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PROBLEMY EKOROZWOJU

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Józef Marceli Dołęga
(1940-2014)

On January 19th, 2015 prof. Józef Marceli Dołęga passed away.
He was the Dean of the Faculty of Philosophy of the Academy of Catholic Theology (ATK) and the Cardinal Stefan Wyszyński University (UKSW) for a long time. The founder and director of the Institute of Ecology and Bioethics of the Cardinal Stefan Wyszyński University, head of the department of Ecophilosopy and Environmental Education.
One of the most prominent Polish philosophers and environmentalists, working on humanistic concept of environmental protection.
He was a member of the Scientific Committee Man and Environment at the Polish Academy of Sciences, Committee on Science of the Polish Episcopate, member of the Council of Environmental Information Center of the National Fund for Environmental Protection and Water Management and a member of the Scientific Council of the Polish Green Lungs Agreement. He was also the editor of the international scientific journal *Studies Ecologiae et Bioethicae* and also a member of the Editorial Board of *Problemy Ekorozwoju/Problems of Sustainable Development* scientific journal.

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EDITORIAL

Philosophy of the Sustainable Development and the Sustainable Future of Humankind – the Survival of Humanity

Filozofia rozwoju zrównoważonego I zrównoważona przyszłość – przetrwanie ludzkości

Timi Ecimovic*,
Roger Haw, Igor Kondrashin, Raoul Weiler,
Fidel Gutierrez Vivanco et al.[1]

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Abstract
On the occasion third year after declaration on sustainability and interdependence, interaction and co-operation (as a basic methodology for a better tomorrow of humanity, which already opened a horizon for the sustainable future of humankind), we think to ask for understanding of the present and to put together the reasons for a survival of the individuals, local communities, and global community of humankind.
After publishing six books on sustainability, announcing the declaration *The World Thinkers Panel on the Sustainable Future of Humankind – WTP-SFH*, bilingual book on sustainability and survival of humanity, multilingual digital book *Anthology 2 – 2001-2014 May 2014* as a platform for implementation of the methodology for sustainability of the global community of humankind, reaching thirteenth session of the Provisional World Parliament, and observing the present, we are looking forward for a better tomorrow.

Key words: sustainable development, philosophy of sustainable development, survival of humankind, sustainable future, World Thinkers Panel, culture, technology

Streszczenie
Trzy lata po deklaracji w sprawie zrównoważonego rozwoju i współzależności, interakcji i współpracy (jako podstawowej metodologii dla kształtowania lepszego jutra ludzkości, która już otworzyła horyzonty dla zrównoważonej przyszłości ludzkości), czas bliżej przyjrzeć się teraźniejszości i zestawić uwarunkowania związane z przetrwaniem ludzkości w wymiarach: indywidualnym, lokalnych społeczności, a także globalnym.
Mając wsparcie w postaci sześciu wydanych książek na temat zrównoważonego rozwoju, ogłoszonej deklaracji *Panelu Myślicieli Świata o zrównoważonej przyszłości ludzkości* i cyfrowej monografii *Antologia 2 – 2001-2014*, będącej platformą umożliwiającą implementację zrównoważoności na poziomie globalnej ludzkiej wspól-

[1] Dana M. Barry, USA, Garfield Brown, South Africa, Truly Busch, Germany, Santhi Nath Chattipadhyay, India, Alexander Chumakov, Russia, Elias Demirtzoglou, Greece, Barbara Dobrila, Slovenia, Hon Ricaardoe Di Done, Montreal, Canada, Jan Dobrowolski, Poland, Mark Esposito, France and USA, Jagdish Gandhi, India, Jorn Hamann, Germany, James Hanson, USA, Marion Hersh, UK – Scotland, Anita Hrast, Slovenia, Zinaida Ivanova, Russia, Sait Kacapor,Serbia, Slavko Kulic, Croatia, David Lingiah, UK – Scotland, Alexander Makarenko, Ukraine, Glen T. Martin, USA, Jalil Mehrzad, Iran, Moamen Nassr, Palestine, Matjaz Mulej, Slovenia, Philippos Nicolopoulos, Greece, Hakikur Rahman, Bangladesh, Portugal and USA, H. A. Shankaranarayana, India, Yonghui Song, China, T. N. Sreedhara, India, Shahid Siddiqi, Canada, Shishir Srivastava, India, Rajarama Tolpady, India and Seminur Topal, Turkey.

noty, bogaci także w doświadczenia wynikające z 13 sesji Tymczasowego Parlamentu Światowego, obserwując uważnie teraźniejszość, spoglądamy z nadzieją w przyszłość, wierząc, że lepsze jutro jest możliwe.

Słowa kluczowe: rozwój zrównoważony, filozofia rozwoju zrównoważonego, przetrwanie ludzkości, zrównoważona przyszłość, World Thinkers' Panel, kultura, technika

The Introduction

In our research the education of the global community of humankind population is the most important work to reach understanding of the present and a reason why we have to go towards the sustainability of humanity.
The short definition of the sustainable future of humankind is harmonious, complementary, coexistence of humanity and the nature – biosphere of the planet Earth.
We are questioning the common understanding of the nature as *living nature* and *non-living nature*.
We are questioning of understanding of the climate change and global warming. We are questioning the present morality and wisdom and reasons for a bad impact of leadership and corruption.
Of course we do not intend to criticize but to put on a new scientific and applied research in natural sciences and humanities, optimal methodology and work for a better tomorrow of humanity because we care.
The philosophy of sustainable development and sustainable future of humankind is the search for a knowledge and understanding of the Nature and meaning of the Universe and life.
Sustainable development and advanced methods, societal technology or possible evolution of the Global Community of Humankind – Sustainable Future of Humankind are of great importance for a long lasting survival of *Homo sapiens* in the Biosphere of the planet Earth.
Education, education and education is the answer to any action towards evolutionary achievements of the humanity. Education for knowledge and understanding as the truth about nature is opening new horizon and frontiers for future of humankind on the planet Earth.
We are in the Globalization era, but we have Internet and far better communication techniques commencing from information era and they belong to keys for a better education and survival of humanity.

The present is summary of the past, and future is unpredictable[2]

The nature as a novelty of understanding is a part of basic environment, which is the Universe or the Cosmos. Within it the Nature exists in countless forms, dimensions and contents. It is **interdependence, inter-action and co-operation** of all matter, energy, information, dimensions, light, rays, forces, powers, particles, and yet unknown contents of the Nature, which is basis of the life. Of course we agree that the Nature is continuum of life. Please see more at the Noble Prize nomination book *The Three Applications of the System Thinking* by Timi Ecimovic (2009)[3].
The philosophy of sustainable development and sustainable future of humankind is the search for a knowledge and understanding of the nature and meaning of the universe and life. Education, knowledge, and understanding are the most important achievements of the *Homo sapiens'* present civilization.
Under the progressive threat of the impact of the climate change system on the biosphere of the planet Earth, which is changing environment and living conditions, our civilization has to meet the challenges and establish a path for long term survival.
The present global social order, life style, education, peace, respect, ethics/morality, wisdom and daily practice of humans needs to undergo a fundamental renewal to meet the needs for long term survival during and after the third millennium.
This discussion presents a contemporary scientific approach to the present ***Nature, energy, drinking water, food, banking, credit and societal crisis*** of humankind in 2008-2013. The present civilization or global community of humankind is facing the largest complex societal crisis, which is also closely inter-related with the impact of the climate change system or evolving planet Earth Biosphere *»crisis«*.
It is the *crisis* for whom – only for the global community of humankind (7 billion + individual representatives).
The impact of the climate change system may in the long run change: biology, geography and living conditions within the biosphere, from suitable ones of the last 12.000 years, to environment not suitable for *Homo sapiens* to live. It is making more complicated and complex the present social crisis of: energy, drinking water, food, banking and credit. In 2008 we entered difficult times for humankind which is here also in 2014.
The world governing, the Federation of the Earth, the Constitution, the Parliament and planetary government are possibility for taking care of corruption, mismanagement, and action toward the sus-

[2] The statement was prepared by Prof. Timi Ecimovic (2013).

[3] Also it is displayed at *Small Digital Reference Library* at http://www.institut-climatechange.si.

tainable future of global community of humankind. Please see the book *Sustainable Future of Humankind – VI, the World Governing* (Martin et al., 2013)[4].

The corporate and individual social responsibility is a part of our society with much more importance as most humans are thinking at present. The possibility for survival is closely connected with social technology/technique of the »Sustainable Future of Humankind« or harmony of our civilization with the Nature/Biosphere of the planet Earth[5]. The corporate and individual social responsibility will have to play a more important part in future, for new great achievement of our civilization to overcome the crisis of living conditions within the biosphere of the planet Earth.

The Discussion

This presentation was prepared in co-operation of many researchers and is taking advantage of new digital books: *Sustainable Future of Humankind – VI, the World Governing* (February 2013), and *The Sustainable Future of Humankind – V, the Action Plan* (December 2012)[6], which are the 5th and 6th books on sustainability of humanity or, in other words, the sustainable future of global community of humankind. 2013 and 2014 (June) added further digital books and presentations: *The Sustainable Development and Sustainable Future of Humankind – the Survival of the Humanity* bilingual booklet, multilingual book *The Anthology 2 – 2001-2014* (May 2014), digital book *The Nature and the Requisite Holism*, which include nice presentation on individual societal responsibility of humankind (March 2014).

The short definition of the sustainable future is – ***The Sustainable Future of Humankind is Harmonious and Complementary Coexistence of Global Community of Humankind and the Nature of the planet Earth***.

Our commencement was after numerous presentations, publications, discussions and talks on the sustainability world-wide, the paper and digital book *The Sustainable (Development) Future of Mankind* (Ecimovic, Bunzl, Esposito, Flint, Haw, Mulej, Shankaranarayana, Wilderer, Williams and Udyavar, 2007). It was the first book of the trilogy on sustainability. Following was a digital book on CD only *Sustainable Future, Requisite Holism, and Social Responsibility* (Bozicnik, Ecimovic, Mulej, 2008), and the third digital book was *The Sustainable Future of Mankind III* (Ecimovic, Esposito, Haw, Mulej, 2010). Next in line the fourth was digital book *The Sustainable Future of Humankind – IV, Xiamen, China and after* (Ecimovic, Haw, et al, 2012). In the book 49 researchers, scientists and professors co-operated.

The sustainable future of humankind is a methodology, social technology or technique coming from the sustainable development concept.

Thus it is a step ahead from a sustainable development mainly because of taking the real Nature as it really is, and the Nature of the planet Earth as the most important part of the solution for a survival and a long life of *Homo sapiens* on the planet Earth.

On 25th September 2011 in Xiamen, China the declaration *The World Thinker' Panel on the Sustainable Future of Humankind (WTP – SFG)* was announced.[7]

The declaration is a result of authors and co-authors' 25 and more years of research and scientific theoretical and applied work. For many of them it is 40 + years of research work. What we are doing is a generation of a frame for implementation of the sustainable future of humankind because we care.

We are using modern research tools and research resulting from the system thinking, philosophy, complex problem solving, case studies, requisite holism, operational research, global studies, globalization, and classical methods of scientific work.

We are following the history of *Homo sapiens* civilisation, and results of great human minds as much as possible. We are observing happenings and processes of the last 60 years, which are fast changing the heart of the present *Homo sapiens* civilization, and the quality of the environment of the Biosphere.

It is because of interdependence, interaction and co-operation of the planet Earth systems and larger star Sun system, galaxies and universe of which we are within the planet Earth a part, very small one.

Our requisitely holistic approach is opening numerous blind alleys, which have been invented by humans, but harmed the Nature of the planet Earth, with which we all have to be interdependent, interacting and co-operating.

The sustainability journey of our civilization is an ever-lasting epic song, and has commenced at some time as *Homo sapiens* evolution, but due to historical options today it does not look good for our humanity.

The sustainability has been discussed at many gatherings of humans for the last 25 years but only recently it has gained a new challenging importance.

The responsible participants commenced forming an organization and everything needed for imple-

[4] See at http://www.institut-climate change.si.

[5] Please see: Ecimovic at al., *The Sustainable (Development) Future of Mankind*, 2007, http://www.institut-climatechange.si and Bozicnik, Ecimovic, Mulej at al., *Sustainable Future, Requisite Holism, and Social Responsibility*, 2008, available at IRDO.

[6] Ecimovic, Haw, Roger et al., *Sustainable Future of Humankind – V, the Action Plan*, see at http://www.institut-climatechange.si

[7] See at http://www.institut-climatechange.si.

mentation of the work on the sustainability of humanity. It is somehow a next step or an evolution of the known *sustainable development* work, from Stockholm, Rio Summit, Rio + 10 years, and Rio + 20 years after 1992 Rio Summit international gathering.

Let us present the Declaration:

The declaration, as it was already mentioned, was announced at the event in Xiamen, a lovely subtropic area in China with 3.5 million inhabitants. The event was scheduled for the 25th and 26th of September as the *International Collaboration Celebration, Declaration of WTP-SFH, Academic and ASRIA Awards Presentation Ceremony 2011*, taking place on the 25th, and the *First International Conference on Protection of Land and Ocean*, taking place on the 26th September 2011.
The declaration (in English) was translated into Chinese and was prepared as the *Xiamen Declaration*, written in both Chinese and English for the first announcement. On 25th September 2011 at a Ceremony in the Xiamen International Convention Centre (Xiamen Declaration) *The World Thinkers' Panel on the Sustainable Future of Humankind* was launched.
It is *my* agenda, *your* agenda, *our* agenda, local community agenda, regional, country, continental, UN, and Agenda of global community of humankind. Humans need interdependence, interaction and co-operation for better tomorrow.
We think that the most important part of implementation is to educate people and to agree upon global alliance needed for information, understanding, building up processes, and evolution of global *Homo sapiens* from up to end of 20th century, to be fit to meet challenges of 21st century. That is why we commenced fostering of the declaration as a promotion of the information, knowledge and understanding exchange for a better tomorrow of humanity after 20th century.

DECLARATION
of
The World Thinkers' Panel on the Sustainable Future of Humankind

People throughout the world are against the culture of violence and war. They are for a culture of friendship, solidarity, tolerance and peace. By a decision of 52/13, the decade 2001 to 2010 was unanimously proclaimed *International Decade for a Culture of Peace and non-violence to all children of the world* (by the General Assembly of the United Nations).

By Prof. Dr. Timi Ecimovic

On 15th August 2011 the World Thinkers' Forum, Ansted University, Sir Prof. Dr. Major Roger Haw Boon Hong, Penang, Malaysia, SEM Institute for Climate Change, Prof. Dr. Timi Ecimovic, Zg. Medosi, Korte, Slovenia, Prof. Dr. Dana Marie Barry (USA) and Organisation for Protection of Children Rights, Hon. Ricaardoe Di Done, Montreal, Canada, Ambassador Dato' Dr. Ang Ban Siong (Malaysia), Professor Tang Shui Yuan, Chairman of the *1st International Conference on Protect the Earth and Ocean* in Xiamen, China, and Dr. Garfield Brown, South Africa, proposed founding the panel as follows:
Within the World Thinkers' Forum is an open and new working panel named: *The World Thinkers' Panel on the Sustainable Future of Humankind.* For short it is represented by the following acronym *WTP-SFM* and has the sign displayed below.

The addresse for it is at Korte 124, SI 6310 Izola – Isola, Slovenia.
A long list of people of good will, academicians, scientists, politicians, workers, administration and governemnt officials, and many others are supporting this Declaration. Among them are members of the SEM Institute for Climate Change, the Ansted University family, and honorable and other members of the World Thinkers' Forum, etc.
The theorethic and practical background for this Declaration can be found in many works about *Sustainable Development* and *Sustainable Future of Humankind.* Ecimovic, and many more scientists' work during the first decade of the 21st century could serve as theoretical background. It can be seen at the http://www.institut-climatechange.si.
Members and supporters of the Declaration are free of charge members. The UN, national governemts, international corporations, international institutiona, national institutions, education institutions and others, are invited to co-operate on the work for the sustainable future of humankind.
The Declaration is giving rights, and is asking for individual social responsibility from members of the human global community: (7000000000+ individuals). The goal is to reach global sustainability of the global humankind community.

The global sustainability is a transition from sustainable development societal technique to the sustainable future societal technique. The UN and agencies, especialy the UNEP and UNESCO, are welcome to co-operate for the common goal of sustaining the future of humankind.

Our individual lives are very short, and their value and meaning are found substantially in fact that we are integral parts of the *human project*. We must support the continuum of humankind because what we are fundamentally is human beings who are inseparable from the continuum, a continuum that includes our descendents and future generations. As human beings we are responsible for each other and for future generations.

The World Thinkers' Panel on the Sustainable Future of Humankind provides a platform for people (interested in the arts, scientific & cultural activities and peace mission projects) to meet and to work together. The primary goal of the said platform is to create a level of understanding and tolerance between the various peoples of the world and to contribute to the promotion and maintenance of world peace. We welcome all individuals and groups of the world irrespective of race, sex, language and religion. The work of *The World Thinkers' Panel on the Sustainable Future of Humankind* is based on the respect of human rights and basic liberties of all peoples of the world. This relates directly to the active participation of UNESCO's project *Culture of Peace*.

The task of *The World Thinkers' Panel on the Sustainable Future of Humankind* is a forum for all non-governmental institutions, ministries, public offices, scientific and cultural organizations as well as institutes, diverse organizations, museums, universities, foundations, unions, associations, business organizations and other establishments. It is also for individuals who are practically, organizationally and scientifically engaged in promoting cultural activities, folk art, culture heritage and scientific activities.

Besides the working order and the activities of our world-wide organization for the practical, organizational, and above all scientific work for culture, we also have to meet a very important, social, humanistic, and cultural-political order. Many of us have learned and grown from being a new member of *The World Thinkers' Panel on the Sustainable Future of Humankind.*

We think all members of global humankind community have the responsibility to help when needed. Many grant foundations of Culture, Arts, and Scientific institutions (from local and international levels) will give support to the development of common interests.

We believe that *The World Thinkers' Panel on the Sustainable Future of Humankind* not only contributes to the attainment and exercise of these rights, but that multiculturalism plays a role in solving some of the problems in modern society.

The founding group of *The World Thinkers' Panel on the Sustainable Future of Humankind* has established the following categories for making *The World Thinker's Panel on the Sustainable Future of Humankind*. These categories (that are listed and described below) are important for the panel to achieve its recognition at the international level.

Categories

1. Characteristics of traditional culture.
2. Virtues of traditional culture in a modern society.
3. Traditional culture and cultural diversity.
4. Traditional culture and rights to culture.
5. Traditional culture and multiculturalism.
6. Plans for the promotion of traditional culture through systematic continuing study of traditional culture, systematization of exchange of traditional culture and regional cooperation, regular conduct of a traditional culture-related forum and development of cultural industry based on traditional culture.

1. Characteristics of traditional culture

A traditional culture is a way and system of life that is practiced by a people for generations, and features an eco-friendly culture where humans coexist with nature, where an individual is relatively less alienated from the others, and when the spiritual culture is pursued more than the material ones.

2. Virtues of traditional culture in a modern society

Since the advent of modernization and industrialization, our modern society has faced a number of obstacles and problems such as the breakdown of ecosystems due to the indiscriminate conquests of nature, severe natural disasters, cut throat competition in the world markets, unbalanced distribution of wealth, widespread human alienation, attachment to material values at the expense of spiritual values, making it so difficult to lead a humane life. In this context, the traditional culture is of great use for solving such problems in a modern society. In particular, the Confucian cultures in East Asia think highly of *filial piety* and *respect* that are core values, and which are of great worth and merit to remove distrust and enmity between generations and help recover the dignity in human beings.

3. Traditional culture and cultural diversity

The traditional culture is the result of communication and interactions between human beings who

have individually adapted themselves to geographical and ecological environments, best representing the individual identity and uniqueness of nations and regions. It can be therefore said that the traditional culture underlies the diversity of world and regional cultures.

4. Traditional culture and rights to culture

The constituents of a nation are entitled to have a political and social life, as well as a culture life. They should have the rights to exercise the freedom to accept the past as well as the present culture. In current times, traditional culture as identified with the past does not belong to the mainstream, therefore, making it difficult for people to appreciate it. In order to satisfy their cultural needs, cultural policies should be set and practiced so that they may have access to traditional culture anywhere and anytime.

5. Traditional culture and multiculturalism

Our contacts and interactions with cultures can make us have a better understanding of other cultures. Therefore, we get to have a better understanding of the different regions and its peoples, further aiding in attaining made and preferentially based on traditional culture. More emphasis on traditional culture and arts is especially needed so that it retains the indigenous ethos of a region.

6. Plans for the promotion of traditional culture

The traditional culture has a meaningful importance as shown above, and for its conservation and promotion, some plans are proposed below. It is so recommended that governments, private groups and communities make active co-operating efforts in realizing this.

(I) **Systematization of exchange of traditional culture and regional cooperation**

The exchange of traditional culture has value in promoting multiculturalism. Until today, the exchanges have been made unsystematically and at random, not probably enabling people to gain easy access to other traditional cultures. In order for a community to exercise their equally cultural rights and enjoy any other traditional cultures, more exchanges and regional cooperation should be ensured institutionally. Governments, private groups and communities should give attention to this.

(II) Regular conduct of a traditional culture-related forum

The forum should be held regularly for enhancing understanding of traditional cultures in areas, for contribution to the peace of mankind and the world at large, and for maintaining diversity of cultures worldwide, thus accepting multiculturalism, and allowing the nation and community to awake to the importance of traditional culture.

(III) **Development of a cultural industry based on traditional culture**

For a traditional culture to be sustainable and alive in modern living, its advantaged competitiveness should be ensured and closely adhered to the life of a community. It is also required that the cultural industry such as folk art and craft art should be developed with traditional cultural assets. The cultural industry affects modern living, and so the traditional culture, uniquely separate from other modern cultural assets, should be made to contribute to satisfying the cultural demands of community.

This Declaration is more fundamental than a mere professional production. It reflects the present endangered status of our global community of humankind, and the absolute need for a better tomorrow characterized by global environmental sustainability and knowledge. The Declaration should be the beginning of the road toward a truly sustainable future of humankind, and harmony of humankind living within the biosphere realities of the planet Earth. This should be our contribution toward the lives of our descendants. The UN and national governments have to transcend from the present, and co-operate for needed changes to sustain the future of humankind. We need a planetary perspective, planetary leadership, and planetary values.

Our present time period should be enriched with active work towards a sustainable future. Also we need skillfull, global, humankind community leadership, under preconditions of individual and collective social responsibility. We must support the accurate scientific knowledge of Nature and humanistic sciences, as well as support and promote respect, peace, morality, and wisdom.

I wish to see the global promotion of ideas from this Declaration and a sustainable future of humankind.

Prof. Dr. Timi Ecimovic

Let us continue with discussion on the roots and present of global community of humankind sustainability:

Humanity after 200000 years of coexistence in the biosphere of the planet Earth and the Nature has to learn about a harmonious and complementary coexistence with the Nature. Humanity's present pollution and resource depletion of biosphere could be described as: *Today humanity's overall pollution*

and resources depletion of the Nature of the planet Earth is higher than yesterday and growing for the last hundred years[8]. The pollution by e.g. transport means system is an invention of humans for a direct pumping of poison into a breathing air, with the possibility of a self-mass destruction.

The latest research on the basic principles of the Nature and systemic sustainable future of humankind is opening a path for sustainability of humanity and the Nature of the planet Earth. The global community of humankind needs to have a long-term future, harmonious life with the Nature, and the Nature of the planet Earth, and life with peace, respect, morality, wisdom, and sustainable future.

Commencement was the evolution of *Homo sapiens* some 200000 years ago. Humans have been and are successful species[9] and in some 120000 years had inhabited almost the whole of the land environments on the planet Earth or better all inhabitable areas. People were living the life in harmony with all global and local conditions of The Nature of the planet Earth.

73000 plus minus 4000 years ago Toba volcano on the present Sumatra, Indonesia erupted (today Toba Lake). As a result of this super-eruption 6-10 volcano winters occurred. The global community of *Homo sapiens* decreased and experienced a possible extinction. At Rift Wally in East Africa a group of 10000 to 15000 people was a new origin of humanity.

In 1993 Ann Gibbons suggested *The Genetic Bottleneck Theory* in her article in *Science* (Ramping, Self, Ambrose, 1998), and together with Ramping (2000) supported this theory.

The bottleneck of human population on the planet Earth occurred some 70000 years ago, and new rapid population increase continued from approximately 15000 people.

The Stone age, Neolithic, Ancient Great Civilizations; China, India, Mesopotamia, Egypt and Persia to mention some, and Greeks, Romans, Germans, Slavic, Africans and other people took lead into Medieval and modern times.

After two world wars in the 20th Century the humanity was facing difficult times. Rebirth of the United Nations, evolution with innovations, research and development resulted into present Globalization Age. A part of this is a social methodology titled *Sustainable Development*, which was born as an outcome of the *Our Common Future* 1987 report.

Among the first researchers of the modern era in 1957 the British scientist **James Lovelock** in his work and later in the book *Gaja – A New Look at Life on Earth* (1979) opened new frontiers for environmental thinking and understanding of life and nature. The result of his research on the planet Earth as some living form has influenced humanity, and has been a commencement of the environmentalism. The James Lovelock work inspired **Rachel Carson**, to write the book *Silent Spring* (1962), and the establishment of the NGOs of environment protection as Greenpeace and others followed.

Let us continue with ***The Club of Rome*****,** which is a non-profit, independent organization founded in Rome, Italy, after April 1968 gathering initiated by Hon. Aurelio Peccei, Italian industrialist and Scottish scientist Alexander King. The membership includes up to 100 members from the science, politics, economics and culture individuals recognized for their work.

The first and the most known report *The Limits to Growth* was published in 1972. Actually it is dealing with global studies, system thinking, and holistic approach to the global problems of global community of humankind and the Nature.

With the dawn of third millennium their activities followed the global problems of humankind and with a reconstructed organization they became an important international club working for a better tomorrow of humanity. Their activities are coordinated by: International Centre of the Club of Rome at Winterthur, Switzerland, and European Support Centre in Vienna, Austria.

Stockholm – 72 was the first UN conference on the Environment held in Stockholm, Sweden, in 1972. The *Stockholm Declaration* and the *Stockholm Action Plan* have been adopted. The main result of the Stockholm – 72 was establishment of the UN Environment Programme – UNEP.

In 1987 the UN World Commission on Environment and Development submitted the report ***Our Common Future*** or ***G. H. Brundtland Report*** to the UN General Assembly, maybe the best report whatsoever presented at highest international political institution of present humankind. It introduced the term **Sustainable Development** and had strong impact onto the global society.

In *Common Concerns* report stated: *Those who are poor and hungry will often destroy their immediate environment in order to survive: They will cut down forest; their livestock will overgraze grassland; they will overuse marginal land; and in growing numbers they will crowd into congested cities. The cumulative effect of these changes is so far-reaching as to make poverty itself a major global scourge.*

Failure to manage the environment and sustain development threatens to overwhelm all countries. Environment and development challenges are not separate challenges; they are inexorably linked. Development cannot subsist in a deteriorating resource base; the environment cannot be protected when growth leaves out of account the costs of environmental destruction. These problems cannot be treated separately by fragmented institutions and

[8] Statement by Prof. Dr. Timi Ecimovic for this presentation, in September 2012.

[9] As taught in 19th century by Charles Robert Darwin (1809-1882).

policies. They are linked in a complex system of causes, and effects (WCED, 1987).

Those statements have been overlooked by coming generations. The spirit of complexity was just talks, reality of issues was neglected. Environmental quality of the planet Earth Biosphere was and is (2014) neglected. Interdependences, interaction and co-operation of all matter, energy, information, particles, rays, powers and forces and yet not known contents of Nature were overpowered by needs of individuals, national elites, security needs, money reproduction, bureaucracies, military needs, wars, riots, genocides etc. up till now (2014).

In *Towards Sustainable Development* section of *Our Common Future* Report the definition of it was stated as: ***Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*** (WCED, 1987). It is a very noble, humanitarian, cosmopolitan, global goal, which after it had been invented was generally misused by countless politicians, bureaucrats and people of individual feelings and not humanitarian quality, knowledge or morality and wisdom.

Also in *Our Common Future* a nice statement said: *Many of us live beyond the world's ecological means, for instance in our patterns of energy use. Perceived needs are socially and culturally determined, and sustainable development requires the promotion of values that encourage consumption standards that are within the bounds of the ecologically possible and to which all can reasonably aspire.*

The world must quickly design strategies that will allow nations to move from their present, often destructive, processes of growth and development onto sustainable development paths (WCED, 1987).

This content was also completely neglected!

Critical objectives for environment and development policies that follow from concept of sustainable development include:

- *Reviving growth;*
- *Changing the quality of growth;*
- *Meeting the essential needs for jobs, food, energy, water, and sanitation;*
- *Ensuring a sustainable level of population;*
- *Conserving and enhancing the resource base;*
- *Reorienting technology and managing risk; and*
- *Merging environment and economics in decision making.*

Objectives stand even today's criteria, and have not been ever taken into consideration of politicians, bureaucracies and nations agendas.

Most significant was the statement on *The Urban Challenge:*

- *In 1940, only one person in eight lived in an urban center, while about one in 100 lived in city with a million or more inhabitants (a 'million city')*
- *By 1960, more than one in five persons lived in an urban centre, and one in 16 in a 'million city'.*
- *By 1980, nearly one in three persons was an urban dweller and one in 10 a 'million city' resident.*

Hon. Tom McMillan, Minister of Environment, stated at WCED Public Hearing, Ottawa, on 26-27 May 1986: *The challenge ahead is for us to transcend the self-interest of our respective nation-states so to embrace a broader self-interest the survival of the human species in a threatened world*.

Dr. Gro Harlem Brundtland talking on report stated: *This commission's report, 'Our Common Future', contains a message of hope and opportunity.*

2nd The UN Conference on the Environment and Development CED-2, Rio de Janeiro 1992 or Rio Summit (the second after Stockholm 1972) attended representatives from 179 countries. A huge document was approved; Agenda for Change and Agenda 21 were adopted. A number of documents were approved, but never implemented.

10 years after Rio at World Summit on Sustainable Development, August-September 2002, Johannesburg, South Africa, was international gathering without visible positive result of co-habitation of the global community of humankind and the Biosphere of the planet Earth. Somehow it is how we have come to 2013 after announcement of *The World Thinkers' Panel on the Sustainable Future of Humankind* or *The Xiamen Declaration*.

20 years after Rio (Rio + 20), international gathering in Rio de Janeiro, 2012, was just continuity of talks directed by 1% and for remaining 99% of global community of humankind?

In **2009 the conference in Copenhagen,** which was announced to produce the follow up of the Kyoto Protocol of 1997, agreed upon by the UN Framework Convention on Climate Change (UNFCCC), appeared to be total flop. Moreover, the failure was total disruption of many years of efforts and has not yet been overcome by international political institutions.

At Xiamen, China, on 25th September 2011 at gala event a declaration ***The World Thinkers' Panel on the Sustainable Future of Humankind WTP-SFH*** was announced as a next possible step forward after the sustainable development social technique, which has not got well around the global community of humankind.

The Sustainable Future of Humankind a societal methodology, concept, technique and technology for needed change of global community of humankind survival under challenging condition at the Nature of the planet Earth in 21st century.

It is an alternative, which short description could be as: ***The Sustainable Future of Humankind is Harmonious and Complementary Coexistence of Global Community of Humankind and the Nature of the planet Earth***[10], and by transcendence from the

[10] It is short definition of very large, global, and complex societal methodology, technique, technology or qualitative change in the human society towards peace, respect,

sustainable development to sustainable future it is a new approach for a better tomorrow of humanity.
Our past and present are reason for needed change. As every living creature within the Biosphere of the planet Earth, also all 7 billion + members of global community of humankind have to comply with living conditions offered by the nature system of the planet Earth.
We think the present status – catastrophe of global community of humankind is dangerous. It is easy to understand how it is possible to have todays' present situation: 1 % against 99 %; Global community of humankind leadership by *Monster Master Money*; Large Pollutions of all three basic environments – Land, Water and Air; Human population explosion, and lack of individual responsibility, respect, peace, morality, wisdom and sustainability.
The Sustainable Future of Humankind is a renewal of Sustainable Development and Agenda 21 Processes adjusted to the needs of 21st century.

Let us continue with a discussion about education:

The goal of this research was to find which cornerstone issue was the most influential on the present status of the global community of humankind, within the framework of the numerous problems that we are dealing with.
There are a number of issues which are preoccupying human society – The Monster Master Money Leadership in global and local communities; The Basic Land, Water and Air Environments or Biosphere; Human Eco Sphere; The Local, National, Regional and Global Societal Structures; Scientific and Applied Research; Individual and Corporate Social Responsibility; Security, Military and War Issues; Agriculture and Food Supply Situation; The Drinking Water Supply; The Climate Change System Impact; The Protection of Nature, Space and Environment Happenings; Understanding of the Nature System, Universe System, Milky Way Galaxy System, Solar System and Planet Earth System; Understanding of the Nature of the Planet Earth System; The Biosphere and Impact of the Global Community of Humankind; The Education System; and many more aspects of human life.
We have been researching a philosophy of them, and the long term survival of the humanity on the planet Earth.
Due to the population explosion, and considering historical, philosophical, scientific, industrial, war and armaments, societal, urban constructions and habitations of *Homo urbanus*[11] and *Homo slumus*[12], and other respected heritages, we took a close look at Education and the Teaching of humans from birth through their whole life-span.
We think that the Whole Life Education System could improve the existence and survival of the global community of humankind on the Journey to a Sustainable Future.
Confucius (551-479 BC) Chinese, according to the book *Confucius – A Philosopher for the Ages* (Xu Yuanxiang, 2007), Confucius is considered to have contributed priceless values of morality and wisdom to humanity.
As a thinker and educator in Chinese history, he is known as the first educator in a private school, which was the commencement of the education system among humans world-wide.
Far from China three great philosophers in Greece also contributed great legacy to the education system: Socrates (470-399 BC), Plato (427-347 BC) and Aristotle (384-322 BC). It was a contribution of morality and wisdom for the western civilization.
More than 2000 years after the inspiration by them, the possibility of establishing a vanguard of the Earth population: *Citizen of the Earth – XXI* has been presented.
The World Philosophical Forum from Athens, Greece, has an important role to play for the upbringing of morality and wisdom of the global community of humankind. You are welcome to cooperate.
Charlemagne (742-814) the King of Franks (768-814) was working on the same question regarding the education system in his kingdom.
As a result he introduced a number of knowledgeable Roman Catholic Fathers and monks, who educated the Franks. Consequently, even today France is among the most educated nations in the World.
On the home page of the World Philosophical Forum, Athens, Greece, there is an exceptional presentation of the distribution of the mentality and understanding of the individuals in the global community of humankind (see Tables 1 and 2).
We did not challenge these numbers but we looked at them philosophically as a way to contribute to our thinking process. Through our research we have come to conclusion that the present **education system** is the most **responsible** for the present status of the human society.
The second most important reason is the lack of the mother's ability to transfer the needed knowledge and experience to her children from the birth to the school age. In a modern society within the human eco sphere, mothers may lack the time to properly educate their new-born children until their age to attend school. The mother is the first educator of a new-born child. If a mother does not know that she

morality, wisdom and sustainability needed for long-term existence of humans on the planet Earth.

[11] *Homo urbanus* is the inhabitant of the constructed urban areas. By 2040 approximately 5,6 billion people will be *Homo urbanus*.

[12] Homo *slumus* is the inhabitant of the slums or barracks centres. By 2012 the number of *Homo slumus* are estimated at 2 billion, and it is included as part of *Homo urbanus.*

has to educate her children, then she does not transfer the knowledge or is not able to do so. This is a common occurrence in urban societies, but is less common in rural areas.

Table 1. Mentality of present humans – 2012.

XXI century	up to	5,00%
XX century		10,00%
XIX century		20,00%
XVIII century		15,00%
XVII century		10,00%
XVI century		10,00%
XV century		10,00%
XIV century		10,00%
XIII century	up to	5,00%
Before XIII century	up to	5,00%

Table 2. The distribution of present humans.

Geniuses, philosophers, personalities	very few
Intelligent people	1,00%
Intellectuals	3 – 5 %
Citizens	10 – 50 %
Humanitarians	10 – 50 %
Philistines	30 – 70 %
Mental underdeveloped	10 – 30 %

However the formation of the mothers is a result of the education system. The inability of mothers to transfer their knowledge and experience also reflects the failure of the education system.

Mothers must learn the basic information about the nature of the planet Earth and its systems, and about the need for a harmonious life between humans and Nature. The human origin is from Nature. Therefore, humans have to learn the good and also the problems and issues that deal with Nature. **A very important task is how to teach children to learn.** The learning process should not end when one leaves school. It should be the choice of humans to learn throughout their whole life.

Back in 1989 we had an interesting targeted meeting about *What people know* and the result was:

- *Humans know that what their mothers were transferred to them from their birth until school age (the knowledge, skills and experiences).*
- *Humans know what they have learned in a schooling system process.*
- *After completing school, many humans DO NOT LEARN AT ALL.*

Or in other words: *Most of the humans on the Earth after completing their education through a schooling system process DO NOT show any responsibility about the future of Humankind and later on DO NOT LEARN anything related to this knowledge and DO NOT ACT to make this future sustainable AT ALL.*

This is where the goal of our education system and method has failed – the method of universal education. The goal of the education system is related to the conservation of the individual, society, humanity and the Nature system. In order to achieve this, the education system should aim toward universal human formation or instruction. The method of the education system is related to knowledge of the laws and principles of the universe – **The Nature system,** allowing us to synthesize and systematize human knowledge, so that we can transfer the universal knowledge or instruction of one generation to another.

For instance, the present schooling system in Europe is based on transmitting knowledge in the *education* of the person. It has not been made explicit in the system. Intelligence is valued by what young persons have learned and memorized, and not by an understanding of the Earth and planet on which they are living; in other words about Nature. In the present economic system, knowledge is expressed in monetary value, destroying any humanistic content.

Of course life is not so simple, but is, on the contrary, very complicated and complex. An individual's ability as a human is to decide on his/her life style and content.

When we analyse the present education system using the results from statistics that are available, it is clear that this system is a total failure in itself. The final result of a student who is taught within the present education system is an obedient servant and not an intelligent, innovative, individually responsible person who should be able to bear the responsibility of humankind on the planet Earth.

We humans are spending time as well as human and other resources on the education of countless specialists. The overall results do not meet the needed expectations; not in life and not in the human sciences. This is because there is no clarity of purpose of an education system in the global era, nor is there a universal method to achieve the goal. Universal culture, universal science, universal knowledge, universal rights, global issues, and the global era, raise the need for a universal human formation or instruction. And for this we need the universal method of an education system that responds to the preservation of humanity in harmony with Nature – the sustainable future of humankind.

Since the 19th century, Charles Robert Darwin (1809-1882) stated, that only successful creatures could live within Nature. The majority of humans even today do not understand this. Also many more researchers after Darwin were experiencing and researching about the complexity of the life system on the planet Earth. However, improvement of the schooling curricula did not follow. *Life as usual* 1 % against 99 % of humans on the planet Earth has been the formula for *success*.

This occurs because of an individualistic model of the education system. Humans emphasize the individual over the collective. On this basis, only one is winning and the others are losers.
This is an education system model error that produces asymmetry between humans. In nature, we all depend on each other (all are interdependent, interacting and cooperating). In the universe of stable systems there are symmetric interdependence, interaction and co-operation of all the elements, contents, happenings etc.
Whether it is *a success* is questionable for 99 % of the population but for the rest – 1 % – it is very profitable. We think that global community of humankind is on the wrong path or even on a suicidal path. The proof of it is the history of Easter Island's civilization in the middle ages. Before the end of the last representatives of the entire civilization, a common activity was cannibalism. Cannibalism is presently repeated in social and economic human eco spheres.
In various areas of science, we have developed *human sciences*, which mostly do not reflect the Nature system and the Nature system of the planet Earth. The result is a critical present, which does not allow any possibility of success for humankind. Present global studies are researching humanity and not the relationship between humanity and Nature. Nature is still to be researched and the discovery of real systems will follow. Many theories are advanced but with no effect on the education system.
All theories of the education system lack a logical, epistemological, axiological and anthropological foundation so they do not give positive results for the formation or instruction of humans in the universe. The Sustainable Development and the Sustainable Future of Humankind as Harmonious and Complementary Coexistence of the Global Community of Humankind and the Nature are among not mentioned contents.
Many people are researching the human sciences but not many of them are reporting on the failure of the education system. We do not consider this to be adequate for the time we are living and experiencing. It is more important because at present we have something like over 4 billion people as urban people *(Homo urbanus)* and over two billion slums, favelas, barracks people *(Homo slumus)*.
We are happy to follow the initiative for research and implementation of new understanding and we are asking for a reform of education. We hope to open a research to the level of understanding of the complex issues involved with a possible renewal of the whole education system.
We wish to see a better education system based upon learning throughout one's whole life and an improved quality of the global community of humankind with individual human responsibility to help sustain the future of humankind.

To achieve this improvement of humankind, it is necessary to build the path; the path is the method of universal human formation or instruction.

Self-destruction of Humankind due to Lack of Knowledge – we have opened this subject as per demonstration of important part of humanity activities, which have a harmful effect on the Nature of the planet Earth.

Self-destruction of Humankind due to Lack of Knowledge 1, has been philosophical contribution to the globalization processes of humankind during commencement of the third millennium, and was prepared by Prof. Dr. Timi Ecimovic, Prof. Dr. Alexander Chumakow, Prof. Dr. James Hansen, Prof. Dr. Glen T. Martin, Prof. Dr. H. A. Shankaranarayana Sir Prof. Dr. Roger B. Haw, Prof. Dr. Philippos Nicolopoulos, Prof. Dr. Igor Kondrashin, and Prof. Dr. Zinaida Ivanova during June/September of 2011.

The presentation of **Self-destruction of Humankind due to Lack of Knowledge 2** is the second philosophical contribution to the globalization processes of humankind during commencement of the third millennium, and was prepared by same authors during commencement of 2013.

The globalization ages we are at this very same present is the most complex society and the Nature phenomenon ever developed since the birth of humankind. It is a systemic process of the global humankind community moving according to the Nature principles and under interpretation of 7000000000+ individual representatives of *Homo sapiens* global community.
We shall try to put a research on possible self-destruction of humankind as contribution towards the globalization, culture cum civilization issues.
After putting together trilogies *The Nature*, and *The Sustainable Future of Humankind* and after publishing *The Principia Nature – Nature and Homo sapiens Global Community* (Ecimovic, 2011), we have been researching possibility for self-distraction of present humankind. As usually we are researching from zero ground position, meaning let us see it as it is. And of course it is impossible due to complexity and understanding. We are thinking to initiate complex problem solving, and present it as contribution toward better future of humankind. Let others contribute and improve situation.
The Nature – interpretation of the form and content of the Nature by humankind has got new turn. First the understanding of humanistic sciences was questionable due to subjectivity of interpretation. Since commencement of the humankind it was newer content of the nature under research but form. So it is even today, and we think it is time to look and research deeply the content of the Nature.

With works presented at two mentioned trilogies, the book *Philosophy of Globalization* (Chumakow, 2010) and books *The Three Applications of the System thinking* (Ecimovic, 2009), *The Principia Nature – Nature and Homo sapiens Global Community* (Ecimovic, 2011), are opening new horizons for the nature content researching.

Humankind took approximately 200.000 years to meet globalization ages and generally talking we may say: *Our technological improvements are so successful that some of them are as a potential threat to self-destruction of the humankind and destruction of life/living nature on the planet Earth.*

Let us commence with globalization, culture cum civilization affairs at 2008-2013. In our opinion and research, we have exposed at mentioned literature, we think the technological improvements of the humankind is not beneficial for long time existence of humankind on the planet Earth.

Present human population is facing lack of food, drinking and sanitary water, living space, and habitation. It is worst situation since commencement of humankind. With urban centres we are experiencing life of humans within fragile environmental qualities, which does not support living.

The reason for technological advancement of humankind could be connected with an early research of algebra and geometry of ancient Greeks, and scientists of great cultures of antiquity – China, Egypt, India, and Persia. Somehow with evolvements of history, mathematics has got a role of scientific language. As side effect the mathematics became a ruler of the development done by humans. It was the mankind way of thinking, writing and measurements needed for technological improvement and constructions. All natural sciences have been influenced by mathematics and consequently a major research has been done on form and contents have been neglected.

Antiquity was time of settlement and improvements of the social issues. In some time it was time when the humankind has chosen on the ground constructions as basic form of constructing houses or monumental buildings. We are discussing the time of around last 12000 years B. C.

As result the urban centers become protected against destructions, which could be done by humans. It was in reality the commencement of the human local environments, urban centers, ports, military barracks, roads, aqueducts, temples and light houses. Major protecting walls have been invented, and improvement of the armaments and military techniques become most important issue of humanity. It was time of tribal movements to new territories, first written documents and commencement of the philosophy and scientific research works. The social improvements resulted with great kingdoms of the ancient world. It was time of ancient Roman's and as Roman, Tit Makcij Plavt invented saying *Homo homini lupus* or *Men to men wolf*. It took humankind 3.000 years to invent nuclear destructing devices, and finally globalization.

So by 2011 we may report the following high dangerous technologies, which could end humankind present civilization.

1. **Nuclear technologies** are humankind inventions as technologies for mass killing of humans. Of course they are present in the Nature, as a part of the matter/energy transformation, construction of the stars, and many other phenomenon of the Nature. Humankind research on the atoms and particles resulted with high tech mass killing armaments, nuclear power stations, and many other innovations of nuclear research practical use. Ecimovic at many occasions statement connected with nuclear technologies is/was: *Nuclear research should remain locked within research laboratories*. The threat of nuclear technologies whatsoever use by mankind is **number one threat for planetary life on the planet Earth**. Not to forget the contribution on The Nuclear Winter, this was the truth about nuclear armaments.

   We are recommending moratorium for use of nuclear technologies by humans. Secondly the research and any experiments with nuclear, particles, matter/energy transformation should not be carried within the planet Earth requisitely holistic system + (Earth body, atmosphere, Moon and 3 million kilometers from the planet Earth surface).

   Present human experiences did not open reasonable possibilities for safe use of nuclear technologies. In status quo of the biosphere humans could have safe use, but the biosphere and planet Earth system is never at status quo, but always is moving according to its evolution. Recent earthquake in Japan has opened reality of our safe use of nuclear technologies. It should never happen again. Our global humankind community, globalization, culture cum civilization could not be happy with leadership during last 200-300 years due to catastrophic possibilities, which could end present biosphere, humankind and other living creatures on the planet Earth.

   Our proposal for management of the nuclear technologies is opening possibilities for sustainable future of global humankind community.
2. Second most dangerous nature phenomenon **the climate change system, which provides, makes, holds, and guards living conditions within the biosphere of the planet Earth,** due to humankind interference with nature, and because of humankind lack of knowledge about the nature operation, as a nature system has been triggered, and the climate change system is on the move. Predicting of the quality of the biosphere environment in future is not possible,

and global humankind community have to undergo long way of sustainable future social technique improvement, which may in future assist survival of global humankind community.

The climate change system needs future research co-ordinated from one centre. The option of survival is closely connected with ability of present global humankind community to understand the Nature, the climate change system and many more systems of the nature.

We are proposing rethinking of present knowledge on the nature itself and the nature phenomenon knowledge, and establishment of the centre for global studies of the Nature. It is prerequisite for success.

3. **The global humankind community population explosion** is not properly researched and understood, and as result we have population explosion. It is not a question whether the planet Earth has enough resources or not. The population explosion theoretically is the natural process, which is leading to diminish the bad impact of the certain evolution process. System thinking, holistic approach, and knowledge should assist global community of humankind to work out proper complex problem solving technique. Definitely it is connected with sustainable future of humankind, and actually it is corner stone issue for future of humankind on the planet Earth. Humankind should understand issues of population explosion, consequences, and on the basis of reality and knowledge should agree on the path for survival – sustainable future of humankind.

   Our proposal is to take a path of sustainable future of humankind – *From sustainability of local community to sustainable future of global community of humankind*.

4. **The global community of humankind synthetic chemical research and production** has been extraordinary successful. Today we estimate that at present synthetic chemical research and production recognize synthetic chemical substances and compounds in millions.

   The problem with synthetic chemical research and production is not in techniques or production technologies, but it is in global humankind community relationship with this field of activity. There is positive attitude towards synthetic chemical research and production, and many well-known scientist and The Nobel Price recipients are among synthetic chemical researchers. But let us make closer look to this global community of humankind activity. Science beyond the synthetic chemical research and production has no connections with knowledge of the Nature. All chemical activity in the Nature has got reason, but in many cases humans do not understand it.

   The synthetic chemical knowledge of humanity has basis at relatively easy knowledge and experimental work. With development of chemistry it was possible to develop synthetic chemical compounds using different techniques. As result many known chemist invented countless number of synthetic chemical products. The use of them, production and commercial success was only important. Almost all of synthetic chemical products of modern humanity have no research on short, medium and long term impact and consequences of them to the nature. Pesticides would never be in use if humankind knew of their medium and long term destructive, and pollution abilities on the natural environment.

   In theory or academic discussion we think, it is possible for chemist to invent synthetic chemical product, which could commence chain reaction in the air, and as result, the oxygen from the air could get status as was during primordial times – zero. It happen with CFC's and commencement of the ozone protection band destruction, If humans, did not learn of chlorine atom destruction ability to break ozone molecule, today would be not many living creatures within the biosphere of the planet Earth. The biocide rays, if not stopped by ozone protection layer would end present life forms including humans

   We are recommending moratorium on use of synthetic chemicals without proper knowledge of them and interference with the Nature.

5. **The leadership of global mankind community –** at present we have chaos of national and international leaders, of whom there is no one able to handle global issues successfully. Even worse, the present humankind has leadership of the ***money master monster*** system including national, international, and all other forms of money, banking, insurance and other financial activities. Real value of the money is many fold artificially increased, and people handling money issues are not able to put it into reality of the present.

   Money, as system should have deep rethinking, to be again useful assistant to humankind, and not a ruler, master, monster, and whatsoever as it is today.

   We are recommending a leadership of global humankind community as direct democracy, world federation constitution, world parliament and world government, which will with morality and wisdom govern global humankind community affairs.

   Self-destruction of global humankind community under leadership of master monster money system is just a matter of time.

6. **The technology management** – number of technologies in use are very dangerous for possible self-destruction. To mention some: GMO and GMP are technologies based upon form of genetic code and generally are issue of experiment: Particles research should be carried out at minimum of 3 million kilometres far from the planet Earth; Wars and armaments development including human mass destruction means either physical, chemical or biological has no place within the planet Earth; On ground constructions and mega concentration of humans at one location (mega cities) are most fragile environments for humans to live at, and should be rethought as form of shelter for humans; Use of natural environment for transition to the human artificial environment – towns, roads, railways, airports, ports, military complexes, education centres, hospitals, sport centres and etc. are taking more and more natural environment space, which practice should be revised; transport technologies, space and universe research and development should clean and reduce waste deposition within the planet Earth space, and etc.
   Any technology management should have clear vision of possibilities for destruction in short, medium and long term use.
   There are activities of humankind which has got special ability of self-destruction of humankind and destruction of other life, and *living nature*[13] on the planet Earth. The complex problem solving of issues with large systems of the nature and humankind as: CFC, climate change system, corporate and individual social responsibility – C&ISR culture cum civilization, female like hormone substances, GMO and GMP globalization, global community of humankind, PCB, social system, nature principles, one planet – one humankind – one government, population explosion, synthetic chemical products, system thinking, sustainable future, and etc. are asking for interdependences, interaction and co-operation.
   So by 2014 we may report the following high dangerous activities, living practices, and technologies, which could end humankind present civilization.
   At our first presentation on the self-destruction of humankind due to lack of knowledge we have put on top the nuclear technologies, and the climate change system, the global humankind population explosion, synthetic chemicals, money master monster leadership, and management of technologies was sixth statement. In second presentation we shall reopen discussion on the synthetic chemicals.
7. **Synthetic chemicals[14].** Discussing the synthetic chemicals we have to bear in mind that synthetic chemicals are placed as forth most dangerous activity of present global community of humankind. There are many issues within this research, production, marketing and application of the synthetic chemicals. Just to mention; Pollution of agricultural lands by fertilizers, pesticides, and other synthetic chemical products in agriculture practices; Plastics; Food additives, and other additives or catalyst; Pharmaceutical substances; Technical products with use of synthetic chemicals, Armaments with use of synthetic chemicals, Medicine, Education, Sport, Construction, Clothing, Catering, Fishing and Hunting, and other humankind activities with use of synthetic chemicals.
   For better understanding we are stating the basic operational practice by nature. The Nature (Universe or Cosmos), and the nature of the planet Earth is operating ceaselessly as long as successful operation is going on. In the nature there are only successful cases[15]. The operating principles are: interdependence, interaction, and co-operation of all matter, energy, powers, particles, dimensions, light, rays, and yet unknown contents of the nature[16].

Man-made synthetic chemical products are alien to the nature

Today we estimate that synthetic chemical research and production recognize synthetic chemical substances and compounds in millions.

A. Today common agriculture production after use of synthetic chemical fertilizers, pesticides and protecting substances has been for over hundred year source of alien substances within the agriculture lands. Today we know how much we have done wrong for our future. Unfortunately use of them was not stopped due to financial gains of the owners of the production facilities and commercial activities.
B. Plastics as synthetic chemical products are very useful at present living practices of humans on the Earth and outside in cosmos.
   From automobiles, aircrafts, and many other technical commercial products to

[13] *Living nature* is conditionally used, because there is living nature only in the minds of humankind, The Nature does not recognize living and non-living nature – it is just one nature, which is interdependent, interacting and co-operating.

[14] Synthetic chemicals are produced by synthesis and are artificial, man made products, are not naturally produced.

[15] It is philosophical application of the Charles Darwin statement about existence of only successful creatures in the nature.

[16] Please see: Ecimovic, *The Principia Nature – The Nature and Homo sapiens Global Community*, 2011, displayed at http://www.institut-climatechange.si.

packing materials of almost all human final products packing, and many more cases.

Actually after innovation of the Bakelite in 19th century many more plastics have been successfully introduced, and even today are coming new products.

To all of them is common to be *very handy* for many kind of uses. All plastics are alien substances to the Nature. As for PCB's – which are genetic structure destroyers, CFS's are ozone destroyers, and plastic foil including large list of them – are the source of *female hormone like substances*.

During use of plastic foil with ability to release female hormone like substances as they are in common use for clothing, packing, technical products – mobile phones, and other electronic devices, TV, radio, PC, etc. automobiles, aircrafts, boats, sport equipment etc. with time they are releasing female hormone like substances, which could affect the health of humans.

There are two sources of female hormone and female hormone like substances. Pharmaceutical industry producing and selling the products for protection against pregnancy, which are with 7 billion + humans on the Earth more and more important, and plastics with countless use at our society.

The result of both is affecting male sperm quantity and ability to fertilize female (all living beings).

Many countries are reporting on reduction of sperm quantities and fertilize abilities of man.

Of course plastics are overtaking pharmaceutical production many folds and secondly plastics are more affecting health of humans, due to direct impact after release of female hormone like substances within the body of humans. As an important issue, there is the release of the female hormone like substances, within the living creature's environment of the planet Earth.

C. GMO and GMP activities have very strong possibility to change biosphere of the planet Earth. Humankind is testing the nature abilities without knowing what result will get. There are many possibilities and the last but not a list should be to understand what could be after it happens.

Something is common to all self-destruction issues of humankind interference with the nature of the planet Earth it is a lack of knowledge of immediate, medium, and long-time consequences.

Presented activities are result of world governing by *money master monster*, who took over leadership of the global community of humankind.

Both 1 % and 99 % of humans should have a chance to learn and upon the knowledge make decisions as they are in practice today.

It is obvious that present humankind has to commence right path-way among which is also research of the possibilities that alien substances together with natural ones could produce new natural substances much more dangerous for existence of the *living nature* on the planet Earth.

We have seen bird using plastics as for making the nest. That is direct poisoning of the reproduction of the bird kind.

The list of possible self-destructions of humans by humans could not be concluded, because the activities are innumerable and many new innovations are coming without the knowledge of their short, medium and long term use implications with the natural environment of the planet Earth.

Our intention with this presentation is not to correct present humankind practices and life-styles but to commence long term process of by morality and wisdom guided global humankind community sustainable future, what we hope is our contribution towards life of our and all humankind descendants.

Effectively, we can't change the state of the world, since we are reaping the crops of the past. The destructive activity of man today is the design of the past.

The humankind has not provided the global impact on the destruction of nature and life. Our voice alert, since knowledge is our seed will be harvested in the future with concrete actions in forming the new people for the harmonious complementary coexistence of humans with humans and of humans with the Nature, and the Nature of the planet Earth.

To achieve this goal, the humans have to follow three ways as mentioned by Dr. Timi Ecimovic in the Manila conference: 1) Education, 2) Education and 3) Education.

Education has the objective of universal human formation. Global problems involves a global solution this requires a global vision of man. This man of global vision is absent in humanity today. Therefore, the long term solution to possible self-destruction of humanity begins with the education.

The education of the new man requires knowledge of the same man this means a new anthropological philosophy. Man has to be understood in its biological, social and spiritual, as an inseparable unit. The biological needs food in calories, workforce needs social, and spiritual needs the energy of understanding and wisdom. Wisdom is the integration of man to the universe. Therefore, education is a way of integrating the individual to the family, society, nature and the universe.

Conclusion

First we are recommending O*ne planet, one government. It* is the first recommendation. Of course,

The Constitution of the planet Earth Federation is first and the planet Earth Parliament and Government follow in line, after ratification of The Constitution of the planet Earth Federation.

Secondly recommendation is a new approach to the *social order*, which has to reflect the present experience, and the establishment of a *new contract for humankind* living on the planet Earth. The goal is to prevent explosion of humankind reproduction, enforce individual social responsibility, peace, respect, reason, morality, wisdom and sustainable future amongst peoples of the Earth, enforces (a globally holistic!) law and order, and with skilful governing allow the coming generations to live and have sustainable future[17] on the planet Earth.

Third recommendation is *redirections of scientific work* from innovations of war and armaments techniques and technologies for destruction, too narrowly market and money-oriented synthetic chemicals technologies, too narrowly market and money-oriented energy technologies, too narrowly market and money-oriented genetic manipulation techniques, societal management based on money monster – the master practices, etc., to discovering viable global systems of nature, space, the environment and universe or cosmos, as essential elements of knowledge needed for education, survival, and sustainable future or harmonious and complementary coexistence of our civilization with the Nature.

In conclusion: *Be the change you want to see in the world* (Gandhi).

Ending, we wish to global community of humankind a rebirth of individual social responsibility, peace, respect, reason, morality, wisdom and sustainable future.

