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Interdisciplinary Co–operation for the Sustainable Development of Historical Cities and Protected Areas. Perspectives of Sound Tourism



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Preface

The Main Purposes of the 11th International Conference

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International community of scientists has a **special mission focused on knowledge-based society** in the **UNESCO Decade of Education for Sustainable Development**. I believe that exchange of experiences during this Conference, followed by interdisciplinary and international pilot projects, will be a proper way for the development of **mission to make our life more reasonable and our civilization more human-oriented**. Let me refer to the basic concept I introduced at the starting points of National and International Summer Schools on the Human Environment in 1967 as well as at the beginning of series of the International Conferences on Sustainable Development in 1989.

The basic principle is linkage between interdisciplinary research and problem solving training, supplemented by education of the whole society as important partners to experts. The key word for success is integration of all age and professional groups for common action focused on better quality of life. From our 1st School in 1968 we recognized the necessity of linkage between learning about different (social, natural, technical etc.) aspects of **global problems of the protection of the Biosphere and integrated action on local scale** (including exchange of methodological experiences not only on pan-European scale, but open for experts all over the world).

The basic subject of this Conference – **sound tourism** – **seems to be really useful for the integration of education of local community and tourists focused on common action for the promotion of sustainable development of regions, offering valuable nature and culture heritage.** We are facing similar problems and exchange of **good practice**

of cooperation of experts, society and decision-makers on regional scale and managers of enterprises, which may be useful in many countries. One of these problems is **reduction of negative effects of motorized tourism, referring to more successful protection of human health** (against direct and indirect risk factors), **biodiversity, old architecture, monuments, etc.**

The crucial problem seems to be linkage between common expectations of better health and quality of life as well as development of labour market (e.g. offering new job opportunities for graduates of universities). Promotion of sound tourism in cities with culture heritage and eco-tourism in ecologically important regions is a big chance of sustainable development for many regions in Europe and outside. The key factor for sustainability is integration in this field of activity of organizers of mass tourism with all other experts. Especially important is **minimization of negative effects of mass tourism concentrated in regions of high natural and cultural values** based on dissemination knowledge about human ecology, ecotoxicology and ecological engineering as integrating factors for common action of experts in different levels of education (including both formal and informal education in cooperation with mass media, NGOs, etc.) and different fields of natural, technical and socio-economical sciences together with local society and decision-makers.

Under democratic condition **the key factor of success is to disseminate among local communities knowledge about environmental risk factors for health, culture and nature in their regions, together with knowledge about new best available technologies** for the reduction of hazard related to these factors by common action of experts and society. Distribution of up-to-date knowledge about methods of **early detection of risk** of irreversible biological effects (mutations, congenital malformation, higher incidence of incurable diseases of civilization, as well as cancer, reduction of fertility and increase of mortality during early develop-

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ment and risk for ecosystems and biodiversity etc.) together with knowledge about innovative methods of **more effective primary prevention** against related environmental risk factors – is a chance of execution by local society from decision-makers human right for proper quality of the natural environment. For successful activity it seems necessary to have both strong enough motivation and practical ability of active contribution of all the members of local society and visitors in common action in this field. **Ecologically oriented tourism gives a special chance for integration of stakeholders and tourists for better protection** of natural and cultural landscape as well as proper conditions for healthy recreation (especially in health resorts). **The most important for pilot projects is interdisciplinary cooperation of all experts** (coordinated by environmental generalists having knowledge in ecological, technical, social and other issues) **with local inhabitants followed by wide-scale application of good practice.**

We have to find also common weak points limiting effective prevention of environmental risk factors as well as overexploitation of natural resources. The most important seems to be the lack of opportunities of training toward system solving of real problems based on interdisciplinary case studies and common action, as well as **the lack of knowledge about useful achievements of science and technology among common people and decision-makers.** Introduction of model of permanent improvement of related activity based on heuristic approach and exchange of experiences of multidisciplinary teams of experts about good practice in different countries seems to be way promising for better future. One of important fields of activity is better linkage between education about nature and human civilization with promotion sound tourism and sustainable society (including distance education by open university e-learning with promotion of interesting regions on wider and wider scale). Development of international tourism is also a way of dissemination of knowledge about different cultures and experiences how to improve relationships among people and to make them involved in the protection of natural and cultural heritage in different countries as well as the whole biosphere.

It is important not only to introduce innovative technologies and systems of management on a wide scale, but also to change the behaviour of both tourists and local inhabitants. **Common responsibility and partnership in the relation to sound tourism may be a good promotion of sustainable development in other fields of human activities.**

Wider cooperation would be useful for all the inhabitants of indivisible Biosphere. The development of international cooperation in this field is of crucial importance. Let me refer to our **33 years interdisciplinary cooperation with eminent experts from Japan** and important for the better future contribution of large group of representatives of the **Japan Environmental Council**, headed by a highly reputed expert both in environmental economics and interdisciplinary cooperation focused on primary prevention – Prof. K. Miyamoto. Let me draw your attention to Prof. Miyamoto's concept of the application of Japanese experiences in problems of the human environment in international action towards Sustainable Society followed by several presentations at our Conference of experts from different fields.

Complementary experiences are very useful not only for early detection of risk factors but also for **more effective at-source-prevention of the deterioration of the human environment.** Tragic experiences of Japanese victims of incurable diseases of contemporary civilization make the best motivation for common action of scientists, engineers, managers as well as local and international society. **Good examples of international solidarity in this field could be e.g. 1st International Congress Scientists for Better Human Environment in Kyoto in 1975** as well as at present so-called Kyoto Protocols.

In practice the only one effective activity seems to be common action of experts, society and decision-makers in real regions involved in international cooperation for promotion good practice in sustainable development. I hope that one of promising for the future is cooperation of several universities and still more and more administrative units of European countries involved in promotion sustainable development (including eco-tourism) in river regions within Network; Union of The Rivers Regions – **Union des Terres de Rivieres.** Promising for the future is also **the extension of the co-operation of experts** from Europe and outside of Europe e.g. within the project of the European Commission Asia Links and similar, as well as expected 7th Framework Programme and new Multicultural Programme, hopefully strongly linked with sustainability.

This special issue of the Polish Journal of Environmental Studies (including reports and posters submitted by some of experts participating at 11th International Conference on Sustainable Development in AGH, Krakow at 18th and 19th September 2006) is a good opportunity for the exchange of complementary experiences from different countries. Let us hope that the exchange of these experiences and good practices will be followed by interesting and **useful for similar regions interdisciplinary projects** – as output of meeting people of different ages and background, but with common interest in **creative contribution to the game how to use progress in science and technology for better quality of life for all!**

At the end let me mention about former rector of AGH University of Science and Technology Prof. W. Goetel, who – as the first in Europe – initiated in 1950s the integration of different sciences (within so-called sozology) and technologies (within sozotechnics) for sustainable management of the natural resources and protection of the environment for benefit of the future generations. Prof. Goetel recommended also eco-tourism, physical activity among students and open for all seminars focused on common action for sustainable development.

Our generation and our predecessors tried to develop interdisciplinary and international cooperation in this field. I high appreciate creative contribution of the thousands of participants of our long-term activity. Let me mention some eminent and deceased scientists and our highly appreciated partners and friends such as: from Japan: Prof. S. Tsuru, Prof. Y. Fukushima, Prof. K. Shibuya, Prof. Y. Tsukamoto, Prof. Y. Yamamoto, Prof. J. Ui, Prof. K. Amaya and many other eminent experts still active like the representatives of the Japan Environmental Council making contribution to our Conference, experts from India such as: Prof. B. Bhatia (J. Nehru University, founder of the School

of Environmental Science, NEHRO), from Poland: Prof. J. Aleksandrowicz (Department of Haematology, University of Medicine in Krakow, founder of Commission for Protection Public Health and informal multidisciplinary team of scientists and practitioners involved in primary prevention of environmental health hazard), Prof. S. Myczkowski (Department of Ecology of University of Agriculture in Krakow), Prof. A. Jankowska-Kłapkowska (Department of Environmental Economics, AGH University of Science and Technology in Krakow) and several experts from different

natural, technical, social and other sciences contributing in interdisciplinary cooperation for sustainable development.

Let me propose to dedicate our papers to all the passed out experts who took part in international cooperation in this field. Let us hope that we could celebrate their memory by spreading the knowledge about their achievements to younger generations and by creative development of common action making our life more reasonable and making our mission for better life for all more successful...

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Teaching and Learning Towards Sustainable Life Across Disciplinary Boundaries

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Abstract

The interaction of individuals and groups with themselves and with the system(s) of which they are part can help to generate a culture of attentiveness with distinctly positive effects. By raising the level of attentiveness, it is possible to enhance substantially both action regulation (action steering) in the cognitive sphere, which manifests itself in, for example, the setting of targets and subsidiary targets, in the heuristic pursuit of complex problem solutions and in interactions with the system or systems, which we aspire to move towards Sustainability. The basis of the approach is the extension of the model of human action in the direction of an integrated model of complex problem solving or control of complex systems. Such an integrated model could help to bridge the gap between scientific theories and human behaviour intended to achieve sustainable life.

Keywords: complex problem solving, human model of action, enhancing the mind, action regulation, mind – system – interaction, multi-disciplinary, sustainability, values

Introduction

What should be taken into account with regard to teaching and learning in higher education towards sustainability? The concept of sustainable development or sustainable life or sustainable future or sustainability is an integrated approach to our big social, economic and ecological problems. Sustainable Development is a complex goal and process. Its success depends mainly upon a better grasp of planning, the interactions among fiscal, economic, trade, energy, social and environmental policies and improved control of the processes.

The goal is a community of nations in which all citizens share in – and have a stake in – a decent standard of living, individual freedom, personal dignity and a healthy environment”, to quote an OECD report published 1997 [1]. Such an ambitious goal needs inter- and even multidisciplinary approaches, including findings about the human mind and its interaction with other systems as a basis of further work.

In order to be able to contribute to the process towards sustainable life, systems theory, systems thinking, systems analysis and cybernetics are more likely to bridge the gaps for the time being than the classical theories. Nevertheless, there seems to be a need for a new holistic theory on complex problem solving and / or complex problem shifting, especially related to issues on sustainable life.

Often complex problems cannot be solved, but only shifted, either towards improving or even aggravating a situation. A new theory should complement the available knowledge on concepts and theories for complex problem solving. Open is whether, for example through the model of human action and its extension, a contribution to such a theory could be made. A useful concept for research and teaching and learning seems to be action regulation. The term is from Dörner [2].

Overview on the Model of Human Action

Similar to the cell in the body, the individual can be seen as the cell or smallest unit of society. If one accepts this, then we can turn to the model of human action of an individual, who depends on sensory perception of external world information. The information may govern the action regulation of the decision maker. By action regulation (action steering) we mean that, – in order to contribute to sustainable life–, the actor has to formulate subsidiary global goals and / or goals for a region and / or a specific location and / or complex problems. The actor or player must identify the interdependence of the variables. He must develop mental models and later plans and monitor their implementation in the system and control the action program. And last but not least, the demands on the player are also to master his or her emotions, if in certain situations stress

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and anxiety may come up. That easily happens, if an actor lacks information related to an important and urgent decision, which has to be made without any delay. The actor might even experience fear.

This is a very abbreviated overview of some important elements of action regulation (steering). The challenge for the human mind is to achieve the best possible combination of the elements of action regulation (steering) while struggling for sustainability.

Moreover, the success of the actor also depends on the co-operation with others. Therefore success presupposes a non-confrontational approach. Cognitive information processing, i.e. action regulation (steering), – in this briefly described sense –, is controlled with a view to achieving the subjective sub-goals. In complex problem solving processes or systems the actor utilises not only his own mental equipment, but also technical instruments. Such tools extend, perhaps, the performance range of the player towards sustainable life, for example a computer programme for minimising costs related to given alternatives (Linear Programming) or processing qualitative information [3].

In general terms, therefore, the basic tasks of the psychology of action are concerned with sensory perception; thinking (cognition); learning, i.e. learning by trial and error, but also social learning, empathy or understanding derived from sharing the feelings of others and memory performances. With the task of mentally preparing and executing an action process, the actor faces not only the need to meet the individual demands inherent in these component elements, but must also meet the overarching demand of mastering and appropriately orchestrating them in conjunction with one another (action regulation or steering).

A further dimension is provided by human language, which is essentially a product of social and cultural achievement. This communication tool equips the player to interact usefully in any sub-process or sub-system of sustainable development. All interactions are characterised by their behavioural qualities [4].

There is another aspect of the process, to which theory has called attention, namely, the gradual transformation of wish into action, the transition from blurred aspiration to focused willpower. It is a long way to action [5]. Let us suppose that there is a player empowered not only by aspiration but also by willpower and motivation to contribute towards the achievement of sustainable life. Dedication to this goal over many years has left him mentally well prepared for the challenge. He enlisted in the Organic Farming Association in the belief that it would be most conducive to the achievement of the basic strategy that he developed during these years. There can be little doubt about the actor's motivation in our case. Put another way, his motivation does not capitulate when it is a question of taking action subject to considerable economic risks. The player will take that into account in his further planning, which is a purposeful process designed to lead to a certain ultimate goal. It is a multi-step programme. Each step has consequences that must be taken into account.

About the Extension of the Model

In the description of the theoretical background of the author's intention, the extension of the model of human action must be explained. It is only in more recent times that attention has been drawn to the uni-dimensionality of the underlying problem, and, hence the shortcomings, of this so-called 'analytical logical thinking'. What are the implications of that (new) approach for research as well as teaching and learning?

It is the role of emotions and its influence on cognitive information processing, i.e. decision-making. We feel justified in drawing attention at this point to a directly relevant study on the subject of 'Emotional Intelligence' [6], in which, analogous to other studies, the role of the so-called Intelligence Quotient (IQ) is placed in an illuminating perspective. Goleman discusses the factors, which are "at work when people of high IQ flounder and those of modest IQ do surprisingly well. And he calls this 'emotional intelligence', a concept that includes self-awareness, impulse control, persistence, zeal and self-motivation, empathy and social deftness.

Emotions also played an important role in studies of Dörner [2]. He investigated how individuals behave when they are challenged to master complex problems in situations where they are subject to the handicaps of deficient information, time pressure, and the awareness of the urgent need to make important decisions. Dörner et al in the course of their research revealed a series of quite decisive action errors that commonly occur. Their findings point to defects under the following headings: goal design and goal specification, component analysis of essential variables, dependence and repercussions analysis, trend analysis according to the inner dynamics of the system, construction of a hypothetical internal model of the system and problem solution, goal ranking and searching for measures, monitoring the application of the action programme, self-reflection [7]. The persons under investigation worked with simulation models, which permitted the derivation of a complex system that was then to be dealt with as well as possible. It will be readily accepted that, in real life situations, the identified elements and / or phases of action regulation (steering) must play an essential role, even though the sequence may not be strictly adhered to.

A theory founded on such a basis would not only explain, but would also predict human behaviour in controlling dynamic systems. Thus, the essential two-fold aim of research and teaching and learning is to enhance our understanding of the causes of inter-individual differences in controlling such systems and at the same time to promote the emergence of a more robust theory that can withstand empirical testing.

The key factor may also be described as action regulation (steering) in the mind of the player and its interaction with the processes or physical systems the player tries to control. Some call this 'heuristic competence'. The basic psychological demands on the actor relate in particular to his capacity for sensory perception, thinking, planning, learning, empathy, and memory performance. His ability to cope with emotions such as stress, anxiety, fear, etc. are also important, especially in critical situations.

Making the Model of Human Action more complex and realistic through integrating group decisions related to sustainability

In this paper hardly anything has been explained about thinking and decision-making in groups as well as power in and around organisations so far. These are mainly issues of social psychology, such as conformity, mass-communication, self-justification, human aggression, prejudice, attraction (why people like each other) [8].

Conformity has to do with issues resulting from the actions of people who behave as non-conformists (individualists) and therefore deviate from the conformists, but change their behaviour or opinion as a result of real or imagined pressure from the group and / or a single person. That change of behaviour can be caused by fear of punishment for showing conformity or deviance. Mass communication or propaganda and persuasion is another important issue. Education as the process or act of imparting knowledge or skills could be seen as a process of communication, i.e. persuasion. Propaganda is, as everyone knows, the systematic propagation of a given doctrine. Which are the factors that determine the effectiveness of persuasive communication?

Self-justification means that the players are motivated to justify their own actions, beliefs and feelings. Whenever an individual simultaneously holds two cognitions (ideas, attitudes, beliefs, opinions), a state of tension occurs which we call cognitive dissonance, according to the theory of cognitive dissonance. Part of complex problem solving is how to reduce cognitive dissonance, which can be the consequence of decision-making. Human aggression can be a behaviour aimed at harming another person. However, the intention can also be to harm no one. Questions are whether aggression is inherited, learned or necessary at all. Aggression always depends on what the player thinks and feels. It is well known that, once you have humiliated a person, it becomes easier for you to hurt him or her in the future. Control of retaliation is a problem. Most victims of massive aggression are totally innocent. Violence breeds more violence. The consequence: being angry is normal, but that anger is not expressed in a violent and destructive manner to attract public attention. Usually aggression is caused by frustration, pain or boredom.

If the cause of a person's frustration is either too big or too vague for direct retaliation, he or she may become a prejudiced personality. Intensive interviewing of people has produced the finding that early childhood experiences in families characterised by harsh and threatening parental discipline lead to prejudiced personalities. The authoritarian personality fears his parents and feels hostile towards them. That is the basis 'of an adult with a high degree of anger which, because of fear and insecurity, takes the form of displaced aggression against powerless groups, while the individual maintains an outward respect for authority.' [8].

