of forest reserves are often treated as part of climate related policies. But these activities can significantly reduce greenhouse gas emissions and air pollution. On the other hand, decisions about improving rural access to modern energy sources, for example, may not have much impact on global emissions of greenhouse gases and photo-oxidants but in a local community they have an impact.

In recent times, there has been increasing reference to the use of biofuels as a "life-saving solution" even when car pollution is in question. But is it a solution, especially since the opening of a series of problems on the other side?

The European Union plans to increase biofuels production using about 70,000 km^2 of agricultural and raw land. According to the reports of nine international environmental groups, this will reduce food production and accelerate climate change,. As a result, the additional amount of biofuels, which the EU will spend over the next decade, will produce between 81 and 167 per cent more carbon dioxide than fossil fuels, as pointed out in the report of nine environmental groups that have analyzed the official data on the EU objectives to obtain 10 per cent of the total amount of fuel for transport from renewable sources by 2020. Individual EU energy strategies concerning renewable energy predict that about 10 per cent of fuel used in transport in

2020. should account for biofuels, of which 90 per cent will be derived from food crops. This absolutely means that it will reduce global food production. Since it is necessary, it must be provided on the other side. This primarily refers to tropical forests and savannas. The reduction of tropical forests means the reduction of oxygen and an increase in CO_2 in the atmosphere. Given these facts, the global debate is focused on how world hunger, in particular, is increasingly taking its toll due to neglect and underdevelopment.

The Republic of Srpska has enough land resources to ensure the nutrition of the population and a certain amount can be set aside for biofuel production. However, we see an accelerated increase in food prices on the world market, so that the production of biofuels instead of food is becoming profitable, especially in view of new energy solutions (hydrogen, solar energy, etc.) for cars. Burning forest areas to clear land for food production or biofuels may lead to the emissions of huge amounts of gases that cause global warming, thus diminishing the benefits of biofuels.

Climate change policies dealing with energy efficiency and renewable energy are often economically viable, improve energy security and reduce polluting emissions. Other forms of improving energy security can also be used to achieve sustainable development, thus preventing the displacement of local populations, job creation and benefits to improve health. Regarding the energy situation and its impact on climate change, Serbia, Montenegro and the Republic of Srpska should be oriented to renewable energy sources (geothermal, solar and wind energy) and the development of heating equipment and plants for the purification of greenhouse gases and photo-oxidants.

As for the forest industry in the Western Balkan countries, they must work on the revitalization and reclamation of devastated forest lands, optimal use of forest resources, and the renewal and rehabilitation of forests. A special problem is posed by forest fires which not only destroy forests, but also produce large amounts of greenhouse gases. This requires consistent work, especially in the Herzegovinian part of the Republic of Srpska. This would reduce the temperature ranges and balance humidity, to achieve balance and swelling of the river which will have a positive impact on hydropower capacity.

As for traffic and its impact on climate change and air pollution, the Republic of Srpska must work seriously on the improvement of the road and street network, as well as the energy efficiency of vehicles and public transport.

As for pollution from landfills (wild and planned) it is necessary to make the greatest possible effort to provide legal disposal of collected wastes. "Wild dumps" should be removed from the territory of the Republic of Srpska and an efficient system of waste management should be developed. This does not mean that we should build a sanitary landfill rather, this means to provide primary and secondary separation, and use organic waste compost and gas obtained in the composting process used as fuel. Compost is used to increase soil fertility, which is in the Western Balkan countries to reduce livestock all

lower. Other waste import recirculation system (recycling). Inert waste used for filling some rivers that are prone to flooding as well as for road in the plains should be developed.

Conclusion

Climate change is a problem of modern humanity, due to a series of negative consequences. The Western Balkans are not a significant factor that would affect global climate change, but that does not mean not to deal with this, admittedly, small "contribution" to the problem. The activities in these countries are primarily directed towards eliminating the causes that lead to climate change, and then mitigating the effects of this change. We should work on the adaptation of our society and economy to the new situation.

In the energy sector, these countries must do everything to boost energy efficiency, cost of energy and increased use of renewable energy. The forestry and forest industry must take into account the rational use of the forest fund and revitalization of devastated forest areas, particularly in the Herzegovinian part of the Republic of Srpska, eastern Serbia and eastern Macedonia and Dalmatia.

It is necessary to upgrade the travel industry and modernize the means of transport. Special attention in freight transport should be oriented to rail transport to a greater extent. As for the problem regarding municipal and industrial wastes and their pollutants emission into the atmosphere, it is necessary to reduces them ultimately and eliminate.

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Miroslav Doderović was engaged in professional projects in the function of spatial planning done by the Institute of Geography, Faculty of Philosophy in Niksic, as follows: construction and equipment areas and locations on the Montenegrin coast and vegetation – flora and other landscape values of the Montenegrin coast. Of particular relevance for spatial planning and his professional work, "Geographic Information Systems", membership in association spatial planning and reviews of published books in the field of spatial planning, rural ecology, demography, geography, settlement, tourism and transport geography. Served as the Secretary of the Council of the Department of History and Geography, and since 1994. until 1997, was a member of the Senate of the University of Montenegro, and a member of Faculty Council.

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Revenue, R is calculated as

$$R = P^*V \tag{1}$$

where

– P is the selling price, and
– V is the volume of sales in units.

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