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A Conceptual Framework for Business Model Innovation: The Case of Electric Vehicles in China

Koncepcyjne ramy dla modelowych rozwiązań biznesowych: przypadek samochodów elektrycznych w Chinach

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Abstract

EVs (electric vehicle), as sustainable technologies, hold the potential to achieve the sustainability of the transport system and challenge the prevailing business models of internal combustion engines (ICEs). To unlock the dominant logic of ICEs and promote the diffusion of EVs, Business model (BM) innovation is necessary. However, BM innovation for EVs still faces many obstacles. This paper makes contribution theoretically and practically by constructing a "3-7" system and proposing a two-phase conceptual framework for BM innovation of EVs. The case of Shenzhen City, China is studied to illustrate how the "3-7" system and two-phase conceptual framework is applied. Based on the case study, this paper concludes two new barriers that are not highlighted by the previous literature and makes a number of suggestions to help address the issues found in BM innovation.

Key words: Business model innovation, electric vehicles, "3-7" structure system, two-phase conceptual framework, value network

Streszczenie

Samochody elektryczne (EVs – electric vehicles), jako technologie prośrodowiskowe mogą doprowadzić do zrównoważoności całego systemu transportowego, stanowiąc tym samym wyzwanie dla dominującego modelu biznesowego tradycyjnych pojazdów spalinowych. Aby przełamać monopol maszyn spalinowych i doprowadzić do upowszechnienia samochodów elektrycznych, konieczne jest opracowanie biznesowego modelu innowacji. Niestety, w przypadku samochodów elektrycznych nadal napotyka on na wiele przeszkód. W tym artykule proponujemy rozwiązania zarówno na płaszczyźnie teoretycznej, jak i praktycznej, proponując system „3-7" i składające się z dwóch faz ramy konceptualne. W celach zobrazowania tego systemu wybrano przypadek miasta Shenzen w Chinach. Na tej podstawie w dyskusji zidentyfikowano dwie nowe bariery, który nie były dotąd omawiane w literaturze i zaproponowano szereg nowych rozwiązań, które powinny przyczynić się do rozwiązania istniejących problemów.

Słowa kluczowe: modelowa innowacja biznesowa, samochody elektryczne, system strukturalny „3-7", dwu-fazowe ramy konceptualne, wartość sieci

1. Introduction

During the past two decades, researchers and practitioner are getting more and more interested in sustainable development, with the hope to be able to tackle with the challenges encountered by our social development. Sustainability has involved so many aspects of our life that nowadays period can be

named as a sustainable development revolution (Pawłowski, 2003, 2008). The transport system, which is crucial for economic development, now is associated with many persistent problems such as air pollution, resource shortage, noise and it can be considered to be unsustainable in many aspects. Achieving the transition to sustainable transportation is very important for the sustainable society.

China, one of the important emerging countries, is still facing many unsustainable problems in its transport sector ranging from emissions of pollutants to depletion of resources (Shan at al., 2012). Most of these persistent problems are attributed to the overall surge of traditional ICEs and the resulting oil consumption and CO_2 emission. During the past few decades in China, car ownership has increased substantially as is shown in Figure 1 (National Bureau of Statistic…, 2011). EV, as one of the sustainable technologies, is widely accepted that it may be a sustainable solution to the energy shortage and environmental pollution in the transport sector (Egbue and Long, 2012). Transition to electricity-powered vehicles holds the potential to meet the above challenges (Xue at al., 2014). The transition theory highlights that transitions are the outcome of the interplay of many areas, which involve not only technological innovation, but also other factors such as BM innovation (Rotmans et al., 2001). Generally, technological innovation is a critical driver for industry revolution, but not the only one. Sometimes, technological innovation alone is not enough to change the dominant industry logics, BM innovation can be of the utmost importance in further changing and driving industry revolution (Sabatiere et al., 2012).

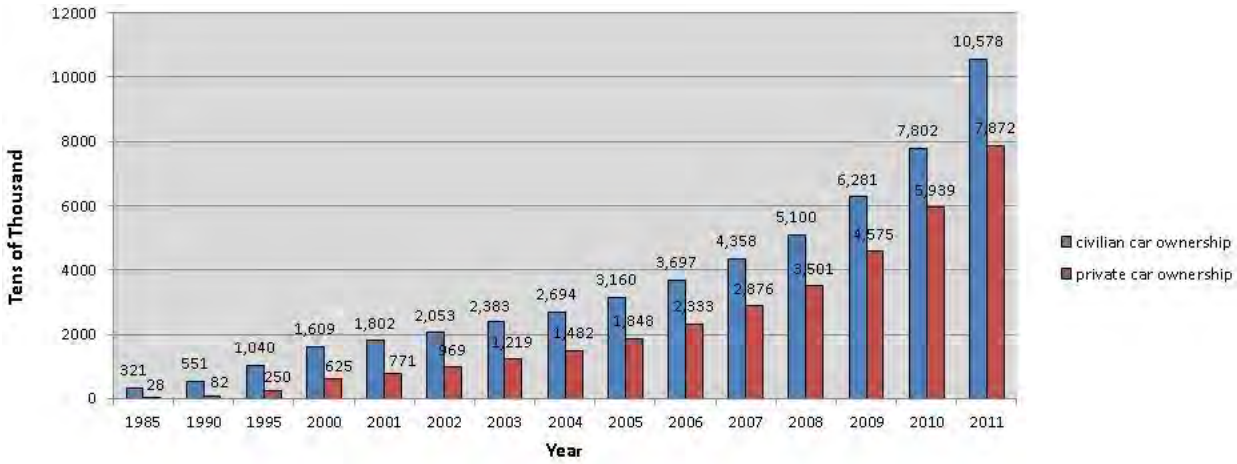

Figure 1. Car Ownership in China from 1985 to 2011

In January 2009, the *Ten Cities, Ten Thousand Vehicles* program was launched by Ministry of Finance (MOF), MOST, Ministry of Industry and Information Technology (MIIT), and National Development and Reform Com-mission (NDRC). A focus of this demonstration program is exploring new BMs for EVs[1]. Although some new BMs have been proposed during the four-year exploration, a dominant BM has not been formed. One important reason for this is the lack of theoretical instructions and a conceptual framework which can guide the BM innovation. So how to further explore new BMs is an urgent problem to be solved.

2. Importance and Necessity of BM innovation for EVs

The concept of BM is not newly born. In the 1990s, with the advent of internet, much more attention began to be attached to it (Demil and Lecocq, 2000). But the problem is why BM innovation gets more attention in the EV area and what are the meanings of BM innovation for EVs? Currently, in-depth research in this connection is rarely seen.

2.1 Discontinuous Innovations Entail New BMs

A technological innovation, if continuous in nature, serves to improve the current product or lift its quality. Regular commercial operation still can be realized through existing infrastructure. This kind of innovation basically doesn't require transformation of BM (Cooper, 2010). However, compared with ICEs, EVs fall into the camp of discontinuous innovation. It has undergone radical changes in technology, infrastructure and energy supply, etc. Its development will bring great changes to major performance indicators for vehicles and wield decisive influence on market rules and the competitive profile. Additionally, for consumers, ICEs and EVs are two totally different products. The latter have changed customers' purchasing criteria. Therefore, development of EVs needs new BMs which are different from those of ICEs.

[1] Source is from MOST website, http:www.most.gov.cn, 2009.

2.2 breaking through the Technological Bottleneck

Technology itself doesn't have a sole objective value. The economic value lying hidden in technology needs to be realized in a certain form through a BM. One technology, if commercialized in different BMs, creates varied economic value (Cherbourg et al., 2002). EV technology has achieved considerable progress since the world's first EV was introduced as early as 1834 in Scotland (Chan, 2007). However, in spite of these developments, current battery technology is still not mature, imposing many barriers on the wider diffusion of BEVs including limited driving range, longer charging time and a purchasing price higher than that of ICEs (Xue at al., 2014). Compared with ICEs, EVs have lower performance/price ratio. Therefore, BM innovation is critical to promoting the diffusion of EVs under the current technological constraints. A successful BM can offset, to a great extent, difficulties inflicted by immature technology and create more economic value.

2.3 Establishing Self-Reinforcement Mechanisms

According to the technological lock-in theory, the path that leads to the lock-in of a technology often starts with a small historical event through which the technology can gain an initial market advantage (Cowan and Hulten, 1996). This initial advantage can create a snowballing effect through some self-reinforcement mechanisms and eventually this technology will gain a dominant position and the society, locked into the technology. In the case of ICEs, various self-reinforcement mechanisms including economies of scale, learning effect, network externality and self-adaptability, etc., as are shown in Figure 2 (Struben and Sterman, 2008), have led to its dominant position. For EV, it is necessary to break technological lock-in of ICEs and establish its own self-reinforcement mechanisms in order to achieve wider diffusion.

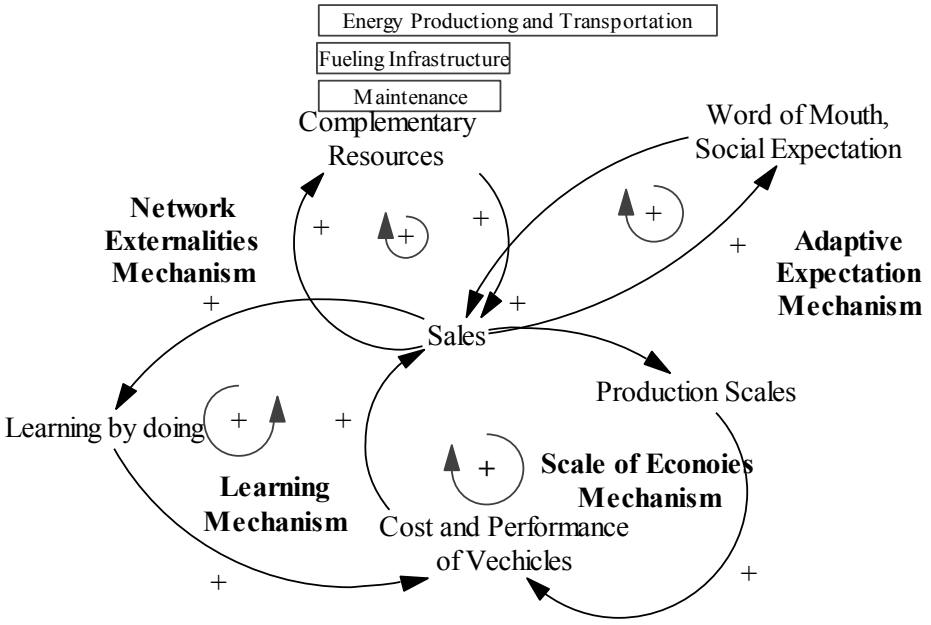

Figure 2. Lock-in Mechanisms for Automobiles

BM is an important tool for EVs to establish self-reinforcement mechanisms, because BM innovation of EVs will create a new value network for EVs, which can promote the establishment and reinforcement of the network externality mechanism. New value propositions and market segments increase consumers' adaptive expectations for EVs and serve as an impetus for EVs' diffusion in the market. Additionally, innovation of revenue model would spur the establishment and reinforcement of economies of scale and the learning effect mechanism. All of this would finally give EVs the initial market advantages and bring about positive feedback effects.

3. Theoretical Framework

3.1 Development of "3-7" Structure System

The concept of BM has been attracting substantial attention from academics and practitioners over recent years. Zott (et al., 2011) conducted a literature review about BM and found that from 1995 to 2009, 1177 papers had been published in peer-reviewed academic journals in which BM was the essential analysis subject. However, despite the overall increase in the literature on BMs, scholars still have not reached a consensus on what a BM is (Zott et al., 2011). Many scholars study the BM without explicitly defining the concept (Pateli and Giaglis, 2005).

BM, by definition, pertains to both static and dynamic perspectives. The former helps us construct a typology to study how different elements of BM are correlated and how such a correlation exerts an impact on the development of enterprises and the entire industry. Nevertheless, the static perspective can hardly help us understand the revolutionary process of BM innovation (Demil and Lecocq, 2010).

BM innovation for EVs is induced by technological innovation, meaning that BM will change with the development of EV technology (Pateli and Giaglis, 2005). The ever-changing nature of EV technology and stagedness of its industrialization determines that the BM (innovation) for EVs is staged and dynamic (Gärling and Thøgersen, 2001). In different phases of technological development and industrialization, entities and elements of the BMs for EVs undergo changes. Therefore the concept of EV BM should be defined not only by a static approach, but also a dynamic one.

Although scholars define BM based on their own research purpose, most agree that BM is the articulation between different BM components to create, deliver and realize value for consumers and thus for the firms (Tikkanen et al., 2005; Demil and Lecocq, 2010). This is also applicable to EV BM, although not specifically for EVs. As we have explained, the definition of BM for EVs should be determined by both the static and transformational approach. Building on the studies of Timmers (1998) and Teece (2010), we argue that the static definition of BM for EVs emphasizes the architecture of different BM components which describes the various actors and their roles in the new value network of EVs and explains how to create and deliver value for one or more market segments and realize value for the firms through the architecture. While the dynamic definition of BM for EVs refers to the evolution of the architecture of different BM components. The evolution emphasizes not only the change of different BM components and their relations, but also the change conducted on different levels including the industry level and firm level.

The definition of BM for EVs shows that the concept of BM components is crucial to BM. The reason for the disagreement on BM definition mainly lies in the varying opinions on what BM components include. So it is critical to define the BM components clearly in order to illustrate the BM definition. The concept of BM components is usually defined in two ways: describing the main components *ex ante* or inducing the components according to the specific firm. An *ex ante* definition has the advantage in measuring the changes in the component consistently across the firms. However, it also holds the disadvantage which assuming the same components across the different firms. To avoid the disadvantage of ex ante specification, Demil and Lecocq (2002) proposed an approach to define the BM components by specifying the core components which encompass different subsidiary elements. This approach can avoid the disadvantage while still can make comparison between firms.

In this paper, we adopt the above approach and specify the components *ex ante* based on the development practice of EVs and the research of Chesbrough and Rosenbloom (2002), Osterwalder (2004) and Teece (2010). We contribute to the definition of BM components by proposing a "3-7" structure system as is shown in Figure 3. "3" refers to three interfaces and "7" refers to the seven subsidiary elements contained in the three interfaces. The former includes customer interface, partner interface and organizational structure interface which can fulfill three functions: creating value, delivering value and realizing value. The latter refers to the seven subsidiary elements contained in the three interfaces: value proposition, market segmentation, value network, partnership, cost structure, revenue model and value chain. Each category may contain different elements to fit the study purposes of scholars.

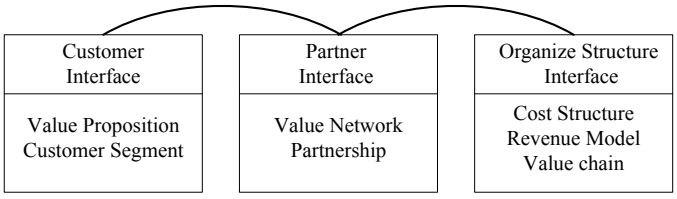

Figure 3. "3-7" Structure System of BM Components

1. Customer Interface. Realization of customer value is essential for a BM. Firm value can only be realized when customer needs are satisfied and customer value is created. Value proposition is the value that a company can create for customers by offering the company's products or (and) service (Chesbrough and Rosenbloom, 2002). Market segment indicates to whom the offerings will be delivered or marketed (Demil and Lecocq, 2002).

2. Partner Interface. This interface describes the cooperation among different actors which is necessary for the creation of value. Value network is composed of all actors in this network including supplier, customers, coalitions and the position of each actor in the network (Demil and Lecocq, 2002). Reasonable value network can improve the efficiency of delivering value to customers. Partnership focuses on how to handle the relationship among actors in order to achieve win-win results.

3. Organizational Structure Interface. This interface focuses on the internal of firms. Cost Structure is the cost that a firm has to pay in order to create and deliver value to customers. Revenue model articulates the way a firm makes money through varieties of revenue flows (Osterwalder, 2004). The difference between revenue and cost generates margin profits for firms. The concept of value chain describes the

activities, resources within the firm and their arrangement which are necessary to value creation (Osterwalder, 2004).

3.2 A Two-phase Conceptual Framework for BM Innovation in EVs

As is explained above, BM definition for EVs has both static and transformational implications. Therefore BM innovation for EVs not only emphasizes the establishment of "3-7" structure system, but also focuses on the evolution of BM components. Most extant studies on BM innovation often select financial dimension as the study perspective and enterprises, the study subjects (Byoung et al., 2007; Desyllas and Sako, 2013), hardly incorporating the changes of external environment into the research of BM innovation. Obviously this doesn't sit with the BM innovation for EVs. Additionally, in the early literature that still exists today, dynamics in BMs emphasize that a firm changes its BM based on the capabilities and learning and the evolving conditions in the market. BM innovation is usually conducted and analyzed at the firm level. (Pateli and Giaglis, 2005; Demil and Lecocq, 2010). However, firm-level analysis unit is not very appropriate for BM innovation in EVs.

The BM for ICEs is no longer applicable to EVs. EV technology changes the power system of ICEs, and electricity-driven engines replace the internal-combustion ones. These cause the change and reconstruction of industry chain and value network in the automotive industry. Some new actors will enter the value network of EV BMs, including electricity suppliers, charging infrastructure operators, new auto manufacturers and car parts suppliers. Some incumbent actors may have to exit the value network of EV BM and the dominant positions of some actors in the value network of traditional ICEs may be changed. So when considering new business models for EVs, the basic questions are: who owns the vehicle or the battery? Who can participate in the new value network and who will have to exit? Who will be responsible for the operation of the infrastructure? Obviously, in this stage, the concept of BM innovation concerning EVs, used mostly at the industry level instead of the firm level, focuses on the actors in the new value network and their roles instead of the internal value chain activities within one firm. However, previous studies on BMs for EVs seldom research from this perspective. We contribute to this by proposing a two-stage conceptual framework to articulate how to promote and analyze BM innovations for EVs.

We visualize the two-phase conceptual framework in Figure 4, which shows our logic about BM development in EV industry over time. This conceptual framework embodies both static and dynamic characteristics and is composed of three parts.

As for the first part, the framework argues that BM is a dynamic concept and the BM innovation for EVs should be achieved through two phases successively: Phase I and Phase II. At Phase I, BM innovation for EVs is mainly conducted at the industry level and at the Phase II, the firm level.

As for the second part, the conceptual framework highlights the static aspect of BM innovation. In each phase, the development of BM involves the innovation of the three interfaces in the "3-7" structure system, but the focus is different. During Phase I, EV industry chain and value network for EV BM is not perfect. Who can enter the value network, what the position of each stakeholder is, which actor can hold dominant position in the EV value network, are not sure. For example, in China there are competitions between petroleum companies (China National Petroleum Corporation, CNPC) and grid companies (such as State Grid, SG) for charging infrastructure operation, as well as between grid companies and auto manufacturers for battery ownership (swapping battery or charging battery). These uncertainties make it difficult to analyze BM innovation from the perspective of a particular enterprise. So we argue that BM innovation for EVs should firstly be conducted at the industry level and its main purpose at this point should be building a partner interface of EV BM from the perspective of industry chain. After the establishment of the value network and partnership for EV BM at the industry level, BM innovation comes to Phase II. As is shown in the Figure 4, following the industry-level BM innovation, different value networks of EVs can be formed, just like the different shapes in the upper rectangle. The result of innovation in Phase I directly determines which actor can come into further BM innovation and may even influence the ways of it at the Phase II. Then at the second phase, BM innovation is conducted at the firm level and focuses on the analysis of how firms integrate internal resources and external value network to better create value for customers. BM innovation of firms in Phase I is to pin down positions in the new value network at the industry level, while in Phase II is to capture more market share and profits. It should be mentioned that although we have broadened the meaning of dynamics in the early BM innovation literature, we haven't ignored it. So for the third part of the conceptual framework, we argue that no matter how BM innovation is conducted, at industry level or firm level, BM in each phase still has original dynamic implications. BM innovation goes through the dynamic process from design and testing to development and scaling up as is shown in Figure 4. BM needs to be continually changed and developed with the change of internal and external conditions.

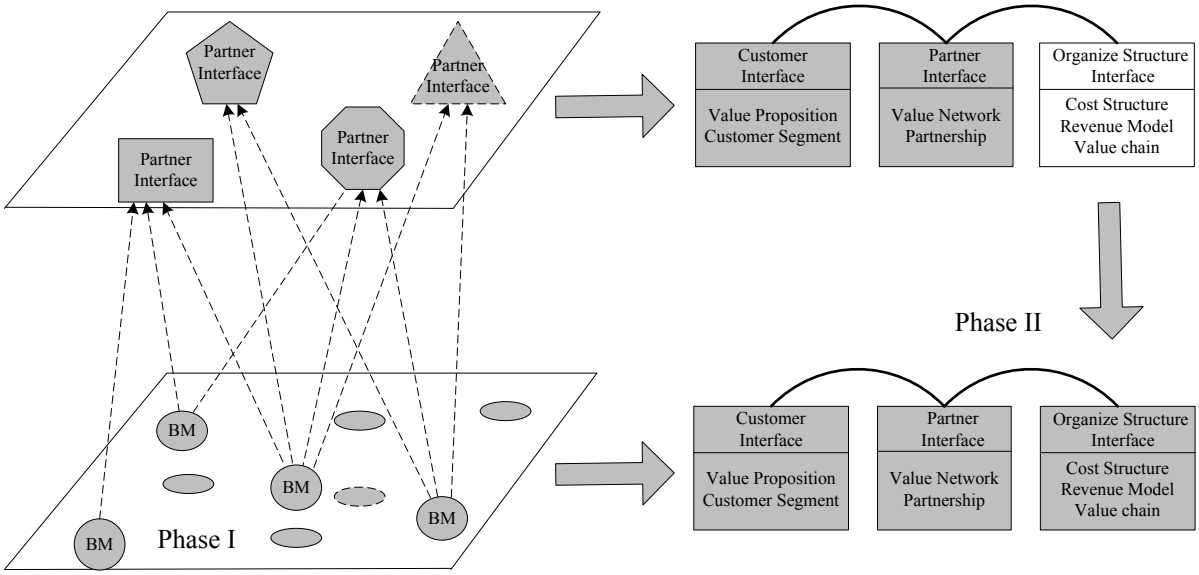

Figure 4. Two-phase Conceptual Framework for BM Innovation of EVs

4. BM innovation Story for EVs in Shenzhen, China

In this section, we choose the case of Shenzhen, China to illustrate how BM innovation of EVs is conducted. From this case, we can see that the "3-7" structure system and two-phase conceptual framework are useful in illustrating the process of BM innovation. it can provide guidance for the BM innovation in other places.

This paper is based on a single case study, which Sosna (et al., 2010) consider appropriate if the case is extreme, unique or revelatory. As we have described, the Chinese government launched a demonstration program *Ten Cities, Ten Thousand Vehicles* in 2009 and 13 cities (Batch I) were approved to carry out the demonstration, followed by 7 additional pilot cities (Batch II) and five more cities (Batch III). One aim of this program is to explore appropriate BMs for EVs through testing and implementing new BMs in the 25 demonstration cities. Among them, Shenzhen (SZ) is one of the *dual-pilot cities*: EV demonstration pilots and pilots of subsidizing private EV buyers. During the period between 2009 and2012, SZ established two different BM models in taxi and bus sectors. The BM is very representative in China and is named *SZ Model* and it achieved large-scale commercial operation for the first time in the areas of electric buses and electric taxis[2]. By June 2012, there were 3147 EVs out on the road in SZ, registering the highest number nationwide (CMEN, 2012). So we select SZ to conduct a case study, which is consistent with the selection made by Development Research Center of The State Council[3].

This research is supported by the *Fundamental Research Funds for the Central Universities (2910219006) in Tongji University* and *Shanghai Science and Technology Development Fund-the Soft Science Research Project (13692100600)* of Science and Technology Commission of Shanghai Municipality. The survey was conducted in the summer of 2012. All the data is either obtained by field investigation and face-to-face interviews with stakeholders including governments, manufacturing companies, charging infrastructure operators and uses, or by secondary source mainly from the internet.

This section describes the process by which *SZ Model* was configured over four years (2009-2012). On a broader level, BM innovation in SZ can be divided into four phases based on the year. In the following passages, we analyze the BM innovation in the context of the proposed "3-7"structure system and two-phase conceptual framework.

4.1 2009: Start-up and Preparation Stage

After SZ was selected as the *Energy Efficiency and New Energy Vehicles Demonstration Pilot City* in January 2009 by MOF, MOST, MIIT and NDRC, the city started the BM innovation process of EVs. *Energy Efficiency and New Energy Vehicles Pilot City Leading Group Office of SZ* (hereafter referred to as PCLGO) was set up to manage the demonstration program.

1. Market Segment. The *Ten Cities, Ten Thousand Vehicles* program focuses on financing vehicles used in the public service sectors such as buses, taxis, governmental fleet, sanitation and postal service vehicles. For the reason of controllability and safety, PCLGO decided to market EVs firstly in public service sectors: bus and taxi sectors, then gradually introduce it into the private car market.

[2] Source is from National Energy Administration website. www.nea.gov.cn, 2012.

[3] Source is from Development Research Center of the State Council website: http://www.drc.gov.cn, 2012.

2. Value Network. In June 2009, *Admission Management Rules for the Auto Manufacturers and Products of New Energy Vehicles (Admission Rules)* was released by MIIT and in July 2009, *Recommendation List of Vehicle Types for the Demonstration program of Promoting Energy Efficiency and New Energy Vehicles-1st part (Recommendation List)* was released. BYD Company was considered eligible to produce EVs for the demonstration project. In the *Recommendation List-3rd part*, Shenzhen Wuzhou Dragon Automobile Co., Ltd (WZD) also got the qualification. BYD and WZD are both located in SZ and therefor they become actors in the new value network of EV BM in SZ as EV manufactures and suppliers. China Southern Power Grid (CSPG), controlled by the central government and formally established on December 29, 2002, is mainly operating in transmission and distribution business and the geographical range covers Guangdong, Guangxi, Yunnan, Guizhou and Hainan provinces. In 2009, CSPG actively cooperated with government, research institutes and related enterprises, and was granted the qualification to build and operate EV charging infrastructure. By the end of 2009, CSPG had developed seven EV charging technology standards and established two charging stations (Dayun, Hexie charging stations) and 134 charging poles[4]. CSPG is also responsible for electricity supply in the new value network.

In 2009, BM innovation of EVs in SZ focused on selecting actors who can participate in the value network and the main market segment.

4.2. 2010: Design and Development Stage

1. Value Proposition. In June 2010, SZ was selected as one of the pilot cities in which private EV buyers are subsidized. According to *Interim Measures to Financial Subsidies Pilot for Private Purchase of New Energy Vehicles* issued by MOF, MOST, MIIT and NDRC, the central government will provide subsidies to EV manufacturers or battery leasing companies in SZ, Shanghai, Changchun, Hangzhou and Hefei[5]. The subsidy standards are made according to the power energy of the battery pack, 3000 RMB / kWh. The maximum subsidy for a PHEV is 50,000 RMB and 60,000 RMB for a BEV. Subsequently, SZ local government officially released *Subsidy Policy on Private Purchase of New Energy Vehicle*, making SZ the first among the 5 dual-pilot cities to formulate the local subsidy policy. According to this policy, SZ local government would subsidize EV manufacturers with a maximum of 30,000 RMB for a PHEV and 60,000 RMB for a BEV[6]. Central and local subsidies can effectively solve the problem of higher price and are helpful to value proposition innovation. Compared with ICEs, initial price of EVs are almost the same. But EVs are more energy-saving, environment-friendly and induce lower use costs. As regards the charging problem for EV users, CSBG is responsible for constructing charging poles in the residential parking place.

2. Market Segment. Bus companies including Shenzhen Bus Group Co., Ltd (SBG), Shenzhen Eastern Bus Company (SEBC) and Shenzhen Western Bus Company (SWBC) are among the target customers for EV BM in SZ. Bus companies use electric buses produced by BYD and WZD. In May 2010, Shenzhen Pengcheng Electric Taxi Co., Ltd (hereafter referred to as PCET), the first electric taxi company in China, was founded by SBG and BYD. PCET buys BEVs-BYD E6 and BYD is responsible for the maintenance. By 2012 PCET had purchased 300 BYD E6 for taxi operation.

3. Value Network. In 2010, CSPG continued to build new charging stations and charging poles, while another company – China Potevio – began to compete for the qualification of charging operation system operators. China Potevio is also a controlled by the central government and its main operation business is information service. After strategic game among different parts, SZ local government granted China Potevio the qualification. Charging stations built and operated by China Potevio mainly provide charging or swapping battery service to electric buses and charging stations set up by CSPG mainly provide charging service to electric taxis or other private EV vehicles.

4.3 2011: Further Development Stage

Value proposition and value network. In 2011, Shenzhen Model has taken shape. Shenzhen Universiade was held in August, 2011 and 2011 electric buses were operated in the event. To solve the problem of capital shortage for bus companies, Bank of Communications Financial Leasing Co., Ltd. (BOCFL) participated in the network value and offer financial leasing service. In July 2011, with the coordination and mobilization of SZ local government, SBG, SEBC, SWBC, WZD, BYD, China Potevio and BCFL signed a finance lease contract according to which BCFL would buy 1133 electric buses from BYD and WZD. During the purchasing process, China Potevio was responsible for the selection of electric bus styles and assessment of bus quality. Then BCFL leased the buses to three bus companies who can independently operate the buses after paying rents for 8 years. This BM innovation is the first one to introduce a third-party finance company into the value network and the BM for electric buses is thus established.

[4] Source is from State-owned Assets Supervision and Administration Commission of the State Council website: http://www.sasac.gov.cn, 2009.

[5] Source is from Ministry of Finance website: http://www.mof.gov.cn, 2010.

[6] Source is from Shenzhen Government website: www.sz.gov.cn, 2010.

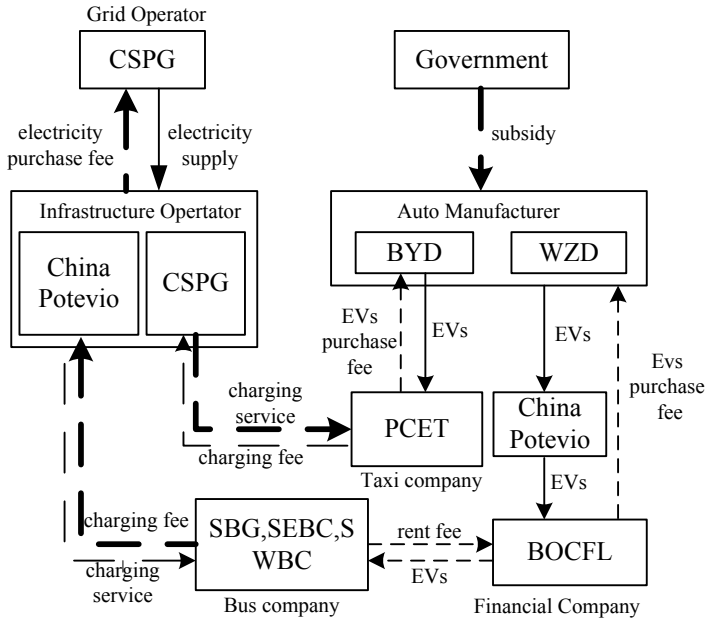

Figure 5. Business Models for EVs in SZ

4.4 2012: Scaling-up and Further Exploitation Stage

In this year, *SZ Model* gradually scaled up. More end users including private consumers purchased EVs and governmental fleets. By June 2012, there were altogether 2112 electric buses, 300 electric taxis, 20 electric government vehicles and 751 private EVs[7]. Charging infrastructure operators had built 5 charging stations and 2512 charging poles in 58 residential areas. Now BYD and CSPG are making preparation to cooperate in the area of vehicle information management.

5. Discussion

Based on the above analysis, we summarize the *SZ Mode*l in Figure 5. Solid lines represent products/service flow and dotted lines, capital flow. The bold dotted line indicates that the capital flow has not been commercialized. From Figure 5 we can see the establishment of value network is the focus of BM innovation in SZ and BM innovation is still in Phase I by now. Overall, BM innovation is mainly conducted on industry level and the aim of BM innovation for related actors is to enter the new value network. During the four years from 2009 to 2012, BM innovation in SZ mainly addressed the following questions: Who owns the vehicles and battery? How to fuel batteries, by charging or swapping? Who builds the charging poles for customers and who acts as the operator of charging (swapping) stations? How to organize a win-win distribution mechanism so as to mobilize related stakeholders? BM innovation has not really entered the firm level, so the organizational structure interface has not really achieved innovation. As Figure 5 shows, auto manufacturers such as BYD and WZD cover their production costs mainly by financial subsidies. The capital flow between grid operator and infrastructure operator is more or less virtual by now, because in China the electricity price is under government supervision and up to now SZ local government has not made any specific provision about the electricity purchase fee. The capital flow between infrastructure operator and taxi and bus companies has not been commercialized. In SZ the charging pricing system currently is TOU (time-of-us) based: 1.0064 RMB/ kWh between 23:00 pm and 07:00 am, and 0.2495 RMB/ kWh in valley time. Under such a charging price system, charging infrastructure operators cannot be profitable. So the charging fee is actually never paid by the taxi and bus companies because the pricing system is still under discussion and changes may be made.

The Shenzhen case is just the application of our proposed two-phase conceptual framework. We argue that value network establishment is vital and should be the first step for BM innovation of EVs. Two-conceptual framework is necessary to analyzing new technology-induced BM innovation which can lead to dramatic changes of the whole industry.

BM innovation always faces barriers. This is the same with the Shenzhen case. In the previous literature, several authors have highlighted the barriers to BM innovation, e.g. traditional dominant logic that hampers the exploration of a variety of new BMs, tensions with traditional configurations of firm resources, resistance of managers fearing negative results for their own business from a new BM, con-

[7] Source is from http://www.cmen.cc, 2012.

flicts with established BMs that still are more profitable than innovative new ones, etc. (Amit and Zott, 2001; Chesbrough and Rosenbloom, 2002; Chesbrough, 2010; Sosna et al., 2010). However, in analyzing the SZ case we discovered some barriers to BM innovation which the early literature does not heed and which may help facilitate the success of BM innovation.

1. Barrier to value proposition innovation. Here we do not highlight the dominant logic barrier to value proposition innovation as the previous studies did, but stress the barriers inflicted by imperfect new technology. Generally, the new technology or new product can either offer value proposition of lower cost or better performance compared with the tradition technology/product. However, EVs have lower performance/price ratio against ICEs. A more prominent value proposition of EVs is environment-friendliness, although this alone is not enough for large-scale diffusion. From the SZ case we can see that SZ model does not offer any special value proposition other than the environmental proposition and the barrier posed by higher initial price is largely removed by the financial subsidy. Although some cases like the Hangzhou Model or Better Place solve the problem of high purchasing price by adopting swapping-battery model, this actually compromises customers' ownership of the whole vehicles.

2. Barrier to appropriate profit distribution. Establishment of a value network is important for BM innovation, but it is difficult when considering the strategic seesaw among different stakeholders, especially for EVs. The product attributes of EVs determine that the value network of BM involves too many stakeholders. The key to building the value network is to decide who can participate in the network and whether the stakeholders in the network can deliver win-win results. SZ and other cases in China show that energy suppliers, infrastructure operators, auto manufacturers and batter suppliers still have different opinions on BM innovation. For example, auto manufacturers advocate the battery-charging BM and grid operators favor the battery-swapping BM, who should get financial subsidies in the new BM, and who has the qualification for infrastructure operation, etc. Strategic seesaw among stakeholders results in the uncertainty of the profit distribution mechanism, thus posing obstacles to organizational structure interface innovation just as the case in *SZ model*.

6. Conclusion and suggestions

This article contributes to the BM innovation research by adopting a dynamic perspective which holds that BM development not only means constant fine tuning based on exploration and exploitation, but also highlights the necessity of analysing BM innovation at both the macro (industry) and micro (firm) level. By introducing the SZ case, we try to integrate BM theory with the BM innovation practices so as to help promote BM innovation for EVs. Drawing from the case study, this paper offers the following suggestions for BM innovation in EVs.

1. A powerful organizer or mobilizer is important for BM innovation in Phase I. In our case, SZ Development and Reform Commission (SZDRC) directly carried out the BM innovation and played a critical role in the partner interface innovation. From 2009 to 2012, SZDRC had organized and mobilized many actors to participate in the establishment of the value network. In China, DRC is responsible for the organization and implementation of the national economic and social development strategies and price regulation, coordinating and solving major issues in economic operations. So it is relatively easier for SZDRC to accommodate the interests among different stakeholders. A powerful organizer can also be a company or other organizations as long as it has enough power to promote the innovation of partner interface.

2. Market segments should be different in Phase I and Phase II. At Phase I, the market segments should be narrowed and focused. EVs' product attributes determine that once the consumer develops a suspicious attitude towards the product, the initial diffusion will fail, and it is of little probability to get customers' recognition again (Egbue et al., 2012). Besides, BM innovation at Phase I focuses on the partner interface and is conducted at the industry level, so it is hard for individual firms to offer outstanding value propositions to customers. We argue that in Phase I market segments should focus on public service sectors, environment-friendly enterprises, or some special private consumers such as multi-car households, which is consistent with the research result of Gärling and Thøgersen (2001). In Phase II, market segments have two different implications. From the perspective of the entire industry, market segments should extend from specific consumers to all consumers in the EVs market. From the perspective of the individual firm, it indicates that the firm should search for its own target customers based on its strategy.

3. Value propositions should be multi-dimensional. Innovation on EVs' value proposition needs to go beyond the traditional proposition of cost advantage and superior performance because of the defective technology and excessive price. Our case shows that environmental advantage or low use cost alone is not attractive to private customers. It has already been pointed out by existing literature that the purchase cost has even a greater impact on the consumers' decision to buy cars. Hardly any of them can rationally and thoroughly weigh the cost throughout the car's entire life cycle (Turrentine et al.). Besides, low cost to use is unsustainable. Overly low cost to use is based on relatively low price of charging service which will adversely affect the benefits of infrastructure operators, thus disrupting the sustainability of

BM for EVs. This paper holds that the value propositions of EVs should be multi-dimensional. Compared with traditional ICEs, the most distinct value proposition of EVs lies in environment-friendliness. Except that, EVs should be endowed with new connotations and cultural implications so as to convey such a message to consumers: buying EVs epitomizes a person's refined cultural taste and dignity. Additionally, the value proposition of EVs needs to shift its focus from product to product-service. Efforts should be made to score groundbreaking improvements in price, performance, insurance and maintenance, etc.; the value proposition of EVs should emphasize solutions for integration of personal transportation; measures should be taken to realize zero-emission and zero-congestion of personal transportation through the synthetic use of vehicle network, smart grid and internet, etc.; the scope of personal transportation needed to be extended so as to develop certain kinds of service such as the wireless network for transportation and social intercourse.

4. Suggestions for the establishment of partner interface of EVs. 1) Innovative approaches need to be adopted to construct the value network. Since the value network of new energy vehicle will incorporate some new entities, efforts should be made, during the reconstruction of the value network, to go beyond the ideological framework of the value network for traditional ICEs and seek the possibility of reconstruction on a larger scale so as to generate more opportunities. Batter place is an example of constructing a value network totally different from that of traditional ICEs. Kley (et al., 2011) adopted the morphological analysis method to find a variety of value network combinations. Interested readers can refer to it. 2) Different stakeholders should reinforce communication and exchanges and forge a coalition to transfer and share profits. 3) Both of the top-down and bottom-up methods should be taken to promote the establishment of profit distribution mechanism. With the former, the profit distribution mechanism can established under the promotion of a certain entity; while with the latter, the mechanism can be built up progressively through the accumulation of development experience and the *Learning by Doing* mechanism (Kaltoft, 2007). 4) Central and local governments should direct the coordination and cooperation between stakeholders through policies, laws, regulations, standards, fiscal subsidies and taxation, etc. 5) The development of EVs, to a large extent, aims at realizing sustainable social development and addressing energy and environmental crises. Therefore, in the process of establishing the profit distribution mechanism, stakeholders need to consider the integration of economic, social and environmental elements instead of taking self-interest or profit maximization as the sole objective.

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Marketing and Sustainable Development

Marketing wobec zrównoważonego rozwoju

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Abstract
The article presents the significant, though not universally acknowledged, role of marketing in generating imbalance in the developmental processes of modern economy and society. As the foundation of such analysis, the authors adopted the category of values, which constitutes on the one hand ethical reflection accompanying human activities connected with sustainable development, and on the other explains the nature of market behaviour of the modern consumer. In the search for the mechanism disturbing sustainable development, the authors pointed to the phenomenon of *degradation* of household as the most important component of the socio-economic system. Such degradation occurs under pressure from the market powered by innovation, the enterprise exposed to fierce competition and the state which supports in its policy the concentration of capital and unbalanced consumption. It has been proved that the processes which shorten the market life cycle of goods and reduce the contemporary human, market participant, to the role of an unreflective consumer, are in conflict with the principles of sustainable development. Modern marketing can be oriented to the realization of the principles of sustainable development, introducing the paradigm of ecologisation into the theory and practice of marketing activity – with reference to the model of managing a modern enterprise as well as to the process of revision in consumers' consciousness and attitudes, gradually turning them into eco-consumers.

Key words: sustainable development, marketing, consumer, ecologisation

Streszczenie
W artykule wykazano znaczącą, aczkolwiek powszechnie nie uświadamianą rolę marketingu, jaką funkcja ta odgrywa w generowaniu nierównowagi w procesach rozwoju współczesnej gospodarki i społeczeństwa. Jako podstawę takiej analizy przyjęto kategorię wartości, stanowiącą z jednej strony refleksję etyczną w podejmowaniu wszelkich działań ludzkich związanych ze zrównoważonym rozwojem, z drugiej zaś, wyjaśniającą charakter zachowań rynkowych współczesnego konsumenta. W poszukiwaniu mechanizmu zakłócającego zrównoważony rozwój wskazano na zjawisko *degradacji* gospodarstwa domowego, najważniejszego komponentu systemu społeczno-gospodarczego, zachodzącej pod presją rynku napędzanego innowacjami, przedsiębiorstwa wystawionego na ostrą walkę konkurencyjną oraz państwa, które w swej polityce sprzyja koncentracji kapitału i niezrównoważonej konsumpcji. Wykazano również, że procesy te, skracające cykl życia rynkowego dóbr oraz redukujące dzisiejszego człowieka, uczestnika rynku, do roli bezrefleksyjnego konsumenta, kłócą się z zasadami zrównoważonego rozwoju. Współczesny marketing można ukierunkować na realizację zasad zrównoważonego rozwoju, wprowadzając w teorię i praktykę działań marketingowych paradygmat ekologizacji, zarówno w odniesieniu do modelu zarządzania współczesnym przedsiębiorstwem, jak również do procesu przewartościowań w świadomości i postawach konsumentów, stopniowo czyniąc ich eko-konsumentami.

Słowa kluczowe: rozwój zrównoważony, marketing, konsument, ekologizacja

Introduction

In the search for the causes of the economic crisis, the dishonourable role of marketing is often pointed to, as it is the function responsible for establishing and sustaining relationships between an enterprise and its environment. This function is realised in the context of increasingly more complex market processes as well as new challenges, such as:

- hypercompetition in the struggle for market resources, including the customer,
- increasing pressure on the effectiveness of production and the profitability of the business,
- capital accumulation and concentration on an unprecedented scale,
- increasing lack of balance in the access to the created wealth,
- the unification of cultural patterns and of affecting the customers' behaviour,
- galloping technological development in the production, distribution and communication,
- degradation of the natural environment (Kotler, Caslione, 2009).

A modern enterprise facing those processes feels forced to employ aggressive marketing instruments which are not always ethical, but efficient in the market game. On the other hand, the common practice of using aggressive marketing tools on a statistic scale leads to the abovementioned processes and phenomena, referred to as turbulent competition. Marketing is, therefore, a component of modern market phenomena, which undoubtedly makes it jointly responsible for the existing crises.

Assuming that the crisis in the world economy as well as on any country's scale is the effect of violating the principle of sustainable development, what role, then, does marketing play here? Is it a solely negative role? How can this influence be explained on the basis of management studies and the theory of business enterprise?

Values – what connects sustainable development and marketing

The essence of sustainable development lies in reducing the range of poverty and social exclusion, providing future generations with conditions of development at least as good as the current ones and preserving cultural diversity. Its features are: sustainability, permanence and self-sustenance of development (Borys, 2005). As A. Pawłowski points out, the basis of all human activities related to sustainable development is ethical reflection concerning the questions about values which should orient our thinking and behaviour (level I). It is on the basis of such reflection that discussions should be held and actions taken on the economic, social and ecological planes (level II) (Pawłowski, 2013). Therefore, it can be assumed that the key to understanding the relationship between marketing and sustainable development is the category of ***values*****,** which should be ascribed to a person, not only as a customer, but in a broader sense: as a market participant.

In the general formula of sustainable development, value is seen as one of the four factors creating the balance or the lack of it in the space of socio-economic activity. It is represented by the formula below (Brunnhuber, 2013):

$$S = D \times T \times V \times G \qquad (1)$$

where:

S (sustainability) – environmental balance,

D (demography) – human potential, subject to demographic phenomena (population structure, market potential, migration phenomena, etc.)

T (technology) – the development of technology through the supply of product, process and organizational innovations,

V (values) – a system of values shared and respected in social and market activity by enterprises, authorities, consumers, employees etc.

G (government) – the policy of central and local authorities towards the economy and the society.

What is a value? According to Great Multimedia Encyclopaedia, *value* is one of the basic philosophical categories. It refers to something which in the absolute sense or within a given set of beliefs is considered precious and valuable. It is – or at least it should – be subject to special care and be the goal of human aspirations, as well as the criterion of human behaviour.

The notion of value can be referred to ideas, persons, objects, situations, phenomena etc., or to their particular features. It can exist on its own or constitute a part of a larger system or a hierarchy. Values have been a subject of interest for numerous thinkers, from Socrates and Plato to M. Scheler and N. Hartman.

In the management studies, there are two meanings of the category of value (Skowron, 2003):

a) as a measurable benefit which one would like to attain or provide for somebody as a result of organized activity,
b) as a basic belief or set of beliefs which guide our behaviour and activity within and in the area of the organization.

In the first meaning, value is present in modern conceptions of management which see the creation and maximization of value added as the main aim of an organization. Such an aim overrides what has so far been seen as the main meaning of any business activity i.e. producing wealth. In this view, value generated by an enterprise, at the same time constitutes value for:

- the shareholder, measured with the formulas of Economic Value Added (EVA) and Market Value Added (MVA) (Brillman, 2002),

- the customer, perceived as a more beneficial relation of product quality to its price than offered by the competition, complemented by greater customer satisfaction (Dobiegała-Korona, 2010),
- the employers, as the effect of the policy of a proper relationship of efficiency to salaries as well as creating opportunities for the increase of this efficiency,
- the society, including market partners, local communities etc. (Porter, Kramer, 2006).

The aim established in such a manner (creating and maximizing value added) as well as its specified measures result in the specificity of managing by values, through which managers have to fulfil the expectations of the increasingly powerful stakeholders of enterprises (Doyle, 2003).

The philosophy of managing by values is the foundation of numerous modern managing methods, such as TQM, benchmarking, reengineering, or the marketing concepts of orientation towards the customer: relationship marketing, affiliate marketing, e-marketing and m-marketing. Its *spirit* can also be found in the modern strategic reflection, expressed in the concepts of: increase and relocation of values by Gretz and Baptista, redefinition of strategy by M. Porter (Porter, 2001), redefinition of strategy of key competences by G. Hamel and C.K. Prahalad, (Hamel, Prahalad, 1999), reengineering (Hammer, Champy, 1996), effective strategies by M. Treacy and F. Wiersema (Treacy, Wiersema, 1995), and other. Moreover, the practice of strategic alliances as well as fusions and takeovers of enterprises prove the presence of the element of values to be a benefit in the business world (Cygler, 2002, Czakon, 2012).

Finally, in this trend of understanding the notion of value, it is equated to a definite potential which an organization accumulates, develops and employs to achieve competitive advantage. This potential is the value of intellectual resources of the enterprise as well as the value of the trademark of its products, which nowadays researchers attempt to measure and assess (Edvinsson, Malone, 2001, Walukiewicz, 2012, Szymoniuk, 2006).

Value in its second meaning, as a set of beliefs jointly determining the behaviours in an organization, is a significant component of organizational culture (Schein, 1986). It determines, on the one hand, the identity and stability of enterprises, and on the other is expressed in the visions of changes and development created by their management. It may be said that the processes of organizational change and the practice of learning organizations are the struggle for, in the name of or against values. Value is the central element of dynamising the world of the organization.

The presentations of the category of value described above can be reduced to a common denominator: *value is a metacriterion of conscious choices made by people, in organizations and in the name of organizations*. Therefore, it is a category which best conveys the essence of the social nature of the market, organizations and management, as it refers to imagination, goal and decision.

Sustainable development from the perspective of management

Sustainable development perceived from the perspective of management appears as socio-economic order resulting from specific mechanisms, forcing rational behaviour of all market participants. In the theory of business enterprise, researchers assume the presence and activity of four main subjects, the participants of the market game and at the same time regulators of economy (Noga, 2009). These are:

a) *The household* as an individual or a group of people who are the final owners of the physical, money, human and intellectual capital, fulfilling various market and social functions: of a consumer, employer, citizen, entrepreneur and manager. The household plays a crucial role in generating and regulating market processes. The multiplicity of theories of business enterprise shows the plurality of conceptions and models explaining the role of the household as the main determinant and goal of setting up and developing enterprises.

b) *The market* as the whole of purchases and sales determining the production, distribution and acquisition of goods, and indirectly determining the use of households' capital. The market, in its key role of the economy's regulator, requires creating strong institutional foundations, a system of property rights, permanent development of submarkets: of products and services, financial-credit, capital, job, enterprise, insurance etc.

c) *The enterprise* as a relatively stable organization which through its autonomous abilities of producing and providing goods ensures higher utility of households' capital.

d) *The state* as a developed structure of public authorities of different levels, using its executive competences to establish and respect principles and procedures.

It seems that presently one more power needs to be added to this set: *the community of internet users*. Organised in loose web structures, these are extremely dynamic environments of exchanging information and sharing knowledge, creating patterns of consumption and behaviour, as well as exerting influence on all participants of the market game in a more efficient way (Castells, 2008, Skowron, 2013). The configuration of these regulators and their mutual relationships provide the basis for analysing the economy as an economic-socio-ecological system.

The deformation of the principles of sustainable development is connected with economic crises as well as perversions of economic systems. Searching for

the sources of these phenomena, we shall try to explain the role played by the policy of *spoiling* the household, of endogenous (initiated and taking place inside the household) or exogenous character – as a combination of influences of other market processes regulators.

Spoiling the modern consumer and its effects on sustainable development

The phenomenon of *spoiling* the household is caused by the excessive diversification of income levels and people's wealth, as well as hypercompetition driven by the increasingly faster introduction of innovations. Ignoring here other phenomena of macroeconomic nature, on the basis of the abovementioned processes their market effects can be pointed out (Żabiński, 2010), such as:

- Declassing of the market, in which the segment of middle-class consumers is shrinking, while the extreme segments (of wealthy and poor consumers) are expanding. They are moving apart from one another not only in terms of the financial level of consumption, but mainly of the nature of demand. The market of wealthy consumers, whose traditional needs are catered for more than satisfactorily, directs its attention not only at a richer and more sophisticated offer of products or services, but expects experiences at a higher level of risk (e.g. stock market investments, extreme sports). Experiential marketing, as one of the types of behavioural marketing, creates the offers for this market. In turn, what the market of poor consumers finds attractive are the products of cheap economy, including packages of goods and services at reduced prices, offered as marketing innovations.
- Overcoming demand barriers. It is becoming one of the tasks of modern behavioural marketing, especially in the crisis period. Such marketing, more and more aggressive, realizes three groups of activity: mass customization – i.e. increasingly better mass adjustment of the offer to individual needs of the buyers; activating the consumers in the role of co-designers of products (relationship marketing); infantilisation of the consumer (including consumerisation of the child).
- Concentrating the activities of behavioural marketing on generating a model of buying needs and behaviour based on a sudden impulse among consumers (including mainly children, teenagers and older adolescents). Propagating such features of behaviours among the whole society, it co-creates so-called *shopping lifestyle*, with its unlimited possibilities of using credit cards and mortgage debt.

The modern consumer, characterised by increasingly incoherent expectations and market behaviour, is the addressee, and sometimes the initiator of the increasing development of product innovations. Therefore, enterprises are introducing new models of business and of market deregulation (Klein, 2007). It is happening because innovations, especially those ground-breaking, cause turbulent changes on the market. They disrupt its structure and functioning (e.g. through a dramatic reshuffle of the market leaders) as well as cause cannibalization of products. It upsets the former market activity of a consumer, traditionally characterized by a certain dose of inertia in market behaviours, both in the shopping period and when no shopping activity takes place. The consumer becomes more and more disoriented, and therefore prone to manipulation and acting on impulse. Modern consumer media and the advertising industry throw him or her off emotional balance and cause neurotic behaviour.

Another circumstance which favours *spoiling* consumers ensues from the race of innovations and from the financial markets' interest in making speculative profit. Quickly purchasing the shares of companies-innovators, their intensive promotion and overestimating their market value often lead to *inflating the speculative bubble*. When the investors' hopes for easy profit are unfulfilled, it ends in a crisis. The virtual game with the values of companies-innovators' shares is not supported by a reliable examination and creation of target market for their products. The value of companies offering innovative products, therefore, bears no significant relation to the value of these products for the customers (Christensen, Raynor, 2008).

The common basis for the phenomena described here is shortening the time perspective in all the subjects participating in the market game. The imperative of setting and achieving short-term goals for enterprises in the form of quick and big dividend for the shareholders is followed by imposing a similar perspective on the consumer. It instils in him or her an orientation towards a shopping lifestyle, often on credit, with an evident loss for his or her long-term condition (Kaczmarek, 2009). Especially reprehensible and detrimental for the natural environment (through unjustified rational use of resources and energy as well as environmental pollution) is *planned obsolescence*, or the strategy of planned premature wear of products. It consists in designing products in such a way that they break down or become useless after a definite period of time – usually right after the guarantee period. Then the consumers are forced to buy new products even though the old ones could still be usable.

In this particular process of spoiling the consumer (excessive consumption, unbalanced by the purchasing power and based on whims, the pursuit of

novelties), the market (the changes of the conditions of competition in particular sectors, sudden regrouping of competing advantages into quasi-monopoly forms) and the enterprise (quick enrichment without any reference to the perspective of strategic interest), marketing also plays its dishonourable role. It is marketing which in its communicative activities offers the customer a vision of quick profit, empty satisfaction from possessing goods, pressure for a consumer lifestyle. The uplifting force for the current practices of behavioural marketing is provided by the communities of internet users, through the environment of strong and quick promotion of knowledge, ideas and patterns of lifestyle and consumption, as well as generating a particular system of values, inherent to the culture of *talk little – play hard*. It demands immediate effect with minimal risk, analytical effort and reflection. What counts is personal interest, while the costs are to be borne by the others.

At this stage, we could ask a question: what does the abovementioned process have in common with the principle of sustainable development? It quite does, and significantly so! This quick, in many cases intentionally shortened cycle of products' and services' market life clashes with the principles of sustainable development, as:

- it narrows down the perspective of acquiring gains to the present moment and one's own egoistic interest, overlooking the interest of the environment and of the future generations,
- it subordinates the development of infrastructure, so significant for the appropriate spatial organization of the economy (which makes it possible to reduce production and distribution costs, to make savings in investments, protect the natural environment and save its resources) mainly to the needs of the increasing competitiveness of enterprises and a faster accumulation of the surplus resulting from the aggressive competition for the customers and draining their wallets,
- it consolidates customer's behaviour and motivation for a more consumer lifestyle, at the same time deforming his or her system of values as the basis for formulating buying expectations and preferences,
- excessive consumerism of a customer causes, in turn, the eradication from his or her system of values the sense of collective interest and environmental sensitivity, which makes him or her closed to searching external economic effects, which appear in the situation of common use of environmental resources, which often requires reaching judicious compromises with the *neighbours* and establishing cooperation with them,
- it makes the consumer lose the instinct of the hosts of their own environment which would require them to take care of it, not to *throw away* the costs of their activity outside and to take responsibility for keeping this environment friendly and beneficial in a longer time perspective,
- it reduces civic attitude in a consumer, which is expressed in transferring the criteria of the consumer choices one makes to the sphere of political, social and economic authorities' choices, as well as in engaging oneself in one's own short-term consumer benefits instead of in social projects bringing general benefits for the present and future generations,
- it offers the mass buyers products and services of low quality, but convenient access, in fact teaching them mediocrity, both in the sphere of consumption and in lifestyle, as well as laziness in the shopping activity. Consumers willingly visit large-format shopping centres, often treating them as places where they can spend their free time, while it is less and less often that they make efforts to look for high-quality goods and to reasonably customize their shopping portfolio according to their purchasing power,
- it brings up the stakeholders of enterprises in a pro-consumption and hyper-competitive attitude, while they, in the same manner, will force enterprises to behave egoistically and anti-environmentally,
- it orientates the state's legislative activity towards guaranteeing conditions for fast accumulation of capital for big enterprises, at the same time neglecting the interests of the SMEs sector (small and medium enterprises sector), whose condition is decisive for the character of economy and the market. For state institutions, the capital of big corporations is more attractive – both as a party in the projects of public-private partnership, mainly in the field of the development of infrastructure, and as a source of financing political projects – than small enterprises, including family businesses. The SMEs sector, however, in its entirety does not provide a threat to sustainable development, as it follows market principles in using natural resources and is subject to mutual discipline and control. On the other hand, big corporations, strong in terms of capital, are prone to act aggressively and egoistically, against the interest of future environment, with silent agreement from

self-governmental and state authorities. It is one of many negative aspects of *egoistic globalization* (see Pawłowski, 2013).

Finally, it needs to be said that ecology as the key component of the processes of sustainable development generates costs – both in the products/services offered to the customer and in infrastructural investments (installations and systems reducing pollution, energy-saving technologies). The effectiveness of employing it in market game reveals itself, however, in a longer time perspective in the form, for example, of extended health protection effects and the availability of natural resources, or through the citizens' responsible activity and awareness of the common good. In the short run it is, however, the source of additional charges ensuing from reduced consumption and lower profitability.

Towards ecological marketing

If marketing works against the interest of the environment, let us think how it can support it. At this stage, we could quote the opinion by the Club of Rome (Brunnhuber, 2013), criticizing the traditional manners of tackling the crisis, consisting in budget cuts and strict fiscal discipline. They do not bring the expected effects, but only deepen social inequalities in the access to resources and their use (health protection, education and others). Instead, he suggests developing mechanisms of activating economic and social potential on a regional scale. According to him, it is in the regions where suitable conditions can be found, through appropriate policy of the local authorities, for controlling money and channelling it into investments whose effect will be the eradication of excessive disproportions in citizens' wealth, as well as encouraging social activity, local enterprise and economic development.