Attraction is another element, which can be developed. According to Carnegie's book: "How to Win Friends and Influence People" there is a simple piece of advice: Be pleasant, pretend that you like him or her, show interest in those things he or she seems to be interested in, be agreeable, without doling out praise lavishly. Then you have a

good chance that people will like you. It seems to be a simple methodology. However, it is somehow related to the generalisation that we like those people who provide us with a maximum of reward at minimum cost. By means of a general reward-cost-theory, one can explain a great deal of human attraction. A further point related to the model of human action could be the power in organisations. Both power and the organisation's development have been influencing cognitive information processing, motivation, emotions and attitudes and, last but not least, success and failure of the actor's or player's attempts to control complex problem solving processes or systems. Power is an important factor if we want to understand and improve the functioning of organisations [9].

An interesting issue could be: who are the players in the systems, which means, methods, tools do they apply to influence the systems and which are their goals. Analysing these and other factors as a whole might help to improve the understanding of the behaviour of organisations and of their cultures. The behaviour of an organisation will not be fully determined by power alone. The basis of power is control of a resource (rights or privileges to impose choices), will and technical skill or a body of knowledge and the culture of an organisation. These and other relevant factors can improve thinking, planning, decision-making and acting.

Research Proposal

Which are the causes of sustainability and how can we support it? As already mentioned, there is the need for inter- and multidisciplinary and international research. The European Commission stated objectives as early as the 90s of the last century, such as "to enhance the understanding of the main societal and economic driving forces of environmental change at global and European level; to identify, evaluate and compare the range of possible options in the field of societal and economic action in response to critical environmental situations, and in the framework of sustainable development" [10]. But what about the human mind?

Related to higher education, the author would like to suggest a pilot study on enhancing the human mind to solve or shift complex ecological and socio-economic problems. It could be case based. In this context, the usual business or social or technological cases applied to teaching and learning are not appropriate. Rather, one could select papers from publications across disciplinary boundaries, but all focusing on environmental and sustainability problems. On the basis of action regulation (steering) (i.e. see extended model of human action), research, teaching and learning could be focused on environmental values and / or sustainability values. Therefore, these values should be identified in selected papers published wherever. Also further 'cultivation' of the identified values could be designed by the researchers. Another step is to develop the teaching and learning strategies for the pilot group (research group) in higher education. The book on Environmental Values [11] seems to provide a well-developed overview 'of the most pressing issues of our time, focusing on the relationship between human values, world views and preferences, and the natural world.'

The author's hypothesis is that the Extended Model of Human Action, provides a necessary 'package of knowledge for everyone' that is interacting with scientific and / or practical projects or systems and for those who are involved in teaching and learning. The knowledge about that extended model and its action regulation (steering) can be provided in seminars, workshops or through distance or e-learning.

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Education for Sustainability: Tourism and the Conservation of Natural Resources

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Abstract

Tourism is a major industry and many parts of the world rely on tourism as a significant source of income. In many less developed parts of the world this is very significant and the governments and local communities in such areas wish to encourage and develop such tourism. In effect, it provides a form of income redistribution from the wealthy west to other parts of the world. So here is the essential dichotomy of tourism – it is at once desirable and undesirable. Thus a compromise is necessary and this paper examines the nature of this compromise. In doing so we argue that there is an important role for education because an educated tourist is a responsible tourist.

Keywords: sustainable development, tourism, education, cultural capital, corporate social responsibility

Introduction

It is almost universally accepted that global warming is taking place and that one of the contributory causes of this global warming is air travel. Travel by air has grown dramatically in recent years, particularly for the transport of fresh produce to the affluent western countries. Another significant area of growth however has been the growth in leisure travel, fuelled in part by the rapid growth of the ‘no frills’ air transport industry. In terms of leisure travel however there has also been a growth in long haul travel as people seek to assuage their jaded appetites by experiencing ever more exotic locations. These exotic locations are of course areas of outstanding natural beauty (e.g. the Grand Canyon) or historic significances (e.g. Machu Picchu) – or often both. And a fashion which is prevalent is eco-tourism. All of this tourism both contributes to global warming and potentially to the destruction of the environments which make the tourism attractive. As such it might seem that such tourism is undesirable and should be discouraged.

The role of tourism in terms of its contribution to development as well as its role in environmental degradation have been recognised in studies of tourism. Although it is the case that ideas concerning exactly what constitutes development have changed over the years tourism has generally been seen as a mechanism for development. Ever since the Brundtland Report (1987) [1] there has been a continual debates concerning development [2,3] and more specifically on the role of tourism in that development which has emphasised the need for community participation in that development. Similarly emphasis has been placed on such things as collaboration, partnerships and stakeholder involvement [4–6].

Advocates of a co-operative approach to development have found difficulty in putting this into practice: actually identifying the stakeholders involved, and their respective responsibility in the complex tourism industry is difficult, and examples of voluntary power-sharing by the private sector or the state are rare [7, 8]. Nevertheless tourism has continued to increase in scale such that by 2002 the number of international tourists around the world numbered around 715 million [9]. At the same time the destinations of these tourists have been changing so that traditional Mediterranean destinations such as Spain have been declining while more exotic ‘long haul’ destinations have been increasing in popularity. This has resulted in an increasing pressure from the environmental movement [10, 11] so that the industry and governments have started to work with other organisations to mitigate the excesses of the tourism industry and its customers [12].

The Introduction of Corporate Social Responsibility to the Debate

Much has changed in the last fifty years in the area of corporate social responsibility (CSR) [13] since it is largely a product of the 20th century [14]. At an international level, some public authorities and organisations increasingly consider different aspects of CSR and promote their intent to present them as actions to be undertaken, via public documents and regulations. For example, the United Nations (UN), with the Global Compact Initiative, analysed CSR in a context of globalisation while the OECD introduced the *Principles of Corporate Governance* (1999) and *Guidelines for Multinational Enterprises* (2000). Similarly the EU pro-

duced Green Papers – *Promoting a European framework for Corporate Social Responsibility* (2001) and *Corporate Social Responsibility: A Business Contribution to Sustainable Development* (2002). The principles contained in these were strongly reaffirmed at the World Summit on Sustainable Development of the UN held in 2002, in Johannesburg (South Africa).

These examples reflect the growing concerns, developments and challenges that each institution wants, or desires, to face and thereby affect in society. This behaviour represents the new age of globalisation. Because resources are scarce while needs are close to infinite, then corporations need to play an important role in fostering social responsibility but, of course, this not a new concept which should be promoted. Social responsibility involves a host of complex and contradictory needs and competition from within and without the corporation influences its ability to respond to social needs [15]. It is important to remember, the Brundtland Commission's [1] definition of sustainable development that is one of the most accepted with increased attention and use:

...development that meets the needs of the present without compromising the ability of future generation to meet their own needs.

This report makes institutional and legal recommendations for change in order to confront common global problems. More and more, there is a growing consensus that firms and governments in partnership should accept moral responsibility for social welfare and for promoting individuals' interest in economic transactions [16].

Sustainable Tourism

Apart from the controversy surrounding the developmental ability of tourism there is a parallel debate concerning the need for tourism to be sustainable. Sustainability is concerned with the effect which action taken in the present has upon the options available in the future [17]. If resources are utilised in the present then they are no longer available for use in the future, and this is of particular concern if the resources are finite in quantity. Thus raw materials of an extractive nature, such as coal, iron or oil, are finite in quantity and once used are not available for future use. At some point in the future therefore alternatives will be needed to fulfil the functions currently provided by these resources. This may be at some point in the relatively distant future but of more immediate concern is the fact that as resources become depleted then the cost of acquiring the remaining resources tends to increase, and hence the operational costs of organisations tend to increase.

Sustainability implies that society must use no more of a resource than can be regenerated. This can be defined in terms of the carrying capacity of the ecosystem [18] and described with input – output models of resource consumption. Thus the paper industry for example has a policy of replanting trees to replace those harvested and this has the effect of retaining costs in the present rather than temporally externalising them. Similarly motor vehicle manufacturers such as Volkswagen have a policy of making their cars

almost totally recyclable. Viewing an organisation as part of a wider social and economic system implies that these effects must be taken into account, not just for the measurement of costs and value created in the present but also for the future of the business itself.

Sustainability is a controversial topic because it means different things to different people. Nevertheless there is a growing awareness (or diminishing naivety) that one is, indeed, involved in a battle about what sustainability means and, crucially, the extent (if at all) it can be delivered by MNCs in the easy manner they promise (United Nations Commission on Environment and Development) [19]. The starting point must be taken as the Brundtland Report [1] because there is explicit agreement with that Report and because the definition of sustainability in there is pertinent and widely accepted. Equally, the Brundtland Report is part of a policy landscape being explicitly fought over by the United Nations, Nation States and big business through the vehicles of the WBCSD and ICC, [20–22]

Creating capital

The market recognises only one kind of capital – which is economic capital. The popular argument for higher education is based upon the creation of a potential for economic capital inherent in the acquisition of tertiary education, and this is considered to sufficient justification in its own right. Universities are concerned however with a different type of capital which they jealously guard and this is intellectual capital. Many within higher education would argue that one of the purposes of a university is to create intellectual capital. Indeed universities seek to appropriate ownership of this intellectual capital and one of the sources of dispute in universities is concerned with who owns this intellectual capital – academics or the universities as their employers. This intellectual capital is seen as a source of economic capital in the future but considerably less attention is paid to imbuing students with such intellectual capital.

According to Bourdieu [23] however there are three types of capital which each of us possess: social capital, cultural capital and economic capital. At the simplest level, social capital refers to our ability to behave appropriately in the circumstances and company in which we find ourselves. Thus we will tend to behave differently in different circumstances, such as attending a formal dinner, being present at a meeting at work or watching a football match with our friends, and we have probably witnessed people who have behaved inappropriately for the circumstances in which they find themselves. Generally speaking the more circumstances in which we are able to act appropriately the greater is the amount of social capital which we possess. Social capital comes initially from our family and our upbringing but it is also acquired through experience and practice and the more which we possess then the wider range of situations in which we feel comfortable.

Cultural capital refers to the range of people who we know and can contact. In essence therefore cultural capital equates to our social network. The bigger our network, particularly when it contains a wide range of people from dif-

ferent backgrounds, then the greater is the amount of cultural capital which we possess. If we know, and can interact with, a lot of people but these people all know each other then the social network of each of them largely coincides and this does not give us a great deal of social capital. It is knowing people who have different networks which largely do not overlap which provides us with cultural capital because this enables us to expand our own social network. It is also important to remember that the more influential – in whatever terms or spheres are important to us – the people in our social network are then the more cultural capital this gives us. Our cultural capital comes from our ability to make use of our social network in ways which are beneficial to us. Possessing a social network, and thereby cultural capital, is not of course solely concerned with being able to use this to our own advantage as others in our network are also seeking to make use of it to assist them. So essentially a social network is a mechanism whereby people can help each other to pursue their individual aims and objectives. This assisting each other strengthens the network and at the same time increases the amount of cultural capital which we, as individuals, possess.

To some extent cultural capital also comes from our family and our upbringing but it is also acquired at university. This is why students from wealthy and influential backgrounds start life with an advantage – they have more cultural capital which can be used later in life. And more prestigious universities – which tend to be attended by those already in possession of more cultural capital – extend this advantage. Economic capital comes in two forms – wealth and income. Although wealth, in whatever form, can be inherited this is not true of income. This must be obtained by our own efforts.

It is important to understand that the three types of capital can be converted into the other types of capital. Thus social capital can be converted into cultural capital because if we understand how to behave appropriately in a wide range of circumstances then we can expand our social network and thereby increase the amount of cultural capital which we possess. Similarly we can make use of the cultural capital which we possess to provide us with opportunities to secure more advantageous employment or better opportunities to acquire income and wealth. In this way our economic capital can be increased. The expansion of higher education through distance learning and virtual learning pays little attention to this view of capital. It cannot be obtained without interaction with others and so learning facts and theories by studying in isolation does not increase this capital [24]. There is however a very strong argument that tourism is educational and thereby provides cultural capital to the tourist while providing economic capital to the tourist destination. When considering sustainability therefore this needs to be taken into account as well as environmental or developmental effects because this kind of capital has an inevitable role to play in the development of the world as a global society. So possibly the other costs associated with tourism are worth paying...

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The Philosophical Idea of Primary Harmony and Construction of Idea of Global Sustainable Development

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Within the notion of eternal Tao which is fundamental for the far-eastern thought, as well as within the ancient Greek notion of logos and within a big part of the European philosophical tradition – starting with the Ionic, Pythagorean and stoic school and ending with e.g. the modern deep ecophilosophy of Arne Næss [1] – a permanent looking after a harmony is to be seen. In the Greek thought, this is to be a harmony inside the self-dependent nature marked by the ancient notion of *arkhe* and by first preformations of the concept of law of nature [2], or a harmony inside the mathematical or logical archetype or hidden structure of the visible reality as it was vaguely marked by Pythagoreans and developed by Plato, or a harmonious way of the individual human's life, or a harmony of social life based either on hierarchic order or on equality and community. One can easily see that harmony is a very attractive, capable and fertile concept, one of the most significant ones in history of the human thought, but – at least in the starting point – one of the most ambiguous and unclear. In a fact, many times it was – and still is – used on a very arbitrary way, and its various meanings are incoherent. It means, however, that this notion gives many chances to us, to make it able to develop into various more specialised concepts, in some cases fulfilling strict criteria of the scientific preciseness.

The history of the first scientific laws being slowly developed from vague philosophical statements trying to express various appearances of the world's harmony, e.g. laws of the hellenist astronomy developed from the Pythagorean mystics of numbers and solids, points out one of the ways of the speculative general notion of harmony being transformed into its scientific forms as well as into the technological, artistic or other ones which are more specific and more precise. It concerns the concepts trying to describe harmony inside the nature, between the human individual and nature, between the human society and nature, and inside the society. The notion of "harmony" in the society was already long not so much made precise but deconstructed: the social sciences have clearly pointed out the causes of various ways of development, revolutions,

economical growth or lack of growth, and many other processes or states which can be qualified as "harmonious", but only if one points out precisely what is or what should be "harmonised", e.g. the budget's outcomes with the incomes, political representation of bourgeoisie with that of labour etc. Then, one can hardly suggest that the concept of "harmony" or "harmonious development" can be useful in its general, ideological form: only its specified, quantified and measurable derivatives (e.g. "harmonised budget") can be. However, even in such a case the axiology of such a derivative, e.g. the statement that budget without a deficit is an ideal, must be taken from outside the descriptive specified and measurable concept corresponding to the notion of harmony.

It is not so simple in the three previous cases. The general concept of harmony – if it is used to the nature as a whole, or even e.g. only to the animals' world – denotes either a metaphysical or theological idea of a harmonious project, similar to that from the Thomas Aquinas' 5th way (*ex gubernationem rerum*) and having not much to do with the scientific method, or a set of particular scientific statements or hypothesis' concerning e.g. the equilibrium between populations of some species in an environment. In both cases one can easily see that the descriptive component of notion of the harmony is dependent on arbitrary normative evaluations or postulates concerning "what should be" in the nature. It is almost the same in what concerns the "harmony" between the human individual and nature as well as between society and nature. Does it mean that seeking the harmony of human with nature is a purely ideological enterprise, expressing an utopian way of thinking?

Even if it is, it doesn't mean that it is useless. In a fact, the utopian component is inevitable in our social thinking: the real question is not how to remove it, but how to make it as realistic – and as effective in our practical life – as it is possible. Obviously we must frequently chose between the different social utopias that we should try to follow, e.g. between the socialist and the free market one, and we would like to base our choice on transparent reasons, especially on a sim-

ple but clear social axiology (e.g. the presumption that the common ownership is more valuable than the private one). If we ask about harmony between human and nature, we face the same situation – there is a choice between various utopias based on different axiologies concerning the “fundamental” relationship between both parties; various axiologies define various understandings of “harmony”, and correspond to various utopias. A good example of that can be archetypic patterns which are characteristic for the eastern religious tradition and for the western one. At the Far East, e.g. in the Taoist tradition, the human’s fate is to find a place which is designed to her/him inside the eternal structure of reality or nature: there is little of place either for a human’s creative activities transforming the nature nor for his domination over nature. Contrary to that, in the Western Judeo-Christian tradition the nature is given to a custody to the human who is obliged to subdue it (Gen. 1, 28) and to exploit it: the human is not only a “crown of creation” but even a kind of deputy Creator. At the East, it is the nature which gives sense to the human; at the West, it is human who gives it to the nature. In the both cases a kind of harmony between both parties is expected, but its axiological foundations are not the same. In a fact, the Eastern approach which is in favour of understanding the harmony as given by the universe or nature is also in favour of a more passive, non-practical human relation to the nature, as well as of more “conservative” kinds of ideological (e.g. religious) one, scientific or technological articulations of the notion of harmony and its derivatives, being rather afraid of causing much changes in the “natural condition” of human and environment [3]. To a contrary, the traditional Western approach which is in favour of understanding harmony, or at least some its particular forms, as being possible to be created by the human, or even more – to be invented and forced by him. It tends also to the more “progressive” or constructivist articulations of that notion. We can easily see that the Western attitude was favourable to the technological and industrial development as well as the liberal society, social revolutions and “modernising” social experiments. Of course it does exclude from the Western tradition neither the technological and social conservatism nor the medieval Franciscan idea of human brotherhood with nature as well as the modern “green” ecopolitical or counter-cultural movements [4].

The modern concepts of sustainability and sustainable development seem to be closely related to the old notion of harmony. Containing the idea of harmony between society and nature as well as these inside society and inside nature, they draft much more general notions related to the traditional notion of harmony than the fundamental natural or social sciences do. So, the transformation of that vague philosophical or theological idea into the science must be a much more complex and risky task if we deal with sustainability in context of the sustainable development. Also the utopist component in thinking about the sustainability, if we understand it very generally, is supposed to be even more significant and inevitable than it is in our thinking about the society and the “social harmony”. It is so, because our evaluative visions of relationships between the human and nature, between the society and nature and inside the nature interfere one to another, and all of them interfere to our vision of the “social harmony”.

However, the more specialised applications of the concept of sustainable development, related to particular areas of science and technology, seem to be less burdened by that difficulty. It is so not only due to the more homogenous and less complicated systems that they try to describe, but also due to more clear axiologies they presume. However, the more general synthetic notion of sustainable development one tries to use, the more ideology and utopia and less of “hard science” can be expected in it. The problem is how to find out the proper balance between ideology and scientific thinking, or between the “pure axiology”, and the “pure descriptive” analysis of materialising the possibilities of goals derived from the presumed axiology.

The natural first step for that problem being solved seems to be a clarification of the axiological hierarchy: what is the superior value that we should try to materialise in our seeking harmony (the more specified notions of sustainability or sustainable development are already suggesting a particular way of understanding the harmony), and what are the lower ones. Should it be e.g. happiness of the human race? The typical purely axiological and ideological language, very speculative and having not much of relationship to the particulars of scientific, technological or social reality, is not very helpful here. It seems more promising to use more specific terms, e.g. the human identity [3]. In spite of being strongly charged by values, they have also a distinguish descriptive component which is possible to be bridged with the language of one or more branches of science (biology, physics etc.) or technology. In such a case the postulate of a value being materialised (e.g. the human identity being preserved) can correspond, at least to some extent, with really technological postulates (e.g. genetic engineering being limited by the specific form of correspondence principle [3]) and with scientific evaluations of their effects.

It is almost the same situation that we face in what concern the social ideologies and social engineering: the more general, speculative and ambitious axiology, the smaller chance to transform it into a realistic political and socio-economic program [5]. Maybe not always the small is beautiful, but the smaller (not too general and ambitious) is frequently more realistic. The axiologies are, however, evolutionary products of the social consciousness (in terms of historical materialism – components of the social superstructure), and after long time of ideologies of the social engineering being critically researched, we do know already a little about their social genesis’ and functions. It is much worse with the ecoaxiologies (the hidden or open foundations of ecological or environmentalist ideologies): until now, we have only a rather superficial and fragmentary knowledge about some of their affiliations [6]. One should repeat, that the concept of sustainable development is related to the complex structure containing nature, society and human individual – so, when we investigate its axiological foundations (by asking e.g. what, in general case, should be sustained and what means the development), we should not be limited by their purely “human” or “social” contents. Our awareness about e.g. the human behaviour being determined – in the social scale – by the type of individual attitude to the nature (sensitiveness onto the human’s unity with nature, etc.) varying in historic time and changing in culture to culture, is very poor in the moment.

The practical problem is, however, how to find out the foundations of a most general, long term and big scale project of the sustainable development strategy, by having only a rather poor – as said above – awareness about historically changing determinants of human relationship with nature. In order to try to, we should start from defining the way of understanding the general harmony that the particular line of sustainable development could materialise or approximate.

First, we should chose between the static or quasi-static and the dynamic understanding of harmony: do we believe in an ideal state of the complex system combined of the nature, social structures and human individuals (the Popperian 1st world) as well as of the way of human thinking (the 2nd world) and of the objective culture (the 3rd world), or rather in an optimally conducted continuous historical process changing the system by preserving some essential balances between its components. Despite the belief in an ideal state of harmony – in a kind of golden age – is typical for utopian thinking, it inspired many of environmentalist social and political movements which were, and still are, very influential in what concern the policies of sustainable development; it influences much also the more particular practical environmentalist legislations and programs [7]. The belief in an optimal process seems more realistically from technological point of view, but materialises until now mainly on a particular level dealing with solving single technological and economical problems (preservation of a raw material sources, etc.) without a more general social, cultural or “deeply ecological” perspective. In the author’s opinion, there is a need as well as possibility of synthesis of the both approaches.

Second, we should chose between the notion of the “natural” (in the sense of being not implemented by humans, or at least not by the deliberate human’s activities) and of the “artificial” harmony. The first choice orders either to assume that the human’s intervention into the nature is possible to be (theoretically or/and practically) neglected or minimised, or that it can be harmonised – at least to remarkable extend – with the natural way of things as they go on in the system of nature. In other words, it divides the whole natural-human complex into two autonomous parts by giving priority to the nature and concerning the human activities as being able to “be subordinated” to the way of the nature’s evolution. That is also a sign of utopian thinking (e.g. of Gandhian type), present at now in the “green” ideologies but also, on the level of particular solutions, in many technological ideas dealing with e.g. the renewable energy. The latter choice would implicate a program of global scale natural or/and social engineering dealing either with a single or with both components (nature and society) of the ecological macrostructure; obviously it is utopian to the extend of all macroscale social engineering programs that the world experienced until now (like the communism) being utopian, as well as any global natural engineering program must be utopian at least to the extend of being dependent on a socio-political utopia – at least because its materialising must depend on disposable socio-political means which seem to be available only in framework of a highly utopist political program. We do not consider here huge technical difficulties in what concern the abilities of

such a huge and extremely complex system (nature + society) being sensibly modelled and its expectable evolution being foreseen. The solution of question “what is realistic” should be than, that the human should either implement his vision of harmony in local scale by taking in account – at least to some extend – also the global balances composing some aspects of the “natural” global harmony, or to try to compensate the undesirable effects of human activities which are harmful to the natural harmony by other ones in order to simulate the preservation of natural harmony as a sum of two or more actions which are opposite one to another. In fact, the practical environmentally conscious activities materialise the both ways, in different combinations.

Third, we must chose between the concept of harmony consciously based on a clear hierarchy of values, especially of these which have clear relationship to the human’s activities and life conditions (avoiding dangers of the sources of energy being exhausted, the air being polluted over the limit which is save for human life, etc.), and the concept – or rather a more or less intuitive “feeling” – of harmony based rather on traditional imaginations, myths, old philosophies and even popular traditionalist and sentimental cult of the “virgin nature”. The first choice is typical for the engineer’s approach aiming a possibly global solution of particular technological and economical problems which seem to be urgent in a medium time scale; in such a situation the real content of notion of harmony is rather narrow and undertaken to a particular fixed vision of technological development (which is expected to be in need of such and such natural means) and of the human needs, and it is hardly possible to include in it a vision of the human and society being fundamentally changed in a future. The second one, addressing to the human romantic desire of unity with nature and neighbours, can be effective in the popular environmentalist and pro-ecological propaganda and education; it seems to be, however, very little useful as starting point of a scientific approach to any global developmental strategy. In the most frequent practice, it is the “green” social or political movement based on romantic “love of nature” and sometimes very ignorant in what concern the hard technological reality (e.g. not able to agree that the nuclear power plants are statistically much more save than the coal ones), which starts the political harrasment in environmentalist questions forcing professionals “to do something with that” – and next the professional staff is trying to do what is not a pure technological nonsense. The first one follow popular myths and emotions, sometimes expressing dreams about a “new society” (and, by the way, a kind of “revolutionary” thinking which use the environmental questions only as a pretext); the second one use scientific knowledge limited by the perspective of a particular line of technological development and ignoring, as a rule, any possibilities of radical social changes. In order to push the problem of ecology out from the dead point, it frequently occurs the both parts are necessary, and a compromise between them seems to be an only solution.

And fourth, we must chose which understanding of the social development should we consider as a fundamental value: quantitative or qualitative, proportionate in global scale or levelling the inequalities between regions, fulfill-

ing some normative legal standards, norms of social justice etc. or not fulfilling them. Despite our knowledge about the mechanics of global socio-economic development is still very poor, it is the society from inside which do we look on the evolution of the whole system nature-human-society-culture, and our thinking about the natural, or expected, or planned development of the whole system is predominantly determined by our expectations from the social development. That is why if a genuine macroscale theory of such a system is available, the reach macroscale social theory including a broad psychological, sociological, politological and other knowledge seems to be a key to it. Being aware of the contemporary situation in humanities and social sciences, especially characterised by fragmentation and incompatibility of languages of various languages, one should not be too optimistic. It seems, however, that at least the pointing out of some initial conditions of starting with such a kind of research makes a sense for today.

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Territorial Analysis Method of Socio–Economic Conflicts Between Human Development and Environmental Conservation*

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Abstract

This paper focuses on a methodology for analyzing potential territory capacities such as local development and conflict resolution of the use of land natural resources.

Ecological economics and *landscape ecology* are the theoretical origins of this methodology so that it's possible to give a value to both economic aspects and social–environmental aspects.

In this case public stakeholder choices will have many actuation opportunities because they will be based on the sustainable development concept.

The aim of our study is to describe the multifunctional role that the agricultural activities carry out within a territory; to do this, it is necessary to find a methodology which can define social functions that characterize the territory of analysis. According to the definitions widely accepted by part of the European scientific community, the agricultural field expresses four of the functions that are particularly important.

For every defined function a set of indicators has been chosen that permit the analysis of the various aspects of agricultural activities. The statistical basis was the 2000 Agriculture Census (Istat, 2001). In this document there is present different types of information that are connected to the multifunctional aspects of the field.

This paper also analyses potential conflicts between environmental conservation and human development, and starts from the many functions of the agricultural sector in the area called Comprensorio Empolese Val d'Elsa, located in the Region of Tuscany.

Keywords: local development, conflict resolution, ecological economics, landscape ecology

Introduction

The goal of the work is the study of a basic methodology for the analysis of the potentialities of territory in terms of local development and the solution of conflicts that may originate from the alternative use of natural resources. In order to achieve the objective the work was developed through the following phases. First of all we analysed the theoretical basis of territorial planning, with special attention towards the recent proposals coming from *ecological economics*, *regional development theories* and *landscape ecology*. The approach that best integrated the principles of these subjects was the geographic multicriterial analysis. Therefore, the methodology was applied to a specific su-

per-municipal territorial reality with the aim of analysing and managing problems linked to grass-root sustainable development compatible with conservation of the environment and the cultural and landscape characteristics of the territory. The area that was selected, the Empolese–Valdelsa district, was considered sufficiently broad and representative of all the problems involved.

Theoretical and methodological basis

Within economic theory the concept of territory has various meanings. From the point of view of environmental economics and ecological economics the territory represents the habitat for wild species, the link among hydro geological, climatic and biological systems and the place for important social services such as outdoor recreation. From the perspective of agricultural economics, the territory represents the place for primary productive activities and is characterised by its agronomic and climatic parameters, its position compared to the market, as well as by its quality, typicality and parameters of tradition [1].

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Through this brief overview, it is easy to realise how, due to its complexity and omni-comprehensiveness, the role of the territory, its conceptualisation and the research for normative and interpretative models is considerably changed in the economics theory in the last years.

The turning point in the construction of a new integrated concept of territorial problems is represented by the development of the idea of ecological economics, historically proposed by Costanza and Daily within the *International Association of Ecological Economics*.

The deliberation of possible alternative concepts of development started at the beginning of the seventies, with the analysis of new concepts such as eco-development and the influence of environmental components of economic growth [2]. Friedman and Waver synthesised such observations in the concept of territorial regional development, that favours strategies based on the activation of factors of endogenous development, aiming at improving the environmental, social and cultural heritage as a source of competitiveness and therefore of economic growth [3, 4]. The concept of regional development in territorial terms becomes hence an expression of “self-centred” and “grass-root” development processes based on the improvement of natural and social regional resources.

Landscape ecology, derived from the interaction among ecology, geography and territorial planning has produced a methodological approach finalised in integrating, on a territorial basis, concepts typical of ecology and social sciences [5]. According to landscape ecology an ecosystem is subject to two main orders of processes:

- Natural causes, such as ecological successions, long term natural phenomena (i.e. sedimentation or erosion) and short-term natural phenomena (natural fires, hurricanes, pests, etc.).
- Human activity that tends to modify landscape and land use through settlements, agricultural and productive activities.

Landscape ecology allows integrating social and economic problems within models of territorial evolution and can therefore be of great practical utility for land use planning, biodiversity conservation or for the management of environmental risks [6].

The need to treat complex sets of multidimensional indexes as well as the need to adopt a pluralistic and “participative” approach are the two main reasons which led ecological economics to mainly adopt decisional analysis models of environmental problems based on multicriterial techniques. Multicriterial analysis in fact represents the most appropriate family of methodologies useful to tackle problems relative to potential conflicts between self-centred development of productive activities and safeguard of the natural environment and of historical and cultural characteristics of local population. More in detail, as underlined by Martinez-Allier [7], more than solving all possible conflicts, the multicriterial analysis allows an in-depth study on the nature of the contrast, improving the informational framework and favouring a transparent political negotiation. The main advantage of multicriterial methods lies in fact in the possibility of considering simultaneously a large amount of information and models derived from various

subjects [8] supplying a backing in not completely structured decisional problems.

A methodological proposal

The analysis of environmental conflicts it becomes a fundamental instrument for sustainable land planning, just because by means of this It is possible to compare possible strategies of development and to consider what is the right way to encourage endogenous development of territory. In areas in which territory is an element characterizing the local development, the analysis of conflicts acquires a particular meaning for the conservation and the improvement of this element. In particular in rural areas in which the agricultural and forest element characterize the environmental, social and economic equilibrium, it becomes a priority to choose the right way of development, which will permit the improvement, and the conservation of territory.

On this subject it is important to emphasize the role of agricultural and forest activities; this sector carries out a variety of functions that can be applied to only economic field but which concern other aspects like environmental and social functions: this characteristic is very rare in other productive sectors. In our research we have individualized, with a view toward sustainable development of territory, typical areas suitable for the production of social functions. The study of social functions becomes the mean instrument to identify conflicts about the use of natural resources.

Important works on environmental conflicts [9] have shifted focus from non-renewable resources to renewable resources. The use of renewable resource conflicts can broadly be categorized under: (1) “direct” or “indirect” conflict; (2) international or intranational conflict. Based on this categorization, a typology was developed with the purpose of achieving two goals: (1) to help researchers and policy-makers better situate themselves in the vast literature in the field of “environment and conflict”, and more generally, “environmental security”; and (2) to establish the framework for a data collection on environmental conflicts which, in turn, will help researchers and policy-makers identify patterns in the linkages between environmental resources and conflict, thereby facilitating conflict resolution and prevention.

To analyse the role that the agricultural field takes, it was necessary to identify mean function expressed by agricultural farms and to evaluate a scale of multifunctionality for the examined territory. In particular, it is possible to analyse socio-economic consequences that can occur due to the change of agricultural cultivation and land use. For this kind of analysis it becomes indispensable to have a wide informative basis, not only macroeconomic variables. We especially need a detailed cartographic database that contains all the local variables. Consequently our database can be defined as a collection of non-redundant computer data organized so that it can be expanded, updated, retrieved and shared for various uses. It is important to underline that a capability of GIS [10] allows the performing an integrated analysis of spatial and attributing data. GIS can be considered as a special purpose digital database in which a common spatial coordinate system is the primary means of storing and accessing data and information. In

such a process it is crucial to have the availability of economic, environmental and social geo-referenced data are sufficiently detailed. For these reasons models of multicriterial evaluation and of analysis of conflicts will have to be implemented within a Territorial Information System*. Normally the two digital representations of territorial characteristics employed in the Territorial Information Systems are rasters and vectors. Even though both representations can be used, in most cases the applications of multicriterial analyses within Territorial Information Systems are based on raster representations.

Functions and indexes

After the set definition of indicators, the next step of analysis was focused on their spatial location and the grid resolution definition of the conflict maps. The database sources were based on the V Agricultural Istat Census [11], the Corine Land Cover, the documents of protected areas provided by the Region, the map of the water network and the geomorphologic and slope maps.

All indexes (indicator measurement) were gathered in cadastral unit worksheets: each cadastral unit represents the maximum useful details of the analysis. In this way, it was possible to maintain the specific details of Agricultural Istat Census database that were joined with territorial characteristics where each database record represents a cadastral unit. Thus vector themes were obtained and directly linked to the three functions of cadastral units.

A new spatial database was obtained and connected to the Geographical Information System and cadastral units are joined to specific farms located in them. Section 19 of the Census questionnaire was used for it because it contains geographical references to the farms.

The core of this analysis step is represented by the definition of multifunctional farms; in particular, three main functions have been identified: environmental function, economic function, social function. The first one is defined by the peculiarities of natural areas and the interaction between human activities and environment, and the analysis of this function was based on three main aspects: type of landscape, presence of bodies of water and human presence.

Eleven indexes are used for defining environmental function analysis: percentage of natural areas within the map-sheet, percentage of urban areas within the map-sheet, Shannon index, fragmentation of forest areas; percentage of urban, rural and uncultivated areas near a body of water (buffer area 10–40 meters), road density and percentage of wetlands; presence of mono cultivated areas within each cadastral unit; presence of biological cultivations; presence of biological livestock; presence of chemical and organic fertilization; presence of natural protected areas.

A special software “Arcview *ATIILA*” was used for index analysis that represents a powerful tool of ESRI program for territorial aspects analysis.

Some “rules” were used for this purpose, such as *border effect* [12, 13] where environmental transformation was directly related to microclimate changes and animal species. The changing entity [14] depends on the type of areas where fragmentation effect has occurred and also depends on the degree of fragmentation.

Some indexes have been used for human activities analysis such as the presence of urban areas close to a body of water, and they describe fragility of the environment; in fact all human activities near a body of water represent a pollution risk. Also agricultural activities have a direct impact on environment: presence of livestock, chemical fertilization or mono-cultivated areas have been directly related to the presence of polluted substances in water and to biodiversity diseases.

The economic function was defined by the production of food or other goods (such as energy, biomass supplies, pharmaceutical products, etc.)