The regional perspective of development brings together all four spheres of activity responsible for sustainable development, that is human potential (D – *demography*), technological development (T – *technology*), the policy of the authorities (G – *government*) and values (V) – see figure (1). On the basis of those four aspects, the superior logic behind *ecological marketing* is revealed, firstly as a philosophy and strategy and secondly as a set of instruments by which an enterprise influences the market and the consumer, and the authorities – the citizen.

Ecological marketing focused on realizing the principles of sustainable development is manifested on two planes:

a) as a systemic function of an enterprise it contributes to the so-called ecologisation of enterprise management,
b) it influences the ecologisation of consumer behaviour, providing them not only with ecological products, but mainly developing in them ecological awareness and sensitivity.

Ecologisation of management accepts the paradigm of functioning in harmony with the environment, as the basis for innovation growth and gaining competitive advantage, which equals to being subjected to a difficult process of redefining organizational culture and the policy of the enterprise, according to the outline (Nidumolu et al., 2010):

- cultivating respect for the binding legal and trade standards, imposing such mindset upon one's partner as a condition for cooperation,
- optimal resources management within all value chains; balancing the structure of these chains,
- creating offers of products and services which are friendlier for the environment,
- developing new business models, based on the commercialization of the innovations which have their source in environment-friendly values and change the bases of competition,
- creating the foundations for the practice of introducing new generation solutions, both technological and organisational, bringing together the criteria of quality, economy of resources and minimising negative external effects.

In the process described above, the role of marketing in an enterprise is manifested in:

1) defining market opportunities as a combination of external conditions favouring long-term effective presence of the company on the market,
2) diagnosing consumer behaviour and expectations from the perspective of the possibilities offered by new technologies, but also respecting their inert nature,
3) establishing effective relationships between the company and other subjects in its surroundings, including: suppliers, local authorities and other stakeholders, and seeing in them potential synergistic effects,
4) cultivating among the managers the conviction that providing consumers with products and services is only a fragment of a broader process, that is value management for the customer,
5) engaging the enterprise in the process of marketing communication for promoting the culture of balanced consumption basing on the paradigm of quality (instead of pushing the customer into excessive consumption),
6) looking for the sources of improving the competitiveness of ecological products and services in comparison with the offers basing on generally accepted and economically profitable standards of production.

As it can be seen in the examples above, the main goal of marketing in an enterprise is to shape business culture, directing it at the participation in sustainable development. Producing, selling and promoting ecological products will only be the final effect of the ecologisation of management. With such an approach, ecology becomes the factor integrating innovation and quality.

Ecologisation of consumer behaviour is a process of revision in consumers' consciousness and attitudes which takes place in the sphere of the whole social and market activity of the consumer, and not only in their buying decisions. In order to understand the meaning and importance of this process, one needs to return to the previous assumption and set the consumer in his or her natural environment, that is in the household. The changes the consumer is subject to are closely related to the changes in behaviour within the whole household. One person – a member of a household – performs a number of roles: a consumer, an employee, a citizen, and sometimes also a manager, an entrepreneur, an expert.

Consumer, the way he or she is, is the *product* of the culture of the household, but also through the market (buying) experiences he or she shapes the system of values of the household and its members. It should not be surprising, then, that egoism, mediocrity, greed for money and extreme experiences, arrogance, ignoring the interest of others, as well as other *sins* of the consumers infect their other roles in the economic system, and as a final effect spoil the mechanisms of democracy.

What does ecologisation of consumer behaviour entail, then, and what role can marketing play in it, understood as a strategy, management process and a set of instruments of influencing the consumer? The main indications of ecologisation of consumer behaviour are (Mazurek-Łopacińska, Sobocińska, 2010):

- following the criterion of maximizing quality and of long-term usability in relation to one's financial resources in one's buying decisions,
- cultivating a healthy lifestyle based on purchasing and consuming ecological products, doing physical exercise and taking care to keep the natural environment clean,
- deconsumption, or reducing the consumption of goods which are obtained with significant exhaustion of non-renewable resources,
- moving from ego-rationality to eco-rationality through economical, efficient management of goods, waste sorting and re-use, reusing products instead of buying new ones and passing them on to subsequent consumers,
- improving knowledge about the protection of natural environment and becoming involved in environmental initiatives.

Summary

In order for marketing as a systemic function of the enterprise to favour and stimulate behaviours directed at sustainable development, it needs in the first place to abandon the doctrine of aggressive behaviourism, in which the customer is merely the addressee of the pressure imposed on him or her. It calls for returning to the classical Kotler concept of looking for permanent values for the customer on the market (Kotler, 2005). Maximisation of those values (for the customer and the enterprises) should result in breaking the dictate of values for the shareholder in a short time perspective. Establishing a good reputation of a company should be based on a strong brand of the product/service, leadership in a selected domain, respecting the work environment, social responsibility and stimulating innovation directed at the consumer's needs and problems. Marketing should promote the culture of quality, while in the choice of the instruments influencing the consumer, it should follow the principles of eco-rationality and long-term accumulated environmental effect.

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Green Information Technology Practices among IT Professionals: Theory of Planned Behavior Perspective

Praktyki zielonych technologii informatycznych wśród profesjonalistów z zakresu IT – perspektywa teorii planowanego zachowania

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Abstract
According to the existing literature, the determinants of environmental attitudes and behavior are important. In this paper impact of information technology adoption environment has been investigated. Some of the studies have successfully utilized Theory of Planned Behavior (TPB) for adoption behavior. This study proposed TPB to explain IT professionals' intentions for Green Information Technology (GIT) practices. For this purpose, a survey was conducted among IT professionals from public and private sector organizations. Core factors of TPB were included in the analysis. Overall, results revealed that the TPB model explains behavioral intent, and all four core constructs were significant predictors of the intent. Limitations of the study, and implications for theory are also discussed.

Keywords: Theory of Planned Behavior, Sustainability, Green Information Technology, IT professionals, ANOVA

Streszczenie
Według wskazań literaturowych, determinanty ekologicznych postaw i zachowań odgrywają istotną rolę w ich kształtowaniu i warto badać wpływ, jaki wywierać może na nie stosowanie technologii informatycznych. W tej pracy wykorzystano teorię planowanego zachowania (Theory of Planned Behavior – TPB), aby wyjaśnić podejście profesjonalistów z zakresu IT do praktyk związanych ze stosowaniem zielonych technologii informatycznych (Green Information Technologies – GIT). Badania wśród pracowników IT przeprowadzono w firmach reprezentujących dwa sektory: państwowym i prywatnym. Otrzymane wyniki pokazały, że model TPB, uwzględniający cztery filary, wyjaśnia determinanty odnoszące się do zachowania. W artykule omówiono także napotkane ograniczenia, a także implikacje dla teorii TPB, które z przeprowadzonych badań wynikają.

Słowa kluczowe: Teoria planowanego zachowania, zrównoważoność, zielone technologie informatyczne, profesjonaliści z zakresu IT, ANOVA

Introduction

Sustainability has increasingly become an important issue for both management scholars and practitioners. This recent advance can be attributed to the facts that while the last two decades have brought much economic growth, there is much concern surrounding both wealth disparity and natural resource depletion (Dao et al., 2011). Research has acknowledged that addressing sustainability issues is critical to the long-term existence and thriving of companies (Porter and Kramer, 2006). This concern has manifested itself in legislation expanding the responsibility of firms, increasing attention on training managers in sustainable management, and the development of theory to support sustainable managerial decision making (Hart and Milstein, 2003). In order to reduce the degree of deterioration of environmental sustain-

ability, it is necessary to understand and change the relevant human behavior (Steg & Vlek, 2009).

Conformity with the environmental regulations, keeping a pace with the competitors, overhauling of the organizational image, keeping the presence in the new markets and value addition to the products are some of the reasons compelling the firms to think about environmentally sustainable products (Chen, 2010). There is clear evidence that the Information Technology (IT) has a predominant role in reducing energy consumption, both as a tool to monitor and optimize the energy efficiency of any production process, and as a target of energy efficiency initiatives (Capra et al., 2012). The production, use, and disposal of IT have a direct effect on the natural environment and eco-sustainability (Hilty et al., 2006). Estimates indicate that the IT industry account for 2% of global CO_2 emissions, which is equivalent to the amount generated by the aviation industry (Gartner, 2008).

As the force of the Moorse law continues to shorten the average life span of IT, electronic-waste is emerging as one of the fastest growing waste that requires serious attention. For instance, in Australia, over 1.6 million computers are dumped in landfills each year and e-waste is growing faster than general municipal waste (Harper, 2006). Although estimates vary, the IT sector had produced 1.3% of global green house gas emissions in 2007 and used 3.9% of electricity (Malmodin et al., 2010). The Internet alone accounts for 10% of energy consumption in the US (Berthon and Donnellan, 2011). For these reasons, concerns regarding climate change along with an increased environmental awareness have spurred interest in sustainable development and Green Information Technology (GIT) both in the field of information systems (IS) (Melville, 2010) and among IT practitioners (Webb, 2008). Jenkin (et al., 2011a) suggested that organizations are still in infancy stage of awareness and adoption of *Green* IT/Information System (IS). They found four types of gaps in this context: knowledge gaps, practice gaps, opportunity gaps, and knowledge-doing gaps. Jenkin (et al., 2011b) also envisaged that environmental orientation is made up of three components – environmental attitudes, cognitions, and behaviors – at both the employee and organizational levels. This orientation reflects the degree to which the organization and its employees have implemented and institutionalized the organization's environmental initiatives.

A wide range of studies focused on the role of moral and normative concerns underlying environmental behavior from different theoretical perspectives (Steg and Vlek, 2009). As they stated, some of these studies examined environmental beliefs and behavior on a basis of the value (see for example: De Groot & Steg, 2008; Nordlund & Garvill, 2002). Another group of studies focused on the role of environmental concern by using different conceptualisations (See for example: Dunlap et al., 2000). A third line of research focuses on moral obligations such as willingness to change behavior (e.g. Nordlund & Garvill, 2003) and policy acceptability (e.g. Steg et al., 2005). These studies involve different antecedents of environmental behavior along with their perspectives. Theory of Planned Behavior (TPB) is a parsimonious conceptual frame work developed as an extension to the theory of reasoned action (TRA) (Ajzen, 1991). The TPB is well established for human behavior related studies and used to hypothesize the individuals' intention to perform the behavior (Nchise, 2013). It also has strong predictive power for wide range of human behavior (Ajzen, 1991). TPB is proven to explain behavioral intentions in information technology (Mykytyn and Harrison, 1993) and environmentally responsible behaviors (Bamberg & Schmidt, 2003). As supported by the literature (Bose and Luo, 2011), there are limited empirical studies in the field of green IT and we could not find any study which relates green IT and TPB together towards incorporating practicing GIT and individuals' behavioral intention. Therefore, there is currently a strong need to develop and gain empirical support for TPB towards adoption of green information technology. The findings of such a study may provide significant implications to identify awareness individuals towards environmentally sustainable approaches in their different tasks.

Therefore, the present study has been conducted to analyse GIT usage behavior with using TPB. The data collected from ICT professionals since GIT is a new concept and IT professionals are observed to be of higher awareness on the issue than other groups. Their utilizations of such new services and technologies may show more informative patterns than other groups in the society at this stage (Jin et al., 2007). Therefore, Findings may undertake a leading role for future studies considering other groups.

The article proceeds as follows; The following section introduces the theoretical development for the hypotheses. Afterwards, research design is stated clearly. The results of the study are, then, presented and discussed. Finally, the paper concludes with conclusions, limitations, and directions for future research in this area.

Hypothesis

In many cases, substantial theoretical and empirical support has accumulated in favor of conceptual framework usage. The Theory of Planned Behavior (TPB) (Ajzen, 1991) is one of those frameworks, which has been applied to environmental issues since it offers a theoretical base for the consideration of behavioral attributes in technology adoption (Nchise, 2013). Some of the latest studies include *testing the effect of environmental friendly activities*

(Han et al., 2010), *exploring environmental behavioral intentions in the workplace* (Greaves, et al., 2013) and investigate the determinants of environmental behavior among youth (Niaura, 2013).

Although, previous studies have examined environmental issues from different perspectives, studies on environmental policies and strategies regarding individuals' Green Information Technology (GIT) preferences and attitudes toward green practices have been rare (Bose and Luo, 2011). Investigation of individuals' GIT behavior is important since these technologies have been identified to have a detrimental influence on the environmental footprint of organizations (Siegler & Gaughan, 2008), which also provides significant information to evaluate the effects of individuals' interventions systematically.

Green IT refers to the use of IT resources in an energy-efficient and cost-effective manner (Bose and Luo, 2011). Over the past few years, green IT strategy, design and practice initiatives evolved gradually into an active research area in the information system discipline, and, presently, there are few empirical researches in the area of green IT (Bose and Luo, 2011). However, in a majority of GIT research to date, there is a lack of social and individualistic perspective (Erek et al., 2009). Additionally, GIT is a new concept and professionals' utilizations of such new services and technologies may show entirely different patterns than other groups in the society (Jin et al., 2007). This means, professionals' perceptions and behavior may influence others in the society at later stages. On the other hand, ICT professionals are observed to be of higher awareness on GIT issues and their behavior may play pioneer role for other groups in the society.

Having considered all these, following hypotheses are postulated.

H1: ICT professionals' Behavioral Intention (BI) to practice GIT is effected by Behavioral Intention (BI)

H2: ICT professionals' Behavioral Intention (BI) to practice GIT is effected by Subjective Norm (SN)

$H3_1$: ICT professionals' Behavioral Intention (BI) to practice GIT is effected by Perceived Behavioral Control (PBC)

$H3_2$: ICT professionals' Actual Usage (AU) of GIT is effected by Perceived Behavioral Control (PBC)

H4: ICT professionals' Actual Usage (AU) of GIT is effected by Behavioral Intention (BI)

Research instrument and data

A survey was conducted to examine the application of TPB to analyse the acceptance of GIT usage (Figure 1). The data were obtained by means of a questionnaire for this purpose containing 8 questions grouped under 5 constructs according to TPB. The questionnaire inquires data as provided in Table 1.

The respondents were IT professionals from major]organizations as the attendees of an annual one-day meeting on issues – problems and developments – in the use of IT in organizations, organized by the Turkish Informatics Association (TIA). The sample was limited to IT professionals since GIT is a new concept and these professionals are believed to possess a higher level of awareness on this issue compared to other groups. The invitations were limited to 190 organizations, and selected from public-and-private sector establishments using *judgment sampling*. A total of 182 completed survey questionnaires were received, and twenty-five responses were discarded from the analysis due to the incomprehensible content. This represents an 82.1% response rate.

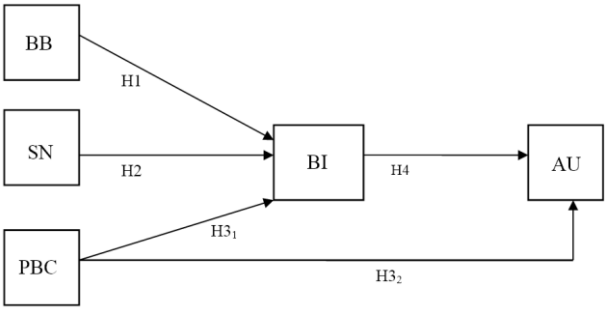

Figure 1. Research model (TPB). Boxes represent the constructs. Casual effects are given by arrows connecting the boxes

Table 1. List of constructs, corresponding items and construct reliabilities

Construct	Item*	Construct Reliab.
Behavioral Beliefs (BB)	Do you think it is easy for you to learn how to practice GIT?	0.950
	Do you think you have no problems in practicing GIT?	
Subjective Norms (SN)	I believe that people, who are important to me, practice GIT.	0.994
	I believe that people, who are important to me, expect me to practice GIT.	
Perceived Behavioral Control (PBC)	How much do you consider the type of your ICT application in practicing GIT?	0.996
Behavioral Intention to Use (BI)	I intend to consider practicing GIT in buying a new hardware.	0.994
	I intend to consider practicing GIT in buying a new software.	
Actual Use (AU)	I practice GIT while using ICT.	-

* A five-point Likert Scale (5 =very much, 4=much, 3=moderate, 2=little, 1=very little) is used for each item.

Table 2. ANOVA test results

Dependent variable	Test variables	Hypothesis	F-value	d.f.	p-value
Behavioral Beliefs	Behavioral Intention	H1	5.03	10/181	0.000*
Subjective Norm	Behavioral Intention	H2	8.65	10/181	0.000*
Perceived Behavioral Control	Behavioral Intention	$H3_1$	22.54	9/181	0.000*
Perceived Behavioral Control	Actual Usage	$H3_2$	37.30	8/176	0.000*
Behavioral Intention	Actual Usage	H4	1.82	9/176	0.066**

* indicates statistically significant at 0.01 significance level,
** indicates statistically significant at 0.10 significance level

The overall internal reliability as measured by Cronbach's alpha was found as 0.707 (Brown, 2002). Thus, data exhibit adequate reliability (Yu, 2007). The factor loadings for multi-item constructs BB, SN, PBC and BI were used to assess the construct reliabilities and these loadings are 0.950, 0.994, 0.996 and 0.994 respectively (Table 1).
This shows existence of construct reliability. For the establishment of content validity, the items and their correspondings constructs were adapted from prior studies and modified according to the context of this study.

Test results

One of the principal areas of statistical inference is the test of statistical hypotheses. These tests deal with drawing inferences about a population parameter on the basis of sample data drawn from the population (Mishra and Akman, 2010). The proposed hypotheses based on the research model were tested individually using the ANOVA technique, and the results are given in Table 2. The ANOVA test provides a nonparametric alternative to the one-way analysis of variance and is robust in its resistance to the outliers and errors in the data relative to the usual normal theory F test (Milton and Arnold, 2003).
Inspection of the p-values shows that the factors, BB and SN have significant impact on BI. Therefore, the hypotheses H1 and H2 are accepted at 0.01 significance level. This means, BB and SN can be used to explain the respondent's behavioral intention while practicing GIT. These show the existence of indirect effect of BB and SN on actual behavior in the adoption of GIT. As a consequence, a motivational stage of intention setting and a volitional stage of intention striving appear to be two significant stages for changing behavior of individuals (Bamberg, 2013). On the other hand, PBC is significantly related to BI and AU at 0.01 significance level and therefore it has indirect and direct effect on GIT adoption behavior of IT professional. This leads to acceptance of $H3_1$ and $H3_2$. In other words, PBC can be used to explain the respondent's behavioral intention while practicing GIT. Interestingly, PBC has been observed to have a far greater impact than BB and SN in determining behavioral intention. The direct effect of PBC on AU was also supported by Chau & Hu (2002). Furthermore, the test results have shown that BI has significant direct effect on actual behavior (p-value=0.066) for adopting GIT behavior at 0.10 significance level, which indicates direct effect of BI on AU. This is an indication of the fact that behavioral gap in individuals intention is an important factor for the level of their GIT actual usage and therefore barriers effect the relationships between intention and actual usage (Bamberg, 2013). Overall, it is interesting to note that all the hypotheses relating to TPB constructs were all supported either for p-value<0.01 or p-value<0.10. This indicates that most of the variance for professionals' attitude for GIT usage may be explained by TPB constructs, which may also leads to the fact that employees believe that they have control over their ability for actual behavior (Greaves et al., 2013). Therefore, the individual's intention to engage in adoption of GIT in their IT activities is strongly positively related to their attitudes.

Discussion

The objectives of this study were all supported by the test results and therefore conclude that TPB constructs have direct and indirect effects on individuals behavior in adopting GIT. In other words, according to the ANOVA test results, there is a positive significant relationship between TPB constructs (subjective norm, perceived behavioral control, intention and actual behavior) and therefore, the conceptual model represents the data.
More specifically, behavioral belief (i.e. attitude), subjective norm and perceived behavioral control significantly affect the behavioral intention of ICT professionals in the adoption of Green IT. Considering the model, this means SN, BB and PBC have significant indirect effect on actual usage of GIT. A plausible explanation may be based on motivational theory that GIT adoption may be considered as an intrinsic motivational factor and behavioral belief, subjective norm and perceived control may be extrinsic motivational factors that could help the individuals self-regulate their motivation on GIT adoption (Park, 2007). It is interesting to note that, PBC has been observed to have a far greater impact than BB and SN in determining behavioral intention. This leads to the fact that people's beliefs have significant control over the behavior and therefore performance or non-performance of the behavior is up to them (Nchise, 2012; Ajzen, 2002). But significance of subjective norm may be an evidence of existence of the perceived social pressure to perform the GIT be

havior, which basically relates to one's intuition about others' exertion of influence (Nchise, 2012).
On the other hand, The respondents, who believe that major players (PC manufacturers, software developers, users, and government) can reduce the negative effect of ICT on the environment, found adopting GIT convenient, worthwhile, and required activity in their work environment. Moreover, they intend to consider GIT issues while purchasing new hardware and software, and to practice GIT in their ICT usage. A possible explanation for our findings is that, the ICT professionals have significant experience and knowledge on using information and communication technologies and this naturally effects their adoption of new developments. This concludes that professionals' behavioral intention is argued to be stimulated by their attitude, subjective norm and perceived behavioral control to getting information, giving information and ultimately using the information in a manner which enhances GIT adoption (Nchise, 2012). Practically, these results provide important indications for organizations and decision makers for their implementations towards increasing employees GIT usage behavior.
An important theoretical implication of this study is that the TPB constructs significantly explain large amount of total variance in professionals' behavioral intention regarding GIT adoption. One plausible explanation for the high variance explained may be based on Greaves, Zibarras and Stride (2013). They concluded that such a high variance could relate the questionnaire development process, which elicited salient behaviors and beliefs that were relevant to the target population (Greaves, Zibarras and Stride, 2013). More importantly, high proportion of the explained variance makes it possible to investigate and explain the antecedent factors of behavioral intentions, which also leads to understanding the underlying reasons about professionals' GIT usage intentions. Therefore, we can conclude that the application of TPB offers a theoretical base for the consideration of behavioral attributes in technology adoption (Nchise, 2012).
Our finding is supported by some of the recent studies that TPB is capable of explaining the behavioral intention regarding ICT usage and environmental issues (see for example: Han, Hsu and Sheu, 2010; Greaves, Zibarras and Stride, 2013; Niaura, 2013). Han (et al., 2010) analysed a total of 428 responses and showed that TPB model has predictive power for intention to visit a green hotel. Greaves (et al., 2013) explored environmental behavioral intentions in a workplace setting based on a sample of 449 participants' responses. In their study TPB constructs were found to explain between 46% and 61% of the variance in employee intentions to engage in the environmental behaviors, which forms a basis upon which interventions could be developed within the host organization. Niaura (2013) conducted a survey among the respondents aged 17-36 (in total 459). He used TPB to examine the gap between the environmental attitudes and the actual behavior of young people. TPB was reported to be supported by the analyses and the results revealed that social pressure has impact on youth's perceived behavioral control ($r=0.22$ and 0.36, p-value<0.001). Just as expected, there are many studies pointing that the majority of people in western society have an awareness for the consequences humans actual behavior on the environment (Fielding, et al., 2008). This leads to display of concerns for the environmental problems from every perspective and there exist countless examples across many nations of the success of people power in preventing environmental degradation (Fielding, et al., 2008).
Recent literature also provides some conflicting results (see for example: Bamberg, 2013; Aboelmaged and Gebba, 2013). Bamberg (2013) uses a model of action phases as a theoretical basis, whose constructs are also taken from TPB. The research data was based on a sample of 1815 citizens from 5 different European cities. In his study, Bamberg (2013) mentioned existence of intention and behavior gap based unforeseen barriers and temptations. According to his view, this may be due to the fact that forgetting the intention may interrupt the intention behavior relation and, as a consequence, a successful behavioral change requires individuals not only to form a strong behavioral intention (motivational stage) but also to develop skills (Bamberg, 2013). Aboelmaged and Gebba (2013) used TPB from a different perspective of technology usage. They aimed to understand adoption of mobile banking based on a survey data from 119 respondents from undergraduate and postgraduate students. Their results indicated that the effects of behavioral control and usefulness on mobile banking adoption were insignificant and TPB has not been found to provide consistently superior explanations or predictions of behavior. Several plausible explanations may be possible for conflicting results. First of these may be based on Greaves (et al., 2013). Referring to Ajzen (1991), they stated that *the relative importance of the TPB constructs may vary from one behavior and one population to another. This may have led to variation in the extent to which employees believed that they had control over their actual behavior*. Especially, differences in the impact of perceived behavioral control may be based on the fact that perceived behavioral control is made up of both the perception or belief of self-efficacy and the person's perception of control over their performance of a behavior (Aguilar-Luzon et al., 2012; Ajzen, 2002b). Both elements are different and albeit related constructs, so the contribution of one and the contribution of the other on intention and behavior are different. Second explanation may be the difference between the level of knowledge and awareness about usage of GIT between the respondents of the samples with different

characteristics. Third explanation could be due to respondents' higher experience and familiarity with ICT technologies in our sample, which increase their expectancies and utilization of technological developments. Finally, an interesting explanation may be based on the differences between attitudes in the collectivist and individualist societies (Pavlou and Chai, 2002). As noted by Pavlou and Chai (2002), individualists perceive that they are relatively free to follow their own wishes, without regard for others' opinions.

Conclusions, limitations and suggestions

This paper explores individuals' environmental behavioral intentions using the theory of planned behavior (TPB). The factors incorporated in the analysis were selected with due consideration of the elements of TPB. Interestingly, the results revealed that all of the core TPB factors are significant. This is an indication of the fact that there is a great degree of *awareness* and *acceptance* of green computing among IT professionals. This observation is also applicable to their working environment. Yen (et al., 2003) pointed the differences in understanding the required knowledge, subject knowledge and technical skills between different groups in the work place and society. Therefore, special training programs in organizations and awareness-developing advertisements in the media for the society can be initiated so as to increase the level of understanding for the impact of GIT.

This study possesses some limitations that should be noted. First, the questionnaire is based on core factors of TPB and extensions considering external factors may help to have a deeper understanding of the behavior. Second limitation is obviously based on the sample frame. Although analysis of professionals or employees is declared to provide valuable information in technology adoption issues in many studies, assessment of the behavior of other layers in the society will certainly provide complementary information. Third, it may be useful to carry out a comparative study between different societies. Specifically, studies between collectivist and individualist societies may lead to interesting and valuable findings. Finally, using models other than conceptual ones may help to have a wider understanding for the factors affecting GIT usage since conceptual models such as Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) are mainly focusing to their core factors.

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The Impact of Environmental Preferences on Public Supporting for the River Ecosystem Restoration Program in China

Wpływ uwarunkowań środowiskowych na społeczne poparcie dla Programu odnowy środowiska rzecznego w Chinach

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Abstract
Restoration of the urban river system is urgently needed as urban river pollution is becoming an important environmental problem in China. Apart from the technical challenge, explicitly including the local residents' preferences toward ecosystem management and restoration often is critical for municipal planners and policy implementation. This study used a contingent valuation method to estimate the public preferences for supporting urban river restoration in Hangzhou and Nanjing, China. The results show that environmental preferences including perception, beliefs and past behavior were better explanatory variables than socio-demographic characteristics for explaining people's support for ecosystem restoration actions. But the respondents' *demand* and *supply* on environment goods are mismatch. People want better environments goods but they are unwilling to make an effort to build the environments. We also find that the average conjectural payment for the restoration project is only 36 Yuan RMB per capital. Efforts to assess and foster support for urban ecosystem restoration should be pay more attentions to the public's perception, beliefs and past behavior.

Key words: river restoration, public preference, environmental awareness, city planning, water quality, urbanization, China

Streszczenie
Odnowa środowiska rzecznego na terenach zurbanizowanych staje się w Chinach ważnym problemem środowiskowym, z uwagi na wysoki poziom zanieczyszczeń. Oprócz wyzwań technicznych, wyraźne uwzględnienie preferencji lokalnych społeczności odnoszących się do zarządzania środowiskiem i jego restytucji stanowi istotne wyzwanie dla miejskich planistów i wdrażanych programów. W tym artykule zastosowano metodę wyceny warunkowej w celu określenia społecznych preferencji związanych z wdrażanym programem odnowy środowiska rzecznego w Hangzou i Najing w Chinach. Otrzymane wyniki pokazują, że preferencje środowiskowe (uwzględniające percepcję, przekonania i dotychczasowe wzorce zachowania) okazały się być trafniejszymi zmiennymi wyjaśniającymi, niż wskaźniki społeczno-demograficzne, w kontekście wyjaśniania poziomu społecznego wsparcia dla działań podejmowanych na rzecz restytucji środowiska. Zarazem *popyt* i *podaż* respondentów na dobra

środowiskowe rozmijają się. Ludzie oczekują lepszej jakości środowiska, ale nie są zainteresowani podejmowaniem osobistych działań w tym kierunku. Okazało się także, że przeciętny poziom hipotetycznego finansowego wsparcia respondentów dla działań na rzecz środowiska wynosi zaledwie 36 yuanów RMB za kapitał. Wysiłki w celu oceny i kształtowania wsparcia dla odbudowy środowiska powinny w większym stopniu zwracać uwagę na społeczny odbiór podejmowanych działań, ludzkie przekonania i dotychczasowe wzorce zachowania.

Słowa kluczowe: restytucja środowiska wodnego, preferencje społeczne, świadomość ekologiczna, planowanie miast, jakość wody, urbanizacja, Chiny

Introduction

Urban rivers play important roles in providing ecosystem services as well as recreation sites for residents. In the past years, pollution along the urban rivers, including the ugly color, bad smell, and visible oil on the surface resulting from untreated sewage being discharged into the river directly without any treatments, has been more severe with the fast development of economics and urbanization in China. Human modification of rivers is a concern to environmental managers, engineers, and economists in many part of the world (Schmidt, 1998; Cairns, 1991; Kern, 1992). Relative regulations and actions like garbage treatment, controlling wastewater discharge or increasing water price indeed have already been implemented by government or non-governmental organizations aiming to diminish the pollution in urban stream.

Understanding public support for ecosystem restoration is an important part of environmental protection (Endter-Wada et al., 1998). Water quality, riparian landscaping, and similar issues have no market price tag. Explicitly including the local residents' preferences toward ecosystem management and restoration often is critical for municipal planners and policy implementation because the sustainability of sound management is rooted in stakeholder support (Lee, 1995; Haney & Power, 1996; Proctor, 1998). Information is generally obtained by assessing the individual's environmental preference and willingness to pay for ecological projects. Those preferences can inform the policy-maker about how people respond to the proposal for change to particular environments.

The Theory of Planned Behavior (Pratkanis, Breckler, & Greenwald, 1989) provided a clear *picture* about the linkages among environmental preferences and public behavior to pay for restoration and protection goals. This theory, developed earlier by Ajzen & Fishbein (1980), asserts that people systematically use the information available to them to shape their beliefs and attitudes about certain actions before deciding to take those actions. Give between external variables (e.g., socio-demographic characteristics, knowledge, past behavior), the individual's environmental preferences including beliefs, attitudes, intended behavior, and real behavior, will significantly impact their final decisions.

Despite growing worldwide interest, restoration river ecosystem has had little research to check how the residents respond these interventions in local environment (Tunstall, Tapsell, & Eden, 1999). Previous research revealing public's support on environmental management is always focused on how people respond to their proposals of changing particular environmental issues (Dunlap, 1991; Kempton, Boster, & Hartley, 1996; Milon, Adams, & Carter, 1998). Deriving evidences, like whether and how much people are willing to pay for restoration programs, is necessary to prove future benefits and expenditure (Bae, 2011). Numbers of studies have made connections between socio-demographic characteristics and concerns for the environment (Jones et al., 1999). Others drawn connections between value orientations and policy preferences (Steel, List, & Shindler, 1994), or risk perceptions (Steel, Soden, & Warner, 1990). Those researchers pay more attention on environmental restoration, such as in agriculture, industrial sectors, ecological systems, and Reservation Parks (Carnes et al., 1998; McCoy et al, 2002; Wilkins et al., 2003; Gunawardena et al., 2005; Chen et al., 2010). Few exams publicize environmental attitudes to the local urban river restoration (Schmidt et al., 1998; Loomis et al., 2000; Downs et al., 2002; Zhang et al., 2007).

By conducting a survey in Hangzhou and Nanjing, the objectives of this paper are to estimate: the environmental preferences impacts on public's supporting for the river ecosystem restoration Program in China by included the factors including beliefs about the environment and economic development, knowledge and involvement of ecosystem protection and restoration, and socio-demographic characteristics (such as age, gender, distance home is from the river, length of residence in the area, and stated political orientation).

Survey Design and Implementation

Study areas

Our study area, locating in Yangtze River Delta, is one of the largest city agglomerations in China (Huang and Jiang, 2009). Hangzhou and Nanjing are two of the most developed cities in this area, ranking 8th and 16th respectively in the 2010 Chinese city GDP. A number of streams cross the cities and influence people's daily lives. Growing population and

industrialization has resulted in severe contamination in the urban rivers. Becoming the wealthiest region in China, the citizens are starting to pay more attention to improve their environmental quality and health safety, allowing the restoration or improvement programs to be conducted in this area. The public is possibly willing to support the restoration project when they gain more from environmental improvement the costs (payment). Therefore, there is a need to reveal the public preferences as important measures toward the change environment quality. Alternatively, governments also can use this information to evaluate policies implemented.

The main rivers in the study areas are Can Hua Xiang River in Hangzhou and Qing Huai River in Nanjing. Along the rivers, some buildings, for example, residential houses, primarily temporary workers 'rooms, elementary schools, and universities are located along the riverside. Residents prefer getting leisure in green areas with some exercise facilities. Numbers of discharge holes are set along the banks, causing serious pollution such as water black, strong odor, and some green bubbles on the surface. Recently, some restoration projects have been executed on the rivers in the cities.

Survey implementation

In survey mode, the NOAA panel recommended face-to-face interviews over the telephone and through postal surveys, since it is one of the most reliable surveys in the studies of developing countries (FAO, 2000). Hadker et al. (1997)states the difference of this method compared from the mailed questionnaires and telephone surveys in those countries. Our survey was conducted by a face to face interview in May 2011. We defined the study area for residents as the Can Hua Xiang River and Qing Huai, including the land on either side of the river. Respondents are sampled randomly including pedestrians, residents, peddlers, and white-collar worker. Of 1586 contacted individuals, 1459 were successfully interviewed, yielding the response rate of 92%.

The questions begin with some description of scenarios, the status quo, and changes in environmental quality, so that the respondents can evaluate their environmental preference for ecosystem changes. Mangione (1995) developed an efficient method, called Total Survey Design Method (TSD), which attempted to meet a best balance across all effort areas. TSD has been successful in securing high response rates from general and special investigations (Hager et al., 2003; Tourangeau, Couper, & Conrad, 2004; Van der Stede, Young, & Chen, 2005). The survey covered the topics including: the level of knowledge and involvement of residents with the urban river; beliefs about the relationship of humans and environment; the perception of environmental problems formed over a long time and awareness of environment influenced by the specific event; the willingness to pay for four different types of ecosystem restoration, and socio-demographic characteristics.

The knowledge scale is created by summing the number of correct answers to three questions. Each question measured a different aspect of a respondent's knowledge about environmental issues and protection. The beliefs scale was generated by using two questions that asked respondents' concern for environment. This is similar to Barro & Bright's (1998) study, who tested beliefs associated with restrictions on land use. We particularly create a perception of environmental problems scale by collecting five indexes about the awareness of environment influenced by the specific impression. Those indexes covered the color, smell, oil in the surface, rubbish, and green belt in the urban river region. We also generate an environmental activism scale by summing the number of environmentally related activities the respondent had participated in the past 24 months. The items included voting for political candidates, joining organizations, and donating.

Referendum method is applied in the collection of respondents' willingness to pay (WTP) by asking a binary question. The sample was divided into four subsamples. Each subsample was provided some values to estimate the preference in different level of payment. The respondents should answer a question if they were willing to pay the price in the form of increasing tax for the urban river restoration program. In order to avoid the bias from defining the range of payment as either too high or too low, we refer to previous studies in the relevant fields and offer the choice of paying a price from 5 to 100 Yuan in the survey (τ_i =5, 10, 20, 50,100) striving to make the payment more feasible and realistic. If $WTP_i>\tau_i$ was selected, the probability of *yes* used in the profit model is $\Pr(WTP_i>\tau_i)$, otherwise the probability is 1-$\Pr(WTP_i>\tau_i)$.(Cameron 1988) argued that adding one more choice, *don't know*, in the binary choice may significantly improve the survey results. Hite (2002)claimed although explicitly modeling *don't know* can alleviate the error in survey process, the bias in econometric estimation cannot be avoided. She suggests an ideal way is to create a follow-up question asking if they would pay any positive amount for the program after people's response *no* or *don't know*. This follow-up question can change the WTP from full censored to partial censored, which is sure to improve the precision of econometric estimates.

Table 1 is the summary of the characteristics of the sample. The sample consists of 42% male and 57% female respondents. The age ranges from 35 to 44 accounted for 60% of all respondents. Seventy two percent of households have been registered as local residents or saying they have local *HUJI*. 50% of respondents reported they have elders in the family, and 29% and 19% respondents reported that children and pets live together with them. Household income

Table 1. Description of Socio-demographic characteristics variables using in the analysis

Socio-demographic characteristics	Mean	S.D.	Min	Max
Gender (0= Male, 1=female)	0.6	0.5	0	1
Household size	3.7	1.3	0	13
Baby (0= no, 1=yes)	0.1	0.3	0	1
Children (0= no, 1=yes)	0.3	0.5	0	1
Old man (0= no, 1=yes)	0.5	0.5	0	1
Age (1= 18~34, 2=35~44,3=45~59,4=60~75, 5=75 or above)	2.0	1.2	1	5
Pet (0= no, 1=yes)	0.2	0.4	0	1
Huji (0= no, 1=yes)	0.7	0.5	0	1
Years residential in this area	16.3	17.1	0	80
Employment (0= no, 1=yes)	0.6	0.5	0	1
Household income (1=less than 12,000 RMB, 2=12,000 RMB~ 36,000RMB, 3=36,000 RMB~ 60,000RMB, 4=50,000 RMB~ 84,000RMB, 5=84,000 RMB~ 120,000RMB), 6=120,000 RMB~ 240,000RMB, 7=240,000 RMB~ 360,000RMB; 8= above 360,000RMB)	3.8	1.6	1	8
Education level (1=primary school, 2=middle school 3=high school, 4=undergraduate, 5=graduate school, 6=others)	3.4	1.1	1	6

Table 2. Description of environmental preferences using in the analysis

Variable	Mean	S.D	Min	Max
Knowledge scale *(KNOW)* (Quadratic Mean)	7.8	3.9	2.4	18
The knowledge about how the water quality of the river has been polluted.(1=unknown, 3= clear)	2.3	0.7	1	3
The knowledge about how the water pollution may harm the health. (1=unknown, 3= clear)	1.9	0.6	1	3
Beliefs scale (*BELIEF*) (Quadratic Mean)	8.5	2.3	2.4	18
Concern for environment issues. (1=weak, 3= serious)	1.2	0.4	1	3
Concern for environment policies scale. (1=weak, 3= serious)	2.8	0.5	1	3
How clean today? (1= very good, 4=extremely bad)	3.4	0.6	1	4
Perception scale (*PERCEP*) (Quadratic Mean)	29.0	9.6	5	45
The color of the river (1= very clear, 2= grey, 3=black)	2.3	0.5	1	3
The smell of the river (1= fresh, 2=slightly uncomfortable, 3= bad smell)	2.3	0.6	1	4
The oil in the surface (1= no oil, 2=slightly oil, 3=full of oil)	2.3	0.6	1	3
The rubbish in the river (1= no rubbish, 2=slightly rubbish, 3=full of rubbish)	2.3	0.6	1	3
The green belt along the river (1= very clean, 2= slightly duty, 3=very duty)	2.3	0.6	1	3
Environmental activism scale (*ACTION*) (Quadratic Mean)	17.4	8.7	1.3	48.8
Donation for any environmental restoration projects in the past 24 month. (0= no, 1=yes)	0.2	0.4	0	1.
Pass away from the river (0= no, 1=yes)	0.8	0.4	0	1
Walking participation (1= every day, 6=never)	3.3	1.8	1	6
Boating and fishing participation (1= every day, 6=never)	3.6	1.5	1	6

Table3. Description of Respondents' perception grade

	Overall		Color		Smell		Oil		Garbage		Green Belt	
Score	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1	7	0.5	31	2.0	90	5.9	133	8.8	63	4.2	289	19.1
2	869	57.3	1,023	67.4	876	57.8	898	59.2	947	62.4	962	63.4
3	640	42.2	463	30.5	551	36.3	486	32.0	507	33.4	266	17.5

Note: the higher grade means worse condition. 1 represent satisfy; 2 represent intermediate; 3 represent worst.

is reported ranges between the interval of 40,000RMB~70,000RMB. Most of the respondents have a high school or above educational experience.

Results

Environmental Preferences for urban river ecosystem

Local residents on average felt the river pollution has been serious (Table 2). Eighty seven percent of respondents believe that water pollutants threaten human health. About 85% of respondents consider that control of environmental pollution is important for development, indicating that environmental issues have become a popular topic in recent years. 93% of respondents were unsatisfied with the river quality, suggesting potential wide demand for better environmental services. More than three quarters of respondents were concerned about the current environmental policies. The respondents have great enthusiasm on the environmental protected activates, but they have few confidences on the governmental program from the earlier experience. Information asymmetry aggravates the discrepancies between publics and governments, which makes most ecosystem restoration projects inefficient.

Respondents' perception toward the river is terrible (Table 3). In general, only 0.5% of respondents are satisfied with the river's condition. Over 42% of respondents felt that the river problem was extremely serious. Evidences comes from five indices, including color, smell, water surface (oil and garbage), and green belt. Each index ranges from 1 to 3 and the higher score means better perception. The results show that less than 10% of scores pass the mean value. Only 2% of residents can accept the river's color and 6% of them said they were comfortable with the smell. Oil and garbage on the water surface was widely thought to be serious. A relatively better feedback was referring to the green belt, with about 20% of the public approval rate.

Respondents' concern for the river, on average, has no significant influence on their specific restoration actions. Only 20% of respondents have participated in environmental protection action although 83% of them will pass the river every day, and half have ever used the river for entertainment purposes. Usually, there are two situations: lack of specific project prevented those who have willingness to pay for the restoration; another situation is that most of the respondents may be a *free ride*. Although they cannot accept the pollution, they will refuse make a payment for the public goods.

Intended support for river restoration: Willingness to pay for ecosystem restoration

Willingness to pay for the special project on river restoration is reported pessimistically (Table 4). Only 47.8% of the respondents voted for the program to promote restoration and 46.6% voted against the program; 6.6% of respondents voted *don't Know*, and were subsequently coded as *no* votes for the econometric analysis. The mean annually individual's WTP from the statistical estimation is only 36 RMB. Respondents may believe the program will offer no improvement in river quality, or respondents might believe the project will actually improve water quality by some unknown amount. Respondents who have had an experience on environmental actions show much higher accepted ratio, 56% of acceptors against 45% rejecters. The mean annually individual's WTP is 43 RMB, which provides an evidence that the environmental activities could definitely influence the respondents' preferences.

Willingness to pay for payment in the subsamples are various (Table 5). Hangzhou obviously has higher accepted ratios and mean WTP. It might be due to the water quality is more valuable for the public in Hangzhou since the city is famous from water, such as, the West Lake and XiXi wetland. Environmental improving can significantly improve attraction to tourists, which will indirectly increase the household's benefits.

In sum, the respondents' *demand* and *supply* on environment goods are mismatch. People are always pursuing higher quality environment; however, they reject to build the ideal environments to satisfy their demand rather than waiting the actions from governments or others. Various environmental theories have assumed that individuals' preference for environment is reflective of perceptual mechanisms that allow the individual to assess whether a particular environment should be accessed or avoided (Appleton, 1975; Appleton, 1975; Ulrich, 1984; Kaplan, 1987). Following this theorizing, respondents' environmental preference is determined by environmental properties that possess a potential functional significance for the perceiver and properties that gradually formed in a long time.

The above theory can interpret why the respondents' *demand* and *supply* on environment are mismatch. For people who are feeling the environment weak or low and chasing a higher quality, they might experience the process of environmental deprivation. They have a highest demand in the environmental quality, but they deeply understand the source of pollution, even though they are also pollutants, publics unwilling to be funding providers or pay less in the restoration. Since the *demand* and *supply* cannot be coincided, most environmental programs always go to failure.

Explaining support for urban river restoration

To explain the factors impact on the public's support for the urban river ecosystem restoration, the econometric analyses are separated two stages. In the first stage, we particularly interest in how to explain the *finished* payment actions for the environmental protection. A Logit model will be employed to estimate the factors impact the *finished* payment actions. In

Table 4. The distribution of bids and respondents in pool data

Bid	Freq.	Percent (%)	Accept Freq.	Accept Ratio (%)
5	311	20.75	230	73.95
10	312	20.81	182	58.33
20	292	19.48	143	48.97
50	298	19.88	113	37.92
100	286	19.08	91	31.82
Total	1499	1	759	-
Mean WTP: 36.03				

Table 5. The distribution of bids and respondents in sub-groups

Bid	Freq.	Percent (%)	Accept Freq.	Accept Ratio (%)	Freq.	Percent (%)	Accept Freq.	Accept Ratio (%)
	Hangzhou				Nanjing			
5	164	20.02	120	73.17	147	21.62	110	74.83
10	168	20.51	115	68.45	144	21.18	67	46.53
20	159	19.41	83	52.2	133	19.56	60	45.11
50	163	19.9	60	36.81	135	19.85	53	39.26
100	165	20.15	59	35.76	121	17.79	32	26.45
Total	819	1	473	-	680	1	332	-
Mean WTP: 37.03					Mean WTP: 34.83			

Table 6. Estimation results with two stage model

Dependent variable =DONATION		*Dependent variable=WTP*		
		Model 1	Model 2	Model 3
Environmental Preferences				
KNOW	0.0851***(0.0163)	0.0590**(0.0271)	0.0649**(0.0256)	0.0604**(0.0258)
BELIEF	0.0508*(0.0282)	0.172***(0.0428)	0.106***(0.0388)	0.0949**(0.0390)
PERCEP	0.0195***(0.00741)	0.0251**(0.0104)	0.0148(0.00977)	0.0122(0.00990)
ACTION	0.0159**(0.00775)	0.0168*(0.0109)	-0.000109(0.0103)	0.00214(0.0105)
Demographic Characteristics				
HUJI	0.313**(0.136)		1.044***(0.218)	1.063***(0.220)
GENDER	0.182(0.137)		0.256(0.195)	0.257(0.197)
INCO1	-0.319*(0.193)		-0.138(0.309)	-0.0702(0.311)
INCO2	-0.291*(0.153)		-0.473*(0.249)	-0.407(0.250)
AGE1	0.303(0.387)			
AGE2	-0.0142(0.398)			
EDU			0.801***(0.207)	0.849***(0.212)
OLDMAN				0.360*(0.208)
PET				0.541* (0.277)
EMPLOY				-0.0949(0.208)
Observations	1,518	1,505	1,505	1,505

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

the second stage, the *finished* payment actions will be treated as an endogenous variable, and an interval regression models with endogenous explanatory variables will be applied to exam how the environmental preferences the *intended* supporting for urban river restoration.

Cameron (1991) introduces an internal model into the Contingent valuation estimation to correspond the referendum survey. The groups *yes* or *no* should be treated as censored over the interval $[-\infty, \tau_i]$ and $[\tau_i, -\infty]$ separately. Such treatment is a standard first-price model in the Contingent valuation estimation. Hite (et al., 2002), Cameron (1991) and Hanemann (1991) applied it in the estimation of non-market value goods. The extension of interval model to the general case of endogenous variables was considered in a non-parametric setting by (Hong &Tamer, 2003), building on the same techniques as in

(Manski & Tamer, 2003). However, these techniques seem rare in the applied literature, arguably because of their complexity. A simple two-step estimator can be defines in the same vein as the two-step estimator for interval models with endogenous explanatory variables by (Rivers & Vuong, 1988). The detail procedure will be show in the appendix.

The results from the econometric analysis are presented in Table 6. The dependent variable in the first stage is a binary variable *DONATION*, which means whether the respondent had a payment in the past two years. This variable represents if the action of payment have already be done before. Alternatively, the dependent variable in the second stage is WTP, which is the money willing to pay in the future. Since it is just a willingness rather than *true* payment, this information may be bias.

Correlations between two dependent variables and the preference variables (knowledge, belief, perception, and action) were strongest, with the expecting signs. The two variables encompassing knowledge about the environment (*KNOW*) and four variables encompassing perception for the existing pollution (*PERCEP*) best explained the public's behavior to support the restoration project, no matter what they *had already paid* or were *willing to pay*. The scale of environmental belief (*BELIEF*) and action (*ACTION*) are only strongly associated with the finished payment rather than the further payment, which implies the gap between *true* payment and willing to pay. Understanding this gap is important for the policy designs and carries out. Too high or too low payment will make the policy inefficient.

Correlations with socio-demographic characteristics were mostly weakest, but were in the direction expected for significant comparisons. The respondents with families with elders, children, or pets have positive preferences for the river program although they are not significant in statistic. This implies the heterogeneities are among the reporters. An exception is from the household register policy. The coefficient of *HUJI* and *EDU* is positively significant at 5% and 1% level in the models, implying the importance of household policy placed and education level are associated with protecting, conserving, and cleaning up the urban river environment.

Subsamples are separated into the two cities of Hangzhou and Nanjing from the pool date after the Chow test. Econometric results indicated the similar result as our expectation that the correlation between preference and behavior supported the ecosystem restoration, environmental protection, and clearing project, that is much stronger in Hangzhou (Table7).

Discussion and Conclusion

Many studies suggest that public preference significantly affects the ecosystem restoration. However, most research only employs some subjective or obscure concepts to assess residents' environmental preferences, such as some questions like: *Do you believe the polluted water may harm your health*, or *Do you think the river environment is satisfactory* (Damigos & Kaliampakos, 2003; Pruckner, 1995; Adamowicz et al., 1998; Rosenberger & Walsh, 1997).

A drawback is that it may subjectively lead to some considerable biases, since individual usually have their own criterion on environment and environment improvement. The objective perceptions (come from appearance or smell, such as sight, flair, auditory sense as well as imagination) employed in this study significantly decrease the biases in the process of preference estimation.

Table 7. Estimation results with two stage model in Hangzhou and Nanjing

	Dependent variable=WTP		*Dependent variable=WTP*
	Hangzhou		Nanjing
KNOW	0.110***(0.0343)		0.00270(0.0409)
BELIEF	0.146***(0.0567)		0.103*(0.0538)
PERCEP	-0.0208(0.0141)		0.0437***(0.0156)
ACTION	0.0382**(0.0163)		-0.0170(0.0193)
HUJI	0.805***(0.295)		1.181***(0.324)
GENDER	0.377(0.264)		0.0495(0.288)
INC1	-0.0367(0.423)		-0.278(0.449)
INC2	-0.109(0.347)		-0.915**(0.365)
EDU	0.539*(0.279)		0.986***(0.311)
Observations	825		680

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We found that past behaviors are better explanatory variables than socio-demographic characteristics for explaining peoples' support for ecosystem restoration actions, which mirrors the findings of (Smith et al., 1997). The model explaining people who had anticipated some actions for support environment might have the higher explanatory power. Understanding that past involvement may influence support for restoration activities may stimulate managers to learn more about the thoughts and past experiences of key stakeholders before developing proposals for restoration activities, or programs to evaluate such proposals.

Geographical diversity on preference for river restoration exists, but is modest. This is largely caused by different traditions and culture in geography. For example, in the study area, both GDP and income per capita in Hangzhou is much higher than those in Nanjing. Excepting habit and custom, environment endowment also influenced the public's preference. Hangzhou is famous largely due to the West Lake, which attracts many tourists as well as local residents to spend their leisure time near the lake or river. People in Hangzhou might have strong environmental preference for protection and restoration because of the importance of water and riverside recreation for the city.

In China, both central and local governments are attempting to address environmental protection and recreational resources in urban areas. Due to restricted space, it is hard to find new land for environmental improvement in cities, for example, building new parks, green belts, or man-made lakes. An efficient way is to restore or improve the status of exiting natural resources like urban rivers or streams for public use. The results indicate individuals' preference for river restoration can largely justify public action for the restoration. It provides an important reference and foundation for the program design and evaluation.

This study helped to illuminate an efficient ways to measure the respondents conceive of restoration activities focused on ecological criteria (protection, conservation) and public-use criteria (e.g., access). These results should provide some reference point for the policy makers in urban water restoration, and builds some foundation for future investigation. But we should interpret it with caution. The robustness of the result of CV studies has been criticized for a long time and still is debated not only in the survey and questionnaire design but also in the estimation choice (Stevens et al. 1991; Cicchetti and Peck 1989; Bohm 1994; Cobbing and Slee 1994). Information deviation or information asymmetry always occurs in the survey process which often leads to a biased result.

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Role of Religion as a Social Institution in Sustainable Development: View from Ukraine

Znaczenie religii i instytucji społecznych w kontekście rozwoju zrównoważonego – przykład Ukrainy

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Abstract
The paper presents preconditions of present social institutions in Ukraine in connection with the necessity to implement the idea of sustainable development. Similarity of basic religious norms with terms of sustainable development concept has been indicated. The role of religion as a social institution in spreading and implementation of the global idea of sustainable development in Ukraine has been substantiated. The necessity to introduce the religious and cultural values into systems of upbringing of people for support of the world community's sustainable development has been postulated.

Key words: sustainable development, social institution, religion, system of upbringing, religious and cultural values

Streszczenie
W artykule omówiono uwarunkowania obecnych instytucji społecznych na Ukrainie w kontekście konieczności wprowadzenia idei zrównoważonego rozwoju. Wskazano na podobieństwo podstawowych norm religijnych z wytycznymi odnoszącymi się do zrównoważonego rozwoju. Udowodniono znaczącą rolę, jaką na Ukrainie mogą odegrać instytucje religijne i społeczne. Wrócono uwagę, na konieczność uwzględniania wartości religijnych i kulturowych w procesach edukacyjnych i wychowawczych, aby lepiej wspierać zrównoważony rozwój globalnej społeczności.

Słowa kluczowe: rozwój zrównoważony, instytucje społeczne, religia, wychowanie, wartości religijne i kulturowe

Introduction

The ever-changing process of international relations is connected with the implementation of the global idea of sustainable development. Due to the continual political crisis in Ukraine, the role of social institutions have been increasing. Present social institutions are important instruments of social regulation. This institutions have significant influence on the behavior of individuals and groups of people, both in a narrow ethnic-regional sense and in a broader international relations aspect, and thus should be used for spreading and implementing the global idea of sustainable development.

Today law nihilism and distrust of public authorities are characteristic features of life in Ukraine. This leads to the impossibility of a purposeful state policy formation and to the non-acceptance of any new ideas, including the global idea of sustainable development. At the same time, the level of trust religious institutions is growing. According to the results of the sociological research conducted by the Ukrainian Centre for Economic and Political Studies named after Olexander Razumkov and Kiev International In-

stitute of Sociology in 2012, the level of trust of the Ukrainian population in the Verkhovna Rada (the Parliament of Ukraine) was 12%; the Cabinet of Ministers – 16%; the President of Ukraine – 21%. The highest level of trust (of all the institutions) belonged to the church – 61.7% (*Dovira Ukraiintsiv…*, 2012). At the beginning of 2013, the level of trust of the Ukrainian population to the Verkhovna Rada (the Parliament of Ukraine) dropped to 6.4%; the Cabinet of Ministers – 8.7%; the President of Ukraine – 15.5%. At the same time, the level of trust in the church increased up to 63.8% (*Ukraine-2013…,* 2013). Thus, today in Ukraine the social institutions being the basic instrument of support for traditional values, have the ability to form new ideas within the consciousness of the population, and provide the preconditions for both stability and development in the local community. In such conditions, religion becomes one of the most effective and influential social institutions.

The level of religiousness of the Ukrainian population is significant. According to the results of the research, conducted by the Ukrainian Centre for Economic and Political Studies named after Olexander Razumkov, more than 50% of the population considers themselves to be believers. More than 50% of believers are Christians, about 1% Islamites, and the rest belong to congregations of other churches and concessions (*Religiia i vlada…,* 2011). At present there are more than 34 thousands of religious communities in Ukraine, and their amount increases with each year. 95% of these communities belong to Christian concessions (the majority of which are Orthodox, *State Statistics…,* 2013). Consideration of religion as a social institution, able to influence the realization of the global idea of sustainable development, is related to its communicative function. As religion (as a social institution) is based on a long-time acceptance of conventional norms and their official or unofficial securing (Radugin and Radugin, 1995), where these norms regulate everyday contacts, various acts of group and intergroup behavior, define the order and the way of mutual behavior regulate methods of transfer and exchange of information etc., then religion can be considered an effective and influential instrument of social regulation, which can be used as strong support for sustainable development in Ukraine.

Of course, spreading and implementing of the global idea of sustainable development in one country is a matter of the political system. However, taking into account the low level of trust to politicians, changes in this area are not to be expected any time soon.

Therefore, taking into account the level of mistrust in political forces and the influential communicative function of religion, one can say that religion has the potential to be a strong support for sustainable development in Ukraine.

Thus, the aim of this publication is to show the similarities between basic religious norms and terms of the sustainable development concept, to substantiate the role of religion as a social institution spreading and realizing the concept of sustainable development in Ukraine. The first part of the article addresses the topical problems of sustainable development, and the second part of the article attempts to uncover the role of religion in solving these problems.

1. The Sustainable Development Context

1.1. General terms of the concept of sustainable development

The concept of sustainable development was first introduced in the Report of the World Commission on Environment and Development (WCED, 1987). This report presented the concept as a guideline for all organizations, enterprises, governments and institutions to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987). Ban Ki-moon defines sustainable development as one of the key areas, where it is necessary for the world community to make progress for the future.

The sustainable development concept assumes the existence of three components: economic, environmental and social (Mensah and Castro, 2004). As the economic component is usually taken into account while setting development strategies and plans, environmental and social components might remain behind attention. However, the interaction of humans with the environment determines the state of the area where they live and the direction of environmental and human development.

Annually, the *United Nations Development Program* (UNDP) the global network of the United Nations in the area of development, prepares a report on human development, which exposes the problems of sustainable development in humanity, such as sustainability and equity (report in 2011), real wealth of nations (report in 2010), fighting climate change (report in 2007/8), and cultural liberty (*Human Development…,* 2004).

This report coincides with the goals of sustainable development, suggested in the report for the Secretary-General of the United Nations in 2013 *An Action Agenda for Sustainable Development* (*An action Agenda…*, 2013).

Based on various research findings on human development (Alkire, 2010, Mahbub ul Haq, 1996, HDR 1994-2011) the following problems of sustainable development can be distinguished:

- Existence of limitless necessities and limitedness of resources for their satisfaction;
- High level of social injustice in population income distribution, social inequality, corruption and shadow economy;
- Provision of literacy and education;
- Existence of interethnic conflicts and conflicts of civilizations;

The aforementioned issues are looked at in greater detail in the following section.

1.2. Existence of limitless necessities and limitedness of resources for their satisfaction

The existence of limitless necessities and the limitedness of resources for their satisfaction, can be named as one of the main objective problems of sustainable development. This problem is primarily concerned with the necessity to save the resources for future generations. The necessities and demands in practical terms are limitless, which means that the necessities and demands of commodities and services are impossible to fully satisfy. Needs change as a result of the appearance of new commodities and services, or so-called new economic blessings. The ultimate goal of any economic activity consists of an aspiration to satisfy varied needs of people. However, many resources for realization of economic activity are limited (Nosov, 2008). At the same time the rate of resource consumption does not *stand still*. As a result of using marketing concepts by enterprises and organizations, the increase in consumerism by society and the impossibility of being satisfied results in the crisis of consumption society and the degradation of the national economic system (Kendyuhov). This demonstrates the necessity of rational and thrifty consumption of resources.

Ukraine can be characterized as diverse, with a high capacity of natural resources potential, which stimulated the development of the corresponding industries in Ukraine during the Soviet Union era: fuel and energy, metallurgical, chemical, construction industries, as well as agriculture. The Ukraine's supply of mineral resources is one of the highest in the world: about 20 thousand deposits and 113 types of mineral resources are found in Ukraine (among which are iron ore, coal, manganese, oil, salt, sulfur, turf, uranium etc.). Out of 97 different types of minerals, 9143 are of deposits of industrial value, related to the State balance of supplies, and about 3310 deposits are being processed by industrial enterprises in Ukraine (Kachan, 2011). The deposits of some of the resources are significant; for example, the present rate of consumption of coal will be sufficient for at least 300-400 years. However, the level of development and utilization of other resources' deposits are considerable (e.g. more than 74% for hydrocarbons and 84% for oil). Ukraine can satisfy its needs with its own extractions from oil by only 10%, and with natural gas – by 20-25% (Doroguntsov, Kotsenko, Khvesyk, 2005). The significant consumption of energy, the limited resources used to satisfy the needs in fuel resources, and the dependence on other countries led to the development of the *Energy Strategy of Ukraine for 2030 and beyond*. The Strategy promotes the use of fuel resources, like coal and uranium, as priority resources (which are enough to satisfy the internal needs of the country), the organization of construction of thermal power stations, the development of hydropower engineering, and improving the usage of atomic power. In 2012 one of the biggest solar power stations in Europe was built in Ukraine with the capacity of 100 MW (with intentions to increase the capacity to up to 300 MW, Jurliga, 2012).

1.3. High level of social injustice in population income distribution, social inequality, corruption and shadow economy

Economic inequality is the difference in economic assets distribution (wealth) and income within or between a population or individuals. M. A. Fletcher claims the result of economic inequality is an inequality of possibilities and a short life-span (Fletcher, 2013).

Statistic agencies use the decile ratio (correlation of total profits of 10% of the most provided and 10% of the least provided population) to measure economic inequality. By expert estimations, the decile ratio in Ukraine was 26:1 in 2000, and 40:1 in 2006. However, the official statistics presented absolutely normative values of this coefficient – 6.3:1 in 2008 and 5.5:1 in 2009, while in Belarus the coefficient is equal to 6:1, in Romania – 7.6:1, in Poland – 9:1, in Great Britain – 10:1, in Argentina – 31:1, in Russia – 17:1 (Moscow – 41:1), and the international norm is 6:1 – 7:1 (Ivashchenko, 2010).

There is an assumption, that 95% of Ukrainians who state that there is a significant difference in wealth think the problem of inequality consists not in the fact that *the pearls are seed* – but rather they are interested why they see the display of luxury by certain citizens with their declared *low official profits* (Ivashchenko, 2010).

The problem of income distribution is connected to corruption. According to the report by Transparency International, the corruption perception index in Ukraine was 26 in 2012, and placed the country on the 144 position (out of 176 total) in the rank of the countries' *cleanliness* and transparency (*Transparency International*, 2012). In 2011 Ukraine took the 153 position among 186 analyzed countries (*Transparency International*, 2011), and in 2010 – 134 out of 178 (*Transparency International*, 2010). According to a comparative analysis of national surveys from 2007-2009, and 2011 prepared by the European Research Association in cooperation with Kyiv International Institute of Sociology the actual corruption perception decreased between 2007 and 2011; however, the level of involvement of the population in corruption experience still remains high (*Corruption in…,* 2011).

Social diseases, which are not caused directly by wars or natural disasters, also bring a threat to the stability of society. Social diseases include criminality, alcoholism and drug addiction, moral degradation and social pessimism. And, in the conditions of

free distribution of information and people relocation, these calamities become global) (Degtyaryev, 2010).

1.4. Provision of literacy and education

The provision of primary education for the entire world's population is one of the *Millennium Development Goals,* set by the United Nations.

About 774 million adults in the world are illiterate, and the two thirds of them are women. In addition, 72.1 million school-aged children do not attend school. Literacy and access to high quality education are within human rights. Literacy plays an important role in the participation of economic, social and political life, especially in today's knowledge societies. Literacy gives people the advantage to critically think, improve their health, engage in family plannings, prevent HIV/AIDS, provides education for children, reduce poverty, activate civil position. For these reasons, UNESCO strives to form a political commitment to spread worldwide literacy.

Between 1999 and 2005 the number of children who attend primary school, for the first time increased by 4%, – from 130 million to 135 million. In Sub-Saharan Africa, the literacy rate increased by 36%, which is considered to be a great achievement after taking into account the strong demographic growth in the region. On average in the whole world education in primary school grew by 6.4% (UN, 2007).

According to UNDP, the literacy level of men and women in Ukraine is sufficiently high. In 2010 the adult literacy rate for both sexes in Ukraine was 99.7% (*International Human…,* 2011), and the expected years of schooling of children was 14.8 years. Furthermore, within the last 30 years, the number of years in school grew by 3 years (*International Human…,* 2011). According to the population census in Ukraine in 2001 more than 90% population (in the different regions of Ukraine the percentage may differ) have some form of education (higher and/or secondary, *State Statistics…,* 2010).

1.5. Existence of interethnic conflicts and conflicts of civilizations

The unsolved problems of any society can threaten its existence, even if provided sufficient reserves of natural resources. A perfect example lays in interethnic conflicts and wars, between countries or civil ones. There have always been wars in the history of the humanity, which resulted in heavy consequences, for those involved and, quite often, wiped the whole government and civilization off the map) (Degtyaryev, 2010). Today, interethnic conflicts have become a wide-spread phenomenon.

Cultural and ethnic conflicts may also arise in Ukraine because of intentional aggravation of the Russian-speaking and the Ukrainian-speaking population. Renaming the streets, changing the language of instruction at schools, attempts to unite churches, setting the *regional languages* as official in the regions, boycotting non-Ukrainian speeches in the Parliament and other events give evidence to the confrontation (*Kulturno-etnicheskiie…*, 2013).

Cultural and ethnic differences are intentionally used today for provoking conflicts between the Eastern and the Western parts of Ukraine, which makes the present situation even more tense and dangerous.

Cultural and ethnic issue is usually named as one of the reasons of the 2014 inclusion of the Crimea Peninsula by Russia. However the inclusion may cause further ethnic and cultural conflicts on the peninsula. The Crimean Tatars leaders predicted possible further armed conflicts between Russians and Tatars: *annexation of Crimea (…) could deepen ethnic and religious divisions in Crimea itself, increasing the risk of communal strife and even armed conflict*, as *opposition to Russia is most intense among the Crimean Tatars (…) and the Crimean crisis could become internationalized*
(Chazan, 2014).

More than 60% of the 2.7 million population of Crimea are Russians. More than 60% of the 2.7 million population of Crimea are Russians, the majority of which are migrants populating the territories, which were deserted and abandoned after the deportation of the native population during several post-war migrations. About one fourth of the population belongs to ethnic Ukrainians, who are predominantly Russianized. The Crimean Tatars, who returned from exile places, mainly from the republics of the Middle Asia, partly from Russia, make about 10% population. The rest are national minorities. The dynamics of such significant change in the ethnic composition of the population in the last few years is related mainly to growth of the percentage of Crimean Tatars. In spite of a relatively small percentage of the Crimean Tatars in the total population of Crimea, the Crimean-Tatar factor plays a significant role in political, economic and social life of the Crimean peninsula
social life of the Crimean peninsula (Belitser and Bodruk, 1997).

2. Role of religion in solving the problems of sustainable development

The Regional Summit on Inter-religious and Interethnic Dialogue in Tirana, Albania in 2004 made a significant contribution to the broadening of the dialogue among different peoples, cultures and civilizations. *The Tirana Summit Declaration* states that *relations among religious communities in the region have often been strained causing grievances and tensions. Religion must not be part of the problem, but part of the solution. Preserving space for diverse religious faiths is one of the preconditions for enjoying cultural diversity. The religions should be able to dialogue and contribute to societal dialogue in an effort that honors their deepest truths and holds promise for humanity. Dialogue must be at the core of*

continued interreligious cooperation and collaboration in the region. All faiths convey a message of peace, justice and human solidarity. All religious leaders, like other civil society and community leaders, have the potential to exercise a moral and positive influence on how people in society understand each other and interact. Reconciliation of religious views is an increasingly significant challenge of our age. This also entails the need to create more awareness among peoples and government authorities about the need to respect the traditions of the use of religious symbols, images and expressions (*Dialogue among…,* 2006).

This is the reason why the Heads of the States, present at the summit, long to educate *a new European generation in the spirit of inclusiveness, instilling a feeling of forgiveness instead of hatred, promoting tolerance, understanding and coexistence rather than conflict and violence, reinforcing civic education and observing human rights*.

For the discussion that follows, the list of grievances presented in the aforementioned paragraph will be addressed.

2.1. Existence of limitless necessities and limitedness of resources for their satisfaction

The analysis of United Nations' documents on human development shows the obvious inattention towards the problem of religious and ethnic regional differences in the context of sustainable development. However, sustainable development is, first of all, connected with the relevance of forming conscious *self-restriction of necessities* by the population. The best way to achieve this is by development of religious and ethnic groups. In each of group, a certain system of values develops based on relation and education.

The role of religion in solving the problem of how to preserve resources and save them for future generations is significant. The most important factor in the present use of resources is the excess of necessities, which are stimulated by producers of different industries with the help of advertising. Meanwhile, almost all the world and regional religions are oriented to self-restriction of necessities, as most religions preach the culture of moderation (frugality), and self-assertion of cultural values, which is an important factor in restraining the irrepressible consumption by society.

Often the problem of limitless necessities is bound by the population growth. For example, Albert A. Bartlett (2012), who believes that one of the conditions of sustainability is stopping population growth, mentions that a reduction in the population brings us in conflict with various religious groups that oppose any reduction of births, for these groups believe unrestricted reproduction is a basic human right. However, in case of Europe there is no problem with the growing population, but rather with rapidly shrinking population. The tendency of population decline can be observed also in Ukraine. On April 1, 2013 the population size was almost 45,513 people (*State Statistics…,* 2013), while in 2001 population census registered 48,457 people.

As a result of the research conducted by Tajik scientists, it was set that almost all world religions preach the culture of moderation (frugality), self-assertion of cultural values, which is extremely important for restraining the irrepressible consumption by society. At present such interrelation of a man and nature is examined in new philosophical subdiscipline ecological ethics which requires harmonization and reorientation from anthropocentrism to ecocentrism. Analysis of theses about self-restriction of necessities in world religions is presented in table 1.

Table 1. Analysis of theses about self-restriction of necessities in world religions. Source: *Ekologiia Moskvy,* 2008; *Tajikistan na puti…,* 2013)

Religion /People	Main thesis
Native Americans of the United States	*Whatever pitiful we may seem in your eyes, we consider ourselves much happier than you consider yourself, because we are thankful for small mercies that we have*. Chief Micmac
Buddhism	*Whomsoever in this world overcomes this base unruly craving, from him sorrows fall away, like water-drops from a lotus-leaf.* Dharmapada
Christianity	*It is easier for a camel to pass through the eye of a needle, than for a rich man to enter into the kingdom of heaven.* Matthew 19:24
Confucianism	*Excess and deficiency are equally at fault.* Confucius
Ancient Greeks	*Nothing in excess* Inscription from the temple of Apollo at Delphi
Hinduism	*The person who lives completely free from desires, without longing, devoid of the sense of 'I' and 'mine' attains peace.* Bhagavad Gita
Islam	*Poverty is my pride.* Muhammad
Daosizm	*He who knows when he has enough is wealthy.* Dao De Jing

Apart from the indicated general principles of self-restriction in world religions, the presence of fasting practically in all of religions should be noted as well. Fasting is a form of religious asceticism, an exercise of spirit on the way to salvation within the framework of religious view and is defined as a voluntarily self-restriction in food, entertainment, socializing with the world. Thus different religions are in fact oriented to the practical realization of the sustainable development concept.

2.2. High level of social injustice in population income distribution, social inequality, corruption and shadow economy

The important element of religion is putting efforts supporting and securing social justice for poor people. Religious leaders and institutes often pay significant attention to the spiritual state of people, whereas government development programs are concentrated on the financial side of the question. Lately, the general concern of global problems and difficulties to overcome poverty sidelined this division. However, there are contradictions in some questions between government development programs and religious organizations. For example, there is a high level of income distribution inequality and social inequality in Ukraine. This problem is connected foremost with the high level of corruption, and the growing power of mafias. Therefore, the country needs certain changes in the state policy, which are directed to legalize the economy. These changes should apply not only to legal documents in the area of regulation and to the creation of stimuli to legal business (laws on large fines for corruption etc.), but to the area of cultural patterns. These patterns are being realized in systems of religious upbringing, education, culture and art. And with this system a person binds his life success and accordingly his behavior and practical activity.

The traditional and widespread models of corruption prevention usually suppose the development of appropriate economic instruments (model of resources allocation taking into account corruption, corruption with a hierarchical structure, corruption restriction, exchange of popularity for a bribe, collective reputation). However, an important aspect is moving away from purely economic statements of the question of corruption and overcoming it by the instruments of state policy (high level of officials' salary, fines, punishments, anti-stimuli) to the religious, cultural and ethnic instruments of social regulation.

2.3. Provision of literacy and education

Another important issue is the insufficient attention devoted to changing the systems of upbringing in different countries in order to orientate them to sustainable human development and to motivate a conscious self-restriction of necessities. Today the complex multilevel system of religious upbringing is the main condition of forming the attitude for sustainable human development. Because there is a very high level of mistrust in public authorities, politicians, programs of political parties in Ukraine, only the system of religious upbringing can become the base for forming people's views on the system of values, which meets the concept of sustainable development.

If we look at the current situation in Ukraine, it differs only slightly from the situation in other countries. As a result of the absence of the integral system of education, oriented to motivation of conscious self-restriction of necessities, today a substitution of human values occurs in childhood. A man from a social being becomes a measureless consumer of *goods*, who maximizes their quantity and achieves his life goals in such a way. The situation in Ukraine is complicated with the absence of the Plato's *limiting measure* at the *governors*, and as a result of the significant disparity in income distribution. As a result, today in Ukraine one can clearly trace a tendency to law nihilism and non-conformism towards any government ideas, interests and concepts. Thus, the ideas of sustainable development still cannot be popularized among the population.

Understanding moral-religious upbringing is one of the most urgent and difficult tasks of state policy in the field of human development. This difficulty is explained by a whole number of reasons. The first reason is the objective difficulty of researching the history of human development and the development of human values. The second reason is that the prevailing view in societal concepts, paradigms, ideas, views and guidelines influence the study of history and usually impede the adequate understanding of the phenomena.

Religious upbringing is a set of spiritual ideas (notions), based on a faith in God (or supernatural forces), which have been inculcated in a person by his family, school, environment, and become apparent in his social life. The tasks of religious upbringing include the forming of spiritually-moral personality qualities and a society in whole. They consist in revealing to people of all ages the known circle of religious information and proper system of values, which become the basis of moral behavior during all man's life.

Therefore, the main attention today should be concentrated on creating the complex and multilevel system of religious upbringing, directed at the regional level to form the attitude of *self-restriction of necessities*.

2.4. Existence of interethnic conflicts and conflicts of civilizations

Religion as a world view, directed at the creation of the world, does not reject the use of force to oppose evil in society (Ryabykh, 2009). The conscience of a man cannot accept the system of public relations, which presents injustice, aggression, stealing, and exploitation of human passions. Human society should constantly make efforts to maintain kindness, as it is easy for evil to act, resting upon sins of a man. In conditions, where the conflicts show pronounced ethnic and religious character, the task of the religious confessions is to try to secularize the conflict; that is, to free a conflict between national communities from a religious constituent. It is especially important to do this in those regions where the tense relations between the communities exist. For example, the Russian Orthodox Church was able to secularize the conflict in such regions as Chechnya and

Nagorno-Karabakh. Such secularization gives religious organizations a chance to become peacemakers.

Conclusions

The research concerning the synthesis of a religious world outlook and sustainable development concept in separate countries and their commonwealths, considering the growing cultural similarity and continuing creation of cultural diversity of international community, is of great importance. Religion as one of the social institutions has great influence on spreading and implementing the global idea of sustainable development for the world community. Having significant influence on behavior of people and single individuals and representing sometimes the only norms recognized by people, religion as a social institution can help to overcome the problems of sustainable development of the world community, and Ukraine in particular, by introducing the religious and cultural values into systems of upbringing of the countries.

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Sisyphean Struggle or Pyrrhic Victory?

Syzyfowy trud, czy pyrrusowe zwycięstwo?

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Abstract
The first two words in the headline allude to a never-ending pursuit of something which is elusive – say *sustainability*, with this endless and dogged *keeping-on* taking the name *sustainable development*. The last two would indicate that what we are talking about could be a zero-sum game. Whether or not even a *Pyrrhic victory* would be attained when it comes to sustaining the water resources on *Terra Firma*, is difficult to say, realistically speaking. A struggle it promises to be, nevertheless… partly-Sisyphean. As the Norwegian explorer, scientist and environmentalist Thor Heyerdahl said, *Life originated in the sea. All life on land is dependent on the unique hydrological cycle which has been designed so meticulously by Nature. Mankind needs to work together with Nature, so that both are saved*.

Key words: climate change, water scarcity, clean water, water resources management, water-energy nexus

Streszczenie
Pierwsza część tytułu pracy odnosi się do trwającego nieustannie poszukiwania czegoś co jest niedookreślone – tak, jak *zrównoważoność*, która w tym procesie przyjęła nazwę *rozwoju zrównoważonego*. Druga część tytułu wskazuje na to, że nie można wykluczyć, że to gra o sumie zerowej. Trudno jednoznacznie powiedzieć, czy możliwe jest choćby pyrrusowe zwycięstwo w kontekście utrzymania zasobów wody na naszej *Terra Firma*. Zapowiada się *walka*, która jednak… przynajmniej częściowo będzie miała charakter Syzyfowego trudu. Jak powiedział zajmujący się kwestiami środowiskowymi Norweski odkrywca i naukowiec Thor Heyerdahl, *życie wywodzi się z morza. Wszystkie formy życia na lądzie są zależne od niezwykłego cyklu hydrologicznego, który został tak starannie zaprojektowany przez Naturę. Aby przetrwać, człowiek musi z Naturą współpracować.*

Słowa kluczowe: zmiany klimatyczne, niedobór wody, czysta woda, zarządzanie zasobami wodnymi, zespół wodno-energetyczny

Introduction

Challenges in the water sector are of a *wheels-within-wheels* nature. Both metaphorically and literally, this doggerel (Venkatesh, 2013) explains what we are up against:

Rob Peter to pay Paul,
Pay Peter by robbing his son.
Plug a leak at Vauxhall
End up flooding Wimbledon.

This quartet at once, puts the meanings latent in both the Greek mythology-inspired terms in the headline, in a lighter vein.

Janus-faced water

Water is peculiarly Janus-faced. It is a *sine qua non* for existence, but can also spread disease and cause large-scale destruction. Mahatma Gandhi, the Indian philosopher-freedom fighter-savant said in his book *The Bhagavad Gita* that if water can be used for a good purpose, it can also be used for an evil one (Gandhi, 1980). The 15th couplet in a compilation in the Tamil language – *Thirukkural* (Project Madurai, 2013), written centuries ago – by the Indian sage **Thiruvalluvar** goes thus, when translated – *Rain by its absence, ruins men; and by its existence, restores them to fortune.* Hark back to pre-Christian era – 400

BC, and the father of modern medicine doctors swear by before commencing their practice, Hippocrates. This is what he said about water – *Whosoever wishes to investigate medicine properly, must consider the water being used by inhabitants – for water contributes much to health.* Over 2 centuries down the line, that goes unchallenged. As gathered from the website – *www.water.org,* in the developing world, 24,000 children under the age of five die every day from preventable causes like diarrhoea contracted from unclean water. The direct and indirect costs of keeping the current deficit of safe water provision in developing countries, such as health-related costs, represent nine times the cost of providing universal coverage, according to a United Nations Development Programme report (UNDP, 2006). Provision of safe water thus, *prima facie,* seems to be a Hobson's choice – if governments are really deeply concerned about the health of their citizens. However, efforts made by entrepreneurial do-gooder technocrats have resulted in the diffusion of hope and happiness among the underprivileged.

Figure 1. 'Lifestraw' being used in Ghana. Picture courtesy: Vestergaard Frandsen, Denmark

Figure 1 depicts a product called Lifestraw and supplied by the Danish company **Vestergaard Frandsen** in the developing world to provide access to safe drinking water, being used by a girl in Ghana. This is a portable, hand-held filter, highly affordable and extremely useful, through which one could suck in raw water (which may be contaminated, at the point of entry), and be sure of ingesting purified water.

Scarcity of water is certainly a concern, but abundance is not a sufficient condition for *peace, progress and prosperity* – the three Ps, stressed on by **Dr Bharat Sharma,** Principal Water Resources Researcher at the Colombo-based International Water Management Institute's New Delhi office, in an e-mail communication[1] with the writer. The quality of the water supplied and consumed is as important as the quantities in which it is available. If scarcity of water is likely to make countries go to war with each other in this century (as stated by **Ismail Serageldin,** former World Bank Vice President for Environmental Affairs, Villiers, 1999) and lead to death and destruction, overabundance in the guise of floods and tsunamis (which are risks vulnerable countries ought to invest in planning for) also wreak havoc of untold proportions. In the former case, water (or lack of it) thwarts peace indirectly, while in the latter, it is a direct agent of ruin. If Serageldin felt that the 21st century could see countries warring over water, in year-2000, **Kofi Annan,** the former Secretary General of the United Stations, was quoted by **Peter Swanson** in his 2001-book, *Water: The Drop of Life* as saying, *As I travel around the world, people think the only place where there is potential conflict* [over] *water is the Middle East, but they are completely wrong. We have the problem all over the world*. The American writer **Mark Twain**, at his satirical best, had written, *Whiskey is for drinking, water is for fighting.* The most valuable stuff in the world, according to The Economist (May 22, 2010), is water – and even diamonds and oil are worth nothing in its absence. Yet, ironically, it is mostly unpriced or underpriced! Not always, however. In a global survey conducted by this author over the e-mail (Venkatesh, 2012a), there were some who opined that water was expensive. Interestingly there were some (from India) who never knew if they paid for the water supply and sewerage services at all!

If the Danish company referred to earlier, has been attempting to solve problems related to water quality (and thereby health) in the developing countries, a young Dutch company which goes by the name **Dutch Rainmaker BV** is promoting a technology which produces clean water from air. (Venkatesh, 2014). Using the water-energy nexus in an ingenious way (no electricity consumption at all), the contraption converts wind energy to mechanical energy using a wind turbine, and uses the same to drive a compressor in a heat pump to *squeeze* water out of air – a perfect solution for water supply in remote villages and deserts where women may need to walk for several miles daily just to fetch water. The maximum capacity of this contraption is 7500 litres of clean water per day – not much, one would say, but surely better than nothing, or for that matter, a useful reserve in cases of a rise in need. According to **Gary White**, the co-founder of *water.org*, in a single day, more than 200 million hours of women's time are spent on the most basic of human needs – collecting water for domestic use. This lost productivity, White says, is greater than the combined number of hours worked in a week by employees at Walmart, United Parcel Service, McDonald's, IBM, Target and Kroger. Put differently, about 66% of the households

[1] Bharat Sharma, Principal Water Resources Researcher, International Water Management Institute, New Delhi, India, in an e-mail interaction with the author, 24 March 2011.

worldwide spend at least two hours daily just to fetch water (Krishna, 2012). Figure 2 serves as an illustration to White's observation.

Figure 2. Two hours spent daily just to fetch water (done by the author himself)

Have more, will waste

Water has possibly been taken for granted over the years. Its value has been known only when the *well has run dry*, to quote **Michael Gorbachev.** But during the last couple of decades, the long-overdue realization of its importance has slowly dawned upon the world. It behoves one and all to seriously contemplate upon and feel grateful for every drop of water that makes our lives livable in the true sense of the term – individuals, governments and industries. Those who are blessed with abundant supplies should spare a thought for those who pine for even a few litres daily. But ought one to stop at the level of thought? And does abundance justify superfluous consumption? Some have asked me, *What do we do by consuming less or reducing leakages from pipelines, when we are not going to export any of the excess water we have for free to those poor people?* Answering this question is certainly difficult.

One flush of a toilet in the developed world, reportedly, uses as much water as the average person in the developing world allocates for an entire day's cooking, washing, cleaning, and drinking. A resident of the USA, taking a five-minute shower uses more water than a typical person in a developing country slum uses in a whole day (*Water.org,* 2011). Of course, consuming less water when you are blessed with a surfeit of this resource, seems inconsequential. However, not if one realizes what has been depicted in Figure 3 (Venkatesh, 2012b).

In year-2010 for instance, in the city of Oslo in Norway, 18.2 million cubic metres of water leaked out of the water pipelines. This volume embodied electricity equal to 6.2 GWh, chemicals (used for treatment) equal to 1.77 million kilograms and greenhouse gas emissions equal to 4 million kg-CO_2-equivalents (Venkatesh, 2012c). What leaks out is directly proportional to what is pumped out by the treatment plants and thereby directly linked to what the consumers *demand*. So, even if one may not be able to export water by saving it (to people who are impacted by its scarcity on another continent), one could contribute to reducing other global problems which are being jointly encountered by all of us – global warming and climate change for instance. Optimizing consumption will enable one to restrain the rate of enlargement of the global carbon footprint. This is one aspect of the much-bandied-about concept of the *water-energy nexus*. How does one make affluent people who may not be bothered by a rise in water tariff at all, to reduce their consumption? By appealing to the goodness which is extant in all our hearts, perhaps?

Forgetting the past

It is so very easy to forget the lessons of the past. Habits die hard, they say. Perhaps, the reference is only to *bad habits*. Lessons learnt during troubled times – more by compulsion than by choice – are forgotten as soon as the dark clouds part and reveal the clear blue sky and the bright Sun. Good habits ingrained during adversities are considered by many to be *austerities* undertaken to qualify for the renunciation of these very good habits when the adversities vanish. This also explains the economic crises which afflict nations from time to time. It is likewise with water.

That depicts very common behaviour on the part of immigrants and asylum-seekers who move from lands where there is great distress, to lands of plenty (as for instance from Somalia to Norway). But one need not relocate necessarily to exhibit it. Climate change will test people in the years to come. Where there was water aplenty and consumption habits ingrained over time, there may be tremendous scarcity (owing also to the *population bomb*, especially in the developing countries) in the not-too-distant future. The conditions may keep fluctuating in a manner which may not be easy to predict.

I chanced upon an American Indian proverb, pithy and allegorical, in *http://www.stthomas.edu/recycle/water.htm*. It was a quote from *Water Wasteland*, a book published in 1971 and written by **David Zwick** and **Marcy Benstock**. It goes thus.

The frog does not drink up
The pond in which he lives.

If an amphibian can do it, humans can certainly emulate it, if not do better. (Perhaps, being a *frog in the well* sometimes has its benefits?).

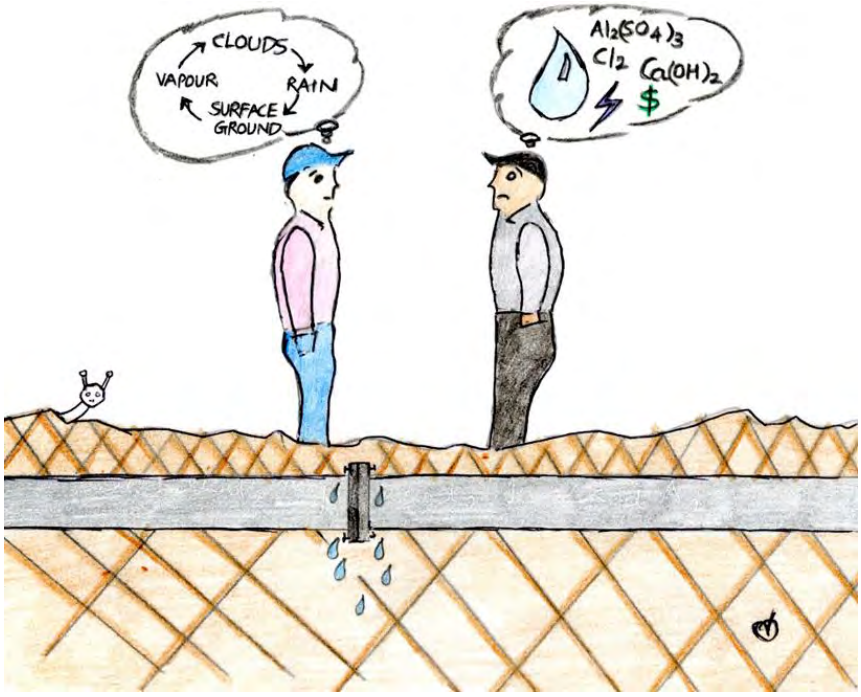

Figure 3. More than just water is lost when it leaks out of drinking water pipelines (done by the author himself)

So near but yet so far

Lateral thinking often uncovers exciting solutions to water-related problems. Success stories abound. Ideas spring up by the dozen and look great not just on paper, but also as far as technological feasibility is concerned. Yet, there often is many a slip between the cup (of clean water, shall we say?) and the lip. Take rainwater harvesting for instance. In Chennai in southern India, as at the end of year 2009, rainwater was harvested in rooftop tanks in nearly 29,000 domestic buildings and 2000 government buildings, according to Grail Research, LLC (*Grail Research…*, 2009), thanks to political will on the part of the Tamil Nadu State Government. At the time of writing, the numbers would surely have risen. According to the Bureau of Statistics, Government of Australia, in year-2007, 21% of all households in Australia reported that their dwelling had a rainwater tank (Rainwaterharvest, 2012). In this case as well, the percentage would have risen over time.

However, what seems to have happened so easily in some parts of the world, cannot be replicated in others…owing to a host of challenges. For example, it is *interesting* to note that in a survey carried out by this writer (Venkatesh, 2012a) despite the fact that the widespread motive behind installing a rainwater-harvesting tank is to combat the unreliability of rainfall, which impacts the municipal water supplies as well, some respondents pointed to this, as the reason for not installing a tank. Other *excuses* furnished were cumbersomeness of installation of tanks and associated plumbing, suspect quality of the rainwater harvested, and difficulty in obtaining permission from all the residents of high-rise buildings.

Shortcuts and conflicts

Water resources management, or for that matter sprucing up the water-wastewater infrastructure, to a politician in the developing world, is at best, a bait to lure prospective voters. Commitment lasts only as long as the attractiveness as a bait remains. There is almost always a yawning gap between regulations on paper, and strict adherence to the same. Venality or otherwise, loopholes are always uncovered.

The applications of all-encompassing water being numerous, more water for one application could mean very less or none for others. More water used upstream in the power sector (hydropower) to meet the burgeoning demand for electricity in the developing world – consumption in industries and households, could mean less available as a habitable ecosystem for fish, and thereby less moolah for fisherfolk and less fish as food on the downstream. If the *upstream* is one country and the *downstream* is a neighbouring country (or some neighbouring countries), one is entering the realm of international politics. As was reported in The Economist (2010), *Thailand, Laos, Cambodia and Vietnam complain that China neither consults nor informs them about what it is up to…distraught Thai, Laotian and Cambodian fishermen and farmers who depend a lot on the Mekong river, blame Chinese dams for killing off fish stocks, cutting irrigation and disrupting livelihoods*. How does one decide among electrification,

urbanization and industrialization in China on the one hand, and fishing and agriculture in Vietnam, Laos, Thailand and Cambodia on the other? Perhaps, a modicum of spirituality will help, in a dog-eat-dog world?

Quo vadis, wasser?

The 2003 Stockholm Water Prize Winner **Prof. Dr. Peter Wilderer,** who is the Director, Institute of Advanced Studies on Sustainability, Munich (Germany), in an e-mail interaction with this writer[2] (a foreword he wrote for an unpublished compilation of poems on water), said, *Water is more than the sum of water molecules and the aggregate of pollutants in it. Water is more than the essence of life. Above all that it carries imagination and religious beliefs. There is something mysterious about it.* The Upanishads – components of the Vedas which form the fount of the Hindus' spiritual wisdom, present water as a transcendental enigma.

Yes, needless to say, apart from the three pillars of sustainable development – the socio-cultural, econo-technological and environmental – all the disciplines of education and application in industry, society and government have an impact on the *present* and the *future* of water resources and their relation to the existence of *homo sapiens.* The natural sciences, social sciences and applied sciences apart, metaphysics and even the spiritual sciences overlap, if a true, holistic and comprehensive understanding is what one aspires for.

There was a reference to the *wheels-within-wheels* nature of sustainability at the start of this article. It would be apt to imagine the various disciplines and sub-disciplines as the spokes of the *wheels*. Just as sportsmen from various ethnic, religious and linguistic backgrounds representing a diverse country like the USA or India or the UK, orient themselves towards one common goal – to keep the flag of their country flying high – practitioners of all disciplines need to work together towards the common goal of sustainability in the water-wastewater sector.

As the Norwegian explorer, scientist and environmentalist **Thor Heyerdahl** said, *Life originated in the sea. All life on land is dependent on unique hydrological cycle which has been designed so meticulously by Nature. Mankind needs to work together with Nature, so that both are saved.* Water encompasses all. Water is involved in everything and influenced by everything[3].

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[2] Prof. Dr. Peter A. Wilderer, Director, Institute of Advanced Studies on Sustainability, Munich (Germany), personal communication with the writer in September 2011.

[3] Attributed to Prof Janos Bogardi of the Global Water Systems Project, who was quoted on Page 12 of the June 2012 issue of *Water21* magazine published by the International Water Association, UK.

PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
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Food Safety and Sustainable Development

Bezpieczeństwo żywnościowe w zrównoważonym rozwoju

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Abstract
Genetic engineering is most often (and apparently rightly) associated with modern agriculture and food production. But besides the real and potential advantages derived from manipulating genes of living organisms, related threats should also be noted. Food and food production provides the basis for the existence and functioning of our civilisation. Tools used by man to sustain his existence affect the environmental conditions which, in turn, determine the production capacities and availability of natural resource diversity. Therefore, human life depends on it. Their careful use will ensure development, while a lack of prudence or control over undertaken actions may have serious economic and ecological consequences.

Key words: food safety, sustainable development, GMO, genetically modified organisms

Streszczenie
Inżynieria genetyczna najczęściej (i chyba słusznie) jest kojarzona z nowoczesnym rolnictwem i produkcją żywności. Jednakże obok rzeczywistych i potencjalnych korzyści płynących z manipulowania genami organizmów żywych należy dostrzec niebezpieczeństwa z tym związane. Żywność i produkcja żywności jest bazą istnienia i funkcjonowania naszej cywilizacji. Od narzędzi jakich człowiek używa dla podtrzymania swojej egzystencji zależą warunki środowiska, które z kolei decydują o możliwościach produkcyjnych i dostępności różnorodności bogactw natury. Od tego zależy więc byt człowieka. Roztropne z nich korzystanie zapewni rozwój; natomiast brak przezorności i kontroli działań może skutkować poważnymi konsekwencjami gospodarczymi i ekologicznymi.

Słowa kluczowe: bezpieczeństwo żywnościowe, ekorozwój, GMO, organizmy genetycznie modyfikowane

Introduction

The achievements of modern biotechnologies based on genetic engineering are applied in multiple and varied ways. Since the very beginning, they have been playing a particular role in agriculture and food production. Generally, they consist in producing and processing products using living organisms or their parts. With this end in view, the genetic composition of organisms is altered using genetic engineering techniques. They are often colloquially referred to as transgenic organisms. This term indicates introduction into the DNA of a food product or an organism intended for consumption of a gene that originally does not make a part of the gene sequence. New information introduced in this way *forces* production and, afterwards, the expression of one or many new proteins.

The development and application of genetic engineering techniques has led to the introduction of certain traits into many species of agriculturally important plants, which is manifested, for example, in resistance to disease or changes in nutritive value. Therefore, the possibilities offered by modern biotechnology can improve the quality of human life. Those expectations provide equal justification for similar applications in medical, chemical and pharmaceutical industries. Obviously, this involves various concerns. The most important of them are connected with the application of bioengineering methods in agriculture and food production in view of the divergence of opinions concerning their possible benefits and related threats.

Arguments for creating food based on modern biotechnologies often provided by its advocates include:

- increasing the availability of food products for developing countries;
- improvement in quality, durability and nutritive values;
- lack of residues from chemical plant protection products;
- production increase, economic effectiveness and, consequently, market competitiveness;
- reduction of deforestation and erosion of agricultural areas;
- protection of biodiversity by the creation of new cultivars;
- application in land reclamation and waste utilization processes.

On the other hand, objections that are raised against them mainly concern ethical and ecological issues. Namely, it is pointed out that:

- it is unethical to expose the man and human life environment to possible risks that science is not able to predict or prevent;
- the introduction of animal genes into plant organisms (and vice versa) can be difficult to accept;
- the cause can never justify the means; in this case, the perspective of economic benefit cannot prevail over the obligation to protect the human being, care for agriculture or the resources of own territory;
- extending intellectual property rights to genetically modified organisms reduces access to the biological potential of food production for populations of the lowest economic and scientific status;
- they demonstrate new toxic and allergenic properties;
- they will cause the emergence of new viruses and antibiotic-resistant diseases;
- we are already dealing with the first cases of biopiracy towards developing states, caused by a race to patent genetic resources;
- a significant decrease in biodiversity, both agriculturally used and natural, has already been observed;
- the use of chemical plant protection products on genetically modified crops is increasing;
- the first insects and diseases resistant to pesticides have already been observed;
- genetically modified plants can turn out to be troublesome weeds, and microorganisms can be pathogenic factors;
- they can cause serious disturbances in ecosystems.

This should be also supplemented with the genetic contamination risk, involving the introduction of new microorganisms to the environment which, by moving, reproducing and adapting to altered living conditions will be able to transfer their own traits to other organisms. Of course, controlling or reversing genetic mutation processes after their introduction to the environment is not possible by any means. Moreover, the genes of bacteria, viruses or insects which determine the synthesis of proteins which originally did not make up a part of the human diet can bring about consequences related to their introduction that cannot be predicted today. Therefore, it is not possible to ensure food safety, since products may contain substances that are toxic for human health.

As can be easily noted, a discussion concerning modern biotechnology and GMO-based agriculture development leads to a polarisation of opinions which, nevertheless, does not resolve food safety issues. Consequently, all discussions that aim to provide an answer to the questions concerning transgenic food, beside developing and improving the agricultural and food industries in the context of economic ethics, should help to identify morally accepted boundaries for scientific research and the development of technology.

GMO, biotechnologies and transgenic food – advantages and threats

In the agricultural sector, the need to improve cultivars, food quality and production level are the factors with the strongest impact on the progress and development of genetic engineering methods. Therefore, research is gradually headed towards selecting specific breeds of animals, or plant cultivars in order to improve them by adding one or more supplementary features occurring in another, yet related, organism.

Today, genetic engineering already makes it possible to introduce into the DNA of an economically interesting specimen of a gene (genes) determining a new trait, which in natural conditions would never have a chance to occur in this configuration. The progress in genetic engineering is so significant that nowadays we refer to genetically modified plants as the first and the second generation. The first group includes mainly plants with those *improvements* which are meant to improve crop results, e.g. improvement of resistance to pests or tolerance of herbicides. They mainly include basic crop plants. The second generation plants, more diversified as regards the number of species and traits transferred by the exogene, are artificially improved towards organoleptic and nutritive features, and elimination of the negative impact of agriculture on the environment. Thus, plants with an increased number of vitamins, proteins and unsaturated fats have been created as well as those producing vaccines or artificial polymers that do not exist in nature. The aim of those activities is thus to create a genetically-modified organism demonstrating specific properties. This may involve, for exam-

ple, quality, productivity, resistance to pathogens or unfavourable environmental conditions, thus the features which make them particularly important for the economy. Other specific properties include lower levels of contamination with residues of chemical crop protection products in food and in the environment, or the possibility to remove genes determining the production of allergenic compounds from products intended for consumption purposes and the other way round – for example, the introduction of those that lead to the production of proteins stimulating immunological reactions.

Numerous benefits of GMO can be expected in the field of environmental protection. Those mainly include plants that do not require the application of agricultural chemicals, plantations of trees that do not produce flowers and, consequently, do not interfere with natural biodiversity, or remove elements from soil such as lead or chromium. These examples are to prove that *enriching* plants with new properties is a delicate, predictable and controllable activity.

A precautionary approach to GMO takes into account mainly the limited predictability of trait expression. The transfer of an alien gene to a sexually incompatible organism is an element of risk in itself, as there are a lot of possibilities for unexpected genetic modifications to emerge. Therefore, it is a phenomenon which would never occur under natural conditions in which male and female gametes join together. Resistance towards genetically modified organisms usually results from threats to humankind, environment or biodiversity that are related to this technology. They include, for example, the possible emergence of toxic or allergenic substances, resistance to antibiotics, transfer of traits to microorganisms and from those microorganisms to humans, reduction of natural and useful biodiversity, the spread of exogens with pollen[1] and, in the case of sudden complications – the risk of agricultural collapse. Moreover, the possibility of side-effects emerging in the long-term future that obviously cannot be specified today, cannot be omitted.

The transfer from the cultivation of genetically-modified plants to food products obtained from them is relatively simple. The possibilities offered by GM crops are, as is known, abundant: fruit that does not spoil, cereals with an increased content of iron and vitamins or beets with a high sugar content. However, a common feature of all these plants is the inclusion of foreign genes and the production of foreign proteins as a result of exceeding natural boundaries separating one species from others. In most cases, the introduced alterations mainly concern two traits, namely, resistance to increased doses of herbicides and the production of endotoxins protecting them against harmful insects. Three transgenic species are prevalent in Europe. These include: soya bean resistant to increased doses of chemical pesticides, maize which is toxic for attacking insects and insecticide-resistant rapeseed. These are also the most widely-cultivated plants in the world. Do they pose a threat to global food production?

To date, we do not have adequate knowledge to predict the risks resulting from releasing GM plants to the environment and from using transgenic food. The interactions of various types between the transgene and the DNA into which it has been inserted are unknown and they remain uncontrollable. What is equally difficult to predict is the impact of plants subject to modifications on other organisms that are economically neutral or even harmful but which coexist with humans.

Genetic engineering in agriculture is also perceived as a solution for an ecological crisis caused by the industrialisation of agricultural and food production. Those benefits are to result from the limited use of chemical crop protection products, improvement of food storage and preservation technologies and increasing yields from areas with a low soil fertility, assuming that this will not involve the occurrence of unpredictable side effects.

The scientific, political and economic debate around the GMO is particularly heated. The reason for this is also unusual, since both supporters and opponents motivate their position not only with scientific and technical arguments, but also with ethical ones. Of course, those do not go into the subject matter scope of possible medical or economic benefits of using genetically modified organisms, but they directly touch on philosophical and ethical principles, which include, for instance, the freedom of research and boundaries which it should encompass.

Therefore, it would seem that in many cases the cultivation of GM plants brings many advantages (and will bring more of them in future) and that it will make it possible to attain unusual results in pharmacology, preventive medicine and, above all, in the agri-food industry due to (apparently justified) hopes for improving the food produced. Nevertheless, the introduction of GMO products to markets has revealed a series of problems related to allergies as protective reactions of the body to unknown proteins included in consumed products or in the surrounding environment, e.g. through contact with pollen of transgenic plants. This should be also supplemented with serious doubts related to economic and social repercussions in the labour market, resulting mainly from the fact that the concentration of potential and scientific knowledge in this field still belongs only to a handful of transnational biotech corporations. No wonder that their actions – actually profit-oriented – focus on restricting the contractual freedom of other business entities and on controlling the directions of agricultural development.

[1] This concerns mainly the so-called *gene flow*, an exogen transferred to other plants together with the male gamete in the pollination process.

To take into account all observed problems concerning food production, what is needed first of all is time, which we are gradually becoming short of. How to reconcile ecological, sanitary, economic and ethical requirements and expectations in legal regulations, which are necessary to guide scientific and economic activities of the biotechnological farming and food processing industries, and in such a way so that they satisfy the basic paradigm – innovative and conscious sustainable development? The assumption is that it will avoid or minimise serious and irreversible changes to the environment, upset the delicate balance of ecosystems and threaten human, plant and animal life.

Legal regulations and principles concerning food safety

Recent years have seen a significant sensitization of European consumers, who are increasingly turning to typical products of specific quality, which may be considered as an expression of changes in food safety perception. Possibly, this is an effect of the gradually growing awareness of citizens, aroused by wide-spread knowledge and *reinforced* by cases in the media concerning threats of a sanitary-epidemiological nature[2]. Those events undoubtedly marked their impact on the agricultural and food processing sector and on changes in culinary habits. However, a greater effect on consumer attitudes oriented towards improvement of the food quality and its impact on human health should be attributed to attitudes resulting from the economic outcomes of business and social development. From this viewpoint, the exceptional role of the agri-food sector in ensuring expected requirements and improving life quality becomes obvious. It is chiefly related to food safety, commonly regarded as an absolute priority, and to protection of the natural environment combined with its reasonable or sustainable use.

At this assumption, the use of genetically-modified organisms overlaps the problems of reconciling consumer expectations with what agriculture is able to offer by allowing transgenic crops. The discrepancy of the opinions on this topic results from the variety of information and published data. Scepticism, and even resistance, towards GM products is caused by doubts as to their quality. This is the result of the lack of scientific and moral conviction of their harmlessness (or at least neutrality) for human health and for the environment. Objections are also raised regarding control systems aimed at ensuring the quality and safety of marketed products.

Therefore, the numerous concerns related to the consumer protection are understandable, as such protection must, on the one hand, take into account the requirement of safety of the transgenic product, and on the other, take into consideration all economic, ethical, social and legal aspects. Consumer protection is not limited only to removing threats of a hygienic and sanitary or epidemiological nature. Its task is also to provide cognitive instruments making it possible to undertake conscious decisions based on information obtained in this area. According to these needs, a series of food-related regulations have been created, aimed at ensuring safety and the hygienic and sanitary quality of products intended for consumption. Those guarantees are intended to cover the entire production cycle, thus creating a closed food safety system.

Generally, western countries have already introduced provisions concerning controlled use of genetically modified organisms and their introduction into the environment. They are mostly based on the precautionary principle. The legislators refer to the need to carry out a precise risk assessment before any activities in this regard are undertaken. This concerns both initiating research activity and production, and in a particular manner, marketing.

Undoubtedly, the best-developed legislation in this regard is that of the European Union, which has introduced, for instance, a unified policy for GMO and biotechnology. Regulations concerning the contained use of genetically modified microorganisms, the release of transgenic organisms to the environment or marketing of those organisms and/or products created from, production and trade of sowing material or legal protection of biotechnological inventions should be particularly emphasized at this point. The key EU regulations include Regulation No. 178/2002/EC establishing the European Food Safety Authority. This regulation also establishes procedures for ensuring safety in this field as well as risk assessment. It provides a basis for provisions aimed at the protection of human life and health by introducing a control system enabling the monitoring of food or its components over the entire process from the producer to the consumer. This regulation constitutes a very important stage in the intervention of public institutions in the development of legislation protecting citizen health and examination of properties of food products by establishing precautionary rules to be followed in the production and functioning of the food market. On the other hand, a closer explanation of the content of precautionary/prudence principle can be found in the EU *Green Paper on the General Principles of Food Law* (1997) and in judicial decisions[3].

[2] This concerns, e.g. recorded cases of bovine spongiform encephalopathy (BSE), poultry and eggs contaminated with dioxins, bird and swine flu, fodder contaminated with dioxins and aflatoxin, etc.

[3] The precautionary principle, initially referring almost exclusively to issues concerning natural environment protection was introduced into the EU legislation in Art. 174.2 TEU: *Union policy on the environment (...) shall be based on the precautionary principle and on the principles that*

A continuation and, at the same time, a subsequent stage, in the development of community food legislation was the *White Paper on Food Safety* (2000). The intent was to create a system of legal protection of consumer health throughout the entire production chain. This system was intended to function along with national and EU controlling institutions. With this aim in view the following resources were employed: the European Office for Food Safety, previous legislation (covering numerous issues of food safety *from the field to the table*), the existing national control systems, promotion of new food policy and extending cooperation with other, non-European producers.

Another important document, with a broader range than the previous ones, is the *Cartagena Protocol* (2000). Its scope – besides food problems – was extended to biological safety, international transport and trade in genetically-modified organisms. Its purpose is the protection of biodiversity, health of people and organisms, permanence of wild and economically-used ecosystems and protecting them against potential dangers related to those issues. This made it possible, for instance, to correlate those works with amended requirements concerning the labelling and marking of GMOs or GMO-derived products. Regulation 278/97/EC concerning novel foods and novel food ingredients and Regulation 1813/97/EC concerning the compulsory indication on the labelling of certain foodstuffs produced from genetically modified organisms have a particular significance in this regard. The maximum compatibility of the development of modern food production biotechnology along with the protection of public health and environmental safety in the European Union, besides the above-mentioned acts, is to be ensured, for example, by Regulation 1829/2003/EC on genetically modified food and feed, which establishes procedures for approving and supervising food and feed produced using GM products. The process also takes into account the environmental risk assessments carried out for the EFSA (European Food Safety Authority). The European Union has also introduced rules for labelling and monitoring GMO-derived food and feed. Regulation 1830/2003/WE concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms provides the consumer with information enabling conscious decision making and avoiding misleading the consumer as to the method of manufacturing or producing a given food product. Food and feed covered by this regulation must be clearly marked as genetically modified. GM products and components should therefore be properly labelled and traceable at each production and distribution stage. The objective of Regulation 65/2004/EC is to establish a system for the development and assignment of unique identifiers for genetically modified organisms. In a certain sense, this is a *legislative consequence* of Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms, Regulation 1946/2003/EC on transboundary movement of genetically modified organisms or Regulation 49/2000/EC concerning the compulsory indication on the labelling of certain foodstuffs produced from genetically modified organisms.

As results from an analysis of those acts, procedures concerning authorization for introduction into the market and consumption of transgenic products are subject to gradual transformations aiming at improvements of authorization procedures. Also, practice shows a growing number of authorizations hedged with safety and control requirements based on the possibilities to label, trace and monitor genetically modified products introduced to the market. Moreover, decisions taken by authorities, mainly in view of the so-called *novel food*, show a trend/requirement for introducing elements of an ethical or philosophical nature. Today it seems natural, although it is not always obvious and not for everybody that numerous discussions of the ethics of introducing modern technologies to food production (beside their cost-effectiveness, environmental and social impact), inevitably and always lead to questions on ethically-acceptable legal solutions – of course considering related risk. Thus, a precautionary approach to the biotechnology of food production and processing seems to be justified. Obviously, one cannot deny the rightness, and even the need to develop research from which we expect so much. Maintaining a sensitive distance towards biotechnological inventions and their application on a broad scale without previous multi-directional verification of their environmental impact, should remain, for the time being, a standard. Fortunately, human health and the condition of the natural environment still prevail over tempting institutional and economic needs and interests (at least in Europe). However, what can be clearly observed is the need to impose limitations dictated by such values as human life or the protection of diversity of living nature by excluding or at least maintaining strict control over the use of genetic diversity resources. It will definitely not be enough to temporarily impose thresholds protecting against the passive experience of results. Methods to develop internal mechanisms activating an ethics of responsibility allowing for conscious co-participation of the possible largest number of persons in the decision-making processes of managing those innovations according to principles of sustainable development of own economy based on the principles of

preventive action should be taken (...). Point 9 of Annex 1 indicates, e.g. that if it is not possible to make a full risk assessment, measures should be based on the precautionary principle, i.e. appropriate measures should be taken without having to wait until the reality and seriousness of those risks become fully apparent (cf. decision of the Tribunal of Justice of 5 May 1998 in case C-157/96, National Farmers' Union et al., Rec. p. I-2211, Point 63).

intra- and intergenerational solidarity should be sought.

Today, the fact that modern biotechnology, besides many hopes, also generates new problems, is not a new finding. These problems include, for example, the obligation to inform citizens and to take their opinion into consideration, but also multiple consumption-related formation and education tasks. This results from the ethical imperative to respect the freedom of the individual and from the collective awareness of sustainable development based on own resources, which is so much needed today.

Biodiversity and environmental impact in food production

Since the acceptance of the *Convention on Biodiversity* (1992), it has been an unquestionable fact that the genetic diversity of the living world in the international legal space should be treated as a unique resource at risk (Par. 20 of the *Preamble* to the *Convention*), for example, by the introduction of modern food production and processing technology. This risk concerns not only the undesirable effects of consuming products produced from, or containing, genetically modified organisms, but also the *ecological context* in which this food is produced. These concerns are caused by the almost total unpredictability of results of introducing genetically modified organisms to the environment. As of today, it is difficult to even talk about its positive or negative results, since new gene combinations always cause changes (not always recorded by a humans). This is an effect of the common spontaneity of reproduction processes in nature, in which the transfer of genes within the species and between unrelated specimens remains totally beyond the control of man.

Controversies around the use of genetically-modified organisms in agriculture result from concern about their harmful impact on the natural biodiversity and the balance of ecosystems. However, sustainable development is not only guided by ecological criteria and it should not entirely omit, for example, the economic impact of new food production technologies, or the advantages of a quantitative and qualitative nature. The question is whether we are able, at least approximately, to seize at least the most important nuances of this completely unprecedented ecological and economic profit-and-loss account. Of course, profits are not a problem. What should raise concern, is, first of all, the possible consequences, whose character and scope we are not able to determine. As a less revolutionary alternative (i.e. predictable and controllable), traditional methods of improving the features by crossbreeding specimens of the same, and in exceptional cases, related species are postulated. Undoubtedly, this method requires incomparably more time and is of relatively low precision. On the other hand, genetic engineering helps to significantly shorten the experimental time and easier attainment of expected results can be emphasized. But is it also true for the long-term effects of the impact of organisms obtained by this method, directly through food and indirectly through the environment, on the human being? Whether and what reactions can be expected from the ecosystems and organisms which man has so seriously changed?

Potential threats are seen in the genetic pollution of wild species, the transfer of herbicide-resistance, immunity development in pests, transgenic pollen transfer, an increase in the application of plant protection methods and a decrease of biodiversity. Significant concerns are also raised by the impossibility of the peaceful coexistence of transgenic crops with the so-called traditional and ecological crops, just for the risk of pollution, upsetting the balance and causing damage to diversity.

Of course, the argument of the probable occurrence of suggested damages cannot override the proposal of increasing food production, improving organoleptic properties and the perspective of limiting the possibility of applying farming chemistry harmful for the environment. The degree of involvement of supporters and opponents of those changes involves the world of politics, economics, science and ethics, making it impossible to reach a compromise. The concept of biodiversity is always in the centre of discussions and it should always remain and be treated as the final objective of each activity related to gene manipulation, as it is the source of uniqueness, variety and wealth of the farming sector. The process of standardization of crop species implies gradual homologation of habits and inclinations, with a simultaneous departure from the diversity of culinary and related cultural traditions. Eradicated species cannot be replaced by man in an arbitrary manner, with the omission of subtle evolutionary processes; such *modus operandi* inevitably must lead to the collapse of ecosystem efficiency and thus threatens stability and continuity of food production, considered in qualitative and quantitative terms.

To rectify the situation, it is worth starting with counteracting the genetic erosion of wild species and to maintain the maximum diversity of agricultural species. A modern economy should therefore be oriented towards sustainable use of the existing potential of plants and animals forming the basis of human existence, for instance, for the mere fact that they already are here, cost nothing and have turned out to be ecologically useful. On the other hand, the potential of genetically modified organisms should be considered in the context of their unusual possibilities, but only as *substitutes* for current food sources in case they prove inefficient and under conditions enabling full control over them (e.g. in contained systems). However, they should be comprehensively examined before that in terms of human and environmental safety.

Moreover, the precautionary principle, which in a changed reality forces a search for a new point of

balance between real and/or possible threats caused by the presence of GMO and expected benefits resulting from it, must be remodelled. It is about the real and the maximum (and not only cultural and ethnographic) use of the potential related to traditional knowledge and local natural resources in agri-technology and the culture of a given region (Krajewski, 2013).

Ethical implications of introducing novel food

The introduction of so-called *novel food* to the market is related not only to transformations in the economy and the environment, but also to serious changes in the sphere of individual and collective ethics. This clearly results from the fact that nutrition entered the legal area and the right to food became, to some extent, a fundamental law. Therefore, the entire subject matter related to production of food – particularly that produced with the use of modern biotechnological methods – besides technical, ecological and legal issues, automatically requires a deeper ethical analysis. The development of civilisation has resulted in food and nutrition not being perceived today as a usual manifestation of physiological processes. They have also changed their character, from individually-treated consumption, we have moved towards socially-managed processes of food and agricultural industry and controlling the distribution of its products. Therefore, the problem is not minor since it contains a significant load of existential and ethical dilemmas. Indeed, what is at stake here is the future of the human community and environment. The answer to the question of what to do somehow arises by itself. It seems rather simple and obvious, at least when dealing with theory and generalities. Implementation of specific solutions usually proves much more complicated and determined by scientific and economic pragmatism. This is mainly for the fact that genetically modified organisms and food produced on their basis are already a fact. Unquestionably, they will remain real. Science has chosen this path and it does not seem to be willing to resign from it (at least until it investigates gene manipulation possibilities). From science in the first place, and then from practice, we should therefore expect conscious rationalism, responsible for the risk, and scientific realism which is reasonable in its determinism.

At this point, important differences between research work and practical implementation of discoveries and inventions obtained through research should be emphasized. Learning the secrets of nature is the main task of science, provided that this is achieved with the use of acceptable methods and is oriented towards implementation of objectives aimed at constructing the integrity of man and improving the quality of human life.