Two specific economic indexes are used in the analysis: presence of cadastral unit fragmentation, presence of model farms. These indexes underline farm efficiency and potential territorial transformation. The meaning of social function can be closely related to landscape conservation, maintenance of local tradition and territorial preservation. In this case indexes used for analysis are: presence of recreational areas, presence of multifunctional areas, presence of planned forest areas, presence of direct selling farms, presence of farms that use forest products for energy purposes.

Multicriteria Aggregative process

The next step of the research was focused on the multicriteria aggregative process of all indexes, using “Fuzzy Yanger algorithm” (1.1). The aggregation of indexes represent the functions’ value.

$$A_j = \frac{ind_1 + ind_n}{n} \cdot C + \min(ind_1; ind_n) \cdot (1 - C) \quad (1.1)$$

where

A_j = j^{th} alternative

ind_n = index value of n^{th} function

C = Fuzzy Yanger operator value

It is important to underline the range that Fuzzy Yanger Operator (C) can assume: it represents the Stakeholders’ choices, in fact they can give a number close to 0 to lower importance functions (alternatives) or they can give a number close to 1 to higher importance functions (alternatives). The best alternative is represented by the higher function values. Each farm is represented by different levels of environmental, economic, social functions, where each cadastral unit is represented by a variable number of farms: the aggregative process of the three functions represents the multifunctional level of study areas that it shows in Fig. 1. (darker colours are higher multifunctional level values).

* The need in territorial planning to consider simultaneously a multitude of geo-referenced objectives also derives from other subject and theoretic-methodological approaches that are converging on the same problems (Bernetti, 1993).

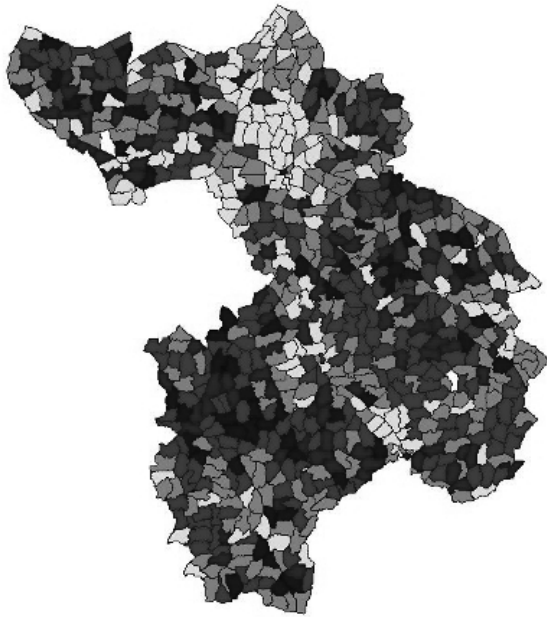


Fig. 1 Multifunctional farms.

Conclusion

The paper focuses on a methodology for analysing potential territory capacities such as local development and conflict resolution of the use of land natural resources where multifunctional areas have been considered the link between human activities and environmental resources, and they are very important for correct territorial planning. Ecological economics and landscape ecology are the theoretical origins of this method that combine MultiCriteria Decision Analysis and Geographical Information System. Three main functions of multifunctional farms were defined. Environmental, economic and social function were analysed according to a set of indexes: thus, they were combined with multicriteria rules (Fuzzy Yanger Algorithm). Subsequently, multifunctional values of farms were produced from this aggregative process: the best alternatives are represented by the higher values (darker colours in Fig. 1).

Higher levels of environmental function are located on the north side of our study area: the municipality of Cerreto Guidi and the municipalities of Certaldo, Montaione and Montelupo Fiorentino. The higher levels of economic function are present in the northeast side of area. Multifunctional farms are located on the north side of the municipality of Montaione and the northwest side of Gambassi terme, on the south side of Montelupo Fiorentino and Montespertoli and on the north side of Fucecchio (Fig. 1).

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Environmental Management Systems in European Municipalities

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Abstract

The aim of the present paper is to focus on identifying the factors, which determine whether municipalities develop, or not a strategy for the implementation of an Environmental Management System, which monitors the impact of their operations.

A verification of a sample of municipalities belonging to different countries in the European Union has evidenced that organisational structure and the pressure exerted by some stakeholders impact the development of certain strategies for the implementation of an EMS. Nevertheless, their subsequent execution is closely linked to characteristics, which are intrinsic to the municipality, such as environmental attitude and operational capacity. Although, to a lesser extent, the pressure exerted by interest groups and geographical location also come into play, factors such as the ideology of the municipal government or services being the predominant activity in the municipality bear no relevance.

Keywords: Environmental Management Systems (EMS), sustainability development, public sector, municipalities, determinant factors

Introduction

Until relatively recent times, the indiscriminate consumption of natural goods was favoured by the fact that they were free of charge based on their abundance and on their hypothetical self-regeneration. It has been necessary to verify the devastating effect of ecological catastrophes, of contaminating emissions, and of any practice, which degrades the environment for us to become aware of its value and of the need for its existence.

Chronologically, it was in 1972, the year in which a Conference on the Human Environment was held by the United Nations in Stockholm, when the starter's gun was fired signifying a new race for humanity, that of the defence of the environment. This concern for global environmental performance initially focussed on an analysis of the impact that the economic activity of developed countries had on the environment across the globe; nevertheless, from then onwards, the environmental awareness of citizens increased dramatically.

Although at the outset it was necessary to resort to different legal instruments mirrored in copious environmental legislation to attempt to halt the abusive use of natural goods

and irresponsible environmental actions, numerous organisations are currently totally sensitised and voluntarily undertaking environmental transformations in the operations and production systems like, environmental criteria in supplier selection, designs focused on reducing resource consumption and waste generations in product usage, etc. [1].

But, moreover, there has been a generalising of the conviction that a reduction in environmental impact can only be achieved on the premise that, in respect of this issue, zero impact does not exist and that it is necessary to make continuous improvements. This is the philosophy underlying the origin of Environmental Management Systems (EMSs), whose purpose is the appraisal of and ongoing improvement in the environmental performance of organisations.

In conformance with Regulation (EEC) no. 1863/93 of the European Union, an EMS can be defined as part of a general management system which includes the organisational structure, planning activities, responsibilities, practices, procedures, processes and resources to develop, apply, reach, review and maintain an environmental policy.

In turn, an environmental policy is taken to be the general objectives and action principles of an organisation in respect of the environment, including compliance with all

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the statutory requirements relating to the same and a commitment to improve environmental performance in an ongoing manner.

In recent years, as is explained by Claussen et al. [2], EMSs have become an indispensable tool, not only for private corporations but also for the municipal public administrations of numerous countries; as is evidenced by the extensive bibliography published in recent years— i.e. Riglar for the UK [3]; Honkasalo for Finland [4]; Aall for Norway [5]; Emilsson and Hjelm for Sweden [6]; Jirillo et al. for Italy [7]; Cockrean and Lusser for the European countries [8]; the Global Environment & Technology Foundation for the USA [9, 10]; Bekkering and McCallum for Canada [11]; Swift and Broady for Australia [12]; Cockrean for New Zealand [13].

Although the general reasons are common, the specific reasons for promoting their implementation in each organisation vary. The following stand out: compliance with regulations [10]; obtaining a better public image [4, 14]; serving as an environmental model for the private sector and citizens [15, 7]; and improving resource management [16].

The implementation and development of an EMS can be systematised and simplified by using standard regulations. In Europe, the most widely accepted standards are the ISO 14001, drawn up by the International Organisation for Standardisation (ISO), and the Community Eco-Management and Audit Scheme (EMAS) developed through Regulations (EC) nos. 1863/93 and 761/2001 of the European Parliament and Council. Compliance with the requirements of these standards leads to their certification or validation, although this is not the primary objective of their implementation in municipal public administrations [6, 13–17].

During the course of the implementation stage of the EMSs, there may exist barriers, which prevent or make the process more difficult. Other factors may include: an absence of political or organisational commitment [10; 15] a shortage of resources [18] a lack of communication between departments [6] and even the size of the municipality [18]. Furthermore, factors such as the ideology of the party of the municipal government promoting the development of the EMS and even pressure on a national scale may foster their implementation [19].

This paper has two objectives: firstly, to determine the degree of implementation of EMSs in European municipalities and, secondly, to statistically verify determinant factors in the current state of development evidenced by EMSs in local administrations, considering the barriers and incentives detected in the implementation of the EMSs, such as the intrinsic characteristics of municipalities, the pressure exerted by interest groups and external factors. To be specific, an analysis shall be made of the factors which determine (i) whether municipalities have an environmental strategy to develop EMSs or not and, (ii) whether they have made a certain degree of progress in applying the strategy.

In order to do this, five hypotheses shall be established which will be tested using the information obtained from a sample of 97 municipalities belonging to 15 countries in the European Union. This document is structured into five sections. The first focuses on defining the environmental

performance of municipalities, as well as the role played by EMSs; the second includes the hypotheses enunciated in the research in accordance with the barriers and incentives detected in previous studies; the third describes the analysis methodology, and the fourth presents the results. The final section is used to show the most important conclusions reached in the work.

Environmental Management Systems in Municipalities

The Triple Environmental Role of Municipalities

Erdmenger [20] identifies three perspectives from which the actions, which municipalities must undertake in the area of the environment, can be contemplated: territorial environmental management, political environmental management and organizational/ administrative environmental management.

The first of these perspectives includes the environmental protection plans of the municipal geographical area. It is, therefore, a special perspective, of *in situ* monitoring. The second perspective embraces strategic plans and environmental policies and programmes, in other words, monitoring at a corporate level. The third perspective aims to reduce the environmental impact caused by the municipal administration on rendering services to citizens. The basic tool of the latter perspective is the EMS, as it enables municipalities to monitor their operations – activities, products or services and processes – which may impact the environment in order to minimize them.

In general, an EMS is set up by complying with the requirements of one of the two officially approved standards in existence; the first is international in nature, ISO 14001, and the second is applicable on a European scale, Regulation 761/2001 EMAS. However, certain competences, such as social and educational services, owing to their special characteristics, require a simplification of said standards [16], which on occasions is used by all the competences in the municipality [17].

Although the two aforementioned standards currently abide by the same philosophy, there do exist some specific differences, including the fact that Regulation 761/2001 EMAS requires that the town council undertakes an Environmental Declaration whose objective is to provide the public and other interested parties with information regarding the impact and environmental performance of the organisation and its ongoing improvement in this area.

Aside from the methodology, which is adhered to in its implementation, it must be pointed out that the setting up of an EMS may have a different scope. In the event that a municipality should decide to implement a system of this kind, it does not have to do so throughout the whole town council, but it may implement it in separate departments or in specific services.

Furthermore, it must not be forgotten that the certification of EMSs, unlike what usually happens in the private sector, is not the basic reason, which leads municipalities to comply with the requirements laid down by the standards. Their objective is broader and is oriented in three directions: compliance with environmental regulations; having

good internal environmental management; and preventing contamination, with the final aim of achieving sustainable development. Certification does not afford any advantages whatsoever to these approaches owing to the fact that there are no external pressures for a municipality to obtain it [13]. Therefore, depending on whether a standard is adopted or not and on its possible certification, we can find the following situations:

- Informal and not certifiable. Its implementation does not adhere to any standards and, therefore, no certification can be applied for.
- Formal and not certifiable. It adheres to one of the aforementioned standards, but the municipality will not apply for any certification.
- Formal and certifiable. The municipality abides by the standard and will apply for certification or verification of its compliance.

Advantages of the Implementation of an EMS

Although initially EMSs were implemented in private corporations, at the present time most development is probably being achieved in municipalities. This is evidenced by studies such as that by Emilsson and Hjelm in Sweden [6], as over 50% of the municipalities in said country were implementing an EMS. The latter was being applied by 25% in all their departments and by another 25% only in the competences with greatest environmental impact, such as water supply, waste collection and urban transport, amongst others. In a subsequent analysis, these authors [17] detected that 50% of the municipalities, which in the first study had implemented an EMS, had increased the number of departments that had already implemented said system. For their part, Jirillo et al. obtained similar results in Italy [7], initially identifying moderate implementation but which, in the medium-term, was forecast to increase significantly. From a broader perspective, Cockrean and Lusser evidence that 15% of European municipalities have an EMS installed throughout the whole town council and 50% in certain functions [8].

In accordance with the Global Environment & Technology Foundation (10), an increase in the implementation of EMSs may be due to a series of advantages included unanimously in all empirical studies of which the following are noteworthy:

- they improve relations with environmental regulators,
- they improve operational efficiency,
- they improve environmental efficiency [4, 11, 16],
- they improve communication with stakeholders [4, 15, 16, 21].

Nevertheless, one of the strongest reasons for the implementation of an EMS by public administrations may be of a political nature. Political leaders consider that advantages may be obtained in the electoral market given that it may mean a competitive edge, provided that voters appreciate and value the importance of said participation [22].

Barriers to the Implementation of EMSs Research Hypotheses

Based on the information provided by the heads of EMSs, empirical studies undertaken in different countries

have evidenced that there is a series of factors, which prevent or make their implementation more difficult in municipalities.

Cockrean and Lusser [8] found that a lack of resources is the main problem behind a failure to implement EMSs in European municipalities. The Global Environment & Technology Foundation [10] identifies as barriers the absence of organisational and political support. Furthermore, Burström [15] and Emilsson and Hjelm [6] also identify as a problem a lack of communication between departments, and Darnall et al. [18] even highlight the possible influence of the size of the municipality.

This paper introduces some basic differences in respect of previous studies on the implementation of EMSs in municipalities. Although, initially, the development of the strategy for the implementation of EMSs is analysed in a descriptive manner, it is then verified whether the barriers identified in previous studies have a significant statistical impact, both as regards the existence of policies geared towards the implementation of an EMS and in respect of the degree of progress made in the process of executing said policy.

In order to fulfil the abovementioned objectives, the barriers will be classified into the intrinsic characteristics of the municipality, the pressure exerted by interest groups and external factors.

Characteristics intrinsic to the municipality

The intrinsic characteristics of the municipality are identified through its size, its activity, its operational capacity and its environmental attitude.

Municipal size. According to Darnall et al [18], the implementation of an EMS can be favoured or adversely affected by the size of the municipality. Small municipalities have the advantage that its implementation is more straightforward, owing to the ease with which activities and the organisation can be analysed; as well as the fluidity of formal and informal communication. Larger municipalities assume a greater volume of competences, which will cause greater environmental impacts, creating a need to develop tools, which facilitate their control. This affirmation allows the following alternative hypothesis to be enunciated:

H_1 : The drawing-up of a strategy to implement a certain EMS and its degree of development depends on the size of the municipality.

Operational capacity. The same author evidences the importance of the role played by technical and economic resources both in the implementation processes as well as in their subsequent maintenance. For their part, Emilsson and Hjelm [6] and the Global Environment & Technology Foundation [10] establish the need to count on human resources qualified in environmental issues, and specifically in the area of EMS. The results of the aforementioned works allow the following hypothesis to be made:

H_2 : The drawing-up of a strategy to implement a certain EMS and its degree of development depends on municipal operational capacity.

Environmental attitude. Support of and political commitment to municipal environmental protection performance are basic elements for the implementation of an EMS [8, 10, 15], the higher the level of the officers who render the sup-

port, the more efficient said support will be. Furthermore, political commitment will be more or less important depending on the ideology of the governing party [16; 19].

Furthermore, the activity type may be a factor, which significantly impacts the environmental decisions of the municipality. It is possible to think that a service activity will generate in municipal governors an attitude which is much more prone towards concern for environmental issues, especially if the activity is tourism related, and even more so if this is top-quality inland tourism.

Furthermore, if the municipalities have signed the Charter of Aalborg, they are deeply committed to sustainable development and are bound to implement Local Agenda 21, a process that unavoidably requires the development of an EMS [11].

An examination of the different aspects of the environmental attitude of the municipality listed above allows the following hypothesis to be made:

H₃: The drawing-up of a strategy to implement a certain EMS and its degree of development depends on the environmental attitude of the municipality.

H_{3.1}: Political commitment at the highest level favours the implementation and the development of an EMS.

H_{3.2}: The ideology of the political commitment favours the implementation and the development of an EMS.

H_{3.3}: The strength of the political commitment favours the implementation and the development of an EMS.

H_{3.4}: The predominant activity in the municipality favours the implementation and the development of an EMS, especially if the activity is service related.

H_{3.5}: Actions undertaken by the municipality in the area of sustainable development will foster the implementation and complexity of an EMS.

Pressure exerted by interest groups

The pressure exerted by interest groups mirrors the actions undertaken by those which have the capacity to impact municipal performance or which may be affected by the activities undertaken by the town council. It is estimated that in municipalities in which direct stakeholders are highly environmentally aware, they will exert greater pressure on the municipality so that the latter reduces its environmental impact.

An examination of the pressure of stakeholders allows the following hypothesis to be made:

H₄: The drawing-up of a strategy to implement a certain EMS and its degree of development depends on the pressure exerted by stakeholders.

External factors

External factors are related to the geographical location of the municipality, as environmental regulations may vary considerably from one country to another. In this sense, Emilsson and Hjelm [17] evidence the existence of different requirements and impositions on the municipality to implement an EMS, depending on the geographical area in which it is located.

H₅: The drawing-up of a strategy to implement a certain EMS and its degree of development depends on membership of a certain country.

Table 1. Implementation of an environmental management system in the municipalities of the European Union.