Practical implementation of the results derived from cognitive activities requires subjecting them first of all to critical assessment from the perspective of philosophy, ethics, law, social sciences and distancing themselves from subjecting everything only to one criterion – profit. The welfare of the man and the human environment has to be an invariable point of reference for all actions that may change existence conditions. Therefore, everything depends on the scale and the method of applying scientific achievements, since from the ethical point of view, it is not right to depart from most promising discoveries without gaining better knowledge about them only for the probability of the risk they involve or immediately implement, without previous examination of their usefulness and developing safe principles for their correct application. The most important of them undoubtedly includes caring for the common good, while recognizing the logic of the market and interests of the group. Therefore, particular caution in activities is required and if there is a probability of a negative effect, a higher organisational precaution should be demonstrated. Due to the risk of weakening the productivity of the life-giving ecosystem, safety of produced food or feed, we are facing changes that may be impossible to reverse. Under these circumstances, it is the moral obligation of everybody to pose a question about the acceptability of subjecting humanity to such experiments. These doubts are serious, especially for the fact that biological phenomena (including genetic modification) cannot be assigned a linear character, as is the case in physics or chemistry, where a specific factor always causes a foreseen effect. The environment, as an open system, in principle, is unpredictable due to the dynamics of mutual relations between species and a multitude of variables affecting the final result. Under these circumstances, ethical assessment concerning the introduction of genetically modified organisms to food production also becomes important from the point of view of an ordinary consumer, since it involves the quality of products containing or consisting of GMO available on the market. Of course, they are expected to be healthy and of full value in nutritional terms. Thus, the consumer is not only the final, but also the most important, link in the entire production chain. The fact that a consumer has been provided with a series of rights and obligations is not accidental. The life or health of consumers may not be put at risk from superficial or unscrupulous regulations governing food production, processing or distribution. Specific regulations concerning quality control, issuing quality certificates or monitoring components and production *from the field to the table* are to serve as safeguards in this regard. Information obtained from research institutions and practitioners should be used for developing a *sense* of making the right decision in consumers, i.e. conscious autonomy and participation in decision-making processes. Therefore, one can talk about building a specific type of consumer ethics, taking into account a broad spectrum of interests:

own, group, national and ecological interests. At the same time, own and group interests cannot be treated in isolation from national and ecological interests, since they mutually supplement and overlap – they are interrelated and equally important.

Summary

The issue of protecting individual and collective interests involves the formation of a framework for institutional and formal safeguards for the conservation of natural biological diversity treated as the welfare of the entire humankind (Par. 3 of the *Preamble* and Art. 2 of the *Biodiversity Convention*), while the use of transgenic organisms (particularly in agriculture) reduces rather than protects this diversity. The creation of gene banks cannot change a lot in this matter. Thus, this is not only a problem of ecology, but also (or even primarily) an ethical problem. While examining the issue, a question arises, somehow spontaneously, whether it is morally acceptable to impoverish the diversity of living organisms and to deprive oneself or others of this abundance of features and properties that they represent. Therefore, the point at issue is the well-being of man and his living environment and, only after that, welfare understood as an economic category. Food safety should be oriented towards quality-promoting activities in agriculture and environment, since interference with nature is morally justified only when it is made with respect to the peculiarity of the features of the examined and used organisms. This eco-compatibility should be the subject of unceasing care of every consumer, since it is directly related to the quality, and therefore the safety, of his/her living environment. Technological, control or scientific information flow systems should be constructed according to the aims of civilisation, without breaching the criterion of ecologic safety. For this reason, the use of privileged economic position towards states struggling with economic problems by carrying out investments harmful for their natural and agricultural environment is ethically unacceptable. In this way, we again arrive at the social dimension of environmental ethics and food safety of modern biotechnologies and agriculture.

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Cereals – Health or Disease

Zboża – zdrowie czy choroba

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Abstract
As a result of appropriate interference in the agro-ecosystems, a man can control their productivity and increase the amount of produced biomass, which can be utilized as food for humans, feed for animals, and raw material for many industries, including fuels. Such agriculture combines the laws of nature and human activity into a single coherent system. FAO has drawn attention to the idea of *food security* for a long time, because sufficient amount of healthy food is a prerequisite for life. The issue of genetically modified cereals not only to increase the yields, but also to stimulate the consumer's appetite, is still little discussed. Pervasive promotion of cereals praised as a healthy food set the trends and fashions in diet and surrendered them the agricultural markets and production fields. Growing the alternative crops, among others the amaranth, shows agriculture as an economic activity that combines natural laws with human interference into a single coherent system operating in accordance with the principles of sustainable development. In this way, resources of arable lands are exploited in a sustainable manner. Moreover, amaranth grains due to the high nutritional value, especially in view of special characteristics of protein, fat, and starch, are becoming more and more popular among producers, consumers, and the industry. Therefore, the aim of this study was to evaluate the usefulness of the forgotten plant species – amaranth (*Amaranthus cruentus L.*) to measure the impact of its raw materials and products on human health and in the context of wheat and its processed products dominance on agricultural markets.

Key words: food security vs. health, wheat vs. health, gluten vs. health, amaranth as eco-product of a future, sustainable development and management of a field production

Streszczenie
W wyniku odpowiedniej ingerencji w agroekosystemy człowiek steruje ich produktywnością i zwiększać ilość produkowanej biomasy, która może być spożytkowana jako pokarm dla człowieka, karma dla zwierząt i surowiec dla wielu gałęzi przemysłu, z paliwowym włącznie. Takie rolnictwo łączy prawa przyrody i działalność człowieka w jeden spójny układ. FAO od dawna zwraca uwagę na ideę *bezpieczeństwa żywnościowego*, gdyż dostateczna ilość zdrowego pożywienia jest warunkiem koniecznym do życia. Jednak publicznie nie mówi się na temat zbóż zmienionych genetycznie nie tylko w celu zwiększenia plonów, ale również pobudzenia apetytu konsumenta. Wszechobecna promocja zbóż zachwalanych jako zdrowa żywność ustaliła trendy i mody w diecie oraz podporządkowała im rynki rolne i pola produkcyjne. Uprawa roślin alternatywnych, m. in. szkarłatu ukazuje rolnictwo jako działalność gospodarczą, która łączy prawa przyrody z ingerencją człowieka w jeden spójny układ działający zgodnie z zasadą ekorozwoju. W ten sposób eksploatuje się zasoby gruntów ornych w zrównoważony sposób. Ponadto nasiona roślin amarantusa (*Amaranthus cruentus L.)*, z uwagi na wysoką wartość odżywczą, a zwłaszcza z uwagi na szczególne właściwości białka, tłuszczu i skrobi, cieszą się coraz większym zainteresowaniem wśród producentów, konsumentów i przedstawicieli przemysłu. Dlatego celem niniejszej pracy była ocena przydatności zapomnianej rośliny jaką jest amarantus pod kątem wpływu surowców i produktów uzyskanych z tej rośliny na zdrowie człowieka i w kontekście dominacji pszenicy i jej przetworów na rynkach rolnych.

Słowa kluczowe: bezpieczeństwo żywności a zdrowie, pszenica a zdrowie, gluten a zdrowie, amarnatus jako ekoprodukt przyszłości, zrównoważone zarządzanie jakością pół produkcyjnych

1. Introduction

As a result of appropriate interference in the agro-ecosystems, a man can control their productivity and increase the amount of produced biomass, which can be utilized as food for humans, feed for animals, and raw material for many industries, including fuels. Such agriculture combines the laws of nature and human activity into a single coherent system. The 21st century is the century of starch and plant-origin fats, and therefore perpetually renewable raw materials. These materials provide new and hitherto little-known products, that are environment friendly, on a large scale. The proper use of the goods given to us by nature leads to the production of economically useful biomass: grain yields, animal feed, and as a consequence – the food (Bender, Gilewska, 1996; Badora, 2012). Even 2,500 years ago, Hippocrates formulated the maxim, *Let food be the medicine and medicine be the food* (Rakiel-Czarnecka, 2010). At the beginning of this millennium, we are equipped in scientific evidences of the need to respect it. Thus, the amount, quality, and proper selection of food components are critical to the physical and mental condition, and hence the length of human life.

For decades, Europe enjoyed increasing a wealth and prosperity based on the intensive use of resources. But now, it is faced with a double challenge: (i) it is necessary to stimulate the economic growth, since it is required to provide new employment and prosperity for its citizens, (ii) on the other hand, it is to make the quality of this growth leads to the achievement of sustainable future (Flis, Konaszewska, 1986; Gawęcki, Mossor-Pietraszewska, 2006; Badora, 2012). The agriculture, that efficiently consumes natural resources, can contribute to the implementation of unusual plants in the crop structure, e.g. amaranth or millet as durable food resource resources with certain biological and consumption characteristics, that are useful from the point of view of the environment potential and population health (Coultate, 2007; Obiedziński, 2009; Rakiel-Czarnecka, 2010; Manahan, 2011; Lustig, 2013).

Therefore, the aim of this study was to evaluate the usefulness of the forgotten plant species – amaranth (*Amaranthus cruentus L.*) to measure the impact of its raw materials and products on human health and in the context of wheat and its processed products dominance on agricultural markets.

2. 'Your health in your hands'

2. 1. Food and nutrition vs. health

According to the World Health Organization (WHO), health is a state of complete physical, mental, and social welfare, and not merely the absence of disease or infirmity. According to this organization, the human health is determined by three main factors: (i) a way of life – in about 50%, (ii) the environment – in about 20%, and (iii) genetic factors – in about 20%. The most important environmental factors that affect our health are: clean air and water, uncontaminated soils, and healthy food (Gawęcki, Mossor-Pietraszewska, 2006; Badora, 2012).

There is a close relationship between food, nutrition, and health. The focal position is occupied by two parameters that can be assessed and be consciously shaped: the health quality of food – including its widely understood safety, which is determined by the content of natural toxic and anti-nutritive substances and environmental pollutants, as well as nutritional value of food – informing about the content of components required for an organism, their relative proportions, and bioavailability. Both above parameters are related to one another. On the one hand, inadequate supply of nutrients increases the body's sensitivity to harmful substances and pathogens, while on the other hand, both acute and chronic poisoning make the nutrients utilization worse, which leads to malnutrition disturbances (Gawęcki, Moosor-Pietraszewska, 2006; Coultate, 2007; Manahan, 2011).

The natural environment (soil, water, air) is important both for health quality of food achieved over a given area (e.g. contamination with heavy metals, aluminum toxicity), and for its nutritional value (e.g. iodine, magnesium, and selenium contents) (Badora, 1999, 2011, 2012). Besides, the *march of chemistry* through the fields and tables is dangerous to the environment and the man himself, spreading allergies and cancer (Traczyk, 2002). Rational nutrition is therefore aimed at achieving a compromise between the comfort of a consumer and his health safety, as well as between the intensification of food production and the protection of the environment (Gawęcki, Moosor-Pietraszewska, 2006).

According to the *Gold Card of Proper Nutrition* (1998) developed by the Council for Promotion of Healthy Nutrition (in co-operation with Medical Societies, the National Institute of Cardiology, some foundations for health promotion, and in accordance with the *National Program for Cholesterol Prevention*), to be healthy, cereal products should be consumed every day in every meal. Other nutrition specialists also agree with this assumption (Rakiel-Czarnecka, 2010). Vice-President of the National Forum of Bakers and Confectioners at the Association of Food Engineers and Technicians promotes the idea that cereal products containing high levels of dietary fiber should be the basis of a daily diet. Consumption of cereal products should range from 5 to 11 servings a day, i.e. one serving of cereal prod-

ucts is equivalent to 1 slice of bread or ½ cup of cooked flakes, rice, pasta, or 30 g of *ready-to-eat* flakes.

For the first time, the public recommendations on an increased consumption of cereals were formulated in 1977 by a committee of the U.S. Senate. Following the adoption of the document *Dietary Goals for the United States* by the Senate, all government institutions, federal scientific and medical centers, as well as some universities, especially those interested in promoting *the fat and cholesterol hypothesis*, got automatically involved (Lustig, 2013). According to Davis (2013), involvement of academic centers has proved very effective, because it gave scientific and medical foundations to the political, economic, and ideological activities of the U.S. government. As a result, cereals could now be promoted under the guise of *health concerns*, namely the *war against fat and cholesterol*. In 1993, The World Bank sponsored a study on *Disease Control Priorities in Developing Countries* (Eades et al., 2002; Marcola, 2006; Berriedale-Johnson, 2012).

The effectiveness of all efforts to improve a human life is measured in arbitrary units called *Disability-Adjusted Life Years* (DALY), which take into account the age, at which health problems occur, as well as the degree of injury. With regard to health problems, rather permanent or temporary health disorder than premature death is taken into account when determining the DALY units (Musgrove, 1996; Świderski, 2003).

Food security means that it will not cause any harm to the health of the consumer, when it is prepared and/or consumed in accordance with its intended use. Safety food is such, that is not toxic and does not have infectious properties. However, food toxicity may be due to the presence of substances of different origins (Norvell et al., 2000; Borkowski et al., 2003; Babuchowski, 2005; Golia et al., 2008; Mościcki, Wójtowicz, 2009).

A definition of nutritional safety was developed during The World Food Summit in 1996; it says that: *The security of the food is referred to when all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy and active life* (George, 2011). The term *food security* has been used during official meetings and in documents. In opinion of George (2011), it does not satisfy however, the majority of progressive forces, which include the international peasant organization *Via Campesina*, operating for over 20 years and promoting rather the notion of *food sovereignty* like most people struggling with hunger. They point out that the official definition of *food security* does not include anything about where food comes from, who, by what means, in what circumstances and in what farms it has been produced. According to the abovementioned organization, this definition either does not specify where, how, and by whom the agricultural products are processed and sold, at what costs and at what price. George (2011) summarizes that when saying *food security*, it is not said anything about who exactly controls the food production chain. However, *the food sovereignty* means the independence of a given community and focuses mainly on the direct control within this one of the most important areas of human life, i.e. food, nutrition, and health.

2. 2. Food enrichment

From an economic point of view, there are no substantial differences between enrichment, supplementation, and changes in dietary habits. Supplementation carries the risk of overdosing, since it is difficult to monitor. However, in an era when farmers grow most of their own food, enrichment is the need to purchase a new product, they had not purchased earlier and therefore enrichment is another form of diet change. The problem of enrichment is often exaggerated by many nutritionists, who fear that it cannot be maintained in the case of an economic downturn. However, the same nutritionists allege that managing of their crops by farmers is a process that affects the changes in a diet and is permanent. In both cases, people's opinions and requirements have to be changed, because economic restrictions affect the price the enriched foods and crops (Musgrove, 1996; Świderski, 2003).

The primary purpose of food enrichment is to increase the consumption of a nutrient or providing a nutrition information to the consumer so that he was aware of his choice. Food enrichment applies to relatively low processed food such as sugar, salt, rice, or flour, and also in relation to the water. These products are directly consumed. Speaking of food enrichment, it should be kept in mind the relationship of element deficiencies in the food with public health concern, which justifies and even requires strong government intervention. It also implies the need to enforce the form of management in order to all supplied food was a subject to enrichment, including penalties for manufacturers who do not adhere to this. Although enrichment does not require any changes to the diet, however, this food can be perceived by the public as different (worse) than traditional foods. It is therefore necessary to appease public opinion for this kind of food (Musgrove, 1996).

According to economic criteria, enriched food is a new quality of a product, not just the original article with higher price. The advantage of food enrichment is that this method can rapidly improve the health condition of a population. It should be noted that the problem of components deficiency in the soil environment can be solved by raising the awareness of the consequences associated and due to appropriate financing measures that allow the acquisition of enriched food. Therefore, the fundamental question refers not to whether people will eat more enriched sugar, flour, etc. because it is desirable for their health, but whether they will still prefer the food not

subjected to this process (Musgrove, 1996; Świderski, 2003).

2. 3. Management of a field production and food security

The concept of culture (fertility) of a soil means such soil condition, which provides growing plants enough nutrients, water, and air, and is the resultant of many natural and soil-forming factors dependent on the climate, bedrock, and vegetation. The highest cereal yields can be usually obtained on soils found in high culture (optimum content of available forms of plant nutrients, such as Mg, K, Ca, P, N, and humus), with regulated relations between water and air and with pH value close to neutral (pH = 5.6-7.2). Weaker yielding of cereal crops on acidic and very acidic soils reflects worse overall status of these soils culture (Noworolnik, 2006).

In case of countries like Poland the soil reaction has a significant impact on agricultural production. Light soils, strongly acidic (pH 4.5) cover more than 30% of the arable lands in Poland, and altogether with acidic soils (pH 4.5-5.5), they occupy about 60% of the area. The main drawbacks of these soils are deficits of water and many nutrients, especially magnesium, calcium, phosphorus, and potassium, as well as increased toxicity and uptake of polyvalent metals such as aluminum, manganese, cadmium, and many others, that may have toxic influences (Ślusarczyk, 1991; Badora, 1992, 2002, 2011; Norvell et al., 2000; Filipek et al., 2006).

Fertilization is a factor that particularly strong affects the yield and quality of cereals. This concept means providing plants with minerals, which are their food, through the soil or due to foliar application in the form of chemicals (fertilizers) and organic agents (natural and organic fertilizers). Fertilization is intended not only to obtain optimum cereal yields, but also improving the quality characteristics of grains within a specific range (Podolska et al., 2005; Filipek et al., 2006; Dietrych-Szóstak et al., 2008).

Soil abundance in macro- and micronutrients has an impact on the quality parameters of wheat grain. Among macroelements, the most important role in this respect is played by an adequate supply of nitrogen, which affects the increase in protein and gluten contents, sedimentation rate, and rheological properties of dough. Phosphorus and potassium along with microelements (copper, manganese, zinc) contribute to obtaining the grain with positive qualitative traits. The content of microelements in soils and their availability to plants depends on many factors (Ślusarczyk, 1991; Badora, 2002, 2011). In some parts of the country, their excessive levels can be met, which adversely affects the growth and yield of plants. Excessively high copper content in wheat grain will deteriorate the baking properties of flour, while the lack of this component leads to a reduction in growth and development of the main shoot and inhibition of the generative organs development, which greatly reduces the yield. Manganese deficit impairs metabolic functions of plants and reduces the sowing value of seeds. Feeding plants of winter and spring wheat with microelements has positive effects on grain quality features such as gluten content and sedimentation rate (Sobiech et al., 2003; Przybulewska, Stolarska, 2004; Kot, Zaręba, 2005).

The primary effect of the negative impact of acidic reaction consists in adverse changes in physical, chemical, and biological properties of soils, as well as poor growth and development of plants (lower yields). Secondary effect is mobilization of aluminum and heavy metal ions in amounts as larger as the soil is more acidic. In acidic soils with pH below 4.2, aluminosilicates are decomposed, whereas concentration of Al^{3+} and Mn^{2+} ions, that occupy space of Mg^{2+} and Ca^{2+} in the sorption complex and contribute to increased leaching of alkaline cations, is increased. These changes are a major cause of poor growth and development of crops (Badora, 1999; 2011, 2012). At first, high concentration of aluminum ions has a destructive effect on the root system, which makes nutrient uptake difficult and resulting in Mg and P deficiency symptoms in plants and their poorer growth. Aluminum ions also limit the growth of shoots leading to the decay of vertices and causing necrosis of leaves. Aluminum also forms the ion ratios in cereals, including enhancement of K+(Ca+Mg) ratio and affects the higher contents of Mn and Fe in the above-ground parts of plants. Ultimately, toxic aluminum reduces the quantity and quality of cereal crops (Badora, 1992, 1999, 2011; Szatnik-Kloc, 1999; Mizerski et al., 2002).

Considering the influence of environmental conditions on the quality of wheat grain, the health aspect of raw material cannot be overlooked, especially the content of heavy metals, including cadmium, even small amounts of which are harmful to the health of humans and animals and which has very high mobility within the environment. Cereals are the main source of cadmium for humans. It is estimated that in Poland, more than 40% of cadmium absorbed by ingestion, is derived from cereal grains and processed products (Kowalik, 2001; Babuchowski, 2005). Studies carried out by Szteke and Szymczyk (2005) and Mościcki and Wójtowicz (2009) revealed that within *Triticum* there is quite great differentiation in the quantity of cadmium uptaken from the soil. More cadmium is absorbed by durum rather than common wheat kernels (Norvell et al., 2000). Diverse cadmium levels are also found in grains depending on the cultivar (Badora, 1999; Sobiech et al., 2003; Grabiński, 2005).

Presence of heavy metals, such as Pb and Cd, in the soil, significantly affects the quality of grain yield, since exceeding the permissible content of these elements in the intervening purchase of cereals (greater than 0.2 mg kg^{-1}) disqualifies the grain for further processing and consumption, which can be associated with large economic losses. It is therefore nec-

essary to monitor the heavy metals content in soils. Most of agricultural soils in Poland have natural content of heavy metals (Terelak et al., 1995). Elevated heavy metals quantities found in soils are mainly a consequence of the industry impact. Therefore, crop production should be set up away from industrial centers and highways. Cadmium and lead are not necessary for the growth and development of plants. However, some plant species, such as wheat or rye, are characterized by a large accumulation capacity of these elements, particularly cadmium, under circumstances of the soil pollution. Because cadmium and lead are toxic elements for the human organisms, their content in grains is determined by Commission Regulation (EC) No 824/2000 of 19 April 2000.

Liming reduces the toxic effects of aluminum and heavy metals on plants. It is mainly used to increase the pH in order to create optimal conditions for growth, development, and yielding of crops. However, organic and natural fertilizers have a lesser impact on the quantity and quality of cereal yields than mineral fertilizers, because grains are sown for consumption purposes in the second year after application of manure or other organic fertilizers to the production field. This ensures a good supply of nutrients and prevents from the appearance of a number of cereal diseases (Rogalski, 1997; Kalinowska-Zdun et al., 1999; Rozbicki, 2002; Tyburcy, 2005).

To obtain good quality yields, it is essential to use herbicides as part of the agricultural technology. The use of herbicides is one of many factors determining the achievement of a well-developed and uniform grain, the characteristics of which indirectly determine its suitability for milling. On the other hand, although the herbicides are important yield-forming factor, there is a risk of adverse effects on the plant. Herbicides may disturb the biochemical processes in plants leading to unfavorable processes such as changes in the morphology of a plant, reduced yield, quality deterioration (Klimont, Osińska, 2004).

The presence of undesirable substances in plant material bears a risk to a consumer's health. Security of a crop production is therefore closely associated with the status of the natural environment. Some substances used a dozen or a few decades ago, have interacted with the environment and the trophic chain until now, being underwent to its continuous bioaccumulation. Enthusiastic use of DDT in the 40's of the 20th century revealed its insidious effect 20 years later. Birds became extinct, which found its reflection in the publication by Rachel Carson *Silent Spring* from 1962. It is an example of CTBs (Chemical Time Bombs), i.e. chain of events leading to a delayed and sudden negative effect within the environment (Stigliani and Anderborg, 1993). Remains of DDT and its conversion products (PCBs, aldrin, and deldrin) can be found even today in milk from lactating mothers.

The production fields in countries like Poland are characterized by the lack of so-called *elements of life* (Mg, Se). Deficiencies of magnesium and selenium in agricultural production area result in deficiencies of these elements in plant material. People need 200-375 mg of magnesium daily. Deficiencies of this element in a diet lead to the occurrence of restlessness, nervousness, drowsiness, sensitivity to stress, atherosclerosis, and cancer. Selenium is an element that is partially necessary for animal organisms, as well as man. A deficiency of selenium can lead to serious civilizational diseases. The presence of selenium in the human diet is essential, not only because its action to free radicals, but also due to the formation of simple and complex bindings with heavy metals occurring in the environment, in food, or living organism. In this way, metals are excluded from biochemical processes. Safe and sufficient selenium dose for adults is set up at the level of 50-200 micrograms per day (equivalent of a single brazil nut, Wąsowicz, Zachara, 1987; Badora, 2000; Wierzbicka et al., 2007). Selenium doses at the level of 1-5 mg kg^{-1} DM are toxic to humans and animals. Selenium deficiency can therefore not be so easily eliminated due to supplementation as it happens in the case of magnesium. Plants rich in selenium are: rapeseed, garlic, onion, mustard, peas, beans, and some cereals.

3. 'The catcher in cereals'

3. 1. Wheat vs. health

Due to the rapid expansion of agriculture, the modern world, in addition to corn and rice, *is governed by wheat* today. Wheat cultivations are donated by large financial sums, and wheat manufacturers are one of the most influential producer lobbies affecting the world of politics, economy, and science. In total, 2180-2200 million tons of cereals are harvested worldwide, of which about 650 million tons of wheat grains, giving it third place after rice and maize. In the structure of world's crops, wheat takes the first place with the surface of 220 million hectares. Cereals have become the fundamental diet of people and animals in the world, providing the organism 2/3 of the required protein amount. The share of global grain products consumption is 47%, including products of animal origin about 32% (Marcola, 2006; Davis, 2013).

Area under cereals in Poland is also large and currently amounts to 8.4 million hectares, while the harvest fluctuates around 26-27 million tons (Rozbicki, 2002; Szozda, 2009). During the past 2 decades, the area under cereal crops has increased even more, including wheat, triticale, and maize for grain, while area under rye, barley, oats, buckwheat and millet, as well as the area under legumes for grain, potatoes, industrial crops, fodder and vegetables significantly decreased (Hryncewicz, 1992; Stanko, 2005). In Poland, some positive changes in the consumption of basic foods can be observed, but consumption of cereal products remains at one of the highest levels in

Europe, especially in comparison with other European Union countries (Tyburcy, 2006).

According to Davis (2013), to make the production and distribution profitable, a demand is needed. According to this author, the real reasons, why the *whole grain cereals* were popularized by state-medical apparatus throughout the world as *healthy food* and became the basis of the food pyramid developed by the U.S. Department of Agriculture (USDA) in the early 80's, should be seen in this need. It must be remembered that the role of the USDA, like any other ministry of agriculture in the world, is primarily a promotion of local agriculture, of which cereals are the dominant part, therefore *healthy eating pyramid* is based mainly on cereal products. The result is the placement of the global wheat consumption at about 70 kg per person annually nowadays. Eades (et al., 2002) cites data by which the average American now eats about 360 loaves of wheat bread per year. Shop shelves are full of various products containing wheat. And it's not just a meal, flour, and its baked goods (bread, rolls, baguettes, etc.), a variety of pastries, cakes and cookies, but also a spectrum of cereal flakes. Today, wheat is used in many kinds of processed food, even sauces for meats. If we add the beer, it turns out that only a fraction of the space in grocery stores is occupied by grain-free foods. By doing shopping at a local store, or visiting a favorite restaurant – we are willy-nilly the catchers in cereals, often without even knowing it.

Nevertheless, it is estimated that the average person living in Poland eats even less than 150 grams of bread and about 40 grams of other cereal products a day, and if the consumption of bread and other cereal products will not increase, a growth in incidence of serious civilization diseases: obesity, cardiovascular disease, some cancers, and diabetes will be recorded in Poland (Rakiel-Czarnecka, 2010). According to the consumer's research conducted by the Institute of Fermentation and Microbiology, Faculty of Biotechnology and Food Sciences, Technical University of Lodz, factor influencing the eating habits of Poles is not the concern about health, but fashion and taste. Therefore, as a consequence, the consumption of many valuable products, including cereal ones, decreases even below the recommended minimum. The consumption structure is also unfavorable – people tend towards more processed foods. Eating different snacks and fast-foods *out on the town* becomes a fashion and lifestyle.

According to many researchers (Rozbicki, 2002; Borkowski et al., 2003; Świderski, 2003; Babuchowski, 2005; Świetlikowska eds., 2006; Tyburcy, 2006; Rakiel-Czarnecka, 2010; Badora eds., 2012) , cereal grains are *the sparks of life* important to human health and fertility. Cereal products, especially whole grain ones, are a good source of fiber and vitamins, particularly from the group B and a number of minerals, and first of all, they provide complex carbohydrates (starch). The plant-origin products also contain proteins, but with less balanced amino acid composition, and are a natural source of unsaturated fatty acids and lecithin. Index Nutritional Quality (INQ), taking into account the content of different nutrients and energy in a product, as compared to the human needs for a given nutrient and energy, is used to assess the suitability of the product for consumption. It indicates that cereals and their products are fairly well balanced, but it should be noted that the one-sided diet may provide some components in a deficient amounts, while other ones in some excess (Rakiel-Czarnecka, 2010).

Davis (2013) refutes myth promoted by the official dieticians that whole grain foods are healthy and should be the basis of an everyday diet. According to Davis (2013) and also to Marcola (2006), both medical practice as well as current scientific knowledge provides conclusive evidence that cereals, especially wheat, can be the source of many *incurable* chronic diseases for many people (e.g. hypertension, diabetes, heart disease, headache, joint pain, arthritis, allergies, etc.), for which *pharmaceutical* medicine is helpless. Davis (2013) and also Lustig (2013) show that a low-fat diet based on cereals driving people into the disease, and patients cannot be cured, instead it only increases their dependence on drugs. The author gathered knowledge about this subject not only from medical literature, but he also reached to agricultural genetics, that in the past 50 years turned traditional wheat into a hybrid product – profitable, robust, and efficient, but virtually with no relation to the original. Noble intentions were behind the biological and genetic modification of wheat, as fear of overpopulation and hunger in the world prevailed in the Western countries in the 60's. Therefore, the increased cultivation of cereals began to be presented as the only salvation for mankind, contrasting it to the *malicious* cattle husbandry and meat production. In an atmosphere of such hysteria, the U.S. government and other highly developed countries have begun to invest huge amounts in research aimed at improving crops and increase yields. And it worked – for example, the average yield per hectare is ten times higher today than it was 100 years ago. However, due to genetics and biotechnology, wheat has been modified to such extent that the new plant is still called *wheat* only for smoke screen.

According to studies performed by Marcola (2006) and by Davis (2013), foods made of wheat raise blood sugar more than any other food, including white sugar. Therefore, to stop eating wheat lowers blood sugar and reduces obesity, as well as joint pain, arthritis, chronic rashes disappear, and asthma receded enough that some patients of Davis (2013) could set aside their inhalers; chronic infections paranasal sinuses, leg swelling, migraines and headaches also disappeared; symptoms of gastroesophageal reflux disease and irritable bowel syndrome went down to relieve as well.

According to Davis (2013), we are faced to a long and difficult battle, which will take place in the so-called *public sphere*. Today, wheat meets about 20% of all calories consumed by people. Its cultivation, collection, fertilization, protection, processing, and distribution requires extensive infrastructure. For this reason, presenting wheat as a cause of civilization diseases is a potential threat to the professional situation of hundreds of thousands, even millions of people, who are part of the infrastructure. There is no doubt that the dogma that *fats are unhealthy, while cereals are healthy* will be held for a long time among doctors. It should be noted, however, that so-called *wheat* is no longer a wheat, but completely changed product of genetic research. Having such knowledge, it is understood that many common diseases can be explained by the consumption of that modern *wheat* and its impact on the human body. According to Marcola (2006) and Davis (2013), two slices of whole-grain wheat bread increase the blood sugar concentration more than white sugar, more than many chocolate bars, and even though nutritionists still recommend increased consumption of whole-grain breads. The more wheat you eat, the higher and more frequent increases of blood sugar levels. This leads to larger and more frequent secretions of insulin into the blood, which in time causes insulin resistance. And this state leads directly to diabetes.

Thus, increased consumption of wheat, that is recommended, is not a good response to the epidemic of diabetes, which, according to Marcola (2006) and Davis (2013), will soon affect half of Americans, and 346 million people worldwide. There is no doubt that wheat in the early stages of agriculture, was used in order to survive periods when hunted or gathered food lacked. As noted by Lustig (2013), wheat as a caloric filler that allows for surviving without hunting, is convenient food. However, from the very beginning its consumption has had negative health effects. Even early cultivars such as einkorn wheat and emmer wheat were not healthy for humans. There are reports from year 100 on the prevalence of celiac disease. However, just genetic changes made in the last 40-50 years, coupled with the global consumption recommendations of increasing amounts of wheat, has led to today's tragic situations. These circumstances have changed wheat – in opinion of Davis (2013) and Lustig (2013) – from unhealthy ingredient of our diet into a dietary scourge of a mankind.

3. 2. Gluten vs. health

There is one component of wheat, which is responsible for all negative health effects associated with the consumption of this cereal. Gliadin directly induces inflammation, but also stimulates the appetite. Gluten is responsible for the occurrence of inflammation in the intestines and central nervous system. Lectins make the intestines become more permeable to foreign proteins that cause diseases associated with inflammation or an autoimmune reaction (e.g., rheumatoid arthritis and systemic lupus erythematosus). Amylopectin A is responsible for the formation of abdominal obesity, i.e. *wheat belly*, which is a cause of inflammation, insulin resistance, diabetes, arthritis, and heart disease (Berriedale-Johnson, 2012; Davis, 2013). Considering gluten, the structure of the amino acids may be different, but all the variants have the same characteristics desired by bakers and consumers – the viscoelasticity. This trait makes possible to mold the dough by tossing into the air, to mold pieces of pizza, to give the dough any shape – from pita to ciabatta. New cultivars being a result of genetics work are the worst and most harmful type of gluten. Changes made to the set of genes *D* (*genome*), that are characteristic for today's semi-dwarf wheat, most likely led to a fourfold increase in the incidence of celiac disease. Only in the last 20 years, the incidence of this disease has doubled. Less harmful gluten was present in old wheat cultivars such as einkorn and emmer wheat – less harmful, but not harmless (Marcola, 2006; Berriedale-Johnson, 2012; Davis, 2013).

According to Davis (2013), gluten is harmful to humans in any form, so it should be completely eliminated from a diet. Geneticists are nowadays working on modifying the wheat in such a way to be less harmful (Marciniak-Łukasiak, Skrzypacz, 2008). One area of the research concerns the attempts to remove all the harmful sequences of gluten. Thus, regardless of what bakers or geneticists do to change wheat, it remains substantially the same food with all unfavorable properties: stimulates appetite, negatively affects the brain functioning, triggers inflammation, initiates autoimmune processes, and causes obesity (Marcola, 2006; Darewicz, Dziuba, 2007; Davis, 2013). It should be noted that amaranth or buckwheat grains are essentially pure carbohydrates and unlike wheat, they do not invoke any immunological and neurological effects, nor stimulate the appetite. However, like oat, they raise the blood sugar levels and produce all the effects associated (increased insulin resistance and glycation in the eye, cartilage, arteries, and LDL glycation). For this reason, Davis (2013) recommends that these grains are consumed in small amounts, i.e. less than half cup after cooking, and only as a part of a low-carbohydrate diet (e.g. an average of 40-50 grams daily).

3. 3. Amaranth (Amaranthus cruentus L.) – eco-product of a future

Due to the Polish climate, major cereals in the country are: rye, wheat, oats, and barley, less popular – buckwheat, and almost forgotten and cultivated by amateurs – millet. The result of narrowing the crop species consists, among others, in depletion of food in terms of the number of plant-origin product lines as well as the size and share in an everyday diet, and thus promoting the development of various diseases due to faulty nutrition. Therefore, long ago forgotten

crops or such, that have not been used for nutritional purposes in our civilization, attracted more interests in the last few years. These plants provide opportunities for new choice during the food production, that is why they are called alternative crops (Gajewska, et al., 2002; Piecyk et al., 2009; Dudziak et al., 2010; Czaplicki et al., 2011; Dudziak et al., 2010).

Amaranth is a plant that can be counted among alternative, somewhat forgotten crops. It has relatively low soil and climatic requirements. It is resistant to cold weather and frosts, although it grows best in warm and dry climates (Niekrasz, 2011; Radziewicz, 2011; Piesiewicz, 2012). Amaranth is a good forecrop on all crops, because it leaves de-weeded position with large amounts of post-harvest residues. Now, cultivations of selected in Poland *Rawa* cultivar are spread, which is characterized by yellow or magenta inflorescences. Amaranth does not require sophisticated soil types, it is drought resistant, and does not require high doses of fertilizers or pesticides (Prokopowicz, 2001; Rywotycki, 2005; Januszewska-Jóźwiak, 2009). Amaranth plants are best suited for light to medium soils with stable pH, but also grow well on slightly acidic soils. The plant is a C_4 cycle (like millet, maize and sorghum) (Świetlikowska, 2006). This type plants produce higher yields than type C_3 plants, like four basic cereals. Moreover, the extraordinary property of amaranth consists in that it binds atmospheric CO_2 with quite great intensity, thus alleviating the effects of global warming (Januszewska-Jóźwiak, 2009; Piesiewicz, 2012).

Polish amaranth plantations appeared early in Lublin region; achieved crop yield reaches 3-3.5 t/ha and green mass yield reaches up to 100 t/ha (Świetlikowska, 2006; Piesiewicz, 2012). The interests in the cultivation of this plant are due to the fact that the seeds of amaranth possess valuable properties: high content of protein abundant in lysine and sulfur amino acids, lack of gluten, presence of tocotrienols, which have assigned the role of cholesterol synthesis inhibitors, especially related to LDL (low density lipoproteins, popularly known as the *bad* cholesterol), high fat content relative to other traditional cereals abundant in essential fatty acids are essential fatty acids (from 65 to 76%), presence of valuable oil component called squalene (5-8% of oil) used in the cosmetics and electronic industry, extremely small size of starch granules (1-3 microns in diameter) present in an amounts from 48 to 60%, which may be used as a carrier in the food, pharmaceutical, and cosmetic industries. An additional advantage of all possible amaranth forms can be the possibility to use the green mass of plants as feed for animals. The leafy type of amaranth can also be used as a vegetable to all sorts of salads (Kłoczko, 2008; Dudziak et al., 2010; Borowy, Kubiak, 2012).

Amaranth contains about 2.5 times more protein than rice, about 40% more than barley, wheat and corn, and about 25% more than rye and oats, and biological value of amaranth protein is high, because there are present exogenous essential amino acids that are not synthesized by human organism. The content of lysine, which is a limiting amino acid (the smallest amount in relation to the egg protein) in cereal crops is twice as high as in wheat and three times higher than in rice and sorghum ranging from 0.701 to 0.908 g/100 g grain. The crop also contains high levels of sulfur amino acids: methionine, cystine and cysteine: 0.591-0.752 g/100g of seeds. Compared to other cereals, amaranth contains twice more sulfur amino acids than maize and rice and about 1.5 times more than wheat. Amaranth protein biological value with respect to the FAO standard for chicken proteins within 100-point scale is at a level of 75-80, whereas for other plants, the value is lower: 44 for maize, 60 for wheat, 64 for soybean (Darewicz, Dziuba, 2007; Marciniak-Łukasiak, Skrzypacz, 2008; Januszewska-Jóźwiak, 2009).

A combination of amaranth with traditional cereal flour can play an important role in human nutrition. The addition of amaranth flour into other cereals improves the quality of the mixture. Available data indicate an increase in protein quality by 62% for wheat flour, by 40% for corn flour, and by 25% for rice at the proportion of amaranth to other cereal flour of 30:70. The amaranth flour can be a natural bread improver. Even small addition not only improves the nutritional value of bread, but also successfully replaces synthetic improvers. This flour improves the rheological properties of dough, making them more flexible and plump, increases the bread volume, and shortens fermentation time (Borowy, Kubiak, 2012). Amaranth is also a valuable component of special bakery products intended, among others, for vegetarians, allergies, celiac disease or atherosclerotic disorders suffering patients, convalescents, and athletes.

The fat content in amaranth grain ranges from 4.8 to 8.1% depending on the species (Darewicz, Dziuba, 2007; Marciniak-Łukasiak, Skrzypacz, 2008; Czaplicki et al., 2011), which is the highest content in the cereal group. The main components of amaranth fat are essential fatty acids, among which linoleic acid (62%), linolenic acid (1.1%), and arachidonic acid (0.7%) make up the highest proportions, as well as monounsaturated oleic acid (20.4%). These acids are very important from nutritional and health points of view. A major advantage of the lipid fraction of amaranth is a high content of valuable squalene (over 6%). Squalene is a regulator of cholesterol synthesis and enhances the immune system through a beneficial effect on the lymph nodes, adrenal glands, and bone marrow. This triterpenic hydrocarbon ($C_{30}H_{50}$) has up to 6 double bonds, due to which it exhibits excellent antioxidant properties (Kłoczko, 2008). Squalene is a natural component of lipids protecting against harmful UV rays and other

aggressive external factors, as well as it helps to remove any kind of non-polar xenobiotics (substances harmful to human health and introduced into the environment and into the organism as a result of industrial activity) from the organism. Xenobiotics are readily dissolved in non-polar squalene and are eliminated from the organism altogether (Kłoczko, 2008; Piesiewicz, 2012).

Although amaranth, like other cereals, is a crop with high carbohydrate content (60% DM), it also has a low content of mono and disaccharides (2-3%). The rest is made up by pentosans (3-4%) and starch (55-65%), which is 2-5 times more readily digested and absorbed than the same complex carbohydrate contained in millet (Januszewska-Jóźwiak, 2009). Fact that amaranth contains more calcium and iron than conventional corn is worth mentioning. Grains of this plant contain extremely much calcium: 217-303 mg/kg. However, the level of vitamins in this alternative crop is similar as in conventional cereals.

The anti-nutritional compounds contained in grains and roots of amaranth include: oxalates, phytates, phenolic compounds, saponins, alkaloids, tannins, and hemagglutinins. In particular, it is important to get rid of the saponins from raw amaranth, since these compounds are harmful to human health (causing damage to red blood cells – i.e. hemolysis). It turns out that technological processes and cooking eliminate almost completely the content of these adverse substances (Januszewska-Jóźwiak, 2009; Piecyk et al., 2009). It should be noted that amaranth grains contain less antinutrients than soybean and rye (Borowy, Kubiak, 2012).

Due to its chemical composition and the pro-health impact, processed products made from amaranth apply to preventive diets reducing the risk of atherosclerosis and heart disease, anti-aging diets, because squalene delays the organism's aging processes, gluten-free diets, the high protein diets (e.g. for pregnant women), diets for persons with skeletal system disorders, because amaranth contains a lot of calcium and tocotrienols (antiinflammatory agent), vegetarian diets, as it contains high concentration of lysine, as well as iron, calcium, and vitamins, including A, E, C, for which 90% of the requirement is covered by about 100 g of amaranth grains (Niekrasz, 2011; Piesiewicz, 2012). Amaranth and its products therefore, meet all the criteria of a healthy and functional food.

4. Summary

FAO has drawn attention to the idea of *food security* for a long time, because sufficient amount of healthy food is a prerequisite for life. The longer the chain of access to some vital ingredients, the more likely that one of its elements will be the weakest link. Nutrition is an extremely important issue that raises a lot of emotions. Nutritionists and other *experts* on nutrition have been heavily indoctrinated by a positive influence of *healthy whole-grain food* on human. The issue of genetically modified cereals not only to increase the yields, but also to stimulate the consumer's appetite, is still little discussed. At the same time, the anti-fat phobia, that has prevailed for over 40 years, discourages to consume foods such as eggs, beef, and pork, because of saturated fats contained. However, saturated fat was never a problem. The carbohydrates in combination with saturated fats cause a sharp increase in blood LDL (bad cholesterol). Carbohydrates rather than saturated fats has always been larger problem.

Pervasive promotion of cereals praised as a healthy food set the trends and fashions in diet and surrendered them the agricultural markets and production fields. Sometimes it seems that we will extinct as a species without a few slices of bread a day, with no cereals and without oatmeal. The truth is that while the development of agriculture and the cultivation of cereals have enabled a rapid population growth and the formation of modern societies based on specialization and division of labor, in terms of health it proved to be a disaster for us, related to the one-sidedness and genetic hybridization of crops aimed at providing food quality and safety. In addition, high consumption of cereal products amounting to about 120 kg/person annually is the cause of their deficit, which leads to the need of its supplementing through imports. The import can be reduced by means of spreading the amaranth cultivation. This crop can be grown on soils not suitable for other cereals. Moreover, amaranth grains due to the high nutritional value, especially in view of special characteristics of protein, fat, and starch, are becoming more and more popular among producers, consumers, and the industry.

As a consequence of deliberate intervention in agroecosystems, a man can control their productivity and increase the amount of produced biomass, which can be utilized as food for humans, feed for animals, and raw material for many industry branches. Growing the alternative crops, among others the amaranth, shows agriculture as an economic activity that combines natural laws with human interference into a single coherent system operating in accordance with the principle of sustainable development. In this way, resources of arable lands are exploited in a sustainable manner, because the soil is a non-renewable treasure of the nations and the most precious resource. Renaissance of the agriculture and sustainable development between countries should therefore be based on a gradual introduction of a variety of plants species, competing with imperialism of herbaceous and cereal crops not only in Poland, but also in other countries. From alternative plants new, healthier. and less processed goods are made. Such approach to the agricultural future promotes not only the safety, but also the nutritional sovereignty of so-

cieties. Beside it is necessary to stimulate the economic growth, since it is required to provide new employment and prosperity for its citizens and to make the quality of this growth, which leads to the achievement of sustainable future agriculture.

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Eco-energy Anthropopressure in the Agricultural Landscape

Antropopresja eko-energetyczna w krajobrazie rolniczym

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Abstract

Eco-energy anthropopressure specifically affects the agricultural landscape, but is essential for society to survive and grow. While developing new dependencies and demonstrating large transgressions against the present state, eco-energy investments affect redefinition of the identity of place, society and landscape. This paper discusses management of eco-energy anthropopressure with regard to the sustainable development of society and the economy. Projects of infrastructure modernisation related to construction of renewable energy sources should consider an assessment of anthropopressure trends, which facilitate definition of priorities in measures exemplified by subsequent investments, considering their economic, environmental and social aspects. The criteria of eco-energy anthropopressure constitute the bases of analyses and guidelines when planning new undertakings. The positive trend of anthropopressure is a condition verifying the correctness of eco-energy engineering development. Application of enzymatic indicators enabling quantification of anthropogenic transformations, along with the ecological results of protective measures related to the generation of renewable energy allow for the long-term monitoring and identification of trends.

Key words: anthropopressure, eco-energy, agricultural landscape, sustainable development, ecological ethics

Streszczenie

Antropopresja ekoenergetyczna, aczkolwiek wywołująca określony wpływ na krajobraz rolniczy, jest niezbędna do przetrwania i rozwoju społeczeństwa. Inwestycje ekoenergetyczne budując nowe zależności i wykazując dużą transgresję w stosunku do stanu obecnego, wpływają na redefinicję tożsamości miejsca, społeczeństwa i krajobrazu. W artykule omówiono zarządzanie antropopresją ekoenergetyczną w kierunku zrównoważonego rozwoju społeczeństwa i gospodarki. Projekty modernizacji infrastruktury związane z budową źródeł energii odnawialnej powinny uwzględniać ocenę trendu antropopresji, co ułatwi określenie priorytetyzacji w działanich egzemplifikujacych się kolejnymi realizacjami inwestycji, uwzględniającymi aspekty ekonomiczne, środowiskowe i społeczne. Kryteria antropopresji ekoenergetycznej stanowią podstawę przy przygotowaniu analiz i wytycznych do planowania nowych przedsięwzięć. Warunkiem sprawdzającym poprawność rozwoju ekoenergetyki jest pozytywny trend antropopresji. Zastosowanie wskaźników enzymatycznych umożliwiających kwantyfikację przemian antropogenicznych oraz ekologicznych efektów realizacji zabiegów ochronnych związanych z wytwarzania energii odnawialnej pozwala na monitoring długookresowy oraz identyfikację trendów.

Słowa kluczowe: antropopresja, ekoenergia, krajobraz rolniczy, zrównoważony rozwój, etyka ekologiczna

Introduction

The idea of sustainable development refers to the balance among three co-existing subjects: the environment, society and the economy (Pawłowski, 2008). Convergence of the goals of these elements is obvious, but in practice they are difficult to bring together and may entail multiple conflicts: spatial (e.g. in a reflexive relationship: environmental protection – anthropopressure), social, and in implementation (Baranowski, 2000; Przewoźniak, 2005; Malczyk, 2012). Maintaining a balance requires praxeological and often dialectical development, necessary to maintain the initial assumptions brought by the definition of sustainable development (Pawłowski, 2011; Malczyk, 2012). The example here may be eco-energy anthropopressure, which causes ambivalent feelings because it opposes two important values: environmental protection and the pressure to implement this protection. Sustainable development strategy includes beliefs referring to the quality of life on the level provided by the current state of civilisation and development. However, with the reservation that it concerns development by which the reasonable needs of the current generation may be implemented without reducing the chances of future generations' needs (Papuziński, 2013). This special care results from increasingly intensive pressure on the environment, which is a consequence of searching for new ways of satisfying emerging needs related to civilisation and development (Pawłowski, 2011). Detailed intervals of this process often result in high costs incurred by following generations in subsequent stages of development (Malczyk, 2012). The rapidly rising prices of conventional energy carriers and the forecasted limitations of their extraction have increased interest in renewable energy sources (Fig. 1).

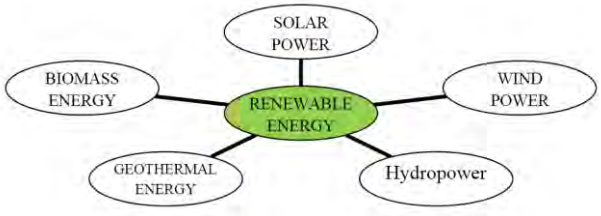

Figure 1. Renewable energy sources

Generation of renewable energy allows for reduction of greenhouse gas emission, increased energy security and stronger agricultural production (Małecki, Gajewski, 2006; Duer, Christensen, 2010). However, it also requires a series of investments, which (besides obvious benefits) measurably affect increased environmental pressure (Malczyk, 2012; Pawłowski, 2011). Eco-energy anthropopressure constitutes a relatively new challenge for the environment. This is related to the series of measures following the manufacturing process of renewable energy extraction devices and their installation on site, the transformation of terrain altitude, the construction of relevant infrastructure for communication and transmission of energy, procedures related to the establishment of energy crop plantations and their maintenance, changes in landscape structure, and nuisances such as noise, vibration and electromagnetic fields.

The European Energy Policy (EEP) adopted by the European Commission on 10 January 2007 constitutes the framework for the development of a common energy market, within which energy production is separated from its distribution. Energy supply security (through diversification of sources and supply routes) and environmental protection are particularly important priorities. The main goals of the European Union in the energy sector until 2020 include:

- increased efficiency of energy consumption by 20%;
- share of renewable energy sources in the energy balance: 20%;
- CO_2 emission reduction by 20%;
- share of biofuels in general fuel consumption in the transport sector: 10%;
- reduction of energy consumption by 13%.

Strategic forecasting of energy economy development at national level in the European Union member states should be coherent with the priorities and directions of measures defined in the European Energy Policy (Jabłoński, 2009).

The draft *Poland's Energy Policy till 2030* (PEP), currently presented by the Polish Ministry of Economy, refers to goals determined by the Union in the EEP. However, the draft Policy considers Polish specificity, characterised mainly by the structure of primary fuel consumption (the dominant position of carbon), which is unusual compared to the European Union. This draft assumes that Poland's energy security will be based mainly on its own resources, especially coal and lignite. However, energy policy related to carbon emission reduction constitutes limitation for coal. Hence the draft particularly emphasises development of clean coal technologies (i.e. highly efficient cogeneration). Due to the derogation of auctioning concerning rights to carbon emission (necessity of purchase of 100% rights on auctions has been postponed until 2020), Poland earned more time for the transfer to low carbon power. In turn, within the scope of imported energy resources, the draft assumes diversification, understood also as the differentiation of manufacturing technologies (e.g. generation of liquid and gas fuels from coal), instead simply of supply directions (as had been the case until recently) (Jabłoński, 2009). The introduction of nuclear power in Poland will also provide a new direction of measures. In this case, the following advantages are mentioned: lack of carbon emission, and the possibility of becoming independent from typical directions of energy resource supplies, which in turn improves the level of the country's energy security.

According to inventory data of the European Commission (*Communication from the European Commission*, Brussels, 27 November 2007), greenhouse gas (GHG) emissions in the Community are dominated by the two largest subjects – Germany and the United Kingdom – who are responsible for one-third of entire GHG emission in the EU. Nevertheless, these countries have managed to reduce their GHG emissions by 340 million tons of carbon dioxide equivalent, as compared with the level from the base year. 1990 is the base year for so-called *old member states,* i.e. EU-15, in reference to GHG (*Communication…,* 2007). The basic reasons behind such positive tendencies in Germany include increased efficiency of power stations and heating plants, as well as economic restructuring of five new districts following the 1989 reunion. GHG emission reduction in the United Kingdom primarily occurred because of liberalisation of the energy markets, the transition from petroleum and coal to gas, and by means reducing nitrous oxide emission in the production of adipic acid (Zaleska-Bartosz, 2008). Italy and France occupy the third and fourth positions on the list of the largest emitting entities – their share in emission amounts to 11%. Since 1990, GHG emissions in Italy have increased (by approx. 12%), mainly because of intensified emissions in road transport, electric and thermal power generation, and oil refineries. Emissions in France were lower by 2% than in 1990. In France, significant reduction of nitrous oxide emission was obtained in adipic acid production, but carbon emission from road transport increased significantly (*Communication…,* 2007). Spain and Poland occupy the fifth and sixth positions among the largest emitting entities in the EU – their share in total GHG emission comes to 9% and 8% respectively. Inventory data of the European Commission (*Communication…,* 2007) shows that Spain increased emissions by 53%, while Poland reduced them by 18%. The decline of energy-intensive heavy industry and restructuring of the whole economy at the end of 1980s and beginning of 1990s constituted the most important reasons for reduced emissions in Poland and in other new member states. Transport, especially road transport, was an exception, as emissions from this area increased (Zaleska-Bartosz, 2008). According to the inventory data of 2005 (*Communication…,* 2007), Germany, Finland, the Netherlands and Romania contributed the most to GHG emission reduction in absolute values. Emission reduction was also claimed by Belgium, Czech Republic, Denmark, Estonia, France, Luxembourg, Slovakia, Sweden and Great Britain. The highest increase in emission among EU-15 member states in 2005 concerned Spain – by 15.4 million tons of carbon dioxide equivalent. This mainly resulted from a 17% increase in electric power generation from fossil fuels by power stations, as well as from reduced electric power generation by hydroelectric power stations caused by a decline in the level of the river water table (Zaleska-Bartosz, 2008). Among *new* member states (EU-12), Poland was the country with the highest increase of emission in absolute values. This amounted to 2.3 million tons of carbon dioxide equivalent. Such a situation mainly resulted from the increase in methane and nitrous oxide emissions by 1% from the agricultural sector, standing at 5% and 4.5% respectively. Increased emission in 2005 was also claimed by Austria, Bulgaria, Greece, Hungary, Ireland, Latvia, Lithuania, Malta, Portugal and Slovenia (*Communication…,* 2007).

The Polish draft EP until 2030 assumes that the share of renewable energy sources in total energy consumption in Poland is to increase to 15% by 2020 and to 20% by 2030. In addition, a 10% share of biofuels in the transport fuel market is planned to be achieved by 2020. The *Renewable Energy Development Strategy* (adopted by the Polish Parliament on 23 August 2001) mentions an increase of the renewable energy share in the Polish fuel-energy balance to 7.5% by 2010 and to 14% by 2020 in the structure of primary carriers' consumption. The goal established in the Strategy until 2010 is nearly half as high as the task imposed by the European Union for themselves.

The Strategy claims that adoption of the level established by the EU for 2010 was impossible, based on information concerning the technical potential of renewable energy sources and on the forecasted capacity of their use.

The Energy Law introduced in 1997, with further amendments and regulations, determines the legal grounds of functioning of the energy market in Poland and the development of renewable energy. The Act defines the principles of forming the state's energy policy, the conditions of supplying and using fuels and energy (including heat), and of energy enterprises' operations. In addition, it determines competent authorities in matters of fuel and energy economy. It aims at developing conditions to provide the state's energy security, the economical and reasonable use of fuels, the development of competition, counteracting the negative results of monopolies, and consideration of environmental protection requirements, as well as protecting the interests of receivers and cost minimisation (Jabłoński, 2009). Continuous amendments are being introduced to the Energy Law to implement national EU recommendations. In the last draft of amendments, the provision concerning energy planning was introduced. It strictly defines a time framework for the preparation of draft assumptions of commune energy media supply plans by voivodes and mayors (draft assumptions are to be prepared for 15 years and updated every three years). According to certain authors (Małecki, Gajewski, 2006), the generation of energy resources and energy will be the main stimulator of agricultural development and transformations in Polish villages, while agriculture's function as a source of energy re-

sources and energy will be as important as its nutritional function.

The term *agricultural landscape* includes an area or fragment of the Earth's surface whose main function is constituted by agriculture (Cymerman et al., 1992). The quality of agricultural landscapes, determined by common influence of many environmental, social, economic and technical factors, has a prevalent significance on the formation of a healthy environment for human life, maintenance of environmental values and ecological balance, as well as in protection of landscape visual values (Fischer, Magomedow, 2004; Bielińska et al., 2008). The concept of landscape as a system of mutual interactions of natural and socio-economic processes defining its structure is an important component of the sustainable development doctrine (Żarska, 2005). Agricultural landscape is a multi-dimensional and multi-faceted system; therefore it changes in time and space. These changes are usually comprehensive, but they occur most frequently through changes in the structural elements (Ryszkowski, 2004; Pływaczyk, Kowalczyk, 2007). Agricultural exploitation disturbs the natural circulation of biogenic components and generates soil contamination related to agrotechnical procedures. In addition, it maintains improper land use structure, technical infrastructure, mechanical transformations of land relief, and intensified soil erosion processes. Therefore, it negatively affects the functioning of landscape systems (Cymerman et al., 1992; Ryszkowski, 2004).

The decline in biotic diversity is one of the most important problems in the modern world. Intensive agricultural activity causes biological impoverishment and weakens the stability of ecotopes. *Resolutions of the Paris Convention* (2002) *on Protection and Permanent Use of Biological and Landscape Diversity in Reference to Agricultural Policies and Practices* (Ryszkowski, 2004) emphasise the significant role of landscape in the maintenance of biotic diversity. The document assumes that:

- agricultural landscape occupying the largest area of Europe is very significant for the protection of biotic diversity;
- operations aimed at permanent and sustainable use of biotic diversity resources on rural areas should be undertaken;
- EU agricultural-environmental programmes should be applied to protect the biotic and landscape diversity of land beyond the areas of territorial protection;
- countries joining the European Union should protect landscapes and biotic diversity by applying EU legal and financial instruments;
- agricultural lands where habitat formation ensures significant increase of biotic diversity should be recognised.