Country	Theoretical Sample	Final Sample	% Response
Austria	25	5	20.00
Belgium	10	0	
Cyprus	1	0	
Czech Republic	2	1	50.00
Denmark	10	1	10.00
Estonia	6	1	16.67
Finland	30	5	16.67
France	30	8	26.67
Germany	59	8	13.56
Greece	58	1	1.72
Hungary	3	0	
Ireland	1	0	
Italy	247	20	8.10
Latvia	5	0	
Lithuania	6	0	
Luxembourg	2	0	
Malta	0	0	
Netherlands	12	1	8.33
Poland	8	0	
Portugal	38	6	15.79
Slovak Republic	3	0	
Slovenia	4	0	
Spain	289	35	12.11
Sweden	22	2	9.09
United Kingdom	57	3	5.26
Total	928	97	10.45

Analysis Methodology

Obtaining the Sample

In order to collect the information, reference was made to a sample of 928 municipalities in the European Union, obtained by means of a random procedure stratified by countries and size, among the 2,277 municipalities, which had signed the Charter of Aalborg at the end of April 2004. The survey in question contained a broad questionnaire of closed questions, including five which focussed specifically on issues related to the drawing-up and development of an EMS implementation strategy; another series of items relating to the different characteristics of the municipality, that is to say, economic, political, and structural; as well as some referring to certain attitudes and situations, i.e. a commitment to sustainable development, and the participation of interest groups. The final sample obtained was of 105 municipalities, corresponding to 15 countries out of the 25, which make up the European Union. Of those, it was necessary to eliminate 8 as they had not provided the necessary information about the EMS. Data by countries are those, which are shown in Table 1.

Dependent Variables

The first dependent variable is of a dichotomic nature and reflects the EMS implementation strategy adopted by the municipality. Thus, the implementation strategy is understood to be both the situation in which the municipal-

ity has decided not to implement an EMS (value 0) and the opposite, in other words, if it has already taken the decision to implement an EMS (value 1). From an analysis of the data obtained, it emerges (Table 2) that 45.36% of municipalities adhere to some kind of implementation strategy. If this is examined in greater depth, it can be seen that said strategy is totally executed in 56.82% of the municipalities which have one, although this has only been certified in 25% of cases. In the remaining municipalities, the strategy is under way (13.64%), or in the pipeline (29.54%).

A second dependent variable will be defined based on the different states or degree of development of the EMS. This magnitude means breaking down the dichotomic value corresponding to the municipalities which in the preceding variable had opted for an EMS implementation strategy, depending on the degree of progress of said strategy.

Thus, the second dependent variable takes values between 0 and 4 to represent: the non-existence of a strategy (value 0); it is in the pipeline (value 1); it is being undertaken or is in progress (value 2); it has been completed (value 3); and the EMS is certified (value 4).

Furthermore, the application objective of the EMS implementation strategy is the entire town council (59.09%), and complies with the requirements laid down in the standards Regulation 761/2001 EMAS and ISO 14001, in this order, followed by other models.

Table 2. Implementation of an Environmental Management System.

Strategy	Exists		Does not exist	
	Frequency	Percentage	Frequency	Percentage
Municipality situation	44	45.36	40	41.24
Degree of progress	When it exists			
	Frequency	Percentage		
		Over strategy (44)	Over sample (97)	
Totally implemented	25	56.82		25.77
Under way	6	13.64		6.19
In the pipeline	13	29.54		13.40
Scope of application				
Affects the whole town council	26	59.09		26.97
Affects specific departments	8	18.18		8.25
Affects specific competences	3	6.82		3.09
Miscellaneous	7	15.91		7.22
Standard applied				
ISO 14001	13	29.55		13.40
Regulation 761/01 EMAS	20	45.45		20.62
Other standards	11	25.00		11.34
Certification				
EMS certified or validated	11	25.00		11.34

Independent Variables

In keeping with some of the guidelines established in previous works and the opinions of the authors themselves, in order to verify the factors which determine the current state of development of EMSs in local administrations, considering the barriers to and the incentives for their implementation and the reasons which have potentially led to a certain degree of progress being reached, the fourteen variables whose definition is shown in Table 3 have been chosen.

In order to verify the effect of the size of the municipality, the POPULATION variable, representing the number of inhabitants, has been chosen, which identifies a criterion which was traditionally used to assign competences to town councils.

The impact of the operational capacity of the town council will be verified using ECONOMIC, TECHNICAL, HUMAN and ORGANISATIONAL variables which represent, respectively, the degree of suitability of the economic, technical and human resources for environmental activity, as well as the suitability of the organisational structure in respect of the needs of the environmental departments and councillorships. All of the above were valued from 1 to 5 by the officer for the environment.

There are two types of factors which determine the environmental attitude of the municipality. The first are of a

political nature and are identified by the MAYOR and DEPUTY, who represent the leadership of the two senior municipal political figures in environmental matters; with the LEFT-WING variable representing whether the municipal government is left-wing in its ideology or not; and with the MAJORITY variable reflecting the manner in which said figures exercise power, in other words, it identifies whether the leadership is exercised with the political control which means having an absolute majority or not.

The second factor type refers to the tradition and strength of the environmental performance of the municipality. Thus, the SERVICES variable indicates whether the predominant activity in the municipality is services, an element which may characterise town councils with a certain amount of experience in environmental care; the PERIOD variable reflects the time which has lapsed from the signing of the Charter of Aalborg, the time when the municipality assumed the role of main player in the area of sustainable development; and the PROGRESSAGE variable includes the degree of development made in the municipality as regards Local Agenda 21.

The CITIZENS and PARTICIPS variables, which will enable Hypothesis H_4 to be verified, represent the degree of participation of the inhabitants and the private companies existing in a municipality in sustainable development processes.

Table 3. Independent Variables.

Variable	Definition	Hypothesis
Population	Numerical variable which represents the size of the municipality depending on the number of municipal inhabitants	H_1
Economic	Numerical variable which represents the level of suitability of the economic resources allocated to the environment, valued from 1 to 5.	H_2
Technical	Numerical variable which represents the level of suitability of the technical resources allocated to the environment, valued from 1 to 5.	H_2
Human	Numerical variable which represents the level of suitability of the human resources allocated to the environment, valued from 1 to 5.	H_2
Organisational	Numerical variable which represents the level of suitability of the organisational structure of the department of the environment, valued from 1 to 5.	H_2
Mayor	Dichotomic variable which takes the value 1 if the Mayor is the leader of the environmental policies and strategies, and 0 if the opposite is true.	$H_{3,1}$
Deputy	Dichotomic variable which takes the value 1 if the Deputy Mayor is the leader of the environmental policies and strategies, and 0 if the opposite is true.	$H_{3,1}$
Left-Wing	Dichotomic variable which takes the value 1 if the governing municipal party is left-wing in its ideology, and 0 if the opposite is true.	$H_{3,2}$
Majority	Dichotomic variable which takes the value 1 if the governing municipal party has a majority, and 0 if the opposite is true.	$H_{3,3}$
Services	Dichotomic variable which takes the value 1 if the predominant activity in the municipality is services, and 0 if the opposite is true.	$H_{3,4}$
Period	Period of time lapsed since the signing of the Charter of Aalborg.	$H_{3,5}$
Progressage	Numerical variable which represents the degree of progress made in the implementation stages of Local Agenda 21.	$H_{3,5}$
Citizens	Dichotomic variable which takes the value 1 if the level of citizen participation in environmental matters has scored a 5, and 0 if the opposite is true.	H_4
Particips	Dichotomic variable which takes the value 1 if the private sector promotes the development of environmental policies and strategies, and 0 if the opposite is true.	H_4
Country	Numerical variable which identifies the membership of each municipality with its country of origin.	H_5

Table 4. Logistic Regression Estimates.

Dependent variable	Existence of an EMS implementation strategy			
	B	E.T.	Wald	Exp (B)
Variables into equation				
Constant	-1.451**	0.539	7.250	0.234
Organisational	0.575**	0.201	8.151	1.776
Majority	-0.984*	0.507	3.763	0.374
Particips	1.285**	0.576	4.972	3.615
-2 log likelihood:	100.359			
R2 of Cox and Snell:	0.231			
R2 of Nagelkerke:	0.309			
Global classification percentage:	73.30			
Chi-squared:	23.695 (sig. 0.000)			

** p<0.05

* p<0.10

Finally, the COUNTRY variable will be used to represent the country to which each municipality belongs and which serves as an approximation of the pressure which may be exerted, or even the imposition made by each national government on its municipalities for the implementation of an EMS.

Analysis Procedure

Given that the first of the dependent variables designed is dichotomic in nature, logistic regression is the most appropriate technique for testing the hypotheses proposed. The magnitude to be explained is interpreted as the likelihood that a municipality has an EMS implementation strategy. The role played by each independent variable is quantified by a parameter which determines its effect on said likelihood. Any municipalities which do not have a strategy are used as a reference group with which the municipalities which do have one are compared.

Table 4 shows the results of the logistic regression, where the statistical test for each parameter reveals the factors which determine whether town councils have an EMS implementation strategy or not. In order to prevent problems of MULTICOLLINEARITY, the variables have been introduced in the model using the stepwise procedure.

As regards the second dependent variable, and given that it categorically measures the degree of progress of the EMS, the model of dependence is based on a logit analysis as a suitable technique for testing the hypothesis. The magnitude to be explained has to be interpreted as the likelihood of the EMS of a municipality being found in each one of the five stages determined by the dependent variable. The role of the independent variables is defined as a parameter which reflects the effect of each of them on the likelihood of each stage.

Table 5 shows the results of the logit analysis when the group of municipalities which has not implemented or is not planning on implementing an EMS acts as a reference group with which the other groups of municipalities will be compared (parameters 0 are assigned to the reference group). Consequently, the statistical tests used for each parameter only indicate the existence of significant differences in respect of the reference group.

In order to verify the effect that the COUNTRY variable may have on the dependent variables, hypothesis H₅, the Kruskal-Wallis test was calculated, and the results obtained are shown in Table 6.

Table 5. Determinant factors in the degree of progress of the EMS implementation strategy.

Factors	Does not exist ^a	In the pipeline	In progress	Completed	Certified	Likelihood ratio test ^b
Interfere	0 –	-6.243** -2.616	-0.150 -1.657	-4.268*** -1.547	-3.249* -1.758	22.369***
Population	0 –	0.000 (0.000)	0.000* (0.000*)	0.000 (0.000)	0.000 (0.000)	9.711**
Period	0 –	0.000 (0.000)	-0.004* (0.002)	0.001* (0.000)	0.000 (0.001)	14.515***
Progressage	0 –	6.140** -2.671	14.962* -8.523	-2.143 -1.991	1.264 -2.084	14.684***
Economic	0 –	-1.069 (0.652)	-1.604 (0.989)	0.562 (0.515)	0.850 (0.669)	9.355*
Human	0 –	-0.130 (0.457)	-1.993* -1.172	0.328 (0.492)	-0.676 (0.658)	6.656
Technical	0 –	1.147 (0.753)	0.409 -1.097	-0.611 (0.702)	0.228 (0.781)	3.994
Organisational	0 –	0.734 (0.570)	0.601 (0.636)	0.890* (0.484)	0.145 (0.487)	5.852
Particips	0 –	0.620 -1.134	1.697 -1.851	1.872** (0.900)	1.008 -1.069	5.075
Citizens	0 –	-22.949 (0.000)	-27.352 (0.000)	2.122 -1.703	-18.219 (0.000)	16.843***
Left-wing	0 –	-18.507 (0.000)	5.997 -3.924	0.272 -1.363	0.828 -1.720	4.714
Majority	0 –	-3.606*** -1.388	-9.940** -4.558	-0.147 (0.818)	-0.612 -1.110	19.673***
Mayor	0 –	2.365* -1.302	8.584** -4.278	-2.524* -1.324	-1.815 -1.381	20.940***
Deputy	0 –	3.371** -1.432	-23.306 (0.000)	-1.315 -1.329	-1.360 -1.759	15.463***
Services	0 –	-0.206 -1.058	0.866 -1.894	-0.006 (0.822)	-0.420 -1.029	0.472

Maximum log-likelihood: 135,144

Maximum log-likelihood of the trivial model (only constants): 231,893

Likelihood ratio test (model fit): 96,749 (sig. 0.001)

McFadden's pseudo squared-R (ρ^2): 0,417

Notes

Standard errors between brackets

^aReference category (zero parameters)^bLikelihood ratio test for variable deletion

* p<0.10; **p<0.05; ***p< 0.01 (Wald's statistic)

Table 6. Kruskal–Wallis Test.

Dependent Variable	Statistic
Existence of Strategy	Chi-squared = 18.562 (sig. 0.137)
State of Strategy	Chi-squared = 24.123 (sig. 0.030)
Strategy execution in pipeline	Chi-squared = 20.796 (sig. 0.077)
Strategy execution in progress	Chi-squared = 8.654 (sig. 0.799)
Strategy execution completed	Chi-squared = 34.339 (sig. 0.001)
EMS certified	Chi-squared = 9.283 (sig. 0.751)

Results and Hypothesis Verification

Factors Determining the Existence of an EMS Implementation Strategy

The global percentage of correct classification of the model is high since, as is shown in Table 4, it allows 73.30% of the municipalities which have an EMS implementation strategy to be accurately identified.

The predictive model comprises three variables: ORGANISATIONAL and PARTICIPS, significant to 0.05, and the MAJORITY variable, significant to 0.10. These results allow hypothesis H_2 , operational capacity, and H_4 , pressure exerted by stakeholders, to be accepted partially, and hypothesis $H_{3,3}$, strength of the municipal government, in its entirety. The rest of the proposed hypotheses have to be rejected.

The ORGANISATIONAL variable, which partially represented operational capacity, bears a direct and positive relation to the development of an EMS implementation strategy. This result indicates that the degree of suitability of the organisational structure is a determinant factor in beginning the implementation of an EMS. Out of the other variables which define operational capacity, none has turned out to be statistically significant, perhaps due to the fact that the implementation of an EMS in itself is not analysed, but rather whether a municipality has an implementation strategy or not. This explanation could also be assumed for the POPULATION variable which represents the size of the municipality.

As regards the environmental attitude of the municipality, only the variable representing the strength of the municipal government, MAJORITY, evidences any significant relation to the existence of a strategy. This is negative in nature, something which is surprising, as initially it could be thought that the support of a very stable party is important for municipalities which are in the process of implementing an EMS, given the level of resources which has to be committed. Perhaps what this variable does show is

that the parties which govern in a majority, regardless of their ideology, are less concerned about environmental issues, and are more geared towards meeting other needs, perhaps of an external nature. It is also surprising that the preponderance of a service-related activity, including that of tourism, is not statistically relevant to a municipality's environmental performance.

The behaviour of the variable representing stakeholder pressure, PARTICIPS, seems to indicate that municipalities which have a private sector involved in environmental issues are more prone to implementing EMSs to improve their environmental performance. This may be due to the fact that these direct stakeholders have undertaken similar activities in their organisations, thus becoming a model to be followed by the municipalities, and not the other way round, as is affirmed in other works [7].

The results of the Kruskal–Wallis Test, shown in Table 6, evidence that there does not exist any difference in the behaviour of municipalities deriving from the country they belong to in respect of the existence or not of an EMS implementation strategy, as the p-value of chi-squared is higher than 0.05. Although some European countries promote the implementation of EMSs in their municipalities, this would imply that their pressure does not bring about significant progress in relation to other European countries. Authors such as Emilsson and Hjelm [17] identify the United Kingdom as one of the countries which foments said implementation; nevertheless, in our work we have not been able to verify any difference, perhaps due to the fact that it is not a legal requirement. These results prevent hypothesis H_5 from being accepted.

From the above, the conclusion can be drawn that the intrinsic characteristics in a municipality as regards its operational capacity and environmental attitude, coupled with the pressure exerted by certain stakeholders linked to the private sector existing in the municipality, determine the drawing-up of an EMS implementation strategy in local administration. External factors, however, make no impact.

Determinant factors in the degree of progress made in an EMS implementation strategy

The results of the logit analysis, shown in Table 5, explain in 41.70% of cases the current situation presented by each municipality regarding the execution level of the EMS implementation policy and evidence the existence of a significant impact made by the intrinsic characteristics of the municipality (H_1 , H_2 , $H_{3,1}$, $H_{3,3}$ and $H_{3,5}$) and the pressure exerted by interest groups (H_4) in the different states of development of the implementation strategy.

An examination of the different states of the EMS implementation strategy verifies that the number of factors which are statistically significant is higher than that obtained in the previous analysis. To be specific, the results obtained in Section 5.1 are reinforced, as the ORGANISATIONAL and PARTICIPS variables continue to have a significant statistical effect on the completion of the process, the same as the MAJORITY variable, which continues to evidence a negative effect in the gestation period.

As regards municipalities whose implementation is still in the pipeline, the positive effect of environmental attitude, defined on the basis of the degree of execution of Local Agenda 21 (PROGRESSAGE), and the commitment shown by the highest political positions, the Mayor and the Deputy, have been verified. On the other hand, the negative effect of the strength of said commitment detected in the preceding section remains, evidencing that governments in a majority are less concerned about improving the environmental and social performance of their town councils in the future.

In respect of the municipalities which are currently implementing an EMS, it can be detected that the effect of the factors identified in the preceding stage is the same. The exception lies in the role of the Deputy Mayor and the negative effect of two characteristics which are intrinsic to the municipality, related to operational capacity in the area of human resources and a commitment to sustainable development expressed in its time angle. In addition, a slightly positive effect of municipal size is detected, although it cannot be described as determinant on account of its coefficient and its reduced significance.

As regards the municipalities which have fully implemented an EMS, but have not certified it, the influence of other factors different to those which impacted the previous states, or which have the opposite effect, has been detected. Thus, a long history of environmental attitude in the municipality is a factor which has a positive effect, an effect which is repeated for the suitability of the organisational structure of the municipality. On the other hand, political commitment by the Mayor now has a negative effect, which could evidence that, although political commitment is fundamental in the early stages of an EMS implementation strategy, this is counterproductive when executing the project fully. Furthermore, the positive effect of the pressure exerted by a part of the stakeholders, i.e. the private sector, is once again verified.