Agriculture as food and energy producer versus sustainable development

Rural areas are one of the most important elements of spatial structure in Poland and the European Union – they constitute 90% of its territory (*CSO,* 2012; *Report…,* 2008). Despite tendencies to concentrate business activity in urban areas, rural areas generate 42% gross positive value in the EU and provide 53% employment, while in most EU-12 member states – more than 73% (*Report…,* 2008). The average size of farm is largest in the EU-15 states (excepting Greece, Italy and Portugal), while the smallest is in the EU-12 member states (excepting Czech Republic, Estonia and Slovakia). Differences in farm structure among regions of the same member state are usually much smaller in *new* states (except Czech Republic and Hungary) than in *old* ones. The largest differences occur in Germany: from 13 ha in Hamburg to 263 ha in Mecklenburg-Vorpommern; however, the differences are even greater if the measuring unit is the average economic size of a farm. In the EU-12 states, the European Size Unit is 10x lower than in the EU-15 states. Czech Republic is the exception, as average farm profitability amounts to a 10.5 European Size Unit (Dudzińska, 2012). In Poland, average farm size is 7.5 ha, while regional differentiation is significant – from one hectare to several thousand hectares (Ministry of Agriculture, 2005). Measures to support the sustainable development of rural areas in *new* member states (EU-12) have been introduced to reduce differences among EU countries.

In Poland, rural areas are included in development strategies represented by sectoral programmes *(Sectoral Operational Programme,* 2010; *Rural Areas Development Programme,* 2012) co-financed by the EU. In the 1990s, the multifunctional development paradigm for rural areas was adopted in Poland. Its implementation consisted in so-called *diversification*, i.e. increase of the spectrum of business activity, which effectively supported the practice of treating the village only as a manufacturing zone (Wilczyński, 2012). No coherent concept of rural area development was established, but that issue was subordinated to the implementation of the *Common Agricultural Policy of the European Union*. Operational Programmes became the source of obtaining funds for particular investments; facilities that were needed but not embedded in the broader developmental context. This was demonstrated in implementation of a series of undertakings, mainly infrastructural (e.g. local roads, *Orlik* sports fields, sewage and waterworks infrastructure, tourist trails), which constituted timely interventions instead of a way to make developmental processes more dynamic (Wilczyński, 2012). The national arrangement – Rural Area Activation Forum – has the possibility of

supporting the environmental protection process in rural areas (Niedźwiecka-Filipiak, 2009). Established in 1984, the European Council for the Village and Small Town ECOVAST has been operating actively for the benefit of development and protection of rural areas (Dziekońska, 1999). In 1994, experts from this association developed a *Strategy for Rural Europe* – an abstract including, among others, indication of principles that should be observed to achieve the character of rural development that takes into account sustainable development rules (Niedźwiecka-Filipiak, 2009). Environmental protection and development in rural areas includes (Ryszkowski, 2004):

- limitation of contamination of ground- and surface water;
- provision of the continuity of natural processes, including biotic and abiotic components;
- comprehensive solutions of village development problems, with particular consideration to water economy, sewage treatment, transport systems and public transport;
- provision of landscape protection against contamination, with regard to conducting agricultural business and waste disposal;
- modifications to basin water balance (change in intensity of evapotranspiration, limitation in runoff);
- reduced intensity of water and wind erosion;
- modification of results caused by the greenhouse effect;
- avoidance of fragmentation of natural landscape structures;
- preservation of spatial and temporal landscape continuity;
- use of renewable energy sources;
- reduction of waste production;
- provision of recreational and tourist values, as well as the climatic conditions of a given area;
- assessment of threats and design of their removal.

The agricultural landscape is not only a very dynamic entity, but also a holistic one, which means that mutual interdependence of elements occurs at different interactional levels. The agricultural system consists of natural resources including elements such as soil, crops, livestock and interactions of inflows and outflows of substances, energy and information (Fig. 2). A change in one element of the holistic system may cause a change in the whole, (*The flutter of a butterfly's wings over the Tiber River may cause a storm in Anatolia*). The comprehensiveness of the agricultural landscape translates into the complexity of the process of its formation. Therefore, the holistic concept of space should be the basis of any new methodology of forming agricultural landscapes with sustainable development conditions.

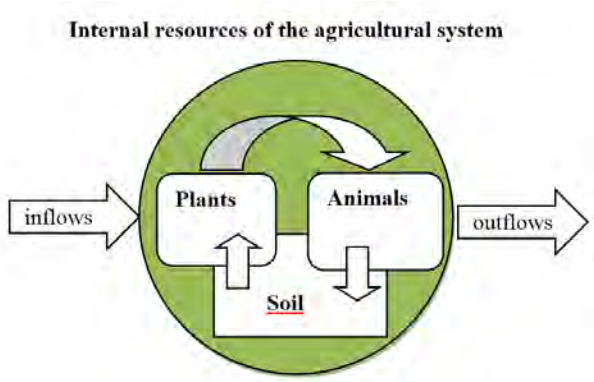

Figure 2. Main elements of the agricultural ecosystem (according to: Piekut, Pawluśkiewicz, 2005)

Organisation of agricultural production and management of agricultural systems able to obtain quantitatively and qualitatively appropriate agricultural production without negative environmental impact (Piekut, Pawluśkiewicz, 2005) constitute the condition of implementing the sustainable development strategy in agriculture. Sustainable management in agriculture considers protection of the commonly understood rural environment, including such natural resources as soil, water and air, biodiversity, ecological relations, and the social and cultural environment (Piekut, Pawluśkiewicz, 2005). Agriculture should be environmentally-friendly, accepted by society and economically vital, which is strongly emphasised by the new legal regulations of the *Common Agricultural Policy* (*Council Regulation No 1782/2003; Commission Regulation No 795/2004; Commission Regulation No 796/2004*).

Agriculture does not generate energy – biomass conversion is necessary as the main energy behind agricultural production. Energy use in agricultural manufacturing space is the reason for the risk of disruptions in the food market, which are indicated by, for example, an observed rise in food prices (Roszkowski, 2008). Agricultural production for energy purposes should be optimised with regard to the maximisation of energy efficiency, instead of qualitative features prevalent in the conventional production of food and fodder. Energy markets are beginning to *manage* agricultural markets due to current economic and legislative considerations. Such tendencies constitute a potential threat for protein-energy relations in plant products. Decisions on energy crop production are made with the use of results of incomplete energy and ecological analyses, often under the influence of changeable economic regulations (subsidy systems). Forecasts for 2015-2020 regard the rise in food prices by 20-50% as fully justified (Roszkowski, 2008).

The main advantages of energy generated in agricultural production include diversification of supply sources and GHG emission reduction, as well as the potential capacity of technological and technical progress. However, it should be emphasised that striving for cheap resources and products (vegetable oils,

wood, bioethanol) causes tendencies of a return to industrial agriculture. These have a negative impact on biological diversity, while in some cases they may increase the GHG emission level in the atmosphere (e.g. palm oil). Simulations conducted by the EU assumed obtaining 25% of transport fuels from biomass, and indicated simultaneous increase of fertilizer use by 40% (Report, 2008). Moreover, neither energy crops nor biomass combustion are neutral with regard to carbon emission. A certain amount of fuel is consumed in energy crop cultivation, and specific energy expenditure for manufacturing fertilizers and plant protection products is necessary. Finally, a certain amount of nitrous oxide is emitted from applied nitrogenous fertilizers (Faber et al., 2008). Therefore, production of biomass for energy purposes is connected with greenhouse gas emission (Tab. 1).

Table 1. Energy consumption and greenhouse gas emission generated in the production of biofuels (Royal Commission on Environmental Pollution)

Fuel type	Energy consumption	Emission (CO_2 equivalent)
	MJ·t-1 *DM*	kg·t-1 *DM*
Wood waste (wood chips)	572	33
Willow (wood chips)	756	35
Miscanthus (bales)	338	40

Another factor intensifying the anthropopressure connected with broader substitution of fossil fuels by biofuels is water content in agricultural biomass. It significantly decreases the amount of usable energy generated (regardless of the manner of its conversion into thermal energy), and increases nitrogen oxide emission (Roszkowski, 2008). Low efficiency of biomass energy utilisation is also related to the necessity of incurring expenditure for transport and preparation of biomass for combustion, as well as financial costs of additional operations increasing energy concentration in a mass unit (pelleting, briquetting, chipping and drying) (Roszkowski, 2008).

The main factors limiting the production of energy biomass in EU countries include the availability of arable land (only 7-8 EU states, including Poland, have at their disposal *energy free* production surfaces, providing the prices on the global crop market are taken into account) and obtained efficiencies (Faber et al., 2008; Kuś et al., 2008; Roszkowski, 2008). The production of biomass for energy purposes should constitute extension of current sustainable agricultural technologies. One's own resources of good/very good soils, dedicated to the production of food and fodder, should not be decreased by commercialisation of biomass production. Selection and technologies of energy crop production should consider the specificity, limitations and environmental considerations of a specific country and region. Soil inventory conducted by the Institute of Soil Science and Plant Cultivation in Puławy (Jadczyszyn et al., 2008) demonstrate that the area of soils most appropriate for energy crops amounts to 569 thousand hectares in Poland. These are soils from 5, 8, 9 and 3z soil complexes located beyond protected areas, in which the groundwater table occurs above 200 cm. They are situated in regions of annual precipitation exceeding 550 mm. The potential total surface for energy crops does not exceed one million hectares, even if plantations are additionally located on soil complex 6, less useful for energy crops. In addition, use of land that is currently set aside in order to establish energy crop plantations is significantly limited. In Poland, large fallow areas on better soils are located in areas with fragmented agrarian structure (the Mazowieckie, Podkarpackie, Śląskie and Lubelskie voivodeships) or near big cities. Larger complexes of set-aside land occur on the weakest soils, where this field of production is unprofitable (Kuś et al., 2008). Good and very good soils, constituting approx. 50% of arable land in Poland, should not be dedicated to permanent energy plantation, due to the necessity of providing the state's food security. Based on the CAPSIM model, the European Commission (Communication from the European Commission, 2007) estimates that Poland may dedicate approx. 4.5 million hectares to energy crops by 2030. Detailed analyses conducted by Polish experts, among others Faber (et al., 2008) and Kuś (et al., 2008), indicate that in the coming years, a maximum 1.5 million ha of land can be dedicated to energy crops in Poland (including 0.4 million ha for production of rape for biodiesel, 0.5 million ha of arable land for agricultural products for ethanol production, and 0.6 million ha for permanent energy crop plantations by 2015). Reaching a renewable energy share of 20% in the general use of primary energy in Poland by 2020 is regarded as impossible (Jadczyszyn et al., 2008; Kuś et al., 2008). Roszkowski (2008) emphasises that the country's capacity should be regarded as a relevant criterion, instead of reference to GDP, as is currently assumed by the EU authorities. In practical terms, selection of species of cultivated energy crops must depend on the adopted method of biomass management (combustion, co-combustion, biogas production, etc.) and the total strategy of its use. Under Polish conditions, it is necessary to create some spatial order in agricultural management of production space (Kuś et al., 2008).

Both Polish and global agriculture are subject to continuous social and economic transformations, which direct their actions to commercial activity oriented towards profit generation.

Anthropopressure in the process of sustainable formation of the environment

Anthropopressure constitutes every form of human activity causing specific environmental impact. It is

necessary for the survival and growth of society. Despite the obvious contradiction in the system of human needs – environmental needs, there is some limit of balance between poles of this system, depending on the type, intensity and scope of anthropopressure (Janikowski, 1999; Bielińska et al., 2008; Malczyk, 2012). While broadly discussing anthropopressure management in the direction of the sustainable development of society and the economy, Janikowski (2004) determines a holon of pressure, which has materialised structures implementing processes related to the collection and removal of matter and energy, as well as passive existence (as such) in the environment. Holons create holarchies, which are a hierarchy of holons (Janikowski, 2004). Immanently, a holon (holarchy) exerts pressure on the environment, while its scope and size depend on all actions directed at satisfying human needs (Fig. 3).

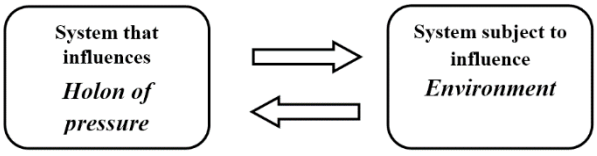

Fig. 3. Basic model of anthropopressure (according to: Janikowski, 2004)

Holons exert pressure on the environment; chemical, biological, physical, and structural-spatial (e.g. anthropogenic barriers in space, land levelling, roads, monocultures). Janikowski (2004) also classifies anthropopressure in its temporal features as temporary, constant and periodical, as well as in the aspect of dynamics: increasing, decreasing, permanent and oscillating. At the level of spatial influence, the author distinguishes punctual, surface, linear, concentrated and dispersed anthropopressure. Due to the number of interacting holons, he distinguishes individual and mass anthropopressure.

Anthropopressure constitutes a derivative of measures forming the environment, which include among others: environmental protection, sustainable landscape management, protection of biological diversity, and environmental engineering – considering other problematic areas, including construction, agriculture, waste management and energy. Anthropopressure is defined by cause and effect, including elementary stages that occur consecutively (Fig. 4). Understanding of the causative sequence of anthropopressure constitutes the basis for paradigm creation, which results in the optimal choice of implementation instruments for subsequent operations, enabling reduction of environmental pressure (Janikowski, 1999).

Assessment of the degree of anthropopressure requires definition of consistent stages, which include (Janikowski, 2004; Malczyk, 2012):

- interdisciplinarity of the environmental formation process with regard to implementing the sustainable development strategy;
- determination of the criteria of anthropopressure affecting formation of the environment;
- definition of the method modelling the consistent process of formation of the environment in a selected area (e.g. agriculture, waste management, environmental engineering, renewable energy);
- in the context of sustainable development, determination of the network of relations among objects affecting formation of the environment, with particular consideration to the legal aspects, science, education, the economy, the labour market, and globalisation (Fig. 5).

Anthropopressure takes the form of an axiological system aiming to define the typification and hierarchisation of actions that are adopted and regarded as important in the implementation of sustainable development. At the same time, it constitutes the reference point for the assessment of a pressure trend, which facilitates diagnosis of the environmental condition, including the assessment of environmental resistance to anthropopressure and the forecast of the effects of changes in the environment which are to occur under the influence of present use and development, as well as the possible intensity of environmental transformations (Majer, 2007; Malczyk, 2012). Anthropopressure criteria constitute the initial point for preparation of analyses, case studies and guidelines for planning new undertakings (Malczyk, 2012).

Eco-energy anthropopressure

Formation of rural landscape constitutes a deliberate human activity aimed at bringing the environment to a condition in which functions performed by rural areas consider the principle of sustainable development (Cymerman, Nowak-Rząsa, 2001). Sustainable formation of agricultural landscape structure will allow for the optimisation of economic and protective measures (Ryszkowski, 2004).

Under this priority, projects concerning modernisation of infrastructure are implemented, mostly related to reasonable energy use and development of renewable energy sources (Biliński, 2006). Completion of these projects results in, among others, reduced emission of SO_2, NO_x, CO_2 and dust, reduced use of energy resources and energy, and improved landscape quality; however, investments in areas where energy is generated from renewable sources are related to the series of hardware and agricultural works putting diverse pressure on particular landscape elements (Tab. 2). At the same time, eco-energy anthropopressure changes the visual quality of a landscape, and grants new spatial (viewing and cultural) dimensions to these areas (Malczyk, 2012).

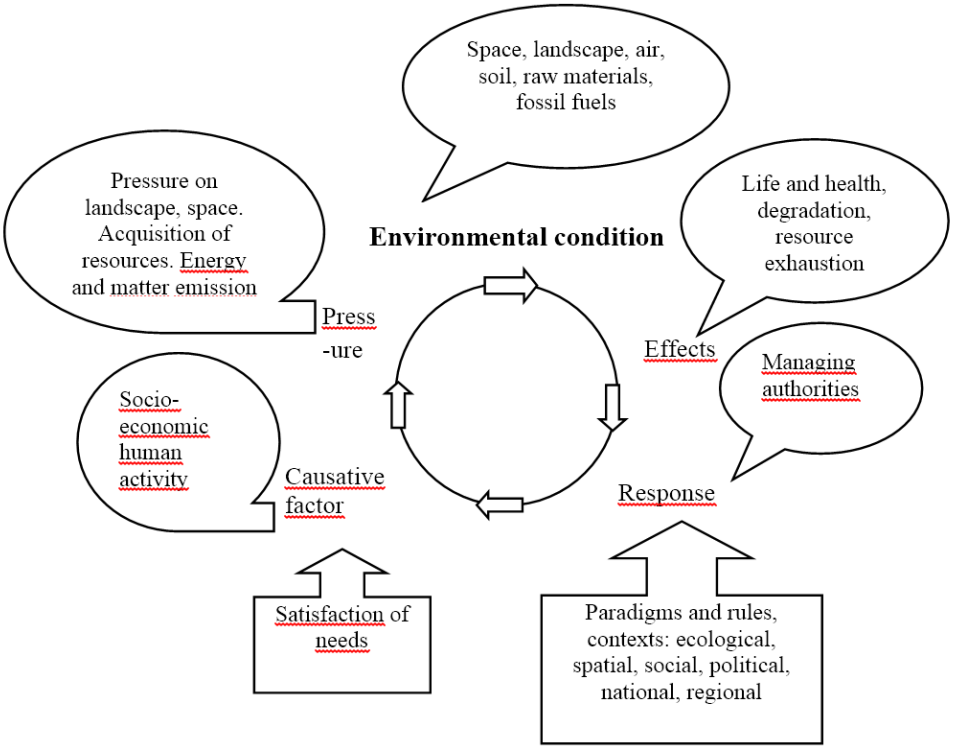

Figure 4. Causative sequence of anthropopressure (according to: Janikowski, 1999)

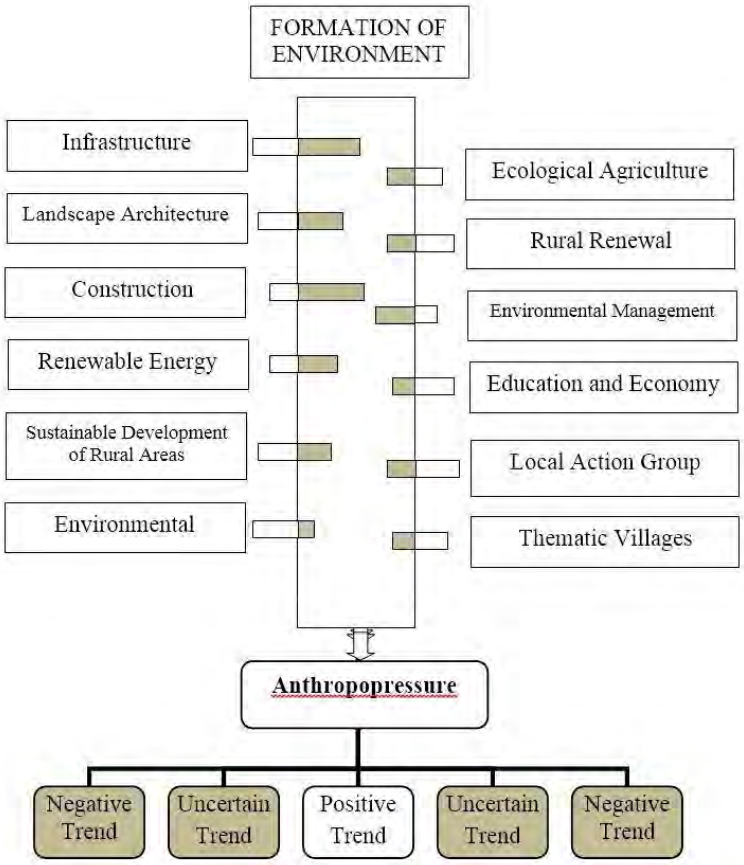

Figure 5. Network of relations among subjects forming the environment, with consideration to the priority of criteria and the trend of anthropopressure (according to: Malczyk, 2012)

Table 2. Summary of hardware and agricultural works affecting particular landscape elements (according to: Cymerman, Nowak-Rząsa, 2001 – amended)

Group of Elements	Impact on landscape		
	high impact	medium impact	low impact
Vegetation	phyto-irrigation, anti-erosive procedures, marking of areas to generate renewable energy and division of land to construct appropriate infrastructure	transformation of arable land, adjustment of non-productive land, division of real estate	transformation of land relief, land consolidation, redevelopment of communication systems, improvement of existing roads
Land relief	transformation of land relief, anti-erosive procedures	land consolidation, phyto-irrigation, irrigation	marking of land to generate renewable energy, adjustment of non-productive land
Water conditions	irrigation	anti-erosive procedures, land consolidation	---------
Technical Infrastructure	redevelopment of communication systems, improvement of existing roads, marking and division of land for the construction of appropriate infrastructure	introduction of elements of devices to generate renewable energy and ground infrastructure	land consolidation, transformation of arable land

Emergy (*emjoule* is its unit), understood as an integrated indicator of environmental pressure, is a useful measure of eco-energy anthropopressure (Odum, 1996). It is constituted by the combined total energy applied in transformation processes (directly or indirectly) for making a product or service (Janikowski, 2004). In order to compare one joule of primary solar energy (PJ) with energy in the ecosystem, one should consider the cost of transformation of one type of energy into another. There are some discrepancies regarding the assessment of energy potential of renewable energy sources in Poland. Based on the available source data, Małecki (2006) estimates it at the level of approx. 2,500 PJ a year (Tab. 3).

Table 3. Energy potential of renewable resources by the capacity of generation (Małecki, 2006)

Estimated amount of energy in PJ/year				
Biomass	Hydro-power	Geothermal resources	Wind power	Solar radiation
895	43	200	36	1340
Total		2514		

In Poland, biomass is the basic source of renewable energy, applied mainly in the production of thermal energy by the process of direct combustion. The share of these fuels in the production of electricity is scarce (Małecki, 2006). Biomass may also be used in associated systems to generate thermal and electric power. Fig. 6 illustrates the options of biomass processing for energy purposes.

Establishment of energy plantation requires consideration of habitational conditions, the agrotechnical requirements of plants, harvest technology, the technology of biomass use, and production profitability (Kuś et al., 2008). Intensive cultivation of bioenergy crops increases anthropogenic transformations of agricultural landscapes, because it leads to signifycant simplification of their structure through genetic standardisation of cultivated plants, elimination of

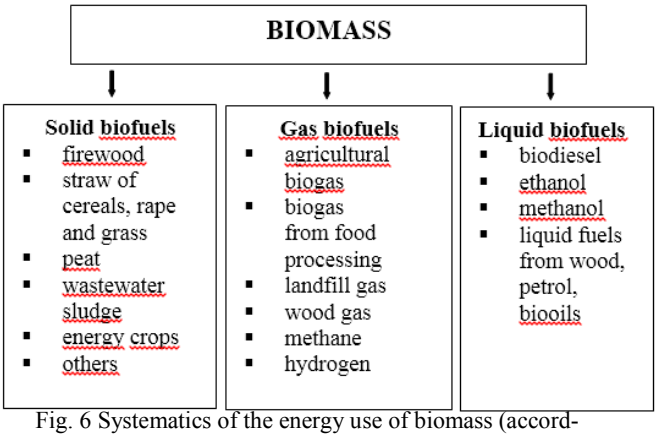

Fig. 6 Systematics of the energy use of biomass (according to: Grzybek, 2003)

weeds, deforestation, ridges, and the elimination of water holes, hedges and small swamps. It leads to:

- a decline in the degree of closure of the internal cycles of matter circulation and the system's decreased storage capacity. Therefore, energy plantations will become intensive sources of areal pollutants;
- lower capacity for modification of external influences on the agroecosystem (Ryszkowski, 2004).

Piementel & Patzek (2005) emphasises that intensive use of agricultural biomass for energy purposes bears specific risks for the environment. Moreover, the significant content of volatile parts in biomass (3x more than in coal) greatly complicates the process of its combustion. The new generation of stoves – fluidised combustion technology – solves this problem (Hycnar, Górski, 2003), but is connected with very high investment costs (Małecki, Gajewski, 2006; Roszkowski, 2008).

Solar power is another significant source of renewable energy, which constitutes a response to the assumptions of the sustainable development concept. In Poland, the application of solar collectors as a

source of energy to heat (especially water for farming or industrial purposes) as well as to dry crops, is becoming increasingly popular (Małecki, Gajewski, 2006).

Farms applying wind power to generate electric energy, which are becoming increasingly popular, constitute one recognised source of renewable energy. The first wind power station (Lisewo) in Poland has been operating since 1991, but the wind power industry has been developing intensively for just 10 years. So far, more than 30 such stations have been constructed (Dołęga, 2006; Malczyk, 2012). Good wind conditions (very good wind conditions for the development of wind power industry occur on approx. 3/4 of Poland's area), advantageous legal regulations and facilitated access to EU funds increase interest in investments for this sector (Dołęga, 2006). The disadvantages of wind power stations are related to relatively high investment costs, low utilisation of installed generation capacity, significant costs of generating 1 kWh of electricity in such power stations in relation to the cost of generation by a conventional power station (Dołęga, 2006), and the investment's pressure on the environment (Malczyk, 2012).

It is very difficult to predict the results of changes in the environment that may occur under the influence of the development of renewable energy, because they cannot always be foreseen. Wätzold (2006) postulates the application of indicators allowing for quantification of anthropogenic changes and ecological effects of protective measures related to anthropopressure management in the direction of sustainable development. According to Ryszkowski (2007), forecasting environmental effects caused by changes in the agricultural landscape structure connected with environment formation has become possible due to systemic analyses and the creation of forecasting models. Landscape multifunctionality analyses (Ryszkowski, 2007), proposed indicators allowing for the monitoring of changes in landscape properties (Fischer, Magomedow, 2004; Wätzold, 2006; Bielińska et al., 2008), and integrated analyses of costs and effects of environmental protection, security, and social and economic stability constitute important elements of sustainable environmental management, extending the achievements of landscape ecology within the scope of theoretical analyses and methods of implementation concerning renewable energy generation projects (Malczyk, 2012).

Continuity of the matter cycle and of the flow of energy among landscape elements constitutes the basis of landscape functioning (Fischer, Magomedow, 2004). Soil microorganisms are one of the most active landscape components, determining its quality. The activity of enzymes emitted in soil constitutes the indicator of their metabolic capacity (Bandick, Dick, 1999; Kieliszewska-Rokicka, 2001). Changes in enzyme activity reflect the interference in the matter cycle and energy flow caused by anthropopressure; they provide information regarding environmental conditions, as well as the nature of changes. They also enable long-term monitoring and the identification of trends (Bielińska et al., 2008). The basic advantages of biological methods of landscape condition assessment, based on enzymatic tests, are more than just the capacity of performing serial analyses – most of all they lay in the capacity of presenting the summarised impact of numerous factors and assessing parameters that cannot be determined otherwise, such as elements of cell metabolism. The application of enzymatic indicators to evaluate soil quality is broadly documented in literature (among others: Myśków et al., 1996; Januszek, 1999; Kahle et al., 2005; Yang et al., 2007), however, there is no information on the application of enzymatic methods for the analysis of landscape functioning. In Poland, the Institute of Soil Science, Environment Engineering and Management at the University of Life Sciences in Lublin conducts research within this scope (Baran et al., 2004, 2009; Bielińska et al., 2008; Bielińska, Ligęza, 2010). These studies show that enzymatic tests allow for credible assessment of the functioning of landscape systems.

Set-aside arable land and areas within dumping grounds should be (and increasingly are) the basis for the establishing of energy crop plantations (Bielińska et al., 2012). The authors of this paper are currently conducting comparative examination of enzymatic soil activity in the area of energy crop plantations and neighbouring set-aside arable land. This has demonstrated the stimulating impact of cultivation on the activity of soil enzymes (Tab. 4). The plants have beneficial effects on the biological properties of the soil, mainly through root exudates (Yang et al., 2007). During their growth, roots produce organic and inorganic compounds, and active substances, which stimulate the activity of enzymes. Plants may affect the activity of the enzymes directly, by increasing their absolute amount, and indirectly, via changes in the content of organic substances and population of microbes (Kieliszewska-Rokicka, 2001). The obtained results (Tab. 4) indicate that energy crops have a positive impact on the landscape's potential for self-regulation, immunity, buffering and resource-function via stimulation of the activity of the enzyme-catalysing processes of the matter cycle and the flow of energy among landscape elements.

Due to the role played by microbes in the maintenance and reconstruction of soil richness, assessment of the impact of anthropogenic factors related to human agricultural activity on their development and activity in soil have become an element to be controlled within environmental monitoring in many countries (Januszek, 1999).

Table 4. Enzymatic activity of soil (E.J. Bielińska, non-published data)

Plant	ADh	AFac	AU	AP
Wicker	4,18	22,16	6,87	9,44
Poplar	2,74	17,41	5,12	6,91
Maple	3,72	19,08	8,23	7,73
Miscanthus	4,33	27,52	7,69	10,56
Jerusalem artichoke	3,95	24,68	7,11	9,28
Sida	3,84	21,29	8,47	9,65
Silphium perfoliatum	3,02	20,34	6,67	8,97
Set-aside soil	1,96	15,52	4,76	5,22

ADh – dehydrogenases in cm^3 $H_2 \cdot kg^{-1} \cdot d^{-1}$, AFac – acid phosphatase in mmol $PNP \cdot kg^{-1} \cdot h^{-1}$,
AU – urease in mg $N\text{-}NH_4^+ \cdot kg^{-1} \cdot h^{-1}$, AP – protease in mg tyrozyny$\cdot g^{-1} \cdot h^{-1}$

Conclusions

1. Eco-energy anthropopressure invokes ambivalent feelings because it opposes two important values: environmental protection and the pressure to be exerted to implement this protection.
2. Parameterisation of landscape assessment measurably affected by eco-energy investments constitutes a difficult and multi-faceted task. While developing new dependencies and demonstrating large transgression against the present state, eco-energy investments affect redefinition of the identity of place, society and landscape.
3. Infrastructure modernisation projects related to the construction of renewable energy sources should consider assessment of the anthropopressure trend, which should facilitate definition of priorities in measures exemplified by subsequent investments, considering economic, environmental and social aspects.
4. The criteria of eco-energy anthropopressure constitute the basis in preparation of analyses, case studies and guidelines for planning new undertakings. The positive trend of anthropopressure is a boundary condition verifying the correctness of eco-energy engineering development.
5. The holistic concept of space should be the basis of a new methodology of forming agricultural landscapes with sustainable development conditions.
6. Application of enzymatic indicators that enable the quantification of anthropogenic transformations and ecological results of protective measures related to the production of renewable energy allow for long-term monitoring and the identification of trends.

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Shale Gas Extraction in Poland in the Context of Sustainable Development

Wydobycie gazu łupkowego w Polsce w kontekście zrównoważonego rozwoju

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Abstract

In June 2010 Poland was electrified by the big news: the country claimed to hold the largest shale gas reserves in Europe. Following the enthusiastic approach of the government and extractive companies, the public discourse has focused on the expected economic and geopolitical benefits of shale gas extraction. Meanwhile, the broader context of sustainability tends to be neglected. Some recent references to sustainable development in the context of shale gas extraction in Poland indicate that this concept needs a more thorough understanding. This article explores the following three aspects of sustainable development that need to be considered in the discussions on shale gas extraction in Poland. (1) Will the extracted natural capital be replaced with other forms of capital to ensure the well-being of future generations? (2) Will the formal institutions ensure that extractive companies prevent and mitigate all real and potential negative effects resulting from shale gas extraction? (3) How will the contribution of shale gas extraction to human well-being and national wealth be measured? The above issues link to important theoretical considerations within the concept of sustainable development, such as the weak vs. strong sustainability dilemma, internalizing external costs, and sustainability indicators (e.g. greening the GDP).

Key words: shale gas, weak vs. strong sustainability, externalities, greening GDP, resource curse

Streszczenie

W czerwcu 2010 roku okazało się, że Polska może posiadać największe złoża gazu łupkowego w Europie. Entuzjastyczne reakcje rządu i firm wydobywczych ukierunkowały dyskusję polityczną na oczekiwane ekonomiczne i geopolityczne korzyści związane z wydobyciem gazu łupkowego. Zaniedbano tym samym szerszy kontekst zrównoważonego rozwoju. Niedawne odniesienia do zrównoważonego rozwoju w kontekście wydobycia gazu łupkowego w Polsce pokazują, że koncepcja ta jest często nadużywana i wymaga głębszego zrozumienia. Niniejszy artykuł przedstawia trzy zagadnienia kluczowe z punktu widzenia zrównoważonego rozwoju, do których powinny odnieść się dyskusje na temat wydobycia gazu łupkowego. (1) Czy wykorzystany kapitał naturalny zostanie zastąpiony innymi formami kapitału, które będą mogły posłużyć jako podstawa dobrobytu przyszłych pokoleń? (2) Czy instytucje odpowiedzialne za zarządzanie procesem wydobycia zadbają o to, by firmy wydobywcze zapobiegały i usuwały negatywne skutki procesu wydobycia gazu łupkowego? (3) Jak będzie mierzony wkład wydobycia gazu łupkowego we wzrost dobrobytu i bogactwa? Zagadnienia te nawiązują do podstaw teoretycznych koncepcji zrównoważonego rozwoju, takich jako rozróżnienie między słabą i silną koncepcją zrównoważonego rozwoju, internalizacja kosztów zewnętrznych oraz wskaźniki zrównoważonego rozwoju (np. zazielenianie PKB).

Słowa kluczowe: Gaz łupkowy, słaba a silna koncepcja zrównoważonego rozwoju, koszty zewnętrzne, zazielenianie PKB, przekleństwo zasobów naturalnych

Introduction

There is a need to discuss shale gas extraction, which is strongly promoted by the Polish government, from the perspective of sustainable development, as it is an overarching objective specified in the *Polish Constitution* and in major European Union (EU) documents (especially the *Treaty on EU*). The authors of a recent article on shale gas extraction and sustainable development published in *Problemy Ekorozwoju/ Problems of Sustainable Development* journal (Siemek, Nagy, Siemek, 2013) have initiated the debate but they also missed the most important issues that can potentially link shale gas extraction with sustainable development. My objective here is to contribute to this debate by raising three crucial issues:

1. Can we talk about sustainable development at all in the case of a nonrenewable resource extraction? And if yes, then to which concept of sustainable development do we refer?
2. How does shale gas extraction relate to internalizing externalities, a key issue from the point of view of sustainable development?
3. How should we measure the contribution of shale gas extraction to sustainable development?

Before we move to a more detailed presentation of these issues in the following sections, we first need to refer to how shale gas extraction has been framed in the public discourse in Poland thus far.

Since the U.S. Energy Information Administration published its report on worldwide shale gas reserves (U.S. EIA, 2011), within which Poland was indicated as one of the countries most richly endowed with this resource in Europe, Polish government has been the most ardent promoter of shale gas extraction in Europe. Even though our shale gas resources were later estimated much more cautiously (PGI, 2012), Polish politicians kept lobbying to promote shale gas extraction in the EU. In particular, they have insisted that little policy action on this topic is taken at EU level, leaving as many decisions as possible at the discretion of individual member states. Also, shale gas extraction has been referred to in the major recent strategic development documents, including the *Long-term National Development Strategy Poland 2030 (LNDS)* (*Ministry of Administration and Digitization,* 2013) and the *Strategy on energy security and environment* (*Ministry of Environment and Ministry of Economy*, 2012).

Interestingly, in the LNDS shale gas extraction is presented as one of the strategies for creating a green economy in Poland. In the time of international economic slowdown, green economy has recently dominated much of the sustainable development discussion as an opportunity to combine economic growth with environmental protection and social inclusiveness. Although multiple definitions of green economy have been put forward, they commonly emphasize ideas such as focusing on well-being rather than GDP, respecting planetary boundaries and other ecological limits, resource and energy efficiency, protecting biodiversity and ecosystems, reducing poverty, justness between and within countries and between generations, participatory governance, green jobs, and internalizing externalities (Allen, 2012). Meanwhile, as we shall see in the following sections, discussions on shale gas extraction rarely refer to any of these principles and quite often contradict at least some of them.

The strategy on energy security and environment also indicates sustainable development and green economy as its overarching objectives. As part of its energy security component it promotes the development of new sources of energy, such as unconventional gas (including shale gas). It indicates a need to prepare and implement a transparent legal and regulatory setting for the extraction of unconventional gas and to further explore the potential of this fuel in Poland.

The government has also initiated revisions of a number of legal documents that refer to shale gas extraction, including the *Geological and Mining Act,* and created draft versions of several new laws, such as the new *Act on a Special Hydrocarbon Tax*. Many of these legal changes have also been linked with sustainable development in the official presentations made by government representatives.

Siemek's (et al., 2013) article fits into this discourse, with their main focus on presenting and discussing the prospects of shale gas extraction in Poland. However, although they raised many technological uncertainties, and in spite of the title of their article, they did not specifically refer to the sustainable development. After an extensive presentation of general aspects related to shale gas extraction, the authors suggested that further development in this area in Poland can follow one of the four scenarios, ranging from optimistic to pessimistic. The optimistic scenario assumes rapid development of shale gas extraction, with few administrative obstacles and high inflow of capital, and with high economic efficiency of extraction. The pessimistic scenario refers to *withdrawal of the most important investors from Poland, no capital support for Polish companies, ecological obstacles blocking gas exploitation in Europe, maximum lowering of Russian gas prices*. Although the authors did not provide more information on any of these potential scenarios, it is quite clear that the sustainable development in the case of their article refer to the challenges for the development of shale gas extraction, separate from the more general concept of sustainable development.

Polish authorities insist on a speedy development of shale gas extraction in Poland and see environmental regulations and protected areas as important risks to this development. Meanwhile, sustainable development involves long-term, strategic considerations, which should not be subdued to short-term interests.

As expressed by Robert K. Sweeney, chairman of the New York State Assembly Standing Committee on Environmental Conservation, shale gas extraction needs a broad analysis and this analysis needs time.

We need to appreciate what we're getting ourselves into (...) It's not just the pumping of chemicals into the ground or the air pollution, it's also the effect on quality of life – something as simple as truck traffic, which other states didn't consider when they issued permits. (...) There's a lot to this issue that argues for taking our time. The gas isn't going anywhere, so what's the rush? If we do it, we should do it right (cited by Schmidt, 2011, p. 353).

Thus, in particular, with regard to sustainable development we should think about the long term and not discriminating the well-being of future generations, which brings us to the concepts of weak and strong sustainability.

Weak vs. strong sustainability

The classic definition of sustainable development – *meeting the needs of the present without compromising the ability of future generations to meet their own needs* (WCED, 1987) – emphasizes intergenerational equity. A long-lasting academic debate has attempted to operationalize this definition, focusing on how to ensure that future generations will be able to meet their needs (Żylicz, 2010). These issues have also been at the center of the discussions on sustainable energy, as interpreted by the International Energy Agency (IEA, 2001), and in the recent articles published in this journal. These discussions take into account that three types of capital are necessary to satisfy human needs: natural, human, and man-made.

Two extreme concepts have been formulated: weak and strong sustainability (Neumayer, 2003). The former suggests that future generations may not need the exact composition of the three types of capital and it will be enough to maintain the total stock of capital, thus allowing for substitution between its different types. The latter suggests that all types of capital are necessary, and that one type of capital cannot substitute for another.

Clearly, shale gas extraction (just like the extraction of any other nonrenewable resource) cannot be called sustainable if one follows the strong sustainability concept (Kronenberg, 2012). It is unsustainable as once a resource is exploited, this resource is no longer available for the future.

However, following the logic of weak sustainability, benefits from resource exploitation might be used to generate other forms of capital that would replace the initial resource's potential of contributing to further development. From this perspective, depleting shale gas resources should be offset by investment in other forms of capital to be left for future generations. The concept of weak sustainability refers to the so-called Hartwick rule of substituting man-made for natural capital (Hartwick, 1977, 1978). In practice, it is often associated with the concept of genuine savings, an adjusted measure of savings taking into consideration the depreciation and depletion of different assets, including natural resources (Hamilton, Bolt, 2007).

The World Bank collects genuine (or *adjusted net*) savings data, which incorporate gross national saving and education expenditure, reduced by consumption of fixed capital, depletion of energy resources (including shale gas resources), depletion of minerals, net depletion of forests, and damages related to CO_2 emissions and particulate pollution. Thus, using the World Bank's practical solution, to fulfill the weak sustainability criterion, the depletion of shale gas resources should be compensated by increased savings or education expenditure. Surprisingly, as the World Bank data demonstrate, many resource-rich countries actually have negative genuine savings rates. Indeed, the tendency to consume rents increases with resource dependence which complies with research in the area of the so-called resource curse (Atkinson, Hamilton, 2003; Dietz, Neumayer, De Soysa, 2007).

This negative relationship between resource abundance and a negative rate of genuine savings requires further scrutiny as yet another risk related to sustainable development in the context of shale gas extraction in Poland. Indeed, the weak sustainability concept is further confounded by additional circumstances, such as quality of institutions. For example, in countries with poor institutions and large corruption, the benefits generated by extraction projects may be captured by the powerful elites or other stakeholders (Mehlum, Moene, Torvik, 2006a, 2006b; Robinson, Torvik, Verdier, 2006). In particular, these benefits may not be available to local communities that suffer most from the initial resource being exploited or degraded. These issues are related to the so-called resource curse hypothesis and have also been studied in the case of potential shale gas extraction in Poland (Kronenberg, forthcoming).

While both strong and weak sustainability concepts have been criticized, for being excessively rigid and loose respectively, several intermediate solutions have been put forward to make sustainable development operational. For example, Daly (1990) suggested that nonrenewable resource extraction projects should be complemented with investment in the use of renewable resources, and the rate of depletion of nonrenewable resources should correspond with the rate of development of renewable assets. Meanwhile, in Poland the introduction of the *Renewable Energy Resources Act* has already been delayed by three years, failing to meet the EU requirements and revealing the lack of political will to promote the development of renewable energy in the country.

The above sustainability-related issues have only been discussed to a very limited extent in the context of shale gas extraction in Poland. The draft revised

Geological and Mining Act presented by the Ministry of Environment in February 2013 foresaw the establishment of a Generations Fund (*Fundusz Pokoleń,* 2013). This fund was meant to collect part of revenue of a state-owned company that would become part of the extractive consortia (NOKE) and invest it in safe and profitable assets. The decision on the percentage of revenue was to be made by NOKE but so far no references were made (either in the draft document, nor in the surrounding discussions) to connecting this percentage with the value of reduction of natural capital available for future generations. Nevertheless, one of the fund's objectives is to ensure intergenerational equity, interestingly *by supporting the pension system*. The other two objectives include supporting innovative potential of Polish economy and protecting human health and life. At a very general level, the notion of such a fund was also mentioned in the LNDS.

Alternatively, future development opportunities might emerge if Poland becomes a European leader in the extraction of shale gas and if Polish companies develop technologies that could later be used to exploit shale gas resources in other European countries. Such a potential strategic advantage of Polish companies was indicated in the strategy on energy security and environment (*Ministry of Environment and Ministry of Economy,* 2012).

Nevertheless, much discussion so far, has argued against the concept of sustainable development. For example, Siemek (et al., 2013, p. 103) proposed that *No additional taxes can be now levied on industry owing to considerable uncertainty in the conditions of production. In the initial period tax preferences should be introduced for companies in this sector, analogous to the USA in the 1990's*. As argued above, these taxes and other payments are necessary to at least attempt to follow weak sustainability and have funds to invest in future development opportunities. Taxes may also be used as an incentive for extractive companies to minimize and mitigate the negative external effects of their activities.

External costs

Another key issue within sustainable development relates to costs which are not borne by those who cause them, i.e. external costs. These can be considered both within a single generation, and in an intergenerational context with future generations not able to protect their interests from the impacts caused by the current generation (Kronenberg, Bergier, 2010). External costs are not reflected in the prices of goods and services traded in the market, leading to consumer decisions being made in the situation of imperfect information. These costs are thus borne by the society as a whole, including local communities where a given activity takes place and future generations.

In the case of shale gas extraction, external costs are mostly related to nuisances for local populations, some of which can also extend to future generations. Examples of negative external effects related to shale gas extraction include increased traffic, vibrations, odors, landscape degradation, as well as noise, air, and light pollution and other environmental risks (Schmidt, 2011; Christopherson, Rightor, 2012; Kavalov, Pelletier, 2012; Broomfield, 2012). While new technologies, such as dry fracking within which gas is pushed out of shale rock with the use of other gas and not any kind of a fracking fluid, can solve some problems (e.g. water use and the risk of water contamination), they still involve other of the abovementioned externalities. Some of the local externalities can be directly translated into monetary costs, such as the costs of repairing road infrastructure destroyed by traffic related to shale gas extraction. In the case of other externalities, non-market valuation techniques can be used to estimate the related costs.

One of the aspects studied in this context was the loss of real estate value around shale gas wells. In the United States, a hedonic pricing study carried out in Washington County, Pennsylvania found out that the perceived risk of groundwater contamination led to a 24% reduction in property values within close vicinity of the shale gas well (Muehlenbachs, Spiller, Timmins, 2012). Similar results for the same county were reported by Gopalakrishnan and Klaiber (2013), according to whose study the reduction in property values within close proximity to shale gas wells was 21.7%. These reductions offset potential gains to house owners from lease payments or potential new economic opportunities related to shale gas extraction.

Another example of an attempt to capture the value of externalities related to shale gas in the US involved a choice experiment to estimate the willingness to pay for electricity generated with shale gas (natural gas from hydraulic fracturing). A study based on a sample of 515 households from 27 different counties in New York State indicated that its residents exhibited a negative willingness to pay for that electricity source (Popkin et al., 2013). They would only accept this kind of electricity had it been 22 to 48 USD cheaper than what they currently paid for electricity (124 USD on average). Higher compensation levels were required by people living closer to shale gas extraction sites. Another study used a contingent valuation method to estimate the residents' willingness to pay for eliminating the risks of water pollution due to hydraulic fracking (Bernstein, Kinnaman, Wu, 2013) in Susquehanna valley in Pennsylvania (based on a sample of 186 residents). Local inhabitants were willing to pay on average 10.46 USD per month to install additional safety measures that would eliminate risks to local watersheds from shale gas extraction. Clearly, the socially perceived negative impacts of hydraulic fracturing are substantial. Although the situation in Poland may be very

different than in the US, similar distrust may emerge once extraction begins. Conversely, as a review of international studies suggested, consumers are generally willing to pay higher prices for electricity generated with renewable resources (Menegaki, 2008).One more example of external costs related to shale gas extraction refers to pushing some other companies out of the market. This may be related to the fact that the extractive sector competes with other sectors for labor and, to a much lower extent, for capital. Even more importantly, the extractive sector may compete with other sectors for access to space, thus competing mainly with sectors that depend on other resources provided by the same areas within which extractive activity is to be located.

Such a competition was studied in the case of the impacts of shale gas extraction on tourism in the Southern Tier region of New York State in the US (Rumbach, 2011). In the short term, the employees of the extractive industry can use the tourist infrastructure and thus might have a positive impact on the tourism sector (especially on lodging and food subsectors). However, they also compete with the traditional guests of this sector limiting availability and raising prices, making the latter less interested in visiting a particular region. More importantly, shale gas extraction may negatively impact natural resources on which tourism depends. This refers principally to landscape degradation (changing rural into industrial landscapes) and environmental degradation (or at least the perceived risk of environmental degradation). Moreover, local and regional tourism relies mostly on local labor while the extractive sector often hires specialized employees from outside of the region.

In fact the nuisances for local communities in Poland may be even more pronounced because, unlike in the US, land owners are not entitled to share the income from resource extraction. Thus, they have smaller incentive to have extractive activity in their land and directly suffer from nuisances. While in some other EU countries, such as France and Sweden, the state is obliged to pay a certain share of payments it receives from extractive companies to land owners (Pearson et al., 2012), such solutions have not been considered in Poland. Instead, Polish authorities introduced an opportunity to expropriate those who would not sell or otherwise consign their land for the purposes of shale gas extraction (Art. 19 of the *Geological and Mining Act,* as enforced since 1 January 2012). Public consultations related to shale gas exploration are usually treated as public relations campaigns by both individual investors and public authorities. Instead of a dialogue and a focus on the needs of local communities, such processes offer ready information sets and standard sponsoring opportunities that are meant to compensate the most apparent nuisances.

Environmental effects of shale gas extraction can also be associated with global externalities, such as greenhouse gas (GHG) emissions. Howarth (et al., 2011) published the first comprehensive life cycle assessment of shale gas GHG emissions and concluded that shale gas GHG emissions were at least 20% and perhaps more than twice as large as those of coal when compared over a 20 year horizon, and comparable to coal when compared over 100 years. Several later studies (Jiang et al., 2011; Hultman et al., 2011; Burnham et al., 2012) suggested that shale gas life cycle GHG emissions were not as high as those calculated by Howarth et al. (2011). However, the variability of assumptions made in the various studies has been very significant. Such variability can be explained by the fact that due to the relatively recent development of shale gas activities and to the lack of systematic and compulsory measurements, an important paucity of reliable data currently restricts our ability to correctly and fully assess shale gas GHG emissions (c.f. Füllemann, 2012). Results obtained in the different studies are therefore strongly dependent on highly uncertain parameters and on specific data used and assumptions made by the authors.

GHG emissions, and especially the most important fugitive methane emissions occurring during shale gas operations, can be mitigated with solutions such as flaring, green completions, leak monitoring, additional controls, maintenance and repair. Differences in results of these studies highlight the importance of defining specific legislations in order to strictly limit GHG emissions. They also highlight a need for adopting a precautionary approach to shale gas operations, especially in light of the high uncertainty with regard to its environmental impacts.

GDP growth as a dominant measure of development

In the public discourse, GDP is broadly used as a proxy measure of development, and many of the discussions on shale gas in Poland focus on its potential to boost GDP growth. Interestingly, the case of shale gas in Poland may very well illustrate the pitfalls of associating GDP growth with development, and sustainable development in particular. Or, in other words, it may illustrate a need for a more comprehensive indicator of sustainable development.

GDP measures the scale of economic activity in a country by summing up the value of all registered economic activities carried out within a given period (or the value of all registered expenses). It does not include things that contribute to human well-being or national development, other than goods and services which are available through the market. For example, energy efficiency, which is often indicated as the most important freely available source of energy, is not given much attention in the discussions on energy future in Poland, even though the energy intensity of Polish economy is over three times as high as that of the most advanced EU countries. This is the

case because energy efficiency does not contribute to economic growth and thus remains outside of most of the political and economic discourse. Finally, GDP does not account for potential hindrances to well-being or development, such as the abovementioned externalities which by definition are not captured by the market.

Extraction of shale gas may accelerate GDP growth but its impacts on human well-being or national development are not equally evident. As argued above, GDP increases as we deplete a resource, thus – *ceteris paribus* – precluding future development opportunities. Furthermore, shale gas extraction also involves a number of so-called *defensive expenditures*, which have to be paid to avoid the deterioration of well-being. For example, expenditure on road infrastructure repair following the degradation of this infrastructure caused by extractive operations only aims at recreating the previous state of human-made capital. Even though the utility of this infrastructure is only comparable to the original state, GDP increases. Inconclusive results on shale gas extraction impacts on human health (Schmidt, 2011) and the defensive expenditure related to avoiding or mitigating health or environmental problems provide examples of similar uncertainties.

One more aspect of well-being related to shale gas extraction is the distribution of income from this activity. Again, this refers to how the benefits of extractive activity will be distributed between the current and future generations (whether they will be used to replace the resource's potential to satisfy future needs), and also to who will benefit from extraction within the shorter time frame. With regard to the latter, it is necessary to explore whether extractive activity will contribute to higher concentration of income (increasing the Gini coefficient of income inequality) or whether the benefits will be distributed more evenly within the society.

In short, putting shale gas extraction within the context of sustainable development requires further attention to broader aspects of development than just material and market wealth as measured by GDP. This is also in line with the concept of green economy which, as indicated above, emphasizes the idea of moving beyond using GDP as a measure of progress and welfare. Instead of GDP, more comprehensive measures of environmental, social and economic well-being should be used, the most immediate alternative being a revised, green GDP, which accounts for the above shortcomings of traditional GDP (c.f. Żylicz, 2010).

Discussion and conclusions

In spite of some references to shale gas extraction in Poland in the context of sustainable development, the above three crucial issues: weak vs. strong sustainability, external costs, and misuse of GDP as a measure of development have not been addressed in this context.

In particular, perceived abundance of shale gas in Poland strengthens a false sense of security, based on an assumption that this resource will ensure future development opportunities. Such a false sense of security leads to downplaying the risks that refer to various aspects of sustainable development (economic, social and environmental). It is also related to a push for quick exploitation, despite the fact that Polish institutions are not yet prepared for managing shale gas extraction[1] and starting exploitation too early may even delay or remove the pressure to reform those institutions.

Meanwhile, supporters of shale gas extraction deplored what in their opinion was a slow development of shale gas sector in Poland and complained about further potential requirements to be introduced by the revised *Geological and Mining Act*. As indicated above, sustainable development requires taking the long term into consideration and thus requires well-thought decisions and regulations. Too many examples are available of resource rich countries which have not been able to translate their resource wealth into development prospects precisely because of poor institutions (Mehlum, Moene, Torvik, 2006a, 2006b; Robinson, Torvik, Verdier, 2006) to repeat their mistakes now.

The discussed author suggested that *The supervision of drilling operations by the State Mining Authority and General Department of Environmental Protection seems to be sufficient in this case*. However, environmental risks tend to be neglected much more broadly in Poland, in spite of their importance in the international academic and practical debate on shale gas (Kavalov, Pelletier, 2012; U.S. EPA, 2012; Broomfield, 2012). Polish Ministry of Environment ascertained that the process of shale gas extraction is safe for the environment, based on the results of a single study carried out for an exploratory drilling in Łebień (*Ministerstwo Środowiska*, 2012). Such a decisive statement, repeated by the representatives of the Ministry on many occasions, is rather surprising, especially taking into considerations the assumptions and reservations expressed in the report on which it was based (PGI, 2011). Interestingly, in the public discourse and even in official reports of government agencies one can find statements suggesting that addressing environmental issues represents a *negative propaganda*, creating *a risk of blocking the development of shale gas extraction* (Taras, 2011, p. 14). This brings about an important issue of whether Polish authorities will be able to ensure the level environmental control and supervision sufficient to prevent problems related to shale gas extraction.

[1] For example the distribution of exploration licenses was done hastily, on the first come, first served basis, without ensuring the proper control over who received them and whether the licensees would actually be able to use those licenses themselves.

The perceived *environment or development* dilemma is perhaps the most important barrier to sustainable development in Poland (Kronenberg, Bergier 2012). Environmental protection is broadly seen as an obstacle to development, both in terms of regulations and protected areas. Clearly, this results from the prevailing focus on economic growth and neglecting other aspects of human well-being. Meanwhile, without protecting the interests of all inhabitants (including preventing nuisances for local communities and future generations), the externalities of shale gas sector (in particular shale gas extraction) may undermine the sustainable development of the country.

To address the challenges of sustainable development in Poland in the context of shale gas extraction, one would need to address the above issues of: how to ensure development opportunities for future generations (weak vs. strong sustainability), how to deal with externalities, and how to measure the contribution of shale gas to sustainable development. These issues have not been discussed so far, and indeed it is not easy to present the extraction of a nonrenewable resource in the context of sustainable development. Some publications and the official strategies (*Ministry of Administration and Digitization,* 2013; *Ministry of Environment and Ministry of Economy* 2012), raised confusion by linking shale gas extraction with sustainable development and green economy without addressing the abovementioned crucial issues.

This example highlights a need for further education on sustainable development in Poland which should result in a clearer understanding of this concept. Thanks to education, the phrase should not be misused and abused as much as it has been misused and abused so far. Sustainable development should not be a catchword that everyone extends to their own meaning as it already has a well-developed theory and understanding in academic literature.

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Drinking Water Consumption in Cracow – an Assessment from a Sustainable Development Perspective

Konsumpcja wody pitnej w Krakowie – próba oceny z perspektywy zrównoważonego rozwoju

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Abstract

The article assesses, from a sustainable development perspective, the current consumption model for drinking water in Krakow. Based on the available literature, it evaluates the quality of tap water in Krakow and compares it with the standards for bottled water. Next it assesses the economic consequences for the average city resident who decides to drink bottled water. The total energy demand for the production, distribution and consumption of bottled water is estimated and is compared to the household energy consumption.

The environmental impact for the current water consumption model in Krakow is estimated by summing the waste reaching landfills, energy consumption, carbon dioxide emission, and Eco-Indicator 99 H/A points. These estimates were calculated based on the data in the reviewed literature revised for the actual quantities of consumed bottled water and bottle recycling levels in Krakow. The potential environmental savings for the city related to an annual reduction of 1 litre of bottled water consumed by an average resident by is also calculated. The different water consumption scenarios are assessed using the multi-criteria Analytic Hierarchy Process (AHP) to see how compliant they are with sustainable development.

Key words: Krakow, sustainable development indicators, LCA, bottled water, PET, AHP

Streszczenie

Artykuł szacuje, z punktu widzenia zrównoważonego rozwoju, aktualny model konsumpcji wody w Krakowie. Na podstawie literatury, ocenia jakość wody wodociągowej w Krakowie, którą porównuje z wymaganiami stawianymi wodzie butelkowanej. Następnie, ocenia efekty ekonomiczne dla przeciętnego mieszkańca miasta decydującego się pić wodę butelkową. Oszacowano energochłonność produkcji, transportu i konsumpcji wody butelkowanej oraz oceniono skalę tej energochłonności w porównaniu z ilością energii zużywanej w gospodarstwach domowych.

Efekty ekologiczne aktualnego modelu konsumpcji wody w Krakowie oszacowano licząc strumień trafiających na składowisko odpadów, energochłonność skumulowaną, emisję dwutlenku węgla, punkty Eco-indykator99 H/A. Szacunki te zrobiono na podstawie danych literaturowych adaptowanych do aktualnych ilości konsumowanej w Krakowie wody butelkowanej oraz przyjmując aktualne poziomy recyklingu butelek. Oszacowano również efekty środowiskowe dla miasta ze zmniejszenia konsumpcji wody butelkowanej o jeden litr przez przeciętnego mieszkańca. Przedstawiono również próbę całościowego zmierzenia za pomocą analizy wielokryterialnej Analitycznego Procesu Hierarchicznego (AHP) jak bardzo poszczególne scenariusze konsumpcji wody są zgodne z koncepcją zrównoważonego rozwoju.

Słowa kluczowe: Kraków, wskaźniki zrównoważonego rozwoju, LCA, woda butelkowana, PET, AHP

Introduction

The healthy lifestyle trends and the lack of trust in the quality of tap water result in mass consumption of bottled water. The problem is particularly significant in rich cities which are visited by large numbers of tourists and also in academic cities populated by young people who are trend setters. Such a behaviour also has consequences from the sustainable development perspective. The most frequently quoted definition of sustainable development *is the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs* (WCED, 1987).

As far as the guarantee of permanent access to clean and healthy water can be regarded as a basic human need, access to bottled water seems to surpass this basic need. The concept of sustainable development can be considered on three levels: ecological, social and economic. However, a problem arises with how to measure sustainable development for such an activity when the negative effects on an economic and ecological level are partially compensated for on a social level. Russell suggests that energy-intensity and material-intensity of comparable products or processes serve as sustainability indicators (Russell, 2010). Life-cycle assessment (LCA) is a tool which enables an assessment of material and energy intensity of tap and bottled water preparation as well as an assessment of the impact on an ecological level. This article attempts to quantify how much bottled water is drunk in Krakow and then using American and Swiss LCA analysis assess the actual environmental costs of such consumption for the city and its residents. Thanks to LCA it is also possible to estimate how the environment and economy will change if an average resident reduces his consumption of bottled water by 1 litre annually. A total assessment method is also presented from the perspective of sustainable development for each of the water consumption scenarios. For the total assessment the multi-criteria Analytical Hierarchy Process (AHP) was used.

The existing water treatment systems are evaluated from an economic perspective as well as from an LCA one (Barrios, 2008). The potential effect of various technological changes on existing facilities are also analysed (Lundie, 2004). General models for the entire water supply and sewerage industry are also being built which can be optimised as they benefit from operational research techniques (Lim, 2010). The article attempts to analyse for a specific city, Krakow a system where the source of drinking water is simultaneously tap and bottled water. The basic problem with this type of analysis is establishing whether the quality of tap water is comparable with that of bottled water, i.e. whether tap water is suitable for drinking directly or whether it has to be boiled first.

An assessment of the quality of drinking water in Krakow

Throughout its modern history, Krakow has been supplied with tap water since 1901. Initially the water was abstracted from the River Wisła but after World War II, due to increased demand and water pollution, additional water abstraction intakes were built on the Rudawa, Dłubnia and Raba rivers. Up to the middle of the 1980's demand for water grew which the supply system could not meet both in quantity and in the quality of water. It is estimated that during this period the supply system supplied only 80% of the required water. The commissioning of a new water abstraction intake *Raba 2* in 1987 radically improved the situation. Political changes in the 1990's reduced the demand for water speeded up the improvement process. However, for the residents, memories of bad quality tap water remain to the present day.

The 1998 Council Directive 98/83/EC is the basic document relating to the quality of water intended for human consumption which defines the standards for the quality of water intended for human consumption. The Directive defines the chemical, physical and biological standards for water in the water supply network. The Polish Health Minister's directive dated 20th April 2010, amending the previous directive dated 29th March 2007, relating to the quality of water intended for human consumption, aligns Polish legislation with that of the European Union. On MPWiK S.A.'s (Municipal Water Supply and Sewerage Company) website there is a statement guaranteeing the good quality of treated water flowing into the municipal network. Values for a number of selected water quality parameters for the last 2 weeks are published (MPWiK, 2013). The MPWiK S.A. Central Laboratory in Krakow currently tests for 140 physicochemical, bacteriological and hydrobiological parameters in raw water abstracted from boreholes, drinking water supplied to the network as well as the water within this network. Since the water supplied to the residents of Krakow easily exceeds the high Polish and European standards, it can be assumed that according to the definition in Directive 98/83/EEC, the water is *clean and healthy*.

A wide scale inspection by the Supreme Chamber of Control (NIK – Naczelna Izba Kontroli) of all water companies in Poland showed that MPWiK S.A. in Krakow is one of five companies supplying the highest quality of water in Poland (MPWiK, 2013).

The water supply network can be a source of secondary water pollution. This hazard is constantly being minimised by replacing steel pipes with plastic ones. It reduces the risk of cloudiness, colouring, iron compounds and bacteriological contamination in water. At the same time the age of the water pipework is being lowered. Due to these actions the num-

ber of distribution network failures in the period 2003-2006 was reduced by 27% (Olko, 2008), which affects the quality of water for the customers.
The good quality of water received by customers is confirmed by results from the laboratory tests performed regularly by MPWiK, inspections by NIK, Chief Sanitary Inspectorate (Główny Inspektorat Sanitarny), Sanepid's tests, and tests carried out in 2011 by *Brita* – a manufacturer of water filter jugs (Sanepid, 2011), (GIS, 2011). Summarising the results, Brita stated: *The results for the individual parameters for water in Krakow are relatively low with respect to the norm, which means complete safety in its use. Therefore assessing the suitability of tap water in Krakow for drinking, based on parameters included in the Health Minister's directive, it should be accepted that the water fulfills all sanitary requirements and is of good quality, chemical and microbiological purity* (Brita, 2012).
These facts do not change the consumer's distrusting attitude. In 2009 a survey was carried out by the Public Opinion Research Centre to determine the Polish people's attitude towards tap water. It turned out that 49% of Poles would not drink unboiled tap water, 57% buy bottled mineral water and 11% use filter systems. However, almost everybody complained about so-called *hard water* (E-instalacje, 2012).
In 2011 Brita carried out tests throughout Poland which highlighted that *as many as 61% of Polish people are distrustful of tap water and the reservations they have are mainly related to its quality* (Brita, 2012).

An Assessment of bottled water quality

Being distrustful of tap water, the residents of Krakow turn to bottled water. Its quality is regulated by the Health Minister's Regulation dated 31st March 2011 in the matter of natural mineral water, spring water and table water (*Journal of Laws*, no 85, item 466). This regulation implements both the Commission's Directive 2003/40/EC dated 16th May 2003 as well as the European Parliament's and Council's Directive 2009/54/EC dated 18th June 2009 on the abstraction and marketing of natural mineral waters. This regulation introduced a significant change related to the term *natural mineral water* replacing a long-standing definition (Błońska, 2010). Previously *natural mineral water* implied water containing mineral riches important for human health which was intended to be drunk for dietary, nutritional, revitalising and prophylactic health reasons (Latour, 2010). The new binding definition of *natural mineral water* introduces a significant change and currently any underground water fulfilling certain conditions of primary purity, when bottled, can be called *natural mineral water*. However, only some of them may have a beneficial effect on health. In practice it means that in many waters which can be called *natural mineral water* there are no minerals, or only in very small, trace amounts which has no physiological meaning. Already several waters containing insignificant quantities of minerals, described to date as *natural spring water* have been recently renamed *natural mineral water* (Goczał, 2010).

Economic consequences for the present water consumption model

An average Pole drinks 72.4 litres of bottled mineral water annually (GUS, 2012). Since most people who drink bottled water have a secondary or university education and reside in cities (Piński, 2006), it can be assumed that a resident in Krakow annually drinks 80 litres of bottled water.
A survey of water prices carried out in one of the supermarkets in Krakow showed that there is a wide range of choice both with respect to price and product. There were 177 different types of water in various packaging. Water in the cheapest packaging cost 0.99 zloty (0,25 euro, 1 euro = 4,2 zloty) and the most expensive 27.90 zloty (6,6 euro). The price of 1 litre of water ranged from 0.66 zloty (0.15 euro) to 30.27 zloty (7,20 euro). The mean price of water was 5.34 zloty (1,27 euro) with the median being 2.98 zloty per litre (0,7 euro, Alma 24, 2013). The price of 1 litre of tap water in Krakow is 0.00343 zloty (less than one eurocent, MPWiK, 2012). Assuming that cheap waters are mainly sold and that the average price of bottled water is 2.50 zloty for a 1.5 litre bottle, (1.67 zloty/litre), it means that bottled water is about 500 times more expensive than tap water. Considering that a person should drink 1.5 litres of water daily, a resident of Krakow drinks approximately 548 litres of water annually, of which bottled water amounts to at least 80 litres (15%). Consequently, a resident of Krakow pays between 53 zloty (12,60 euro) and 2,422 zloty annually for bottled water whilst the remaining 85% of water drunk costs just 1.60 zloty.

The effect of bottled water consumption on the natural environment

One of the main burdens on the natural environment associated with the consumption of bottled water is its energy-intensity and the waste produced. Currently 95% of the bottled water sold in the USA and over 90% in Poland is in bottles manufactured from polyethylene terephthalate (PET) (Berbeka, 2012). PET is the most common plastic used in food packaging. It is harder and more enduring than nylon and can be formed and shaped as required. It is resistant to heat, mineral oils, solvents and acids. It is carbonation resistant, strong, light, impact resistant, naturally transparent and fully recyclable. In addition it practically leaves no taste or smell on the products it comes into contact with. The properties of materials used for food packaging are strictly controlled in the EU by framework Directive 1935/2004 (EU, 2004)

amongst others. On the one hand, PET is considered to be a safe material for packaging water but studies are indicating that there are various substances, often in significant quantities, found in the water bottled in containers manufactured from PET (Bach, 2012; (Sax, 2010).

Energy is required for PET and bottle manufacture, water treatment, transportation of bottled water, chilling the water and maintaining it at low temperature. The energy demand for bottle production depends on bottle size. For a 1 litre bottle weighing 38 grams about 4 MJ of energy is required (Berbeka, 2012). The energy required for the treatment of drinking water depends on the technology and the degree of pollution. For example ultraviolet disinfection requires only 10 kWh/million litres but the energy required for reverse osmosis can reach up to 1600 kWh/million litres or more as in the case of sea water desalination (Gleick, 2011). Water treatment in a water bottling plant consists of a number of processes.

The transportation's energy demand depends on two factors: distance and means of transport. The vehicles used in Poland have a medium energy demand between 3.5-6.8 J/(kg km) (Gleick, 2011). Table 1 shows the total estimated energy demand for bottled water (Berbeka, 2012).

Table 1. Total energy demand for the production and consumption of one litre of bottled water

Stage	Energy Demand MJ_{th}	Percentage
Manufacture of plastic PET bottle	4	39-71%
Water treatment	0.0001-0.02	0-0.3%
Bottling and labeling	0.01	0-0.1%
Transport – dependent on distance and type	1.4-5.8	25-57%
Chilling	0.2-0.4	3-9%
Total	5.6-10.2	100%

In the above analysis the energy requirements for the long-distance transportation of water through the pipeline or from deep boreholes have not been taken into account. It is assumed that water is first treated and then poured into plastic PET bottles, capped, labeled and packed in a bottling plant. Then it is distributed into shops and chilled before consumption. Based on these assumptions the total energy required for bottled water varies between 5.6 and 10.2 MJ/litre. For comparison, tap water requires on average 0.005 MJ/litre (Gleick, 2009) for treatment and distribution. This means consumption of bottled water is between one and two thousand times more energy intensive compared to that of tap water.

Waste

It is estimated that between 100,000 and 150,000 tonnes of PET packaging is manufactured annually (Berbeka, 2012). Some of it is recycled, but most ends up in a landfill. According to the estimates of Organizacja Odzysku REKOPOL (Warszawa) (Rekopol Recovery Organisation S.A. Warsaw) currently about 40,000 tonnes of PET waste is collected annually (Rokicki, 2005). Other sources estimate that 28% of plastic PET bottles are recycled in Poland (*Onet*, 2012). In 2010, 73% of packaging waste was recycled in some form in Krakow (*Bip Miasto Krakow,* 2010). Based on this data we can assume that the average resident of Krakow, drinking 80 litres of bottled water in 1.5 litre bottles annually, uses 53 bottles of which 39 bottles are recycled whilst the remaining 14 end up in a landfill occupying 0.019 m^3 (density of compressed plastic PET bottles is 44 kg/m^3 (Kreith, 1994) and an average bottle weighs 60 grams). For the whole of Krakow this means 14,000 m^3 of waste being sent to landfill annually.

Adapting LCA analysis for the consumption of bottled water in Krakow

To more accurately assess in the model the effect of drinking water consumption on the environment in Krakow, two reports on a similar subject were studied: a LCA report on drinking water systems in the state of Oregon, USA (Sauer, 2009) and a similar report for the water supply for Swiss regions (Jungbluth, 2006). In the reports various drinking water supply scenarios were analysed ranging from unboiled tap water to bottled water transported long distances. Taken into account were various types of packaging (tap water, bidons, bottles), transportation (different size vehicles, shipping), consumption (boiled, unboiled, chilled) and packaging waste disposal policy. 48 different scenarios were analysed in the American report and 19 in the Swiss report. The American report assesses the effect of individual scenarios measuring their energy requirements, the quantity of waste produced. and 9 categories of impact on the natural environment assessed in accordance with the US Environmental Protection Agency methodology, namely TRACI (Tool for the Reduction and Assessment of the Chemical and other environmental Impacts). In turn, the Swiss report assesses individual water supply scenarios by measuring primary energy use, its effect on global climate change and estimates the Environmental Performance Indicators (EPIs-97 and Eco-indicator 99 H/A). EPI-s-97 is the indicator for measuring energy consumption, the quantity of waste and pollution emissions produced with respect to the Swiss environmental policy objectives. The Eco-indicator 99 H/A is an indicator consolidating individual emission and raw material streams, taking into account their effect on human health and the natural environment from the point of view of an average European. A direct comparison of the results from these two reports and adapting them for the conditions in Krakow is difficult. The reports measure the environ-

mental impact differently. An example of the problem of how to adapt the results in the American report to the conditions in Krakow is the fact that in the state of Oregon 25% of households get their drinking water from private wells which affects the results. In addition, the accepted recycling levels for packaging in some scenarios are difficult to achieve in Krakow. It was eventually decided that the conditions in Krakow were best reflected by the scenarios in the Swiss report. This report envisages nine tap water supply scenarios, out of which four assume water consumed directly from the tap, without chilling or carbonation. The differences between these scenarios are related to the source of the water and consequently to its treatment. The scenarios cover water from abstraction intakes typical for Switzerland (Kr.1), Europe (Kr.2), Swiss rural areas (Kr.3) and Swiss urban areas (Kr.4). The Kr.4 scenario is 28% more energy intensive than the Kr.1 scenario. This is not much if we take into account that the Kr.6 scenario which assumes additional boiling of water in an electric kettle increases the energy demand by 10,000%. The Kr.4 scenario, which describes the water supply to the region around Zurich, is the closest to that of Krakow. The city of Zurich is supplied with water from Lake Zurich and water is treated in six steps: pre-ozonation, rapid sand filtration, intermediate ozonation, granular active carbon filtration, slow sand filtration and reservoir in the plant (Hammes, 2010). In Krakow each abstraction intake uses different water treatment technology (Olko, 2008). They all have coagulation, sedimentation and disinfection stages. Since surface water is the source for both Zurich and Krakow i.e. water having similar parameters, it can be assumed that the water treatment processes have a similar burden on the natural environment in both cities. As for bottled water the Swiss report assumes 10 scenarios depending on the location where the water is produced (Switzerland, Europe), vehicle transportation distance (from 50 to 1000 km), the distribution method to the households (from 0 to 10 km by delivery van), the type of water (carbonated, still), drinking temperature (chilled, not chilled), packaging (1.5 litre PET, 18.9 litre demijohn for recycling, 1 litre glass bottle for recycling). The 3 scenarios for bottled water consumption which were closest to the conditions for Krakow were chosen. All of them relate to consumption from 1.5 litre plastic PET bottles since as much as 90% of bottled water is sold in plastic PET bottles in Poland (Berbeka, 2012). The scenarios differ in the distance the water needs to be transported between the producer and the consumer which according to the report can be 50, 200 or 1000 km. Only one scenario assumed a water transportation distance of 200 km. For Krakow the most popular carbonated and still waters are *Cisowianka, Muszynianka, Nałęczowianka and Żywiec Zdrój* amounting to 73% of the water sold (Berbeka, 2012). Their places of production are Nałęczów (250 km), Muszyna (150 km), Mirosławiec (660 km) and Żywiec (110 km) from Krakow respectively (*Żywiec Zdrój* is bottled in 2 locations) (Grzegrzółka, 2002). Therefore the scenario assuming a transportation distance of 200 km seems the most appropriate. The But.5 scenario assumes that the water consumed is unchilled, carbonated and transported 200 km by lorry. In reality some of the water in Krakow is still and some is sold and drunk chilled. Accepting the assumption that all the water is carbonated and chilled, from the point of view of the burden on the environment, they partially compensate each other and thus the But.5 scenario seems to be a good choice for the water consumption model for Krakow. Based on unit indicators estimated in the Swiss report and assuming that 756,186 residents drink 1.5 litres of water daily, the annual consumption of primary energy and greenhouse gas emissions have been estimated – see Table 2.

Table 2 shows that the environmental impact depends on the water consumption scenario. Many people boil water in the summer only because they are afraid of bacteriological contamination. This causes a hundred-fold increase in primary energy usage. Energy consumption and greenhouse gas emissions are about 400 times greater for a glass of bottled water compared to tap water. This is quite a considerable amount of energy as it is estimated that an average resident uses 780 kWh of electrical energy annually (*GUS*, 2012). This means that primary energy used in water production and consumption comprises from 0.2% to 162% of electricity used in households, depending on the scenario.

In reality water consumption in Krakow is a mixture of scenarios. About 15% of water (80 litres annually) is drunk as bottled water, which approximately corresponds to scenario But.5, whilst the remainder is drunk as tap water which corresponds to scenario Kr.4 or Kr.6. Using scenarios Kr.4 and But.5 as the base the impact of the intermediate scenarios on the environment were estimated. The results are shown in Figure 1.

These charts can be helpful in estimating the expected impacts when changes to the water consumption model are made. The impact of reducing consumption of bottled water by one litre on the global environment and the city was also estimated. These estimates are both city-wide and for one resident. The results are shown in Table 3.

Reducing consumption of bottled water by 1 litre produces primary energy savings of 4.4 MJ which is equivalent to 0.2% of electricity used by each resident. Reducing consumption of bottled water by 1 litre by every resident in Krakow will reduce carbon dioxide emissions by 149 tonnes annually on a city-wide scale and save the residents approximately 1,258,000 zloty annually. Taking into the account the current PET waste recycling level for Krakow a 1 litre reduction in the consumption of bottled water also means a saving of 181 m^3 in landfill. The impact on the environment is measured using Eco-indicator

Table 2. Energy consumption and GHG emissions for different water consumption scenarios for Krakow

Scenario		Unit Indicators		Data for Krakow	
		Energy consumption	Greenhouse gas emissions	Energy consumption	Greenhouse gas emissions
Description	Abbreviation	$\frac{MJ_{eq.}}{l_{water}}$	$\frac{kg\ CO_{2\ eq.}}{l_{water}}$	$\frac{GJ_{eq.}}{year}$	$\frac{kg\ CO_{2\ eq.}}{year}$
Water from a municipal water supply network, unchilled	Kr.4	0.014	4.06E-04	5,631	168
Water from a water supply network, boiled in an electric kettle	Kr.6	1.07	1.65E-02	442,991	6,831
Bottled water, transported 50 km, still, unchilled, plastic PET bottle	But.4	4.35	1.78E-01	1,800,944	73,694
Bottled water, transported 200 km, carbonated, unchilled, plastic PET bottle	But.5	4.38	1.98E-01	1,813,365	81,974
Bottled water, transported 1000 km, still, unchilled, plastic PET bottle	But.9	8.34	4.25E-01	3,452,845	175,954

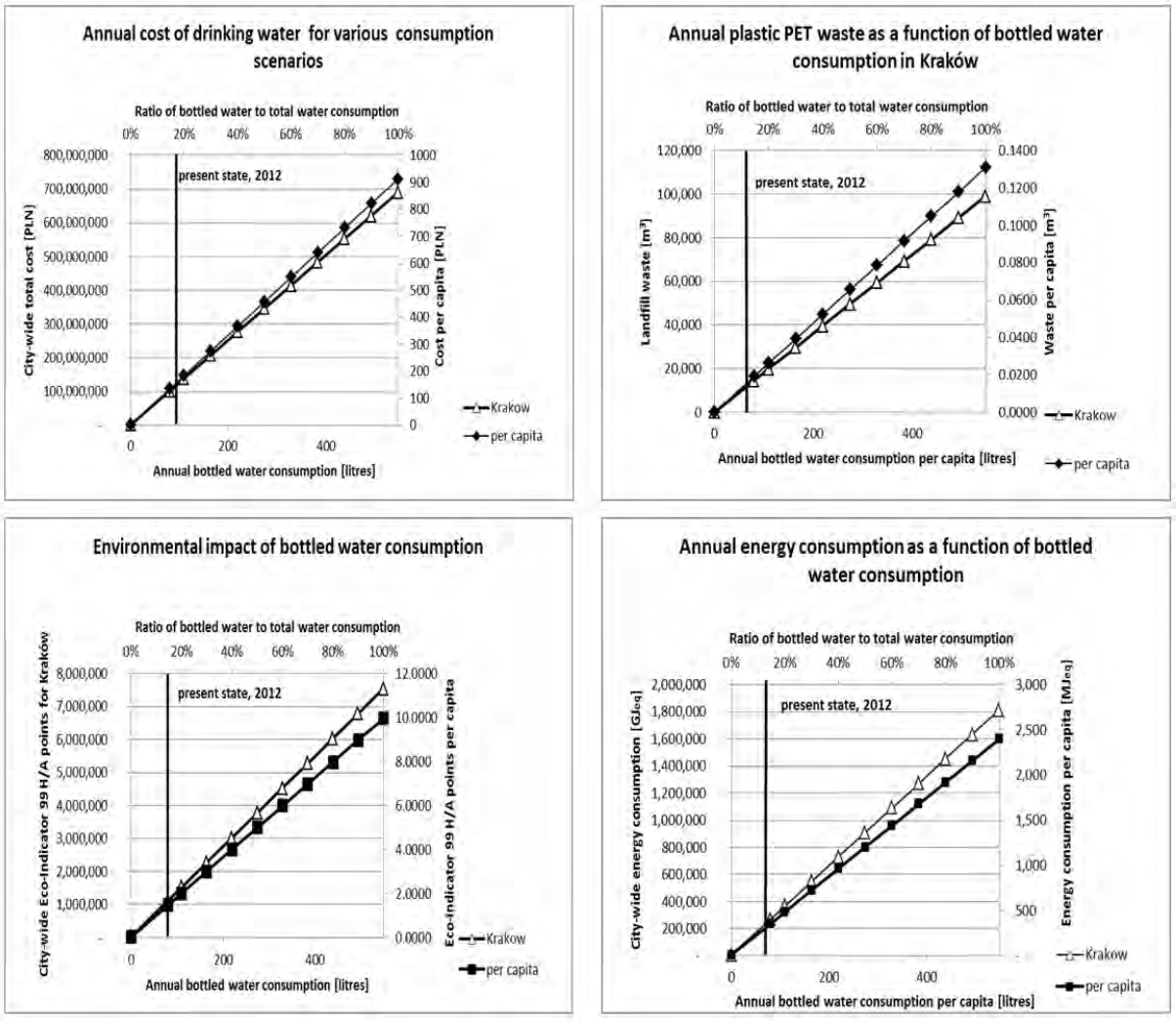

Figure1. Economic and environmental impact for different drinking water consumption scenarios in Krakow.

Table 3 Environmental impact of a one litre reduction in the consumption of bottled water

	Reduction in bottled water consumption	Energy consumption	CO_2 emission	Cost	Volume of waste	Environmental impact
	Litres	MJ_{eq}	kg CO_{2eq}	PLN	m^3	Eco-Indicator99 H/A Points
For 1 resident	1	4.366	0.198	1.66	0.0002	0.0182
For Krakow	756,183	3,301,797	149,417	1,257,711	181	13,733

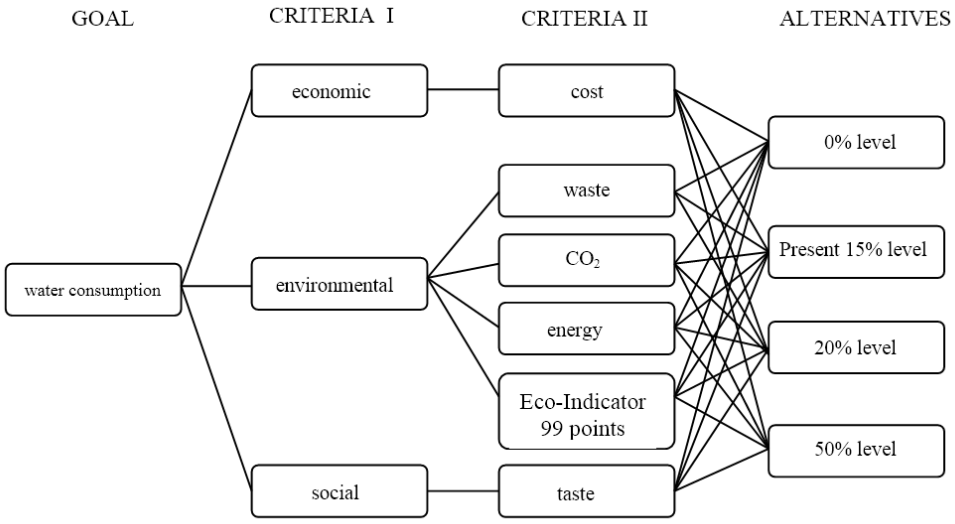

Figure 2. Hierarchical tree of criteria for AHP analysis

99 H/A points. It is estimated that the impact on the environment is $3.93*10^{-5}$ points when consuming 1 litre of tap water. However, for bottled water it is 463 times greater at $1.82*10^{-2}$ points. Eco-indicator 99 H/A points are used primarily to compare different scenarios and 1000 points have been defined as the annual environmental load of an average European citizen. Consequently one can approximate that the reduction of litre in the consumption of bottled water annually by every resident in Krakow is equivalent to a reduction in the environmental load by 14 Europeans. In comparison, for tap water a reduction of 1 litre in the consumption of bottled water is equivalent to a reduction of 463 litres of tap water which is 85% of the annual water consumption intended for drinking purposes.

Evaluation of the water consumption model in Krakow from a sustainable development perspective

The evaluation of individual water consumption models from a sustainable development perspective requires an analysis of these models with consideration to their effect on society, the natural environment and economic impact (Munasinghe, 1993), (Pearce, 1994). The next stage is to work out the individual criteria and to select the comparison method. The Analytic Hierarchy Process (AHP) is one of the universal comparison methods which can be used to compare products or processes from a sustainable development perspective (Stypka, 2012), (ReVelle, 1997). This method involves:

- Constructing a hierarchical tree of criteria,
- Determining the weightings for each criteria using pairwise comparisons,
- Assessing how the analysed solutions fulfill individual criteria by making a series of pairwise comparisons for the solutions. Otherwise assessing the degree of compliance with the criterion by introducing direct data,
- Calculating the final ranking of the individual solutions, which is the sum of the products of the weightings assigned to individual criterion and the degree of compliance for a particular criterion for the analysed solution.

In the case of water consumption in Krakow, four potential scenarios were considered, each differing in the percentage of bottled water of the total water consumed. Scenarios where bottled water constituted 0%, 15%, 20% and 50% of the water drunk were analysed. On the basis of the available criteria, a hierarchical tree of criteria (Figure 2) was constructed and using the described method above the degree of compliance with individual criteria for each scenario was evaluated (Table 4). Minimum and maximum values in each category were assigned to the scenario where bottled water consumption was 0 and 100% respectively. As a social criterion the taste of water was assigned between 0 and 10 points. The same satisfaction level from drinking water was assigned to all scenarios since in reality both professionals and amateurs find it difficult to distinguish the source the water originates from (Berbeka, 2012). The authors of this article assigned the weightings to individual criterion in accordance with the AHP procedure, comparing individual criteria pairwise. The Web-HIPRE application supplied by the Helsinki University of Technology was used for analyses (*Hipre*, 2013).

Table 5 and Figure 3 show the results for the AHP analysis.

In accordance with the accepted procedure the scenario which assumes drinking only unboiled tap water has an overall score of 0.953 where the maximum score is 1. However, the scenario where 50% of wa-

Table 4. Degree of compliance for individual criterion for various water consumption scenarios

Criteria	Unit	Scenarios analysed (% of bottled water consumed)				Minimum	Maximum
		0%	15%	20%	50%		
Energy consumption	MJ eq/capita	7.45	356.00	485.57	1,202.75	7.45	2,398.05
GHG emissions	kg CO_2/capita	0.22	16.03	21.86	54.31	0.22	108.41
Waste	m^3/capita	0.00	0.02	0.03	0.07	0.00	0.13
Cost	PLN/capita	1.88	134.94	184.00	457.19	1.88	912.50
Environmental impact	Eco-Indicator 99 H/A points	0.02	1.47	2.01	4.99	0.02	9.96
Taste	points	5.00	5.00	5.00	5.00	0.00	10.00

Table 5. AHP scores for the drinking water problem in Krakow according to sustainable development criteria

Criteria	Weightings for level ll criteria	Analysed scenarios (% of bottled water consumed)			
		0%	15%	20%	50%
Waste	0.22	1	0.854	0.800	0.500
CO_2 emissions	0.09	1	0.854	0.799	0.500
Energy consumption	0.08	1	0.854	0.800	0.500
Environmental impact	0.62	1	0.854	0.800	0.500
Criteria	Weightings for level I criteria				
Economic	0.250	0.250	0.213	0.200	0.120
Environmental	0.655	0.655	0.559	0.524	0.327
Social	0.095	0.048	0.048	0.048	0.048
Total		0.953	0.820	0.772	0.495

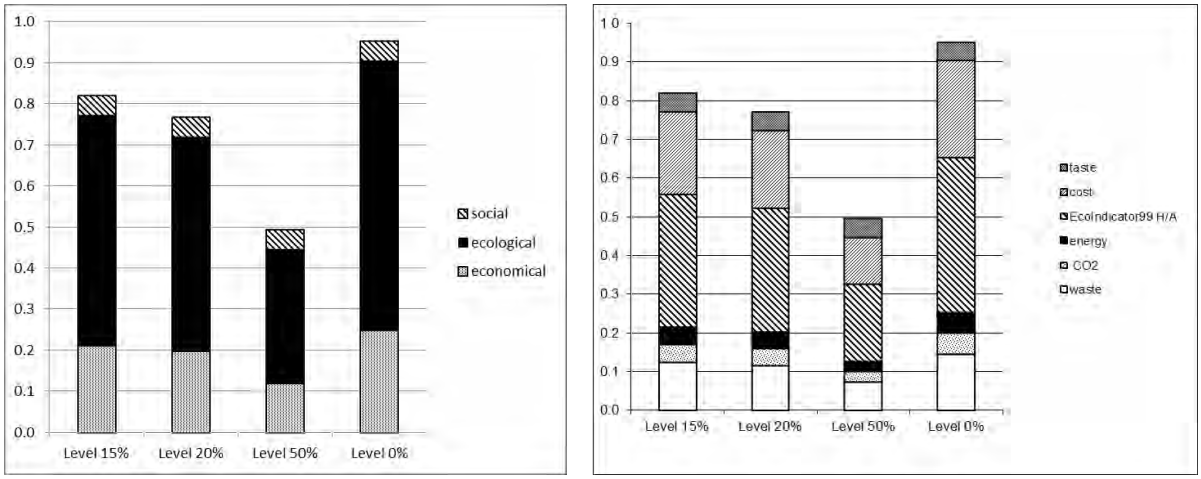

Figure 3 AHP scores for the drinking water problem in Krakow using sustainable development criteria

ter drunk comes from plastic PET bottles scores 0.495. A sensitivity analysis shows that when the weightings are changed the overall score for the individual scenarios also changes, but their relative ranking remains unchanged. The current water consumption scenario for Krakow has an overall score of 0.820 and is 14% worse than the best scenario from the sustainable development perspective. The environmental impact, particularly when measured using Eco-indicator 99 H/A points is the most important criterion for Level I.

Conclusions

An analysis of the water results for Krakow and of the scientific literature on environmental loads for different water intended for human consumption models leads us to the following conclusions:

Tap water in Krakow is *clean and healthy* and is suitable for direct consumption without boiling.

The promotion of drinking tap water is in accordance with the concept of sustainable development, significantly reduces loads on the natural environment, is

economically advantageous and does not have negative social impacts.

The average resident in Krakow drinks approximately 547 litres of water annually, of which 80 litres is bottled water. Bottled water accounts for 15% of the total water used for human consumption.

The main environmental burden caused by bottling water is energy demand and waste. The energy demand for bottled water is between 5.6 and 10.2 MJ/litre whilst for tap water it is 0.005 MJ/litre. This means that consumption of bottled water is approximately more than a thousand times more energy demanding than that of tap water. Bottled water is approximately 500 times more expensive than tap water.

Assuming a high level (73%) of recycling of plastic PET bottles, 14,000 m^3 of waste is produced annually in Krakow which reaches landfill following consumption of bottled water.

On the basis of an existing LCA report for Switzerland the current water consumption model for Krakow can be used to estimate the impact on the environment.

According to such estimates, the average resident in Krakow, through drinking water annually, gets through 356 MJ, produces 0.019 m^3 of waste and pays 135 zloty. The environmental load is 1,474 Eco-indicator 99 H/A points.

On a city-wide scale the current water consumption model expends 269,201 GJ of energy and creates 14,473 m^3 of waste. The total drinking water expenditure for the city's residents is 102 million zloty whilst the environmental load is 1,114,896 Eco-indicator 99 H/A points annually. This is equivalent to the total activity of approximately 1,115 Europeans exerting a load on the environment.

Reducing consumption of bottled water by 1 litre annually will save Krakow 3.303 TJ of energy, reduce CO_2 emissions by 149 tonnes, reduce the amount of landfill waste by 181 m^3, save its residents 1.258 million zloty, and reduce the environmental load of 14 Europeans.

The multi-criteria AHP method can be used for the complete evaluation of different water consumption scenarios from a sustainable development perspective. The scenario for drinking only tap water scored 0.953 (on a scale of 0 to 1), whilst the scenario for the actual state of affairs scored 0.820. The evaluation depends on the accepted criteria weightings, but the ranking of the various scenarios is insensitive to changes in weightings.

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Urban Flooding and Sustainable Land Management – Polish Perspective

Powodzie miejskie i zrównoważona gospodarka terenami – polska perspektywa

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Abstract
There have been many events connected with damaging abundance of water in Polish towns in recent decades. Some of them have been caused by flood waves on rivers passing through towns. Others have been caused by intense precipitation overwhelming the capacity of storm sewer systems. A brief review of the topical area of urban floods in Poland in last decades is provided. Mechanisms responsible for increase of flood risk are discussed in a systematic manner. In result of multiple mechanisms, the frequency of inundations has increased and is likely to increase further. Examples of sustainable management issues related to floods are reviewed. Flood protection and flood preparedness are examined in the sustainability context.

Key words: urban floods; land management; sustainable development; Poland

Streszczenie
W ostatnich latach w Polsce miało miejsce wiele niebezpiecznych zdarzeń związanych z niszczącą siłą wody. Niektóre z nich były spowodowane falami powodziowymi płynącymi przez mijające miasta rzeki. Inne uwarunkowane były intensywnymi opadami przekraczającymi pojemność systemów kanalizacji deszczowej. W tej pracy dokonano przeglądu tego typu zdarzeń z okresu ostatnich kilku dekad. Omówiono i usystematyzowano mechanizmy przyczyniające się do obserwowanego wzrostu zagrożenia powodziowego. Przedstawiono przykłady zrównoważonego zarzadzania w kontekście powodziowym. Przeanalizowano także istniejącą ochronę przeciwpowodziową i poziom przygotowania na przyjęcie powodzi.

Słowa kluczowe: powodzie miejskie, zarządzanie terenem, zrównoważony rozwój, Polska

Introduction

Since the dawn of civilisation, destructive floods have jeopardised settlements located near rivers. Despite developments in technology and extensive investments in flood control works, flood damages are indeed growing, reaching globally tens of billions of USD, per annum, in both developed and developing countries. The number of floods in Europe exceeding selected severity and magnitude thresholds has been increasing (Kundzewicz et al., 2013). Damages are particularly high in urban areas. This can be seen in context of the increasing proportion of population living in towns – more than 50% globally. Cities constitute a driving force of the economy. Indeed, the 21st century can be called the age of cities (Sztumski, 2013).

In recent decades, several Polish towns have been hit by inundations. Major floods, with high material damage and fatalities, have been caused by passage of a flood wave on rivers running through towns.

Many problems have resulted from intense precipitation on largely impervious urban areas with insufficient storm sewerage network.

The most destructive flood ever recorded in Poland was the July 1997 flood on the rivers Odra, Vistula, and their tributaries (Kundzewicz et al., 1999) resulting in high material damage and fatalities in urban areas. Having inundated the town of Racibórz (65 000 inhabitants), the River Odra devastated further large towns located downstream: Opole (131 000) and Wrocław (700 000). The flood protection system of Wrocław, designed for a flow rate of 2400 $m^3 s^{-1}$, had to fail since the peak flow rate was about 50% higher. The absolute all-time records of water level were observed in all gauges of the upper and medium reaches of the River Odra and, in result, all towns on the Odra in Poland, upstream of Słubice, were damaged by the 1997 flood. Słubice itself, laying in depression, with its centre about 4.5 m below the flood water level in the River Odra, was the most upstream town on the Polish Odra that avoided inundation in July 1997. The levees survived but since the risk of failure was high, the population of the town was evacuated. The nationwide toll for both Odra and Vistula floods of summer 1997 was an all-time high in Poland as far as economic losses are concerned. The estimates of material losses range from 2 to 4 billion US$ (at 1997 value), indicating that the costs were of much significance to the national economy. The number of fatalities reached 54. The number of flooded towns and villages was 2592 (1362 totally and 1230 partially inundated). The flood caused damage to 46 000 houses and apartments and the number of evacuees was 162 000. Around 6650 km^2 of land were flooded, of which over 4500 km^2 consisted of agricultural fields. The flood destroyed about 480 bridges and damaged 245. The serious damage to roads and railways occurred at 3000 km and 2000 km, respectively. Loss of 1900 cattle, 5900 pigs, 360 sheep and around 1 million poultry was recorded. Embankments were damaged or seriously weakened at a distance of about 1100 km.

The 1997 flood was extensively covered by Polish media. For several weeks, it was the dominating topic in the press and the principal theme of cover stories of weekly magazines.

Another, more recent, train of destructive floods occurred in Poland in 2010 (Kundzewicz et al., 2012a), causing high material damage and fatalities, also in urban areas.

In recent decades, there have been many problems related to intense precipitation in urban areas, throughout the country, e.g. in Warsaw, Poznań and the Wielkopolska Province (e.g. Swarzędz, Kostrzyn – cf. Fig. 1, Luboń, Mosina). Spectacular problem arose in the Three-Towns (Gdańsk, Gdynia, Sopot) when on 9 July 2001 intense rain fell. In Gdańsk, precipitation of 90 mm was recorded within 2 hours and roads down the slope turned into torrential streams. In result of this urban flooding, 134 buildings were badly damaged and had to be torn down.

Figure 1. After intense rain water inundated the underground pedestrian passage under railway in Kostrzyn Wielkopolski in June 2010 (Kowalczak et al., 2010)

Virtually, in every year there are numerous inundations caused by intense precipitation in Poland. In June 2013, an important road within the capital city of Warsaw was inundated by water from intense rain to the depth of up to 2.5 m and this led to a political crisis as the mayor was declared guilty and heavily criticized by the opposition.

Flood disasters and flood defences can be regarded in the context of sustainable development, even if this notion may mean different things to different people, some definitions lend themselves well to applications in the topical area of floods:

a) assuring that the development meets the needs of the present without compromising the ability of future generations to assuring their own needs (best known, classical, definition, so-called *Brundtland definition*, after WCED, 1987);
b) living on the *interests* from the Earth *capital* without depleting (preferably, with augmenting) the capital itself, as inherited from former generations (cf. Kundzewicz et al., 1987);
c) improving the quality of human life (attaining non-decreasing human welfare over time, with welfare understood more broadly than GDP, including assets related to environment) within the carrying capacity of supporting ecosystems (IUCN, 1991).

Floods bring destruction to cultural, and in particular – urban, landscapes, with their infrastructure – buildings, industry plants, historical monuments, communication infrastructure: bridges, roads, and railways,

inherited from former generations. Floods may destroy the human heritage and undermine the development by breaking continuity.

Mechanisms of changes in flood risk in urban areas in Poland

Kundzewicz and Schellnhuber (2004) generally attributed changes in flood risk to three categories of mechanisms: changes in socio-economic, terrestrial, and climate/atmospheric systems. Changes in socio-economic systems of relevance to flood risk embrace land-use change, increasing exposure and damage potential, floodplain development, growing wealth in flood-prone areas, and changes in risk perception. Damage potential grows with economic growth (Fig. 2). Changes in terrestrial systems include land-cover change – urbanization, deforestation, elimination of natural inundation areas (wetlands, floodplains) and river regulation – therein construction of embankments. Finally, the category of changes in climate embraces changes in water holding capacity of the atmosphere in the warming climate, increase in intense precipitation, changes in snow cover, seasonality of precipitation, and weather circulation patterns. All these mechanisms are of relevance to flood generation in urban areas.

In result of mechanisms of change listed above, water level in a river gauge in an urban area with a certain return period, e.g. 1000 years (i.e. with annual exceedance probability of 0.001), used as a design flood in urban areas, where damage potential is very high, and growing, and therefore adequate level of protection is necessary, may have already increased and is projected to increase further. That is, a 1000-year water level determined for past-to-present is likely to be attained more frequently in the future in many areas, i.e. it will correspond to a return period of fewer years (Fig. 2, Kundzewicz et al., 2010). This rhymes with the *Leitmotiv: stationarity is dead* of Milly (et al., 2008).

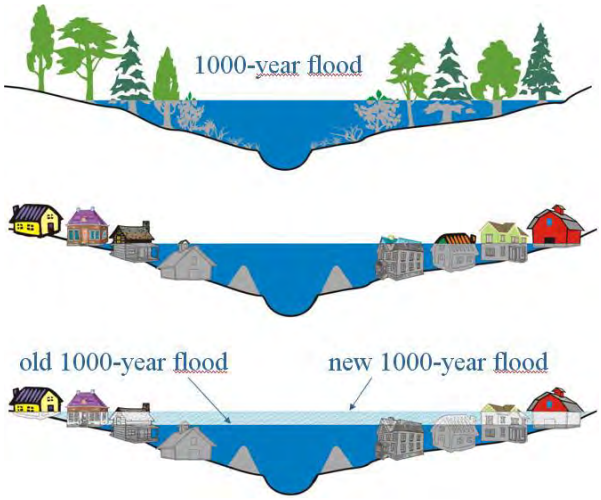

Figure 2. Changes in socio-economic and terrestrial systems induce changes in flood risk (Kundzewicz et al., 2012)

Urban areas have shown particularly strong human impact. Human activities result in change of the water systems, climate (at all scales), and vegetation. There is a growth of impervious (sealed) areas that substantially reduces infiltration into the ground, transformation of soils – reduction of storage, elimination of small surface retention areas, and drainage – dewatering of shallow groundwater and rain waters. Impermeable roofs, roads, pavements and car parking constitute an increasing portion of urban areas. The value of the roughness coefficient gets lower, green areas are shrinking and small rivers are often conducted underground. In result, flood water in urban areas is conveyed faster from the source of runoff generation to the receiving areas, than in rural areas, where higher infiltration rates occur that enable recharging groundwater and where wetlands and meadows provide water storage buffers thus lowering the inflow to rivers. Unfortunately, nowadays, drainage of wetlands and channelization of waterways have reduced storage and infiltration capacity of floodwaters (Kowalczak & Kundzewicz, 2011). Levees are constructed and flood plains are cut off (Fig. 2). In brief, land-use change leading to land-cover change has resulted in reduction of storage, a higher flood peak, and a shorter time-to-peak.

The distribution of the frequency of high flows changes adversely, due to the increasing portion of hydrologically active (i.e. runoff-generating) areas. Water storage in all its guises is reduced, and the amplitudes of high flows increase. Another source of problems is the increasing loading of the storm sewerage network, dewatering the growing urban fabric, without creation of adequate water storage space. Storm sewerage can be rated as increasingly insufficient and expensive.

Increasing flood exposure results from human encroachment into floodplains and economic development of flood-prone areas. Many wrong locational decisions have been taken, and the assets at risk from flooding are high, and growing. Risk perception has changed – people feel more secure behind the dikes, but this feeling is not justified, as there is no such thing as absolute flood safety.

Anthropopressure causes the tendency to use additional land, that is also the flood plains that attract development due to their flatness, soil fertility, proximity of water, and aesthetics.

In mountainous areas, urban and semi-urban development extends to hilly slopes which are at risk of landslide and debris flows. The problem is increasing with residential area development on the hill side, deforestation, and road construction (Kundzewicz & Takeuchi, 1999).

Management issues

In this section a review of management issues will be tackled. Particular flood preparedness measures will be looked at from the sustainability perspective.

There exist a roster of strategies for reducing flood losses by flood protection and management and all of them are of relevance to urban areas. They may modify (Kundzewicz & Schellnhuber, 2004):

- susceptibility to flood damage;
- flood waters; or
- impact of flooding (during and after flood).

Flood protection measures can be structural (*hard*) or non-structural (*soft*). Dams and flood control reservoirs, diversions, etc. belong to the category of structural flood mitigation measures. Constructing reservoirs where the excess water can be stored allows a regulated temporal distribution of streamflow and helps alleviate the flood problem by flattening destructive flood peaks.

A sample of possible non-structural (*soft*) means include:

a) zoning, regulation for flood hazard areas development leaving flood plains with low-value infrastructure, e. g., vegetation occasionally flooded;
b) flood mitigation system of forecasting, warning (issuing and dissemination), evacuation, relief and post-flood recovery;
c) flood insurance, that is division of risks and losses among a higher number of people over a larger space and time; and
d) capacity building (improving flood awareness, understanding and preparedness), enhancing participatory approach.

An important flood protection measure is the source control that is watershed management including land use and soil conservation to minimise surface runoff, erosion and sediment transport. This idea is implemented by enhancing infiltration e.g. via pervious pavements and parking lots, local storages: ponds, building and groundwater storages (Kundzewicz & Takeuchi, 1999). Enhancing retention counteracts the adverse effects of urbanisation (growth of flood peak, drop in time-to-peak of a hydrograph, drop in roughness coefficient and in storage potential) and channelization (faster flood conveyance through shortened and straightened rivers).

The flood damage potential is increasing because of urbanization and over-reliance on the safety provided by levees and reservoirs etc. Typically, dikes offer adequate protection against small and medium size floods, i.e. the number of damaging floods in this range is decreasing. Yet, when the deluge is of disastrous size and the dikes break (Fig. 2), the losses in a dike-protected landscape are higher than would have been in a natural state (without levees, Kundzewicz & Takeuchi, 1999).

An important measure that lends itself well to solving the urban flooding problems is spatial planning (*room for rivers*), based on zoning and restriction of new development. However, we have to provide a high standard of protection for existing built-up areas of high historical and material value. As an alternative (and/or a complement) to structural flood defenses, rainwater management (*catch water where it falls*) could be used, providing multiple benefits, such as increasing the available water resources and enhancing ecosystem services, in a cost-effective way.

Regulations on zoning (identifying direct flood risk areas, with ban on construction; and potential flood risk areas (if a levee breaks), with restricted development, have been in place in Poland, but they have not been effectively enforced yet.

Levees protecting agricultural and rural areas upstream of a large town eliminate natural storage areas, whose presence would be beneficial for catching the water and weakening of the impetus of a flood wave. Hence, the elimination of flood plains upstream of a town may adversely affect the flood protection of the town. During the Odra River flood in Poland, in July 1997, the idea emerged to intentionally break levees upstream of the large town of Wrocław, in rural areas. The inundation of rural areas was envisaged to be a lesser evil, aimed at reducing aggregate flood damage by avoiding inundation of a large town, with much higher flood-damage potential. However, the idea was not implemented, because of strong resistance of the farmers and, as it turned out later, in this particular case, the envisaged sacrifice of the rural areas indeed would not have saved Wrocław. The masses of water propagating along the River Odra were simply too large in comparison to the emergency storage volume that would have been gained by a levee break. However, the lesson from this experience was learnt: the flood time is not the appropriate moment to consider, in the improvisation mode, technicalities and consequences of breaking a dike. This should be studied and tested well in advance, in a non-flood time. This remark actually refers to the entirety of flood protection / flood preparedness system that should be prepared beforehand, in flood-free time. No experiments should be conducted during a flood event.

There was a controversy on reservoir management between the upstream and downstream riparians observed during the large flood in July 1997 (see Kundzewicz *et al.*, 1999): large spills from upstream water storage reservoirs were blamed for aggravating the flood damage in several towns downstream.

In Poland, several activities aimed at strengthening the flood protection and preparedness system have been undertaken since the 1997 flood. Large, and costly, programmes like Programme for the Odra 2006 and programme of flood protection in the drainage basin of the Upper Vistula River have been proposed. Yet, it remains to be seen whether these very costly activities will indeed substantially reduce the flood risk.

European Union legislation aims to alleviate problems related to flood risk reduction. Since 1 May 2004, the Republic of Poland has been a Member

State of the European Union (EU); hence, obeying to the advanced EU environmental legislation. Implementation of the Floods Directive of the European Union (CEC, 2007), a unique act of international law, probably the most advanced worldwide, brings hope that flood risk and vulnerability will be reduced at the level of the whole 28-country organism of the EU, including Poland. EU Member Countries are obliged to adhere to Floods Directive and prepare flood hazard maps and flood risk maps for areas which could be flooded by floods with a low probability (or extreme event scenarios); floods with a medium probability (likely return period ≥ 100 years); and floods with a high probability. The EU Floods Directive foresees that Member States shall ensure that the flood hazard maps and flood risk maps are completed by 22 December 2013. Member States shall also ensure that flood risk management plans are completed and published by 22 December 2015. According to the Flood Directive, flood risk management plans should be periodically reviewed and – if necessary – updated.

The advent of flood-risk maps and potential flood-damage maps, and plans for flood risk management is healthy, and augurs well for urban flood risk reduction in Poland. However, the so-far flood risk awareness in the country is not adequate. For many dwellers of riparian areas, the finding that they have been living in a 100-year flood area is a shocking news. Beautiful locations near a river used to be among the most expensive sites in some towns. When the flood risk maps become public, the impact on the real-estate market can be very serious and the value of some properties (land and buildings) are likely to drop dramatically. Insurance companies would propose high (in some cases, unaffordable) premiums, because of the high flood risk in such locations. Nevertheless, the EU Floods Directive is a fair rule, enhancing implementation of the *risk-taker pays* principle, likely to enforce the appropriate, and much needed, zoning.

Klijn (et al., 2004) made a call in the Netherlands to move away from resistance to resilience approach in the flood management policy. The notion of resilience, understood as the ability of a system to withstand a disturbance, incorporates hazard control (e.g. heightening of dikes). However, higher dikes can give false feeling of perfect protection against floods enhancing more development in floodplains behind dikes. Then, less room is available for flood waters between dikes, because floodplains are cut off. This, again, necessitates additional heightening of dikes. Resilience is understood as system's ability to recover easily and quickly from a disturbance. In this approach, land use must be adapted to allow the river to temporarily inundate large areas during floods while reducing flood damage.

This attitude is similar to replacing the policy of *fail-safe* systems by *safe-fail* systems (Kundzewicz & Takeuchi, 1999). It is impossible to design a system that never fails (fail-safe), in general, and in flood protection in particular. What is needed is to design a system that fails in a safe way (safe-fail). Since a flood protection system guaranteeing absolute safety is an illusion, a change of paradigm is needed: it is necessary to live with the awareness of the possibility of floods. No matter how high a design flood for a structural defence is, there is always a possibility of having a greater flood, inducing losses. Rather than trying, in vain, to eradicate floods, one could accommodate them in planning and learn to live with them, preparing for flooding and reducing damages.

It is advisable to restore natural processes in the urban environment in order to enhance infiltration and slow down the devastating effects of high runoff values. Such advantageous processes can be mimicked using swales, eco-roofs, constructed wetlands and detention basins.

Providing effective flood protection to the dwellers of the Kozanów estate in Wrocław, which was inundated in both large recent flood events in 1997 and 2010, would be prohibitively expensive. Hence, a conflict has emerged between the groups of inhabitants of Wrocław – those living in the estate and those not living there. The former wish to be protected, no matter what the cost (to be borne by taxpayers), while the latter subscribe to the *risk-taker pays* principle, and do not want non-resident tax-payers to support the costly protection of people living in unsafe, flood-prone, areas (Kowalczak & Kundzewicz, 2011).

A common reason for controversies is the lack of synchronization of setting the law and planning new endeavors. Rainwater management in Polish towns is basically an area dominated by fiscal politics, whereby a tax is introduced, determined according to some measures of impervious area.

Management of rain waters in urban areas has been embraced in programmes of small storage and biologically-active surfaces in local plans of spatial arrangements in many European countries (e.g. Austria, Denmark, France, Germany, Great Britain, the Netherlands, Sweden, Switzerland). Rainwater management has been also introduced in several Polish towns (e.g., Leszno, Krotoszyn, Gdańsk). However, in Poland, several problems related to rainwater management (of social, environmental, economic, legal, planistic and aesthetic nature) and a number of barriers (planning-organization, legal, economic, social) can be distinguished. The traditional attitude is as follows: rainwater has to be fed to storm sewage. There is lack of awareness and lack of examples of good practices. It is necessary to develop a system of information on risk for the population, and to undertake awareness raising action (Januchta-Szostak, 2011)

Poznań is one of the towns in Poland, where the increase in storm sewer drainage in recent decades has been very strong: from 1.3×10^6 m^3 in 1945 to 20.3×10^6 m^3 in 2000. As a result, surface runoff and

infiltration decreased considerably. Yet, intense precipitation on increasingly sealed areas is a tough challenge to the storm sewer drainage, designed for less demanding conditions. Hence, measures to reduce impermeable areas have been considered, but their effectiveness is questionable. The municipality of Poznań introduced a precipitation-drainage tax, determined according to the roof area of a property. The debate about the principle of taxation has taken place in different towns, and a range of solutions were envisaged. The tax included impervious areas; e.g. in Elbląg, it was calculated according to the area of pedestrian pathways, roads and car parks (Kowalczak & Kundzewicz, 2011).

During a river flood, levees serve as flood protection, whereas during an urban inundation caused by intense rain on the town side of the levee, structural defense is a drawback hindering conveyance of water out of the inundated town to the river network.

Different flood types require different measures. For example, in Słubice, in case of an ice jam flood there is a 4 h advance notice for evacuation. If the flood wave on the Odra is caused by snowmelt in the mountains, the advance notice is of 6-7 days, so that there is ample time to undertake effective flood action.

Difficult and potentially conflict-generating problems are related to flood insurance. During the 1997 flood, the then Prime Minister of Poland, Włodzimierz Cimoszewicz, stated soberly that only insured inhabitants can count on receiving compensation for flood damage. This undiplomatic statement (essentially right but delivered when many Polish people suffered acute flood losses) was heavily criticized and is believed to have contributed (among other things) to the fall of the government. However, flood insurance is expected to play an increasing role in Poland and to enhance sustainable land management.

The 1997 flood has taught humility to arrogant politicians and militant environmentalists alike. The new reservoir in Czorsztyn, subject to violent and long-lasting dispute that had lasted for decades, proved to be very much needed during the flood, saving settlements from inundation.

Sustainable development context

The ecologic, economic, and socio-cultural goals of sustainable development should be realised to provide a decent life for people, while preserving the existing environmental capabilities (Rogall, 2009).

Sustainable development should have a built-in mechanism of maintenance of resilience against surprises and shock, such as a violent abundance of destructive water. A common interpretation of sustainable development is that civilisation, wealth (human and natural capital) and environment (built and natural) should be relayed to future generations in a non-depleted shape. This can be illustrated by the notion that we borrow the environment from future generations. Devastating floods destroy cultural landscapes and undermine sustainable development by breaking continuity and impairing the quality of life (Kundzewicz, 1999). While flood protection is necessary to the present generation to attain a fair degree of safety from disastrous events, it must be done in such a way that future generations are not adversely affected. According to the UK Environment Agency (1998, p. 9), sustainable flood defense schemes should *avoid as far as possible committing future generations to inappropriate options for defence.* When building flood protection systems. one should not paint oneself into a corner from which retreat is impossible (or unaffordable).

Many objects of flood protection infrastructure have been criticised in the context of sustainable development as solutions closing options for future generations and introducing inacceptable disturbances in ecosystems (Takeuchi et al., 1998). *Soft* measures that do not involve large structural components can be rated as more sustainable than hard measures, yet the latter may be indispensable in particular circumstances (e.g. when very valuable urban fabric has to be protected also against large floods). Distributed, small-scale, structural approaches, such as source control, flood proofing, building codes, extending permeable areas etc., are also sustainable.

Gardiner (1995) compared options of flood defence and assessed their performance from the viewpoint of sustainable development. The rating ranged from very good for source control to bad / very bad for channelized rivers. He also noted that, among the many advantages of source control, it conserves resources, buffers systems from possible climate change impacts, conserves energy through increasing retention *at source*, promotes biodiversity by retaining water, improves self-sufficiency and recharges groundwater.

In order to measure the progress towards sustainable development, suitable criteria and indicators are needed, assisting one to steer action, to make decisions and to increase focus on sustainable development. One can take recourse to a general proposal of four conceptual criteria for evaluation of sustainability, that is: fairness, reversibility, risk, and consensus, recommended by Simonovic (see Takeuchi et al., 1998), all relevant in the context of flood defences.

Fairness or equity means that flood protection should be extended to all members of the society. Yet, difference in vulnerability to floods even between neighbouring households can be enormous and there is a social dissonance between the urban poor and the wealthy citizens (Sztumski, 2013). The notion of fairness may come about when examining management issues related to recovery after flood. Restoration after natural disasters, such as floods, can be lucrative to some companies that maximize profits (Klein, 2007).

Reversibility is not a strong feature of large, structural flood defences. Yet, there have been several examples of decommissioning of dams (e.g. in France) and of intentional removal of dikes, i.e. renaturalization of rivers (e.g. in Germany and Switzerland). In some cases, the cost of transformation of an engineered system to the original unengineered state happened not to be prohibitive (Takeuchi et al., 1998).
Risk is typically understood here as a product of hazard (probability of failure), being usually low, and consequences, usually high. The concept of risk can be illustrated in the context of structural flood defences – dikes. Existence of dikes creates a false feeling of absolute safety and may trigger intensive development of low-lying areas. If a dike breaks, this defence does not act as a protection, but rather as an amplifier of destruction; flood losses without a dike would have been lower.
Consensus means that involved and affected parties should agree as to the programme of flood protection and management. Yet, striving for absolute consensus can suffocate decision-making as clearly visible in some newly democratised countries.
One could add to these criteria also a measure of efficiency and synergism; a multi-purpose reservoir may have a number of functions related to sustainability: flood protection, water supply, hydropower, navigation, etc.
Gardiner (1995) suggested using four groups of criteria to compare options of flood defence and assessed their performance from the viewpoint of sustainable development. These criteria related to global environment (resilience to climate change, energy efficiency, biodiversity), inter-generational equity (retention of strategic adaptability / future options), natural resources (quantity and quality of surface water and groundwater, wildlife habitat) and local environment quality (morphological stability, landscape and open land, recreation and amenity and enhancement of river environment).
Criteria, indicators and checklists could be used to compare options for flood protection. Usually, there exist a spectrum of means to achieve a development target of concern, with differing values of quality criteria. One has to evaluate the advantages and disadvantages of alternative means for flood protection, both structural and non-structural, weighting their pros and contras (not only short-term benefits but also long-terms impacts and side effects, Kundzewicz, 1998). The viable alternatives should be revealed, made transparent to the public, subject to public discussion and, finally, the decision as to how to solve the problem should be accepted by the society.
Examples of quality indices which could be used when comparing alternative flood preparedness systems may relate to socio-economic and financial feasibility, related investment and operational costs; degree of intervention in the natural regime, stress to ecosystems and humans, use of energy and raw materials, and safety, risk and reliability issues, and opportunities for reversibility (flexibility) and rehabilitation (Kundzewicz, 1999).