As regards the phase which would close the EMS implementation process and would guarantee its proper development, that is to say its certification, the results of the analysis show that none of the factors compared make an impact.

As regards the COUNTRY variable, unlike what happened with the first dependent variable which represented the existence or not of a strategy, the p-value of chi-squared is now lower than 0.05, as is shown in Table 6, indicating that it has a significant effect on the degree of progress of the strategy in municipalities which have opted for implementing an EMS, and would imply the partial acceptance of hypothesis H_5 .

The effect of the significance of the country of origin factor in the level of implementation of EMSs needs analysing in more depth. The same table summarises separately the contrast statistics for each of the degrees of progress in the strategy execution. It was detected that there are significant differences between the town councils whose execution of the strategy is currently in the pipeline and those who have implemented it fully, but not certified it. These results would partially confirm the affirmations made by Emilsson and Hjelm [17] which had previously been rejected.

Thus, once the decision has been taken to implement an EMS, its development level is influenced by the intrinsic characteristics of the municipality, the pressure exerted by interest groups and external factors, although their effect is limited to specific factors.

Conclusions

A growing concern for the environment has brought about attitudes prone to its protection, both by organisations belonging to the private sector and to the public sector itself, such as municipalities.

Proactive attitudes include the development and implementation of environmental management systems, geared towards monitoring the processes, activities, and products or services offered by the municipal administration in order to lessen the environmental impacts generated.

Previous research evidences the existence of a series of situations which act as factors inhibiting their implementation, such as the absence of political commitment, insufficient organisational structure, insufficient resources, municipal size and a lack of communication between departments.

A verification of the effect of a series of factors – catalogued as characteristics intrinsic to municipalities, pressure exerted by stakeholders and external factors – in the existence of an EMS implementation strategy and its subsequent development evidences that the characteristics intrinsic to the municipality, especially the latter's environmental attitude, have a significant effect. The drawing-up of the strategy and the initial phases of its execution are linked to municipalities where the municipal government does not fulfil its duties with a majority. Furthermore, whilst the implementation is still in the pipeline, the commitment shown by the main political leaders is fundamental, although a commitment is counterproductive when executing the project fully. However, it is true that party ideology bears no influence whatsoever.

The environmental attitude linked to the tradition of the municipality in sustainable development matters impacts the execution of the strategy, as both the length of time the municipality has been committed to sustainable development and an active performance in its promotion, by means

of participation in Program 21, have a positive impact on the different stages of implementation of an EMS, with the exception of the duration of the commitment in the commencement phase.

Within intrinsic characteristics, operational capacity is also relevant in the drawing-up of the strategy and the completion of the process. On the contrary, human resources have a negative effect on the development process. The effect of municipal size is less significant than in the case of the two preceding factors, although it has a small influence on the initial execution stage of the strategy. The pressure exerted by interest groups is only determinant regarding the private sector, and affects the drawing-up of the EMS implementation strategy and the completion of the project.

In spite of the existence of different policies, the country in which the municipality is located has no effect whatsoever on the drawing-up of the strategy, but positively impacts some of the EMS implementation stages analysed.

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Environmental Information and Sustainable Development: An Analysis of Spanish Firms from Different Sectors

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Abstract

Focusing on environmental aspects, this paper has a two-fold objective: on the one hand, to verify empirically how some Spanish firms that trade on the Ibex–35 index present their environmental information, considering that environmental aspects are indispensable factors for attaining sustainable development, and on the other hand, to analyse whether some of the firm in the Spanish tourism sector (not traded on the Ibex–35) present this type of information or not. Subsequent to this we shall discuss the results obtained. The indicators relating to biodiversity are reported on to a greater extent by firms belonging to the energy and water, transport and communications and construction sectors. The indicators relating to emissions, effluents and waste are more reported by the firms belonging to the energy and water and industries of transformation, construction and basic metals sectors. As regards the tourism sector, we have verified that to date not many firms present information on environmental aspects, but focus more on other aspects such as social and economic ones.

Keywords: environmental information, sustainability report, sustainable development, sectors of activity, Spain

Introduction

One of the most significant topics to appear in the reporting of firms in both the national and international arenas is that relating to corporate social responsibility. Although the concept of CSR integrates economic, social and environmental concerns, in this paper we focus on environmental information. For the Global Reporting Initiative [1] ‘the environmental dimension of sustainability concerns an organisation’s impact on living and non-living natural systems, including ecosystems, land, air and water’.

The problem is how firms have made known this environmental information. With this in mind, we undertook the present work with a two-fold objective: to verify empirically how some Spanish firms present their environmental information with regard to materials, energy, water, biodiversity, emissions, effluents and waste, suppliers, products and services, compliance, transport and overall, considering that environmental aspects are indispensable factors for

attaining sustainable development, and on the other hand, to verify whether some of the firms of the Spanish tourism sector present this type of information. The results obtained will then be discussed.

To accomplish the above, we chose certain companies belonging to different sectors of activity (financial and insurances, industries of transformation, transport and communications, energy and water, construction, basic metals, new technologies, real estate, trade and other services and mass media). All these companies trade on the Ibex–35, which comprises the main Spanish companies on the Stock Market. In addition to these, other firms from the tourism sector were analysed. Specifically we selected a sample of the 20 largest firms in this sector that do not trade on the Ibex–35, and whose income in 2004 oscillated between 2,200 and 200 million euros [2].

In order to achieve the above aims, we develop our work as follows. After the introduction, we consider the problems arising from the information on environmental concerns and review the empirical work on the topic. Following that, we describe the situation in Spain. To develop our own empirical evidence, we describe the objectives that we are attempt-

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ing to achieve, indicating the methodology applied to the research. Finally, we offer an explanation of the results obtained and discuss the general conclusions of the work.

Disclosure of Environmental Information. A Literature Review

In recent years the concept of corporate social responsibility has gained prominence to such an extent that the concept seems ubiquitous in the media and is gaining increasing attention among academics from a wide range of disciplines. The term corporate social responsibility is in vogue at the moment but as a concept it is vague and means different things to different people [3].

Gray et al. [4] point out that 'mainstream CSR literature identifies four major themes for CSR: natural environment, employees, community and customers'.

According to the Green Paper 'Promoting a European Framework for Corporate Social Responsibility', issued by the Commission of the European Communities in July [5], corporate social responsibility is defined as a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.

Crowther [6] indicated the benefits from increased disclosure and the adoption of environmental accounting:

- an improved image for the organisation which can translate into additional sales,
- the development of environmentally friendly or sustainable methods of operation which can lead to the development of new markets,
- reduced future operational costs through the anticipation of future regulation and hence a cost advantage over competitors,
- decreased future liabilities brought about through temporal externalisation,
- better relationships with suppliers and customers which can lead to reduced operational costs as well as increased sales,
- easier recruitment of labour and lowered costs of staff turnover'.

Undoubtedly, all these aspects justify the current importance of the publication of reports on economic, social and environmental information for firms all over the world, which in our opinion are necessary to know whether the firms are fulfilling the objective of attaining sustainable development.

After analysing the different definitions proposed by different authors, we now tackle the problem of the disclosure of environmental information.

At the international level we might refer to some works that show how companies have made public their environmental information.

Deegan and Gordon [7] documented a review of corporate environmental disclosures made by Australian firms in their annual reports. The results indicate that: the amount of voluntary environmental disclosures in Australia is typically low; the environmental disclosures are typically self-laudatory with few or no negative disclosures being made by the firms in the study; a general increase in environmental dis-

closures occurred during the period 1988 to 1991, and this increase is positively associated with increases in environmental group membership; there is a positive correlation between environmental sensitivity and the level of corporate environmental disclosure, and there is a positive correlation between environmental disclosures and firm size.

We can also refer to a recent survey drawn up by KPMG International's Global Sustainability Services together with the University of Amsterdam and published in 2005 [8]. This survey analyses the top 250 companies in the Fortune 500 and the top 100 companies in each of 16 selected countries (the UK, Japan, Italy, France, Spain, Netherlands, Australia, Denmark, Finland, Norway, Germany, South Africa, Belgium, Canada, Sweden and the USA). The survey not only covers incidences of CR reporting, but also their content and the drivers that are motivating companies to produce CR reports. Some of the most significant conclusions of the survey, which reveal the importance that this topic is taking on all over the world, are the following: one of the most pressing environmental issues for companies is climate change – not surprisingly, about 85 percent of the CR reports address climate change, while 67 percent measure and report on the amount of direct greenhouse gas emissions from their own business operations; many companies report on a wide range of activities undertaken to reduce emissions, such as the introduction of hybrid vehicles by automobile companies or the purchase of renewable energy; the oil & gas sector has for years been one of the leading sectors in environmental reporting; traditionally, the chemicals sector has been perceived as polluting and hazardous and has been afflicted by several high profile incidents; four of the regions where CR reporting is still at an emerging stage are: Asia, Latin America, Russia and Africa.

In Spain, it is important to mention different papers on social and environmental information reporting, all of which concern information disclosure in the annual reports. Archel [9] analysed the social and environmental information disclosure found in the annual report of the biggest companies operating in Spain throughout the years 1994–1998, and established some determining factors of companies disclosing such information. After calculating several social and environmental disclosure indexes, the results suggest a slow but steady increase in this type of reporting, especially environmental reporting. Moreover, it can be deduced that oil and energy firms are the ones reporting the most social and environmental information.

Moneva and Llena [10] analysed the environmental reporting practices found in the annual reports published by companies operating in Spain, and determined the evolution of these practices during the period 1992–94, on the basis of stakeholder theory. In order to carry out this analysis, they examined the annual reports of seventy large companies operating in industries considered to be sensitive to the environment. The reporting practices were grouped into a number of categories: type of environmental reporting provided, sections of the annual report devoted to environmental reporting, corporate environmental policies and projects, activities and achievements for the protection of the natural environment, and disclosure of environmental data in the annual accounts. As regards the type of environmental re-

porting provided, they found that environmental information significantly increased on the global level during the period 1992–94; as refers to the second aspect they were able to deduce a variety of ways and several alternatives: compulsory reporting (annual accounts and management report) and voluntary reporting (general corporate information and separate environmental reports). The Spanish firms studied have also taken an important qualitative step in the area of environmental policies and projects and their disclosure: a significant increase was found in the information disclosed with respect to atmospheric pollution, liquid waste, product and clean production processes and energy saving and efficiency. Also noteworthy is the increase in the number of firms reporting on environmental expenses, investments and provisions for environmental liabilities.

Furthermore, besides the works carried out by different authors, a number of bodies have established recommendations for the inclusion of environmental reporting in the financial statements and other parts of the annual report: [11–13]. In Portugal, the Portuguese Institution of Certified Chartered Accountants published in 2002 rules (Accounting Directive No. 29: Environment Matters) which oblige Portuguese firms to produce and publish an environmental report from 2003 onwards; until now there have been no specific requirements for the publication of environmental or social information, either by accounting law or by standards [14].

Focusing upon our own country, during the period 1992–94, there were no obligatory rules on environmental reporting in Spain [10]. However, this situation has been altered by the recent inclusion in the accounting regulations of obligatory environmental data for companies operating in the energy sector. Also very important are Resolution 25 March 2002 [15] of the Spanish Accounting Standard Setting Board (ICAC), which obliges Spanish firms to produce and publish an environmental report in the annual accounts, and the White Paper for the Reform of Accounting in Spain, compiled by the Spanish Accounting Standard Setting Board (ICAC) in 2002 [16], which besides indicating other information that can appear in the annual report, marks as voluntary information that which is social and as compulsory information that which is environmental.

Although our review of papers at an international level and in our own country reveals that there has been an increasing propensity for companies to publicly disclose information about their environmental performance, such information has predominantly been disclosed within the organisations' annual reports; however, there is a new trend in many countries for organisations to provide environmental performance information within a stand-alone environmental report. This new trend in many countries is reflected in the Global Reporting Initiative (GRI).

The GRI was launched in 1997 as a joint initiative of the U.S. non-governmental organization, Coalition for Environmentally Responsible Economies (CERES), and the United Nations Environment Programme with the goal of enhancing the quality, rigour and utility of sustainability reporting.

The first set of GRI Sustainability Reporting Guidelines appeared as an Exposure Draft in 1999. Following testing and public comment, the GRI released the June 2000 Guidelines. A revision process began immediately and con-

tinued over the next two years, culminating in the work of 2002. At present, work is being done to improve their contents and soon the Draft G3 Guidelines, currently under revision, will be approved.

The Global Reporting Initiative is a long-term, multi-stakeholder, international process whose mission is to develop and disseminate globally applicable Sustainability Reporting Guidelines. These Guidelines are for voluntary use by organisations for reporting on the economic, environmental, and social dimensions of their activities, products, and services [1].

The Guidelines document is structured in five parts: introduction; part A, using the GRI Guidelines; part B, reporting principles; part C, report content and part D, glossary and annexes.

Part A describes the key elements of the GRI guidance: What is a GRI sustainability report? Who should use the Guidelines? and the GRI family of documents.

Part B of the guidelines identifies reporting principles essential to producing a balanced and reasonable report on an organisation's economic, environmental and social performance.

Part C of the Guidelines specifies the content of a GRI-based report. The report content is organised in what the GRI considers a logical order, and reporting organisations are encouraged to follow this structure in writing their reports. The Guidelines comprise five sections: vision and strategy; profile; governance structure and management systems; GRI content index and performance indicators – this section listing the core and additional performance indicators for GRI based reports. The performance indicators are grouped under three sections covering the economic, environmental, and social dimensions of sustainability. The core environmental indicators are: materials, energy, water, biodiversity, emissions, effluents and waste, suppliers, products and services, compliance transport and overall.

It is important to point out that a number of major companies around the world have adopted the GRI Guidelines, such as Agilent Technologies, Alliant Energy, AMD, American Home Products, Baxter International, General Motors, Johnson & Johnson, British Airways, BBC, Carillion, British American Tobacco, Laing, Ford Motor, Royal Dutch Shell, Toyota Motor in the United Kingdom and the USA, among other countries.

We would also like to indicate that although this model is accepted world-wide for preparing reports on sustainability, it is not very often used by small and medium enterprises (SMEs). For this reason work is being done on a shorter model for this type of firm as well as on sector supplements. In fact, at present the GRI already has some different sector supplements: financial services, mining and metals, public agencies, tour operators, and telecommunications, and in development: apparel and footwear, energy utilities, logistic and transportation.

The Situation in Spain

In the case of Spain, the disclosure of environmental information in Spanish firms has changed substantially in

recent years. Contributing to this was the Green Paper, 'Promoting a European Framework for Corporate Social Responsibility', issued by the Commission of the European Communities in July 2001 [5]. Also very important is Resolution 25 March 2002 of the Spanish Accounting Standard Setting Board (ICAC) [15]. In the drawing up of this Resolution the Spanish Accounting Standard Setting Board (ICAC) took into account the Recommendation of the Commission of the European Communities of 30 May 2001 [17] relating to the recognition, measurement and publication of environmental matters in the annual accounts and annual reports of firms. This Recommendation in turn takes into account what has been regulated by the International Accounting Standards Board in the different norms referring to these topics as well as the position maintained by the task force on international accounting and information rules (ISAR) of the UN. Another important document is the White Paper for the Reform of Accounting in Spain, compiled by the Spanish Accounting Standard Setting Board (ICAC) in 2002 [16]. This includes environmental information as obligatory relevant information and social information as voluntary information to be included in the annual report in order to disclose the company's actions in improving the quality of life of its workers and the social conditions of its surroundings.

We must also highlight the importance for Spain of the Commission of the European Communities [18] issuing of the "Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the Sixth Environment Action Programme of the European Community 'Environment 2010: Our future, Our choice'. This programme identifies the environmental issues that must be solved if development is to be sustainable: climate change, the over-use of renewable and non-renewable natural resources, the loss of biodiversity and the accumulation of persistent toxic chemicals in the environment.

This Communication proposes a series of programmes related to the different environmental aspects, such as: stabilising the atmospheric concentration of greenhouse gases, protecting the functioning of natural systems and loss of biodiversity, achieving levels of water quality that do not give rise to significant risks on human health and the environment, better resource efficiency and resource and waste management, among others.

Last but not least, of course, we have the disclosure recommendations of the GRI, which we have explained previously and which take in aspects that are also taken into account by the Commission of the European Communities.

One of the first firms in Spain to present the sustainability report was the Spanish Association of Accounting and Business Administration [19], which did so in 2002, following the sections of the GRI Guidelines. The Guidelines 2003 have now been published, with more emphasis on the contents than the 2002 edition. To be exact, some environmental indicators presented in the Sustainability Report 2003 are the following: electricity consumed at AECA offices, initiatives to improve energy performance, used paper recycled, average paper consumption per work station, paper consumption by suppliers.

In Spain, the environmental information and other aspects of CSR have also increased following the GRI and

the creation of the FRC (Forum for Corporate Reputation), which is a meeting place for working on the analysis and dissemination of trends, tools, and models of corporate reputation in business management. It considers that the social responsibility of the company is one of the components that has most impact on corporate reputation, given that the satisfaction of the legitimate needs of the stakeholders generates relations based on confidence, respect and credibility. It proposes a series of measurement indicators, such as energy consumption, paper consumption, training of employees, supplier selection policy, stakeholder dialogue, and others. The main lines of action are [20]:

- to share research and disseminate knowledge in the field of corporate reputation,
- to analyse different models for managing corporate reputation,
- to define indicators and develop corporate reputation measurement systems and other related methods that make it possible to quantify the impact of corporate reputation policies on business management,
- to study the influence of and interrelations between the main intangible variables of corporate reputation: ethics, social responsibility, identity, brand and corporate governance.

Although at first it was constituted with 4 companies, currently there are 11 belonging to the FRC, most of which produce sustainability reports in accordance with the GRI guidelines.

By way of summary, we can say that environmental information is situated within corporate social responsibility and has evolved considerably in recent years both in the international sphere and in Spain and its divulgation is considered necessary for creating social progress and protection of the environment. Knowledge of all this information can have a positive effect on sustainable development.

Objectives and Methodology of the Empirical Study

We derived a classification from different theoretical contributions concerning environmental information, accepting the importance and the influence in Spain of the Green Paper issued by the Commission of the European Communities in July 2001a, the GRI framework, the Sixth Environment Action Programme of the European Community 'Environment 2010: Our future, Our choice', and the White Paper for the Reform of Accounting in Spain, compiled by the Spanish Accounting Standard Setting Board (ICAC) in 2002a.

Taking the early works and regulations as references, we undertook the present work in an attempt to verify empirically how certain Spanish firms present their environmental information relating to materials, energy, water, biodiversity, emissions, effluents and waste, suppliers, products and services, compliance transport and overall, and how this information can affect sustainable development.

To accomplish the above, we chose certain companies belonging to different sectors of activity and all the companies trade on the Ibex-35, which comprises the main Spanish companies on the Stock Market. Table 1 shows the number of firms in each sector. [Take in Table 1].

Table 1. Number of firms by sector of activity trading on the Ibx 35.

SECTOR OF ACTIVITY	NUMBER OF FIRMS
Financial and insurances	5
Industries of transformation	3
Transport and communications	4
Energy and water	7
Construction	6
Basic metals	2
New technologies	5
Real estate	1
Trade and other services (tourist sector)	1
Mass media	1

It is important to point out that some of them form part of the selective Dow Jones Sustainability Index, which includes only the 250 firms with the largest and best reputations in the world. We also refer to other large firms in the tourism sector that do not trade on the Ibx-35 and which are shown in Table 2.

able year (2002 and 2003), as we think that the information available on the web sites is more significant than that which we might have obtained in a questionnaire, since it is public information. The study of the environmental information reflected in the sustainability report was carried out by the content analysis method. This analysis technique is

Table 2. Number of firms of the tourism sector not trading on the Ibx 35

Firms analysed from the tourism sector	Presenting environmental information	Do not present environmental information
20	8	12

The Dow Jones Sustainability Index is focused on meeting the financial market's demands for rational, consistent and flexible indexes to benchmark the performance of investments in sustainability companies and funds. This index is focused on independent reliable indexes as a basis for derivatives and funds focused on sustainability companies. The DJSI family meets these demands by combining the expertise and resources of the experience of the leading index providers, Dow Jones and Company and STOXX Ltd., as well as the world-renowned pioneer in corporate sustainability assessment, SAM. The company selection process for the indexes is done based on a corporate sustainability assessment and is carried out by SAM. According to SAM this assessment allows the calculation of a sustainability performance key-figure for each company. The sustainability performance reflects the company's ability to create economic, social and ecological added value and is the result of a process of analysing and assessing sustainability. The figure is calculated for every company within the investment universe of the DJSI World. The corporate sustainability assessment can be divided into three levels: questionnaire, quality of publicly accessible documents and verification, and the criteria for the sustainability assessment of a company cover, for example, the following areas: strategic planning, environmental performance, external stakeholders and corporate governance, among others, [21]. Table 3 shows the Index structure by countries.

Spain is in a good position with respect to the number of firms pertaining to the Dow Jones Sustainability Index, occupying ninth place [21].

Regarding the methodology used to carry out the research, we took advantage of the information available on these firms' web pages, corresponding to the latest avail-

based on detecting the presence or absence of information covering a number of different subject areas [22]. Thus, the presence of a subject area is given the value 1 if it is reported, and given the value 0 if the subject area is not reflected in the sustainability report [10]. We then represented this information in percentages in Table 4.

It is important to note that the information the firms analysed present on their web sites does not only refer to environmental concerns. They also give information about economic aspects (net sales, suppliers, employees, donations to community and others) and social aspects (labour, practices and decent work, health and safety, human rights, society, and others). They also give information referring to the annual report (balance sheet, profit and loss account, notes to the annual accounts), information for shareholders and investors, economic-financial information, information for suppliers and clients, corporate government, dividends, and other aspects which, in our view, attempt to make the current situation and development of the firm's activity known.

Results of the Empirical Study

Following the considerations and methodology referred to above, we proceeded to analyse the information on environmental aspects presented by each of the companies.

To determine which environmental information is most relevant within the organization, we analysed different types related to materials, energy, water, biodiversity, emissions, effluents, waste, suppliers, etc., to see whether the firms of the sample report this information. Table 4 shows the percentage of environmental indicators used by the sample firms belonging to different sectors of activity.

Table 3. Index structure by countries.

Countries	Percentage	NAME OF SOME FIRMS
USA	34.76	Adobe Systems Inc, Johnson & Johnson, Ford Motor Co.
United Kingdom	24.30	Barclays PLC, British Airways PLC, Rio Tinto PLC.
Japan	7.28	Canon Inc, Fujitsu Ltd, Toyota Motor Corp.
Switzerland	6.25	Nestle, S.A, Novartis AG, Valora Holding AG.
Germany	5.47	Bayer AG, Siemens Ag, Volkswagen AG.
Netherlands	5.00	Royal Dutch Petroleum Co, Aegon NV, Fortin NV.
France	4.49	Aventis SA, Carrefour SA, Groupe Danone.
Australia	2.77	Amcor Ltd, Coles Myer Ltd, BHP Billiton Ltd.
Spain	2.09	Inditex SA, Grupo Santander SA, Iberdrola SA.
Finland	1.88	Nokia Corp, Fortum Oyj, TietoEnator Oyj.
Canada	1.68	Royal Bank of Canada, Dofasco Inc, Shell Canada Ltd.
Sweden	1.31	Volvo ABB, Electrolux ABB, L.M Ericsson Telephone Co.
Taiwan	0.42	Taiwan Semiconductor Manufacturing Co. Ltd.
Italy	0.41	Banca Monte dei Paschi di Siena, Unicredito Italiano SpA.
Denmark	0.36	Danisco A/S, Novo Nordisk A/S, Novozymes A/S.
Norway	0.32	Telenor ASA, Statoil ASA, Storebrand ASA.
Hong Kong	0.19	MTR Corp. Ltd, Swire Pacific Ltd. A, Li & Fung Ltd.
Brazil	0.18	Companhia Energetica de Minas Gerais, Intausa.
Belgium	0.17	Dexia SA.
South Africa	0.17	Barloworld Ltd, Bidvest Group Ltd, Standard Bank Group.
Ireland	0.16	CRH PLC
Malaysia	0.07	British American Tobacco Bhd, Sime Darby Bhd.

As regards the environmental indicators, the following aspects should be mentioned: direct energy use segmented by primary source is reported by all the firms in the industries of transformation, transport and communications, energy and water, basic metals and real estate sectors. Total water use is reported by those firms belonging to industries of transformation, transport and communications, basic metals and real estate. Greenhouse gas emissions are reported by those firms belonging to industries of transformation, basic metals and real estate and total amount of waste by type and destination is reported by industries of transformation, transport and communications and real estate sectors.

It is also important to point out that the indicators relating to biodiversity are reported on to a greater extent by firms belonging to the energy and water, transport and communications and construction sectors. The indicators relating to emissions, effluents and waste are more reported by the firms belonging to the energy and water and industries of transformation, construction and basic metals sectors. All of this can be justified by the activity sector to which the firms analysed belong.

Some of the information provided by firms concerning environmental indicators comprises: paper consumption in tonnes, consumption of recycled paper, energy consumption, total energy employed, renewable energy sources (installation of photovoltaic panels, solar heat energy for domestic hot water, wind energy generation water consumption), toxic and hazardous waste, insulation of dishes and adjustment of facilities to avoid electrocution of birds, installation of equipment to reduce noise and vibration, financing of very different biomass projects which share the common advantage of a substantial and beneficial impact on the environment, protection of fauna and avifauna, preservation of the environment and protection of nature reserves, initiatives designed to reduce atmospheric emissions, and investment in projects to protect and improve the environment, among other things.

As can be seen, the study has focused on the environmental information provided by firms pertaining to different activity sectors including trade and other services. Only one firm belonging to the tourism sector was considered (a hotel) and unfortunately it did not present any kind of environmental information (although it did present information on economic and social aspects). As Ayuso [23] argues, this situation may be due to the fact that environmental indicators (energy consumption, water consumption, waste production and others) seem to be very little known by Spanish hotels. Along these same lines we have the work carried out by Alvarez et al. [24] which shows that the responses of firms to environmental concerns have overwhelmingly focused on the manufacturing industry. Service firms, however, have attracted much less research attention since environmental legislation has a lesser importance and environmental issues are nearly neglected in such industries. In this sense we can also say that on a global level, of all the organisations using the GRI guidelines (a total of 846 from different activity sectors) only 7 non-Spanish firms pertain to the tourism sector, and present information on: total water use, greenhouse gas emissions, other significant air emissions, waste, significant environmental impacts of product and services, compliance (incidents and fines).

To confirm the above we selected a sample of twenty large Spanish firms of the tourism sector that do not trade on the Ibex-35, and whose income for 2004 oscillated between 2,200 and 200 millions euros [2]. From the results obtained it can be deduced that not all the firms analysed from the tourism sector present environmental information (as shown in Table 2), since they focus more on providing information about economic and social aspects. Specifically, only 8 firms presented information on environmental aspects related to materials, energy, water, emissions, effluents, waste, biodiversity and compliance. The environmental indicators most used are shown in Table 5.

Table 4. Percentage of environmental indicators used by the sample firms.

Environmental indicators	Sector of activity	Financial and Insurances %	Industries of transformation %	Transports and Communications %	Energy and Water %	Construction %	Basic metals %	New technologies %	Real estate %	Trade and other services %	Mass media %
MATERIALS -Total materials used other than water, by type -Percentage of materials used that are wastes from sources external to the reporting organisation		60.00	33.33	75.00	28.57	16.66	50.00	40.00	100.00	0.00	0.00
		0.00	33.33	50.00	28.57	83.33	0.00	40.00	100.00	0.00	0.00
ENERGY -Direct energy use segmented by primary source -Indirect energy use -Initiatives to use renewable energy sources and to increase energy efficiency		80.00	100.00	100.00	100.00	33.33	100.00	40.00	100.00	0.00	0.00
		0.00	0.00	50.00	14.28	16.66	0.00	0.00	0.00	0.00	0.00
		40.00	33.33	50.00	57.14	16.66	0.00	0.00	100.00	0.00	0.00
WATER -Total water use -Total recycling and reuse of water		60.00	100.00	100.00	71.42	33.33	100.00	20.00	100.00	0.00	0.00
		0.00	0.00	25.00	57.14	33.33	0.00	0.00	0.00	0.00	0.00
BIODIVERSITY -Location and size of land owned, leased, or managed in biodiversity-rich habitats -Description of the major impacts on biodiversity associated with activities and products in terrestrial environments -Total amount of land owned, leased for production activities -Impacts of activities and operations on protected and sensitive areas -Changes to natural habitats -Objectives, programmes and targets for protecting and restoring native ecosystems and species in degraded areas		0.00	0.00	50.00	14.28	0.00	0.00	0.00	0.00	0.00	0.00
		20.00	33.33	75.00	57.14	66.66	0.00	20.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00
		20.00	33.33	0.00	14.28	0.00	0.00	20.00	0.00	0.00	0.00
		0.00	0.00	25.00	42.85	16.66	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	25.00	57.14	50.00	50.00	0.00	0.00	0.00	0.00	100.00

EMISSIONS, EFFLUENTS AND WASTE																				
-Greenhouse gas emissions	40.00	100.00	75.00	85.71	16.66	100.00	20.00	100.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Use and emissions of ozone-depleting substances	40.00	0.00	25.00	14.28	16.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-NOx, SOx and other significant air emissions by type	0.00	66.66	50.00	85.71	16.66	50.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Total amount of waste by type and destination	0.00	100.00	100.00	85.71	83.33	50.00	40.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Significant discharge to water by type	0.00	33.33	0.00	57.14	33.33	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Significant spills of chemicals, oils, and fuels in terms of total number and total volume	0.00	0.00	0.00	57.14	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Other relevant indirect greenhouse gas emissions	0.00	33.33	0.00	28.57	16.66	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-All production, transport, import of any waste	0.00	66.66	0.00	0.00	16.66	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Water sources and related ecosystems					16.66	50.00	0.00													
SUPPLIERS																				
-Performance of suppliers regarding environmental components of programmes described in response to Governance Structure and Management Systems.	40.00	33.33	50.00	42.85	50.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PRODUCTS AND SERVICES																				
-Significant environmental impacts of principal products	20.00	33.33	75.00	28.57	83.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-Percentage of the weight of products sold that is reclaimable	0.00	33.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COMPLIANCE																				
-Incidents of and fines for non-compliance with all applicable international declarations	0.00	0.00	50.00	28.57	16.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRANSPORT																				
-Significant environmental impacts of transportation used for logistical purposes	0.00	0.00	25.00	14.28	16.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OVERALL																				
-Total environmental expenditures by type	40.00	0.00	0.00	71.42	16.66	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Own preparation with reference to the web pages of the different firms.

This leads us to reflect on whether it is not considered necessary for these types of firms to present environmental information. To respond to this question, we based ourselves on a paper drawn up by the European Commission [25] that points out different environmental aspects to be considered for this type of firm, ranging from waste and water pollution to crushing and disturbance of fauna, data necessary for example to control water quality and detect possible changes in the pollution level. All things considered, it is also consid-

emissions and investment in projects to protect and improve the environment, among others.

As regards firms in the tourism sector, we found that there are still not many firms presenting information on environmental aspects; rather, they focus more on economic and social aspects.

Knowledge of all this information can have a positive effect on sustainable development. If we consider that some of the objectives that firms hope to obtain with sustainable

Table 5. Environmental indicators used by the firms of tourism sector.

Environmental indicators	
MATERIALS	-Total materials use other than water, by type
ENERGY	-Direct energy use segmented by primary source -Initiatives to use renewable energy sources
WATER	-Total water use
EMISSIONS	-Greenhouse gas emissions -NOx, Sox and other significant air emissions -Other relevant indirect greenhouse gas emissions
EFFLUENTS	-Significant discharges to water by type
WASTE	-Total amount of waste by type and destination
BIODIVERSITY	-Description of the major impacts on biodiversity

ered necessary for firms of the tourism industry to present environmental information since it can serve to avoid considerable damage to the environment and will have positive repercussions on sustainable development.

development are social progress, protection of the environment, prudent use of natural resources and the maintenance of stable levels of economic growth [26], it is our opinion that only if firms all over the world present information regarding these topics can we achieve this kind of development.

Conclusions

In the present work we have concentrated on the disclosure of environmental information and on how this information can affect sustainable development. We began with a literature review on the publication of this information, accepting the relevance of the GRI and others rules issued by the Commission of the European Communities. Subsequently, we determined the situation in Spain, which we have divided into two stages: one before 2001–2002, when there were no compulsory rules on environmental reporting, and one after that date with the recent inclusion of obligatory environmental responding in the accounting regulations.

Our empirical work has attempted to verify how Spanish firms trading on the Ibex–35 and other Spanish firms of the tourism sector disclose their environmental dimensions and the importance of this information for sustainable development.

With respect to the protection of the environment and the prudent use of natural resources, the Spanish firms report relevant information that affects sustainable development, as is shown in the environmental indicators they report on: paper consumption in tonnes, consumption of recycled paper, energy consumption, total energy employed, renewable energy sources, water consumption, insulation of dishes and adjustment of facilities to avoid electrocution of birds, installation of equipment to reduce noise and vibration, financing of very different biomass projects which share the common advantage of a substantial and beneficial impact on the environment, protection of fauna and avifauna, preservation of the environment and protection of nature reserves, initiatives designed to reduce atmospheric

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The Baltic Sea Region – Conditions for Development of Tourism Environment and Nature of Middle Pomerania, Northern Poland

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Abstract

Poland has really diversified lay of the land. Wide sandy beaches of the Baltic sea, dunes covered by resinous forests, a varied postglacial landscape – it is the Middle Pomerania, Northern Poland. Nature has gifted our region generously with tourist attractions and natural treatment remedies. The priority principle in this region is the protection of the natural environment, i.e. water, air and land. Economic activities are based on local natural resources. In the economy are farming and industry related to it: wood industry, sea economy and tourism.

Keywords: Middle Pomerania, Northern Poland, nature, environment, tourism

Introduction

The Baltic Sea Region is the first region in the world to adopt common goals for sustainable development within in sectors: agriculture, energy, fisheries, forests, industry, tourism, transport and spatial planning, an additional sector – education. Poland, thanks to its location on the Baltic Sea Coast, has great conditions for development of maritime tourism [1, 2]. Two historical routes run through the Baltic Sea Region: amber route, connected with expeditions of Romans to the Baltic Sea and Cistercian route with relics of sacral architecture. Wide and sandy beaches as well as local microclimate, characterised by high insolation and humid air filled with iodine, are the main tourist attractions here. The climate together with scents of volatile oils and phyto-cides exhaling from the surrounding forests have a stimulative and beneficial effect on the human body.

The unique values of Middle Pomerania Region

The Middle Pomerania region is one of the most attractive tourist regions in Poland. Over a dozen of holiday resorts are situated in the coast strap alone. In the maritime zone alone, there are placed several leisure spots. The basic domains of economy in the Middle Pomerania Region are:

agriculture and agricultural–consumable industry, wooden industry, tourism and healing therapeutics, sea economy. The future of the region however depends mainly on the development of agriculture and various kinds of tourism.