Concluding remarks

There have been many recent events of damaging abundance of waters in urban areas in Poland. River floods constitute an important category of problems. Large floods can be caused by large rivers, the Vistula and the Odra and their tributaries, in particular headwater streams conveying waters from intense rain in the southern, highland part of the country where precipitation is typically higher than in the rest of, mostly lowland, Poland. Another category of problems are inundations caused by intense precipitation on urban areas (e.g., 50-100 mm of rain in an hour or two) that cannot be conveyed by the existing storm sewerage systems. The waters inundate streets (paralyzing communication) and pour in into cellars and underground pedestrian crossings. Urban drainage is not adequate to changing land use (and resultant changes in water storage, runoff coefficient, and roughness).
Occurrence of the following situations of complex (multi-mechanism) flooding in Polish conditions, inundations can lead to particularly severe flooding (Kundzewicz et al., 2012b):

- Flood wave on a tributary coincides with a flood wave on the main river.
- Intense rainfall occurs during snow melting.
- Intense rainfall occurs in urban areas during passage of a flood wave on a river.

As stated by Smith & Ward (1998, p. 5) *floods constitute a « hazard » only when human encroachment into flood-prone areas has occurred*. Indeed, for the nature floods are typically more a blessing than a curse – they recharge aquifers, providing abundant water to ecosystems.
Consequences of the inherited non-sustainable land management can be overcome if humans move out of harm's way. When adequate flood protection cannot be provided, permanent evacuation of floodplains is a viable option that definitely belongs to sustainable development.
Which flood protection measures are sustainable for sure? No doubt that *source control* and *soft* approaches belong to this category. However, this is not sufficient as a remedy against extreme floods and, in particular, urban flooding. Despite the criticism of structural flood protection measures, they are absolutely indispensable in order to safeguard existing high-value developments (including historical and cultural heritage) in urban areas. An effective flood protection system is therefore a mix of structural and non-structural measures.

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Perspectives for Development of Hydrotechnical Infrastructure in Poland in view of the European Union Water Policy

Perspektywy rozwoju infrastruktury hydrotechnicznej w Polsce na tle unijnej polityki wodnej

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Abstract

The article presents general conditions and perspectives for development of hydrotechnical infrastructure in Poland, as compared to the European Union water policy, which take into account demands of sustainable development. The hydrotechnical infrastructure analyzed in the article includes technical projects associated with flood control, water power engineering and water transport. Poland is in a particular situation because, due to historical determinants, including partition of its territory and war damages, the development of water management processes which may be observed in western European countries proceeded at a slower pace or simply did not take place at all. The current water policy stemming from the *Water Framework Directive* should be based on harmonization of economic growth and environmental requirements. In addition, cohesive sectoral planning documents are required. It is also imperative that water management plans for river basins take priority over other water management plans.

Key words: directive, hydromorphology, flood, water power engineering, shipping, development

Streszczenie

W artykule przedstawiono uwarunkowania i perspektywy rozwoju infrastruktury hydrotechnicznej w Polsce na tle unijnej polityki wodnej, uwzględniającej wymagania zrównoważonego rozwoju. Infrastruktura hydrotechniczna analizowana w artykule obejmuje przedsięwzięcia techniczne związane z ochroną przed powodzią, hydroenergetyką i transportem wodnym. Polska znajduje się w szczególnej sytuacji, bowiem, z racji uwarunkowań historycznych w tym zaborów i zniszczeń wojennych, procesy dotyczące rozwoju gospodarki wodnej zauważalne w krajach Europy Zachodniej zostały spowolnione lub wręcz nie zaistniały. Obecna polityka wodna wynikająca z *Ramowej Dyrektywy Wodnej* powinna być oparta na harmonizowaniu rozwoju gospodarczego i wymagań środowiskowych. Ponadto wymagana jest spójność sektorowych dokumentów planistycznych i nadrzędność planu gospodarowania wodami dla dorzecza w stosunku do innych planów z zakresu gospodarki wodnej.

Słowa kluczowe: dyrektywa, hydromorfologia, powódź, hydroenergetyka, żegluga, rozwój

1. Development of hydrotechnical infrastructure in the context of sustainable development

Based on various open definitions of sustainable development (*Agenda 21*, 1992), it may be assumed that it is development which meets the basic needs of human beings and preserves, protects and restores health and integrity of ecosystems without jeopardizing the ability to meet the needs of future generations and without exceeding long-term limits of their capacity. The definition of sustainable development indicates that it should be analyzed in ecological, economic and social terms. The development of each infrastructure, including hydrotechnical, should take

into account the requirements acknowledged in the above-mentioned categories.

In terms of the environment, development of hydrotechnical infrastructure must take into account the demands of ecosystems. In this respect, compliance with the binding legal regulations is the primary requirement in the EU member states. In course of the design process, technical solutions which do not generate changes in hydromorphological conditions and provide appropriate compensation should be taken into account. Directive 85/337/EEC on assessment of the effects of certain public and private projects on the environment, as amended by Directive 97/11/EEC, ensures that environmental consequences of projects are identified and evaluated before issuing relevant permits. Projects should take into account the overriding public interest and detailed justification for such decisions.

In economic terms, plans for development of hydrotechnical infrastructure should be accompanied by economic analysis. Possible external costs generated by the planned infrastructure should also be taken into account in the analysis. Thus, in the case of water transport, economic reasoning must not be restricted exclusively to simple analysis of transport costs. Published analysis (*White paper..., 2011*) indicate that it is possible to transport by water 127 tons of goods at a distance of one kilometer using a liter of fuel, while by rail it is 97 tons and by roads only 50 tons. Economic analysis should also take into account the environmental costs associated with construction and operation of waterways. In the case of water transport, external costs of environmental impact amount currently to about 10 euro per 1000 ton-kilometers (35 euro for road transport and 15 euro for rail transport). The socio-economic effects of sudden breakdowns, air and noise pollution, climate changes and changes in the environment should also be taken into account. It is estimated that in case of the transport sector, they increased by 91,5 % in road transport, by 6% in air transport, by 2% in rail transport and by 0.5% in water transport.

From the social perspective, development of hydrotechnical infrastructure should be regarded in a broader framework, not only within the context of fulfillment of social needs in the area of security and flood protection, ensuring power supply or alternative forms of transport. Implementation of such projects creates jobs, during the implementation phase of the investment and continues to provide them during facility operations. This is emphasized in the latest European Union documents (NAIADES II, 2013). On the other hand, it may also change and restrict the existing practices associated with the use of water for recreation and tourism, influence landscape changes and consequently harmony and social aesthetic sensitivity. Implementation of infrastructure projects also causes major changes in spatial development and creates problems which are particularly arduous during in the implementation stage of investment.

In program documents on water management it is stressed that decentralization is the key element of decision-making (Catley-Carlson, 2001). Local authorities have at their disposal the appropriate means, know-how and organisational structure to ensure proper sensitivity to problems associated with hydrotechnical infrastructure plans. Thus understood decentralization does not interfere with the government's statutory control of overall water resources and fundamental decision making.

It is as well fundamental to strengthen the dialogue between competent authorities responsible for sectoral policies. Furthermore, to assure appropriate balance between different water use and protection of water resources, cooperation between experts and interested parties is also indispensible. Each sectoral policy has its own set of laws for planning. Implementation of Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment can actively assist in the processes of coordination and integration between the various policies.

Most of the problems associated with water management materialize at the local level (Garrido, 2001). In many cases they are also resolved locally. In addition, in many countries, representatives of local authorities and communities play an important role in river basin committees which undertake important decisions on planning and implementation of water resources.

For many decades, the key tasks of water management concerned exclusively the sphere of use and technology. Achieving short-term use effects, a number of rivers were transformed from natural watercourses into uniform channels, devoid of any natural values, limited to the function of water drainage. At the same time, without any control, dynamically growing land development of flood lands for construction purposes as well as their use for agricultural purposes forced further and more intense regulation measures (*Rhine 2020…,* 2001).

In the history of water management it is possible to chronologically specify given periods of development. Among them, it is possible to define respectively the following:

- development of water transport, river control, city development, intensification of structural activities in flood control of cities located on the banks of larger rivers and their tributaries;
- progressive deterioration of water quality in consequence of pollution from industry, communities and agriculture;
- development of warning systems for flood control;
- development and progressive execution of water control programs;

- implementation of water quality monitoring systems, including monitoring of warning systems for incidental occurrences;
- renewal and reconstruction of water ecosystems which take into consideration:
  - ✓ the *status quo* of current spatial management;
  - ✓ transport functions of rivers and their tributaries;
  - ✓ flood control including, above all, reconstruction of flood lands where it is possible and safe.

The up-to-date approach to water management is the result of its gradual, historic development and is currently based on the principles of IWRM – Integrated Water Resources Management (*A Handbook for…,* 2009). This approach is the basis of sustainable development which should include various forms of flood control, electric energy production and transport.

Initially, integrating activities on the level of a river basin were of limited character. Particular sector problems and needs were analyzed and solved individually (*Gestion des Ressources…,* 1994). Next, activities aiming at integrated development of infrastructure emerged. According to assumptions, they were to carry out numerous tasks, i.e. water supply, water power engineering, flood control, shipping. The final stage of evolution took into account the management process of various dimensions of the natural environment (*Dorzecze Wisły...,* 2012; Lampart-Kałużniacka, Wojcieszonek, Pikuła, 2012). During the Dublin conference (*Rhine 2020…,* 2001), the adopted key IWRM principles stipulated, among others, that:

- water is a limited and sensitive resource, significant for maintaining life, development and the environment;
- development of water resources and their management should be based on cooperation between users, planners, and management of all levels;
- water has an economic value in all competitive kinds of use and should be regarded as an economic good.

The key directive of the EU water policy, based on the IWRM, is the Directive of the European Parliament and of the Council of 23 October 2000, known as the *Water Framework Directive – WFD* (Directive 2000/60/EC, 2000). It established the framework for Community actions in the field of water policy to achieve good status of all water bodies. Rescheduling is possible in achieving good status of water bodies, i.e. deferment of implementing the objectives of the *Water Framework Directive* till 2027. Such a postponement should be supported by analyses of the unworkability of technical solutions or by economic analyses indicating that activity costs are unproportional to the results. The *polluter pays principle* should be used (Miłaszewski, 2003; Miłaszewski, Walczykiewicz, 2004).

At the same time the WFD implements, in the EU member states, the obligation to plan and manage water economy within boundaries of river basins. Supplementary to the WFD is the *Floods Directive*, i.e. the Directive of the European Parliament and of the Council of 23 October 2007 (Directive 2007/60/EC, 2007) on the assessment and management of flood risks. Classification of flood control actions was developed within framework of research programs financed by the *EU Framework Program V* and *VI* (*Best practices…,* 2003) allowing for technical activities.

Poland is an example of a country in which, due to historical determinants, including the partition of its territory and war damages, the development of water management processes which may be observed in western European countries, proceeded more slowly or simply did not take place at all.

Unlike western European countries, Poland was not a beneficiary of 19th century achievements when other countries were creating a basis for an integrated technical infrastructure. Independence and building of a foundation for statehood presented authorities with a series of tasks which aimed at integrating territories which, for dozens of years, were included in three different political bodies (the Polish territory was partitioned among the Kingdom of Prussia, the Russian Empire, and Old Austria). Despite numerous years which have passed since that time, dissimilarities in development of the territories are still visible. Differences in the development of hydrotechnical infrastructure are also characteristic. Years following World War II did not favor growth of investments.

Admittedly, several programs were initiated but not completed. For example, the Upper Vistula watercourse was constructed in 1949-2002 and of the eighteen planned barrages only six were built. In practice, the watercourse has no transport function. In turn, the barrage build in Włocławek in 1963-1970 is the only completed construction on the planned Lower Vistula stepped falls. The current spatial distribution of cross river constructions (barrages, dams, groynes) and lengthwise river constructions (embankments, regulations) is presented in a schematic form in Figure 1. It illustrates, on the national scale, the differences stemming not only from natural conditions but also from the aforementioned historical circumstances. In consequence, in planning hydrotechnical infrastructure in Poland, it is pertinent to take into consideration (*Projekt…,* 2008):

- the country's economic history and civilization delays,
- geopolitical changes,
- condition of the existing infrastructure,

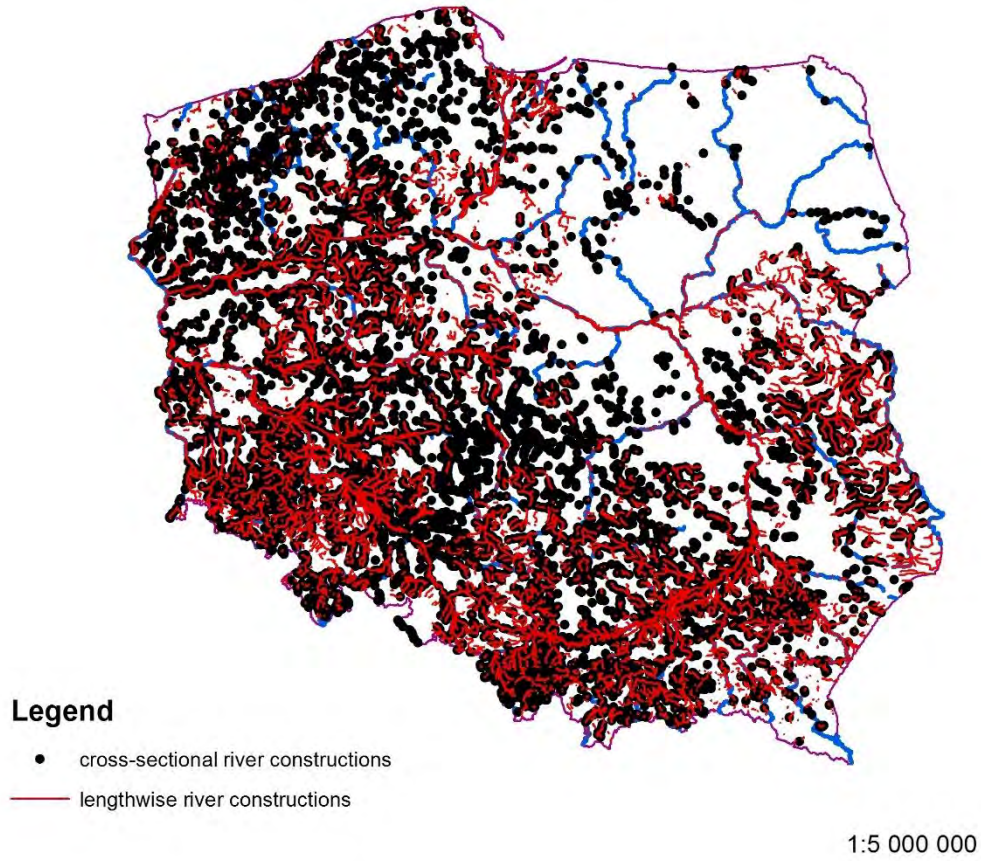

Figure 1. Spatial distribution of cross-sectional and lengthwise river constructions in Poland. Source: Author's own work

- considerable expenditures which have to be incurred,
- search for a compromise between the need for the protection of water and ecosystems stemming from the EU water policy and the development of hydrotechnical infrastructure necessary to assure water security and sustainable development.

2. Plans and programs of hydrotechnical infrastructure development in Poland in view of the EU water policy

The respective EU member states have their tradition of water economy planning. It is generally considered that the best solution in planning is the one in which spatial planning and water economy management are linked into one coherent, synthetic plan (*Integrated Flood…,* 2004; *A Handbook for…,* 2009). In Poland, the *Draft State Water Policy* was based on the EU concept of sustainable development which integrates political, economic and social actions while maintaining the natural balance (*Projekt...,* 2010; Gromiec, Winnicki, 2011). At the same time it stresses the need to guarantee fulfillment the fundamental needs of a particular population or citizens.

All activities should be characterized by a comprehensive approach to both the broad concept of environmental protection and water resources, water economy and associated water pollution control, taking into account sustainable development. Cohesive sectoral planning documents are required as well as for water management plans for river basins to take priority over other water management plans.

Despite these guidelines, the sectoral approach to water management dominates in Poland. It is taken for granted that water management plans for a river basin area are defined by the *Water Framework Directive* as a specific *master plan* for a river basin. There is also space for specifying new investment projects justified by social and civilization reasons. Their need must be supported by economic analyses which take into account environmental costs.

As mentioned earlier, efforts were undertaken in Poland in the area of hydrotechnical infrastructure development programs. They underwent multiple modifications and transformations. Their current status and range are presented in Figure. 2. Among them, the *Odra Program* has the longest history (*Program…,* 2009). It takes into account both flood control, development of water transport as well as retention and water power engineering in the Odra River Basin.

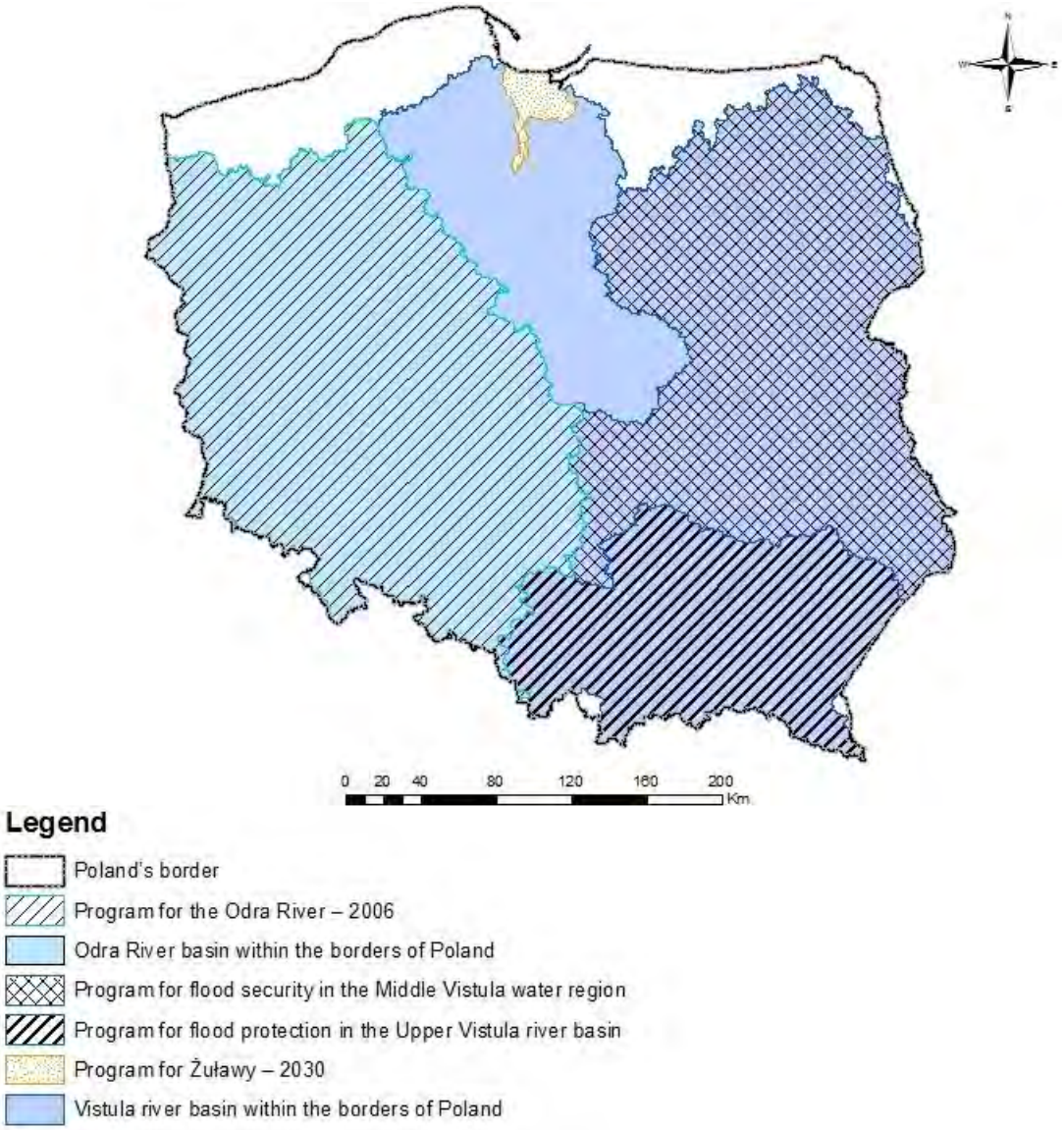

Figure 2. Programs affecting development of water infrastructure. Source: Author's own work

In turn, the *Program of flood control in the Upper Vistula River Basin*, adopted by the Council of Ministers in 2011, includes the area of five voivodeships (*Resolution no. 151/2011 ...,* 2011). It is an investment program which establishes regulation of waterbeds, construction of water retention reservoirs and protection of inhabitants of large municipal agglomerations against floods by technical measures.
In 2011, in order to reinforce the safety of citizens living in the area of the Central Vistula, the idea of the *Program for flood safety in the Central Vistula water region* was established (*Program…,* 2012). Next, in the area of the Lower Vistula, especially endangered by floods are Żuławy Wiślane. Comprehensive precautionary flood measures for Żuławy are to the carried out in 2009-2030, within framework of the *Żuławy Program 2030* (*Program…,* 2010).

3. Problems in implementing the EU water policy within the framework of development of hydrotechnical infrastructure

Implementation of the EU water policy is a difficult task and it demands cooperation of all the interested parties. The analysis of experience in implementing water management directives allows to determine the elementary sources of difficulties associated with implementation by each of the EU member states (Walczykiewicz, 2006). Along with them may be distinguished, among others, the lack of laid down action plans stemming from the directives or their general character, improper interpretation of regulations and above all, too general an interpretation of detailed requirements formulated in the directives. The problems also affect Poland. In the case of projects on flood control, water power engineering and

water transport, problems manifest themselves in an improper and too general an interpretation and incomplete regulation transposition. In consequence, in 2012, the European Commission presented the Polish authorities with its standpoint in which it questioned the programs undertaken in Poland in the area of hydrotechnical infrastructure, including the aforementioned programs. The disparity between the formulated plans for water management of river basins and the hydrotechnical infrastructure development programs was stressed. It was recommended to carry out a review of water management plans for river basin areas and harmonize them with the requirements of the WFD, in particular in the area of article 4, that is in the part dealing with the planned hydrotechnical investments.

4. Planning procedures and tools in agreement with the EU water policy

Undoubtedly, where it is justified, the WFD stresses the significance of the natural condition of water bodies as well as the need to review existing modifications of the physical characteristics of water from the perspective of function and economics. The planned investment projects should be the result of broader, coordinated by water management plans for water basin areas, sectoral plans which were subject to strategic environmental impact assessment. It is necessary to justify the planned projects in regard to the social and economic needs which take into account demands of the sustainable development policy and to subject these plans to bone fide assessment. In the Directorate-General for the Environment in the European Commission, within framework of the *Common Implementation Strategy* for the *Water Framework Directive*, documents were developed (*WFD and Hydro-morphological pressures…,* 2006; *Good practice…,* 2006) which specify the planning strategy and actions in this area.
Within framework of water control this strategy should take into consideration:

- close coordination with the spatial planning policy which regulates growth in flooded areas, allows more open space for floods and in consequence decreases the need for construction of new flood control equipment,
- protection and development of agriculture and forest economy for improvement of natural retention.

In Europe, structural solutions for flood protection are based on dams which usually accomplish multipurpose tasks, washlands and embankments. There are about 7,000 large dams in Europe and thousands of smaller dams. The pace of implementation of new facilities has decidedly declined in the second half of the 20th century. Currently, flood protection in western European countries is based on the following four fundamental principles:

- structural solutions, taking into account that they do not provide full flood protection,
- providing more space for rivers and reducing sealed surfaces of catchment areas,
- providing local and individual flood protection by the local community,
- acquiring insurance against floods and financial measures, taking into account that 100% protection is not possible.

It is certain that (*Good practice…,* 2006) traditional technical solutions (dams, canalization of rivers, embankments) have exhausted all the means of impact on flood control. In consequence, it is necessary to strive toward creating space for rivers and floods in places where danger to the population and economy is at a low level.
The possibility of producing electric energy in hydroelectric power plants depends on natural conditions, including surface features of the terrain. For example, the possible water power engineering potential of Austria is 53 700 GWh/year and the share of energy production by hydroelectric power plants is 67,4% (World Atlas, 2001). In turn, in Spain where the territory is larger , the water power engineering potential is 41 000 GWh/year and the share of electricity produced by hydroelectric power plants is 20%. Norway is the leader in producing energy by hydroelectric power plants, where this share is 99,4% and the useable potential amounts to as much as 179 600 GWh.
In the area of water power engineering, it is necessary to aim setting clear guidelines for issuing permits for construction of water energy facilities, in accordance with the WFD requirements. First, in order to limit the number of new locations for water power stations, the existing facilities should be technically upgraded and their capacity be increased.
In regard to water transport, according to the Communication of the European Commission (2006) on promotion of inland navigation, it is stressed that the development of the water course infrastructure should progress in a manner coordinated and integrated with the management plans for river basins. Renewed revitalization is observed in Europe in the area of development of water transport. In September 2013, the European Commission presented NAIADES II, a new action program which aims to increase freight transport by rivers and channels in Europe. In twenty EU member states there is approximately 37.000 km of inland waterways. Every year 500 million tons of cargo is transported there. However, the transport is principally concentrated in densely populated areas with high traffic density. The Commission proposes to improve waterborne transport of cargo by upgrading water gates, bridges and shipping channels. The NAIADES II action program aims to create a stable long-term framework for investments in high-quality innovate inland waterway transport. In the *Connecting Europe* facility for the period 2014-2020 and guidelines for develop-

ment of the Trans-European (TEN-T) Transport Network emphasis was put on new possibilities of financing inland waterways.

5. Perspectives for Poland

The current model for water management planning must be subordinated to the plans formulated in the *Water Framework Directive*. The binding regulations on execution of new investment projects in the area of environmental requirements considerably draw out the preparation phase of an investment. As mentioned before, cohesive sectoral planning documents are required as well as the priority of water management plans for river basins over other water management plans must be established. Implementation of these mechanisms in consecutive planning cycles also calls for additional time. In consequence, in comparison with the practice in the past years, it may be expected that the phases for planning and investment preparation will be prolonged, whereas the construction phase is expected to be reduced. Also, current financial determinants will be of significance. It should be understood that accomplishment of most hydrotechnical investment projects will still be based on the state budget and EU funds. Unfortunately, according to the opinions of experts, the next financial perspective of these funds is to be the last of any significance for the development of infrastructural projects in Poland. Only some investment projects may count on support of capital groups interested in potential profits. In practice this may only regard some water power engineering investment projects. Therefore, further to meeting significant environmental requirements, it will be necessary to guarantee financing by the state budget. This would stipulate currently and in the foreseeable perspective, that water management be accorded special status and that the condition of the Polish and EU budgets consequently improve. However, this perspective is uncertain, given the current financial situation of the European Union. It will be necessary to look for other solutions, including public-private partnership. Subsequent determinants regard changes of climate and policies related to adaptation to these changes. Analyses of the results of forecasts on changes in water resources, in perspective of the year 2020 (Walczykiewicz, 2012), do not point toward any significant changes in the near future. Results of the analyses show that changes in waste management will mainly involve waste decomposition in time with slight changes of the mean annual values. However, taking into consideration that our country is relatively deprived of water, these changes may be the reason for problems in areas where the water use index is high today. In addition, the increasing need for water which stems from projected economic growth, despite the observed tendency of decreasing water absorption per product unit, must also be taken into consideration. Variability of the time schedule of precipitation will also have impact during rainfall occurrence on increasing flood risks. In consequence, the pressure to plan and construct new retention reservoirs will grow. This will mainly concern small retention reservoirs. The natural geographic conditions in central and northern Poland and the dispersed development of river valleys in southern Poland limit opportunities to localize new facilities. Only for very few of them, for over forty years, land reserves are have been kept for their future construction.

The technical condition of the existing infrastructure represents a considerable challenge. Most water power facilities have been operating for over fifty years. The majority of these operating over one hundred years are located in the Kujawsko-Pomorskie Voivodeship. In addition, in the Podlaskie Voivodeship are ten flood gates built over one hundred eighty years ago and they are still functioning (*Dorzecze Wisły...*, 2012). Over eighty five percent of the length of all embankments has been built over forty years ago and an additional thirteen percent were built over one hundred years ago. Thus, in the future, a new modernization program will be enormous financial objective.

Taking into consideration the aforementioned conditions it is possible to approximate the real perspective of changes in infrastructure used in flood control, water power engineering and water transport. It must be stressed that these changes should be accompanied by water protection actions aiming at minimizing threats to aquatic ecosystems and water-dependent eco-systems. Revitalization of the existing facilities, such as retention basins, will also be necessary to reduce the risk of environmental disasters.

This perspective reaches the year 2030, taking into consideration the procedures and time needed for realization of new investment projects and the existing documents on the country's spatial economy. According to the Author of this article, significant changes in this matter should not be expected. Mainly, infrastructure for flood control will be modernized. It will, above all, comprise flood embankments. Taking into consideration their current condition it is a long-term task. Small retention reservoirs will be upgraded. Neglected irrigation systems will be renovated as often they are the cause of local flooding. There will be a need for consequent support of infrastructural activities by a spatial planning policy which will limit land development in areas threatened by floods. Resettlements should also be allowed in economically and socially justifiable cases as a measure of reducing the risk of flooding.

It is expected that a minor increase in the share of energy produced by water power stations will take place in the area of water power engineering. In this respect Poland, despite being a country with a large territory, has a small potential of only 7 000 GWh/year. In consequence, the share of electricity produced by hydroelectric power plants is 1,5%.

First and foremost small water power stations will dominate at the locations of already existing dams.
In Poland, an increase in the importance of inland shipping is determined by management and modernization of the existing, in a limited range, water courses, construction of links for transport and trans-shipment which allow to carry out intermodal transport. Due to the deteriorating condition of waterways, there is slight interest in inland waterway shipment as an alternative form of transport. The development of river transport in Poland is determined by the construction of a network of waterways of suitable quality and adjacent to infrastructure. Social education is also of considerable importance. River transport is among the cheapest and most environmentally friendly means of transportation. The total length of waterways in Poland is about 3800 km. Only a small part of them meets the relevant standards.
According to the report on the *Condition and perspectives for development of inland shipping in Poland*, inland water transport, regardless of low participation in the service of joint transport needs, may play a very important role in selected segments of the market (*Stan i perspektywy…,* 2013). This will include passenger transport as well as transport of aggregate dredged from river bottoms. Transport of other stock, due to the fact that for many years competing forms of transport are being developed, will not be possible in the analyzed time perspective. Investment activities for the creation of conditions for water transport will concentrate on the Odra River. A short segment of the Upper Vistula watercourse, which in practice is not used for any form of transportation, will remain as an unresolved problem.
At the same time, taking into consideration the requirements of the EU water policy, in planning in Poland new infrastructural projects, the following two premises will be of significance:

- decisions undertaken on investment matters in water management will have to constitute a compromise taking under consideration not only the expectations of various social groups, historical conditioning as well as the aforementioned requirements;
- modernization of the existing hydrotechnical infrastructure, implementation of programs compensating losses caused by changes in the physical characteristics of surface waters are tasks which, within framework of the EU water policy, will be regarded as being of a more compromising character than realization of totally new projects.

Western European countries are in a decidedly less complicated situation in regard to the possibilities of choosing paths of sustainable development based on optimally balanced share of different energy sources, diverse forms of transport and flood control infrastructure which will be modernized. In Poland, the search for complex solutions which allow to maintain and use the existing facilities will remain a problem. In many cases, such as the Włocławek drop or the Upper Vistula water course, they constitute only a fragment of great projects which are in the planning stage. In other words, hydrotechnical infrastructure will not partake in an important manner in the process of enforcement of sustainable development policies.

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Multifunctional and Multiscale Aspects of *Green Infrastructure* in Contemporary Research

Multifunkcjonalność *zielonej infrastruktury* we współczesnych badaniach

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Abstract
This paper provides information on the definition and benefits *of green infrastructure*, outlines the *green infrastructure* solutions and technics and their influence on multifunctionalty and multiscale of current research. Examples of *green infrastructure* practices include green, blue, and white roofs; hard and soft permeable surfaces; green alleys and streets; urban forestry; green open spaces such as parks and wetlands. *Green infrastructure* approaches help to achieve sustainability and resilience through practices such as among many others: urban forestry, and water conservation. This paper evaluates benefits of selection of particular *green infrastructure* solutions on the background of broader ecological context.

Key words: *green infrastructure,* connectivity, urban structure

Streszczenie
Idea *zielonej infrastruktury* jest jednym z najważniejszych kierunków tworzących nową jakość w zarządzaniu środowiskiem przyrodniczym. *Zielona infrastruktura* oprócz funkcji ekologicznej ma wpływać na poprawę: warunków zdrowotnych, poprawę poszczególnych komponentów środowiska, a nawet kontrolować rozwój przestrzenny miasta. Niektórzy badacze przyjmują założenie że *zielona infrastruktura* powinna być traktowana równorzędnie z techniczną.
Celem artykułu jest określenie rodzajów *zielonej infrastruktury* w strefie zurbanizowanej ze szczególnym uwzględnieniem obszarów wielofunkcyjnych, które dzięki swojej atrakcyjności przyrodniczej i krajobrazowej, wynikającej z różnorodnych form użytkowania, mogą zapewnić optymalną ilość i jakość terenów rekreacyjnych. We współczesnych badaniach zauważa się, że strefy wielofunkcyjne w obrębie których preferowane są metody użytkowania gruntów, chroniące różnorodne biologicznie ekosystemy, zatrzymując czysta wodę, zabezpieczając przed erozją, powodziami służyć mogą różnorodnym potrzebom mieszkańców miast. W artykule prezentowane są zasady rządzące funkcjonowaniem zielonej infrastruktury, szczególnie najważniejsza z nich dotycząca poprawy łączności między istniejącymi obszarami przyrodniczymi, w celu przeciwdziałania ich fragmentacji i zwiększenia ich ekologicznej spójności.

Słowa kluczowe: *zielona infrastruktura*, łączność ekologiczna, środowisko zurbanizowane

Introduction

Habitat fragmentation affects numerous ecological process across multiple scales, including changes in abiotic regimes, shifts in habitat use, altered population dynamics, and changes in species compositions (Schweiger et al., 2000). Patch size has been identified as a major feature influencing the existence of plant and animal communities.
The main challenge in spatial development is to find the basis to build a hierarchic system of functioning of green areas. Current studies show how important it is to work on different scales of green areas – from single parcels to the whole continent in order to

maintain ecosystem integrity (Burgi, Herperger, Schneeberger, 2004). The hierarchic structure of green areas and extent of vegetation in urban environment have an impact on temperature, humidity and surface run-off. Groundwater levels are gradually falling across all European countries. New housing developments influence fragmentation of habitat and species isolation (Forman, 1995; Mazza et al., 2011). One of the development priorities is to maintain and expand municipal forests and to improve the ecological network between the cities and its suburban neighborhood. In order to preserve the most valuable virtues of the environment and to prevent its further deterioration, the need to find solutions for building an environmentally functioning web (*green infrastructure*) is growing. *Green infrastructure* may be most successful when it functions at multiple scales in tandem. In the Toronto's *Greening the Portlands* project in Ontario *major parks*, *minor parks*, *wide corridors*, *narrow corridors* and *development parcel landscapes* create the basis of *green Infrastructure* (*Portland's Green Infrastructure,* 2010).

Green Infrastructure definition

In landscape ecology, the mosaic model of green areas describes the spatial configuration of landscapes. The model uses landscape elements and on the basis of theirs correlation define landscape structure: patches corridors, and the matrix. A patch, which provide multiple functions, is a homogeneous nonlinear area that differs from its surroundings. A corridor is a linear area of a particular land cover type that is different in content and physical structure from its context (Forman, 1995; Ahern, 2007). The matrix represents the dominant land cover type (Forman, 1995; Forman, Gordon, 1986).

The ecological network, which aim is to maintain the integrity of environmental processes is a model that has developed over the past 30 years. It promotes the sustainable use of natural resources in order to reduce the impacts of human activities on biodiversity and/or to increases the biodiversity value of managed landscapes (Bennett, 2004). This coherent system of ecological components include: core areas (hubs), where the conservation of biodiversity takes primary importance, corridors (linear linkages between core areas), which help to maintain vital ecological or environmental connections, mix land used buffer zones (transitional areas), which protect the network from external influences and finally sustainable-use areas. Core areas (hubs) as origin or destination for wildlife and ecological processes play essential role within the *green infrastructure*. Not limited by the size or scale they incorporate: large protective areas (national parks, wildlife reserves), managed native landscapes (national forests), working lands (private farms and forests), regional parks and preserves of regional ecological significance and community parks (Benedict Mc Mahon, 2002). In the coherent, self-regulating network of *green infrastructure*, corridors as a physical linkages between the core areas are essentially devices to maintain or restore a degree of coherence in fragmented ecosystems. Bennet and Mulongoy (2006), who distinguished three physical forms of corridors: a linear corridor (examples: hedgerow, forest strip or river), stepping stones (examples: ponds, small woods), consisting of small patches of habitat that animals use during movement for shelter, feeding and resting and other various forms of interlinked landscapes, widen the term *corridor* to describe many different kinds of measures, including first of all landscape linkages (examples: marine linkages, sea-river linkages) but also recreational routes (example: greenways) and entire ecological networks (example: coastal systems). The concept of a buffer zone created in the 1930s as an integral part of the management approach in UNESCO's *Man and Biosphere Programme* become an important conservation instrument in the 1970s. Buffer zones can act as protected and transition areas in which sustainable resource management practices can be developed. Ecological networks develops conservation actions to ecosystem processes, create coherent network of habitat patches and extend biodiversity conservation through compatible forms of land use (Bennet, Mulongoy, 2006). The ecological network evolved out of developments in ecological theory, primarily MacArthur and Wilson's island biogeography and metapopulation theory in which habitat fragmentation increases the vulnerability of species populations by limiting opportunities for dispersal, migration and genetic exchange (MacArthur, Wilson, 1967). Important for the subsequent ecological network model was Diamond proposition of configuration of the nature reserves introduced in 1975, now partly included in the principles IUCN's *World Conservation Strategy,* according to which reserves should be as large, round as possible and located as close as possible to each other.

Connectivity is a property of landscapes which illustrates the relationship between landscape structure and function (examples: water flow, nutrient cycling and the maintenance of biological diversity, Leitão et al., 2006; Ahern, 2007). In urban highly modified landscapes connectivity is greatly reduced and manifest in fragmentation – the separation and isolation of landscape elements.

The principle of connectivity is included in the EU's most important biodiversity conservation legislation, the 1979 *Birds Directive* and the 1992 *Habitats Directive.*

Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention) protects the transboundary linkages used by migratory species. Under the Convention, a series of agreements and memoranda of understanding have been adopted by UE member states with the aim of conserving

threatened migratory species and theirs habitats. These create the background for representative system of protected areas throughout the EU – Natura 2000, which increasing constantly and now cover approximately 17 percent of the EU's territory. Natura 2000 as the crucial part of *European Green Infrastructure* constitute a reservoir of biodiversity that can be drawn upon to repopulate and revitalize degraded environments and catalyze the development of GI. This will also help reduce the fragmentation of the ecosystem, improving the connectivity between sites in the Natura 2000 network and thus achieving the objectives of Article 10 of the *Habitats Directive* (1992). In Central and Eastern Europe, several national ecological-network programs developed in the 1980s (with the first *Estonian Network of Ecologically Compensating Areas* elaborated in 1983). Now Ecological networks in Central and Eastern Europe are being developed in three main ways: through framework of the *Pan-European Biological and Landscape Diversity Strategy* (adopted in 1995, through national or regional government programs and through various NGO projects). In *Western Europe TEN (Transnational Ecological Network)* – a cooperative project between regional governments in the United Kingdom, the Netherlands, Germany and Denmark helps to maintain and enhance ecological integrity on wetlands and aquatic ecosystems. One of the newest ecological network at the international level in Europe is *Green Belt* (launched in 2004) stretching along the entire border region of the former Iron Curtain. In North America the principal ecological network *(Widland Project)* was launched in 1991 and helps to protect and restore the natural heritage through the establishment of a connected system of *wildlands*, that is *reserve networks* including core areas, corridors and buffer zones – examples: USA: *The Southern Rockies Wildlands Network*, Canada: *The Bow Valley Wolf Corridor* (Noss, 1993; Bennet, Mulongoy, 2006).

Many definitions of *green infrastructure* (GI) have been developed. It is therefore difficult to cover all aspects in one sentence. The following definition was used for the purposes of the Communication from the Commission to the European Parliament paper (Brussels, 6.05.2013): *a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services*. According the Commission: *it incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings*. According to Naumann (2011) it *is the network of natural and semi-natural areas, features and green spaces in rural and urban, terrestrial, freshwater, coastal and marine areas*. Originally, *green infrastructure* was identified with parkland, forests, wetlands, greenbelts, or floodways in and around cities that provided improved quality of life or ecosystem services such as water filtration and flood control (Mc Mahon, 2000). Now *green infrastructure* is more often related to environmental or sustainability goals that cities are trying to achieve through a mix of natural approaches. The development of GI across the world is well known. In the 1990's, Florida, Maryland and several initiated programs to strategically identify, protect and restore interconnected systems of conservation land and other sites of ecological value. The President's Council on Sustainable Development (USA) in report *Towards a Sustainable America* (1999) identified *green infrastructure* as one of five strategic areas that provide a comprehensive approach for sustainable community development. Over the last 20 years, new examples of GI projects have been carried out and there is a wealth of experience demonstrating that the approach is flexible and cost-effective. GI projects are carried out on a local, regional, national or transboundary scale. The concept of *green infrastructure* is endorsed in the Milton Keyes and South Midlands Sub-Regional Strategy and *The Northamptonshire Green Infrastructure Project* (*River Nene Regional Park*, 2005). *Green infrastructure* is highlighted as an important resource to support the *Northwest's Regional Economic Strategy*, published in 2006 (case studies: Mersey Waterfront Regional Park, St Helen's Urban Fringe).

Benefits of *green infrastructure*

Green infrastructure utilize the natural retention and infiltration capabilities of plants. In urban and suburban highly modified landscapes green infrastructure could bring a lot of benefits, among them: biodiversity enrichment, reduced and delayed stormwater runoff volumes, enhanced groundwater recharge, lowered incidents of combined storm and sewer overflows (CSOs), Urban Heat Island mitigation, reduced energy demands and GHG emissions. Incorporation of trees and vegetation in urban landscapes contribute to improvement of air quality, human health and creates additional wildlife habitat and recreational space. Plants can naturally filter and break down many common pollutants found in stormwater. Finally, as it is suggested in a number of case studies, *green infrastructure* can increase surrounding property values through converting degraded parts of cities into more greener and clean space (Foster et al., 2011).

The superior role of *green infrastructure* in flood protection is invaluable. Restoration of floodplain forests can deliver many ecological benefits as: maintaining the water table, preventing erosion and reduction of pollutants by filtering the water. Introduction of riparian woodland, protection forests in mountainous and restoration of coastal wetlands combined with infrastructure can decrease disaster risk. *Green infrastructure* mitigates the negative effects of fragmentation of the landscape through bet-

ter integration of urban land use areas with ecosystems.

Green Infrastructure is based on principle that maintaining, enhancing nature connectivity and natural processes and integrating nature into spatial planning add multiple benefits for human society. In the context of this in *COM(2013) 249 final, The European Economic and Social Committee and the Committee of the regions Green Infrastructure (GI) — Enhancing Europe's Natural Capital* (2013) *green infrastructure* is identified as one of the investment priorities, contributing to regional policy and sustainable growth in Europe. GI have significant potential to strengthen regional and urban development, through encouraging business investments and creating jobs.

Social aspects of *green infrastructure*

Between 2009 and 2011, the UK National Ecosystem Assessment (UK NEA) analysed the natural environment in terms of its benefits for society. The UK NEA found that the well-being of society depends on the range of services provided by ecosystems which include: soil formation, photosynthesis, supplying food, fibre and fuel, regulated air quality and climate, controlled erosion as well as non-material benefits for people, for instance: recreation (*Green Infrastructure…,* 2013). To understand the term well-being, it is crucial to take into consideration its broad range of biological, sociological, economic and environmental factors. This term was used by WHO (1948) to introduce definition of health and public health.

What is more, vegetation has a positive impact on human health. In the research it is suggested that urban green spaces can create a stronger sense of community (Kim, Kaplan, 2004). There is close relationship between longevity, health and access to green space (Tzoulas et al., 2007). Boulevards, squares, parks, green roofs and walls in cities creates attractive landscapes for leisure and recreation. Vegetation provides cooling and cleaner air, mitigates the urban heat island effect and creates more spaces for living creatures. It should be also mentioned that green areas of high quality can have a positive impact on land and property markets as well as create job opportunities (*Green Infrastructure...,* 2013). Finally, well managed network of green areas may encourage business investment. Green infrastructure solutions, especially in coastal areas, increase tourism economy, create attractive wetland habitats close to human settings and improve the development of leisure facilities. Easily accessible nature gives opportunities for physical activity, relaxation and healthy living. New green areas encourage social interaction, provide a range of educational opportunities based on close relationship of local communities surrounded by the natural environment. Furthermore, river valleys, waterways, pedestrian and cycle paths, offer sustainable transport routes.

Economic aspects of *green infrastructure*

Green infrastructure provides long lasting and sustainable benefits, for instance saving money, cleaner air as well as groundwater recharge. New York City 2010 Green Infrastructure Plan includes precised calculations (total annual benefits) for every acre of green infrastructure connected with reduced energy demand and CO_2 emissions, improved air quality, as well as increased property value. Statistics presented in Bird's study (2004) concerning five major UK cities show more than £ 1.8 million savings for UK National Health Service (if 20% of the population within 2 km of an 8-20 ha green area used that space to reach a target of 30 min., activity, lasting 5 days a week, Tzoulas et al., 2007). Green alleys, rain barrels and tree planting are estimated to be 3-6 times more effective in managing storm water per $1000 invested than grey infra-structure methods. Green infrastructure methods, which clearly illustrate this correlation, were implemented in Portland (US) as Green Streets projects; which cost $8 million. It was estimated, that they enabled saving of $250 million in hard infrastructure costs (Foster et al., 2011). Philadelphia, which has been implementing green infrastructure solutions since 2006, and saved approximately $170 million so far (Foster et al., 2011). The value of green roofs has been estimated to be 40% higher than a conventional roof due to storm water management, reduced electricity costs and improved air-quality. Green roofs give energy savings up to 15-45% of annual energy consumption (Foster et al., 2011). Urban trees enable further additional savings for city inhabitants. They have positive impact on carbon and storm water storage (trees can reduce runoffs in urban areas by up to 17%). It was estimated that the value of street trees in Washington, D.C. reached around $10.7 million annually, for all benefits (Foster et al., 2011). In Atlanta, GA (USA) trees provide $833 million in storm water management benefits (Foster et al., 2011). The benefits of green infrastructure in mitigating climate changes are also visible, which has positive economic consequences. Studies carried out in Manchester (UK) have shown that additional 10% of green cover in high density areas would keep surface temperatures at a level below historical baseline (Gill et al., 2007; Foster et al., 2011). Green infrastructure helps to achieve greater urban sustainability and resilience, as well as builds stronger communities based on diversity, flexibility and self-sufficiency.

Multifunctionality and multiscale research

The ecological network concept has been introduced into spatial management with an idea to create a landscape strategy at broad scales which will include continents, nations and regions (Jongman, Pungetti, 2004). The concept aimed primary at maintaining biodiversity has been rarely applied in urban con-

texts (Ahern, 2007). The multi-scaled research involves assessment and planning of landscape patterns and ecological processes at multiple scales. According Ahern (2007) in urban environments the appropriate scales are: the metropolitan region or city, the districts or neighborhoods, and individual sites. Application of *green infrastructure* approaches range in scale from large centralized public *macro* projects (example: *Staten Island Bluebelt project*, 2003, incorporating 16 small urban watersheds into water management system) to small scattered *micro* applications on private properties (example: rain barrels to collect stormwater). Benefits of *green infrastructure* multifunctionality include among others: better management of storm-water runoff, decrease of combined storm and sewer overflows (CSOs), water capture and conservation and purification, flood prevention and mitigation of urban heat island (UHI) effects.

Multiscale approach of *green infrastructure* could include vertical integration, where various functions are applied in one location (examples: wildlife crossings under/over roads, infiltration systems beneath building or parking lots, or green roofs on buildings (Ahern, 2007). *Green infrastructure* stormwater system could incorporates green roofs, infiltration wells, vegetated bioswales, small ponds and created wetlands. New York City integrated the extensive existing wetlands into their water management plans. In Staten Inland Bluebelt project the stormwater system joins sanitary sewer system, and a separate stormwater system using existing wetlands. The Bluebelt project implementation effects in reduce of the quantity and velocity of runoff, and remove of contaminants from the runoff by introducing aquatic plants for bioremediation. This multiscale project integrates watersheds, subwatersheds and isolated wetlands (Ahern, 2007).

Nowadays, pursuant to the *Convention of Biological Diversity* approved in Rio de Janeiro in 1992, protection of biological diversity is directed at the whole natural space, most of all at terrains used by man, and even at terrains transformed by him significantly, such as towns. This must be taken into account in model considerations. Protection of biological diversity and use of its elements in a sustainable way are strictly interrelated. Within urbanized areas it is important to maintain enclaves of different types of unused habitats (swamps, mid-field afforestation, peat bogs, basins of surface waters, water courses, river valleys, mid-field balks, etc.).

Change and regulation of riverbeds also results in a change of water management throughout the whole river valley. A large majority of rivers have been modified by dams and other engineering works. In Europe, floodplain losses approach 95% (Tockner, Stanford, 2002). Groundwater levels are gradually falling across all the EU countries. The need to protect remaining floodplain systems and to restore degraded river valleys has grown in recent decades (Ward et al, 1999). In agglomeration scale *green infrastructure* projects could include wetlands buffering areas against river flooding for regional infrastructure and housing. The use of a wetland system, which store and release water gradually also helps communities to buffer against drought.

Planting and maintaining trees in urban settings deliver multiple benefits for resilience, adaptation, and climate mitigation. Trees filter storm-water runoff, prevent from flooding, improve water quality and clean the air through absorbing pollutants. In urban environment trees protect buildings from wind damage, and regulate heat island effects through shading and evaporation. Trees absorb and reduce various pollutants found in the cities, including particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and ground-level ozone (O_3).

GIS in *green infrastructure* research

Usage of GIS to identify *green infrastructure* in a Multi-State Region was introduced in the *Southeastern Ecological Framework Project* (2002). The key task of the project was to identify ecological significant areas and connectivity in the southeast region of the United States. The states included in the project are Florida, Georgia, Alabama, Mississippi, South Carolina, North Carolina, Tennessee, and Kentucky. The project was conducted in 1999-2000 by the University of Florida GeoPlan Center and sponsored by the US Environmental Protection Agency Region 4. Consistent, reliable data are essential for effectively deploying *green infrastructure*. Information is needed about the extent and condition of ecosystems, the services they provide and the value of these services so that ecosystem services are correctly valued and then priced if appropriate, to promote GI solutions in spatial planning and decision-making processes in relation to infrastructure. Traditional land conservation and *green infrastructure* planning both focus on environmental restoration and preservation, but *green infrastructure* also concentrates on the pace, shape, and location of development and its relationship to important natural resources and amenities. The innovation of usage GIS in *green infrastructure* models is connected with creation GIS based analysis which allow to indicate habitat patches and connect them across multiple jurisdictions, scales and landscape types. GIS programs could be used to identify vital ecological areas and linkages prior to development in suburban and rural landscapes and identify a *green infrastructure* network that connects these primary ecological areas, indicate *green infrastructure* classification and assessment and finally to introduce the model of *green infrastructure* and test of its impact on the environment and its biodiversity. GIS programs are generally used to describe form, configuration, and composition of the landscape pattern and are considered

to cover principal aspects of structural landscape assessment of crucial ecological meaningfulness. Crucial dataset are: CORINE Land cover (CLC), LIDAR scan data converted to 1 m resolution raster model-layers: DEM (Digital Elevation Model), vegetation height (trees, shrubs), buildings (vector layer of buildings), Urban Atlas (GMES/Copernicus), online aerial photography datasets, Street View photography and orthophotomaps. Online aerial photography datasets, and especially the Bird's Eye photography and the Street View photography can be invaluable as a supplement. All of the GI mapping using would carried out in ESRI's ArcGIS Desktop.

Green infrastructure projects through introducing new green areas has an important role in enhancing stormwater infiltration rates and reducing the volume of runoff flowing to urban sewer systems. The natural infiltration capabilities of green infrastructure technologies can increase groundwater recharge. On the other hand vegetation provide natural water storage and flood protection by slowing the passage of flowing waters and reducing sedimentation Green cover constitute a buffer zone for pollutants being transported to surface waters. *The Cambridge Sustainable Drainage Design and Adoption Guide* introduces SuDS methods such as: ponds and wetlands, retention and infiltration basins, swales and filter strips, filter drains, canals, rills and channel systems. In ECOS CENTRE (60 ha urban park in Northern Ireland) reed-bed water treatment technology helps to deal with waste in a sustainable way, willow coppice is used to produce biomass fuel. The reed-bed system implemented in is also used for Swindon Borough Council to filter surface water with low-level contaminants running off the urban forest. On urban areas green infrastructure can mitigate the effects of urban heat islands, reduce energy demand and as an effect improve the air quality and human health. Greenways, parks, urban forests, wetlands, and various forms of green infrastructure provide increased access to recreational space and wildlife habitat. Enhancing the surface of green roofs in cities has important impact on the level of reducing of rainwater. Consultants *for Greening for Growth project* in London's Victoria Business Improvement District (BID) identified that fitting 25 ha of green roofs could deal with 80,000 m^3 of rainwater each year (Green Infrastructure…, 2013).

Examples of *green infrastructure* technological practices include:

1. eco-roofs: green roofs (roofs partially or completely covered with plants or trees), blue roofs (non-vegetated source of control that detain stormwater), and white roofs – cool roofs (flat roofs that have been painted white);
2. hard and soft permeable surfaces;
3. green alleys and streets;
4. urban forestry;
5. green open spaces (examples: parks, wetlands);
6. wastewater treatment system.

Green alleys incorporate various technical solutions to achieve better stormwater management, heat and energy reduction goals. These solutions include: permeable and reflective pavements (allowing water allow water to soak back into the ground), introducing of rain-gardens (installed in artificial depressions to capture rainwater), downspout disconnects and rainbarrels, tree-planting, landscaping and bio-swales (artificially contained vegetation), cisterns, ecoroofs (green, blue, white) and recycled materials (*Chicago Green Alley Handbook*, 2010). Studies have shown that permeable pavement with porous layer of soil underneath can reduce runoff volume by 70 to 90%. The goal is to produce runoff characteristics in cityscapes that are similar to those in a meadow or a forest (Foster et al., 2011). The downspouts disconnects are incorporated in water collection or slow dispersion system, such as a cistern (for storage) or a rain garden (for slow dispersion). It is a method of controlling rainwater management system and reducing CSO danger (Foster et al., 2011). In Chicago, in 2007, 30 green alleys with permeable pavement and reflective concrete had been installed, together with 200 catch-basins in various parts of the city. The central goal was to slow the rate of stormwater runoff along alleys through allowing water to soak into the surrounding neighborhoods more naturally (*Chicago Green Alley Handbook,* 2010).

Current questions

The current research assume that *green infrastructure* is the framework for conservation and development and we need to design *green infrastructure* systems strategically to connect across urban, suburban, rural and wilderness landscapes and incorporate green space elements and functions at the state, regional, community and parcel scales.

The main research questions are:

1. To identify vital ecological areas and linkages prior to development in suburban and rural landscapes and identify a green infrastructure network that connects these primary ecological areas.
2. To identify opportunities for the restoration and enhancement of naturally functioning systems in already developed areas.
3. To provide a mechanism to identify green areas used for multiple functions: including ecological, recreational, cultural, aesthetic and other uses.
4. To develop an understanding of the spatial scale issues involved in analyzing the ecological connectivity.
5. To create a scientific system of analysis for *green infrastructure* identification in urban and suburban areas.

6. To calculate the economic and social benefits of *green infrastructure* practices to reduce the barrier against its implementation.

Green infrastructure models have an important role in air conditioning, improving the microclimate and overall softening of the urban heat island effect. The present questions included are how to improve the understanding of the links between biodiversity (species/habitats) and the condition of the ecosystem (vitality, resilience and productivity) and between the condition of the ecosystem and its capacity to deliver ecosystem services and how to provide a mechanism to balance environmental social and economic factors.

Conclusions

Green infrastructure is a strategic approach to land conservation that addresses the ecological and social impacts of urban sprawl and consumption and fragmentation of landscape. It is described as *natural life support system* which creates *an interconnected network of waterways, wetlands, woodlands, wildlife habitats and other natural areas; greenways, parks and other conservation lands; working farms, ranches and forests; and wilderness and other open spaces* (Benedict, Mc Mahon, 2006).

In many major urbanized areas, green space is rapidly disappearing. Accelerated consumption of land for growing cities and fragmentation of landscape caused by urban sprawl are primary conservation challenges. Creation of more isolated patches of green areas and decrease of wetlands and riparian zones restrict the biodiversity and reduces their capacity to control floods. Shrinking natural habitats lose its ability to filter out toxins, excess nutrients, and support wildlife and plant species. In this highly modified environment *green infrastructure* provide a framework for smart growth. Better usage of existing infrastructure (*gray, green, blue*) can help to create more compact, mix used and healthy communities.

Green infrastructure practices (such as green roofs, green alleys etc.) included in local governments strategies have impact on sustainability and quality of life of local communities. They are seen as main potential tools in climate adaptation. Broader implementation of *green infrastructure* solution is connected with uncertainty involved in economic and social costs and benefits for local governments (Foster et al., 2011). *Green infrastructure* planning should be the first step in the land-use planning and design process. It should be coordinated with planning for *blue and gray infrastructure* – roads, bike trails, water, electric, telecommunication and other essential community support systems. Integrated planning *green and gray infrastructure*) and design should connect the two in a more sustainable network.

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