The tourist capital of the region is Kołobrzeg – a town situated on the sea, not only a holiday resort but also a spa. Rich mud deposits, brine springs, very sunny local climate and lots of accommodation are the most important advantages of this town. Similarly to the other seaside towns it offers a wide choice of accommodation, from comfy sanatoria and holiday centres through small hostels and board accommodation to camping sites of various standard.

The area around Połczyn Zdroj, Czaplunek and Złocieniec is the prettiest part of the Drawskie Lake district and is often called the Połczyn Switzerland. As well as Kołobrzeg Połczyn is an important spa. Drawskie and Szczecineckie Lake Districts are lands of lakes, rivers and forests. It's an attractive region for water sports, angling, hunting, mushrooming and picking forests fruits. Developed places are here close to sanctuaries of peace and silence.

The Middle Pomerania in one of the richest in game in Poland. It is thanks to huge forest and agricultural areas and a good climate. We have thousands of deer, wild boars, and a couple of hundred of follow deer. In the last years the number of small game such as hares and partridges have increased distinctly. Hunters from Poland and abroad hunt for example in the Manowo community. In this community like in many others, there are good

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conditions for hunting. The unique values of postglacial scenery and valuable specimens were the reason for protecting the areas where the nature has survived in the original or almost original shape. We use several forms of nature protection in the district. The most frequent are sanctuaries, scenery parks, national monuments and protected scenery zones [3]. The most beautiful and most valuable part of the Drawskie lake district is protected as the Drawski Scenery park. It spreads on more than 63 000 hectares. An exceptionally varied landscape is the result of the last phase of the Baltic glaciations. Inside the park there are several sanctuaries and national monuments. The Dolina Pięciu Jezior (the Five Lakes Valley) shows up due to an exceptional beauty. Five lakes connected by the river Drawa are surrounded by marches and bulrushes with the hillsides overgrown by beech woods. It's natural shelter for many animals and a perfect place for nests of many swamp and water birds.

A several so far established sanctuaries help to protect the most valuable areas in the district – several more are being planned for the nearest future. Among them there are sanctuaries of landscape, forest, peat, flora and unanimated nature.

The Koszalin seaside zone is of different width and about 85 kilometres long. The flora of this area is varied, from pioneer species on dunes, through growths, mosses and moors, up to pine and mixed forests. The most beautiful mixed forest with beech, oak, ash tree and spruce can be found near Kołobrzeg. On the Mierzeja Jamneńsko-Bukowska (The Jamneńsko-Bukowska sandbar) we can see a huge wealth of plants and birds. Additionally this is a place where birds stay temporarily during their summer and autumn migrations. The protected areas occupy over 1/5 of the Middle Pomerania area. The nature and tourist potentials are waiting to be developed.

Middle Pomerania district has a lot of surface waters – almost 4% of the total area. What's more we are situated on the Baltic Sea. A district has many oxbow, moraine and coastal lakes. There are almost 700 of them with the total area of 26 000 ha. More than a half of all the lakes are considered to be of the first and second class of water purity. Flowing waters – about 45 rivers have total length of almost 1300 km. Some of them flow down directly towards the sea, for instance Parsęta and Grabowa others like Drawa and Gwda flow towards the South, to the river Noteć. About 30% of all the rivers are class one or two of water purity.

The natural resources of the Middle Pomerania Region are mainly minerals, which are used in building and road building industry. One of the largest exploited deposits of aggregate is near Sępólno Wielkie. The local mine's output reaches a few hundred thousand tons a year.

At the beginning of the eighties exploitation of petroleum and gas began in Karlino. Having local significance only the output of Karlino makes nevertheless several per cent of the national output. Rich deposits of therapeutic mud and spas are situated near Kołobrzeg and Połczyn Zdrój. Healing peat from Mirociny near Kołobrzeg, is a very good balneologist raw material and is used in the Kołobrzeg Health Resort. A famous curiosity of Kołobrzeg is a small brine spring on the Wyspa Solna (The Salty Island).

Protective measures in Middle Pomerania

The Middle Pomerania district belongs to the leaders of the ecologically clean seaside districts in Poland [2, 4]. Almost 35 cubic hectometres are district every year. Sewers treatment is usually done using traditional methods based on active sediment. After 1991 all the sewage treatment plants that were built or modernized were additionally adapted to remove nitrogen and phosphorus compounds. Most of them were built thanks to a financial support of the Voivodship Fund for Environment Protection.. About 60% of all the sewers are cleaned in biological way. There are often built root sewage treatment plants directly for leisure resorts and small settlements. They use natural properties of soil and plants. The plan for the next years is to eliminate the discharging of all heavily polluted sewers that are not cleaned. As the air pollution is caused mainly by burning fuels in numerous boiler houses and rooms a problem which has to be solved as soon as possible is the liquidation of those that burn solid fuel. Many activities have been undertaken for air protection in the Middle Pomerania for example about 100 boiler houses that polluted the air worst were closed down in the last 10 years. In the same time a dozen or so of new ones were opened, fitted with hi-tech machinery for reducing pollution, including some which burn gas. The gas boiler houses pollute the air in a minimal degree. More and more towns and settlements switch to gas which eliminates many sources of so called low emission. At the same time coal elimination from many types of boiler houses leads to lower air pollution reducing dust, sulphur dioxide and carbon oxide. Such two-way activities bring good results. As a result, today the Middle Pomerania district is proud of almost unpolluted air – the standards of pollution are virtually nowhere exceeded. Another source of air pollution are car fumes. Rapidly growing traffic is a source of very harmful substances. In our district it's particularly strenuous in the summer time when there are many tourists. Recently introduced ban import of cars without catalysers, lower price of unleaded petrol and more and more common LPG gas fuel are the main measures against it. It is impossible however to eliminate in a short time all the old cars.

As in the whole country an important issue for environment protection is storage, utilisation and recycling of garbage, both household and industrial. In the district there are a several dumping – grounds, which have been built or rebuilt lately, using modern and safe technologies. On the Koszalin's one, in Sianów, specialist equipment, so called compactors, is employed for crushing and condensing the wastes. The ground is sealed with plastic foil. About 80% of rubbish is stored every year on the communal dumping-grounds. The rest goes to the country ones. In many cities rubbish selection is already common. Thanks to this recycling is possible.

Although the Middle Pomerania is one of the not much urbanized in Poland, the noise made by the industry and traffic begins to be a problem in some places.

In order to act efficiently for the environment protection it is necessary to check its condition and changes which are taking place. A regional monitoring is the basis for the research done by the District Inspectorate for Environment

Protection in Koszalin. This work is sponsored mostly by the District Fund for Environment protection and Water Works. As a part of a national monitoring the District Inspectorate checks surface stagnant waters. According to the results of a continuous monitoring almost 50% of the district lakes are of I and II class of water purity. For many years the Inspectorate conducts researches on the air pollution in our district. The most important determinations are the concentration of the gas pollution, and the amount of dust–fall and suspended dust. The checking team takes two kinds of measurements: day–average and temporary ones. The temporary measurement are taken in 30 minutes intervals.

Industrial noise checks are carried out every year in the most burdensome enterprises. Traffic noise is checked in the biggest towns of the district. The results are taken into account in town planning.

Conclusion

Considering the nature and scenery our district is one of the most attractive and valuable in Poland, which makes

us very happy. But at the same time we remember, that we are obliged to preserve and reconstruct our natural environment.

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Idea of *Green Lungs of Poland* In Context of Sustainable Development

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Abstract

The North–East part of Poland has been characterized, as a region covered by the *Green Lungs of Poland* idea, with special attention to resources, both natural and manmade. The main goals of the GLP Programme has been analysed.

Keywords: sustainable development, environmentally protected areas, environmental management

The idea of the *Green Lungs of Poland* (GLP) has been created in the beginning of 1980s. It was an alternative for previously made economic plans for large regions [1]. From its early beginning it has been corresponded with the scenarios of eco–development prepared at this time.

Basic information on the *Green Lungs of Poland* area [2,3]:

- total area 60759 km² – 19.4% of Poland;
- population 3.7 mill. persons – 9.6% of Poland;
- forestation is 25.8% – average for Poland 28%;
- increasing protected areas.

The general aim of GLP project was to describe conditions of implementation of sustainable development at the local level and to prepare the scenarios for eleven selected communes.

Among the identified particular goals, connected with the rules of sustainable development, understood as the most important, are the following[5–7]:

1. Inventory of all natural resources of the region.
2. Natural resources protection by creation of the network of protected areas, mainly national parks.
3. Preparation of the spatial plans for regional development.
4. Increase of quality standards of the environment, focus on: surface waters, atmospheric air and soil protection, by investments and administrative–organizational actions.
5. Funds rising for GLP Programme, both from domestic and foreign sources.
6. Promotion of the GLP idea in Poland and internationally.

The scenario comprised a list of proposed actions and was intended to begin organizing economic system which would meet requirements and absorb restrictions resulting from the functioning of the GLP region. In the future a system should lay grounds for such a local economic structure which could contribute to better living standards and welfare of local people.

The development of the GLP idea could be measured by number and position of institutions involved in this agreement, as: previous Ministry of the Environmental Protection, Natural Resources and Forestry (MEPNRF), National Fund of the Environmental Protection and Water Management (NFEPWM), Eco–Fund Foundation, and other ministries, agencies, and governmental institutions. In the best time period for the GLP Programme 30 parties has been involved. The Programme received great support with the most spectacular recommendation given by the Parliamentary Committee for the Environmental Protection, Natural Resources and Forestry.

There are nine programmes leading towards *Green Lungs of Poland* Development [8–10]:

1. Natural environment protection.
2. Improvement of waste management.
3. Protection and rational use of water resources.
4. Improvement of live conditions.
5. Management of tourist values.
6. Economic development, particularly development of road, rail and air transportation.
7. Development of renewable energy generation and energy distribution infrastructure.
8. Rational use of water and sewage systems.
9. Promotion and marketing.

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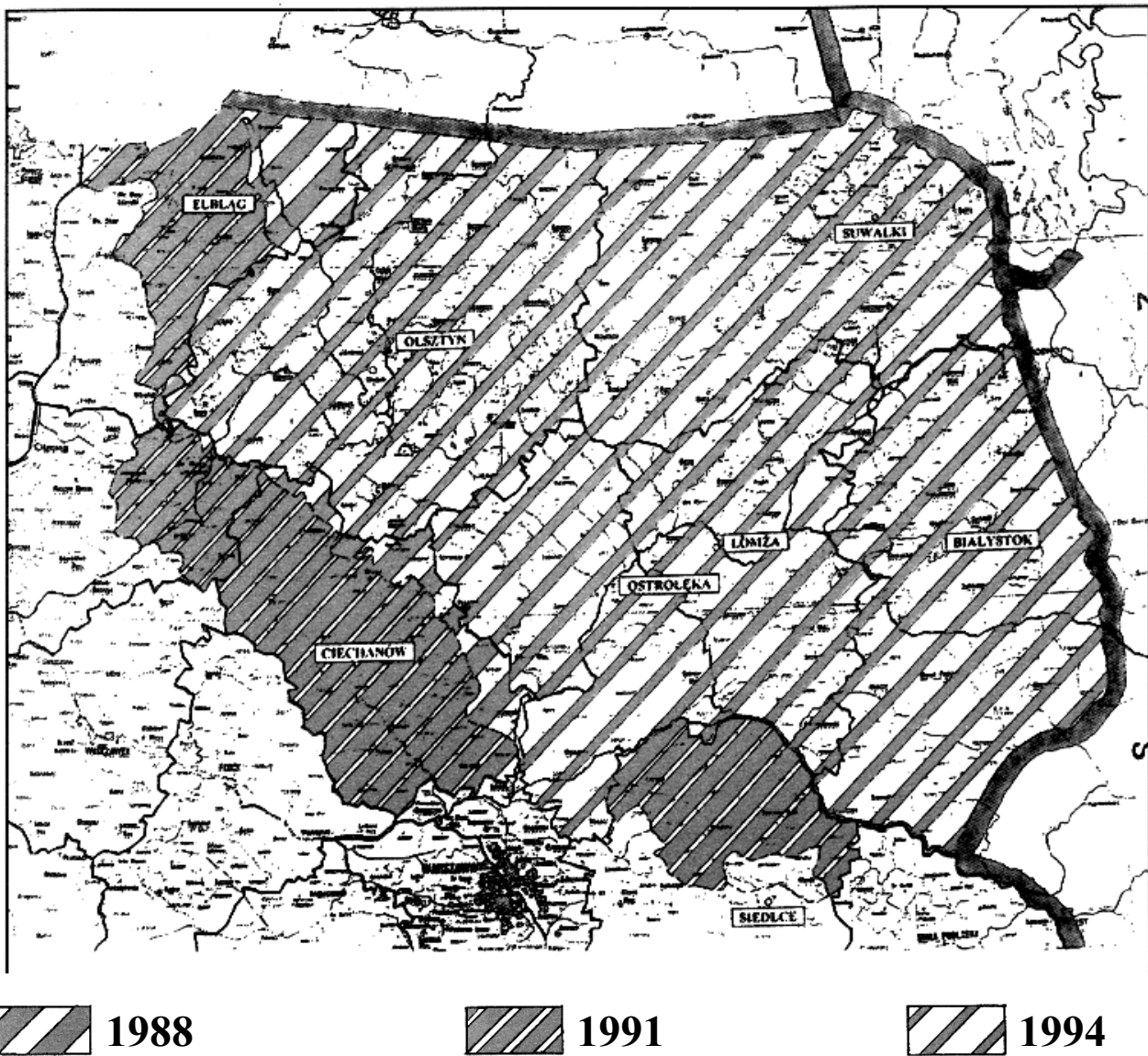


Fig. 1. Territorial Evolution of Green Lungs of Poland [11].

Realization of proposed programmes should provide to reach the following results:

- Biodiversity protection.
- Establishing the European Centre for Recreation.
- Increasing the level of life standards.

Significant part of undertaken research focused on social conditions of implementation of GLP. In the surveys the problem of living standards as a measure of sustainable development drew much attention and concern. The system and financial sources for environmentally sound projects has been examined as well as the organizational and institutional term of sustainable development implementation. The final result were scenarios of economic structures changes of local communities and cost–benefit analysis of the structures.

The strategy of development of *Green Lungs of Poland* is an example of realization of constitutional declaration in Poland to implement Sustainable Development.

The research have been partially done by the team of scientists working at the Department of Economics and Natural Resources Management, Faculty of Management, AGH

University of Science and Technology, particularly with two leaders: Professor Anna Jankowska-Kłapkowska and Professor Rafał Pajda. Additionally members of the Environmental Association of Environmental and Resource Economists – Polish Division have been involved in the development of the concept of ZPP as well as process of implementation rules of sustainable development at the regional and local level.

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Landscape Changes and Protection of Polish Carpathian Mts. with the Usage of Historical GIS

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Abstract

According to unfavourable modifications of Polish Carpathians' cultural landscape, an attempt has been made to answer to what extent our attitude towards tradition, our aesthetic sense and knowledge determine our attitude towards its preservation. Carpathian landscape as perceived through school education and tourist activity does not create any bonds with the past and does not provide with the awareness of being "at home". It has been remarked that the possibility to browse and analyse historical 3D maps enables to create a sense of emotional relationship, which causes greater attention paid to one's own living area and greater desire to decide about its transformations by actively looking after it.

Keywords: historical GIS, Carpathian Mountains, landscape protection, archival maps

Introduction

In the Polish Carpathians in the early 20th century, environmental protection schemes were undertaken as a consequence of increasing negative impact of deforestation, unfavourable changes of hydrologic conditions caused by engineering works, decrease in population of some species of flora and fauna [1–6]. The factors destroying cultural heritage include inappropriately located, chaotic and ethnographically unmatching housing, unplanned development of communication tracks as well as improper land-use management [7]. Spiritual cultural heritage has been endangered by the lack of continuity in cultural tradition, or even the lack of basic knowledge of it, as well as inappropriate approach to the environment in both cognitive and ethical sense.

The aim of the investigation was to verify the hypothesis that using GIS to visualise historical maps may contribute to better understanding of the landscape of the 'local homeland' and helping its protection. It is known that historical GIS can be used effectively to shape problem-based inquiry and constructivist learning [8–13]. Chapter 36 of Agenda 21 (created at Rio de Janeiro in 1992, reaffirmed at Johannesburg in 2002) emphasized that education is critical for promoting sustainable development and improving capacity of the people to address environment and develop-

ment issues [14]. The document states that educational authorities should promote proven educational methods and the development of innovative teaching methods for educational settings. Many authors point out the tendency to marginalize the utility of archival and historical cartographical sources due to technical difficulties in initial processing of historical maps and certain inadequacies of the analytical methods [15–18].

It has been assumed that objects and phenomena are difficult to be protected from adverse transformations, as we may even be unable to notice some of them. The work aspired to answer the questions of what the perception of the surrounding natural-cultural environment depends on, as well as to what extent our vision of the world is determining our attitude towards the issue of environmental protection.

Materials and Methods

The work uses historical maps coming from Viennese archives' collection and made on the basis of the First and Second Military Survey of Galicia [19], an orthophotomap and a digital elevation model [20]. The rectification and visual presentation of the maps were performed according to applicable GIS procedures [21–23]. The proposal to use visualised maps in order to develop the awareness of one's roots and identity was presented together with the results of

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a survey. The survey comprised of two questions related to the perception of cultural landscape of Polish Carpathians [24]. The first question concerned the objects, landscape features, phenomena etc. which are most strongly associated with Polish Carpathians and are its typical elements. The second question involved pointing out the order and scale of importance of the elements of Carpathian landscape which should primarily be protected from destruction and transformations.

Table 1 and Table 2 present the results of a survey for school and university students and non-school adults (220 persons overall), which was intended to gain insight in the perception of the Polish Carpathian landscape and the values worth protecting from destruction and transformation.

Results and discussion

The Perception of Polish Carpathian Landscape and Landscape Protection

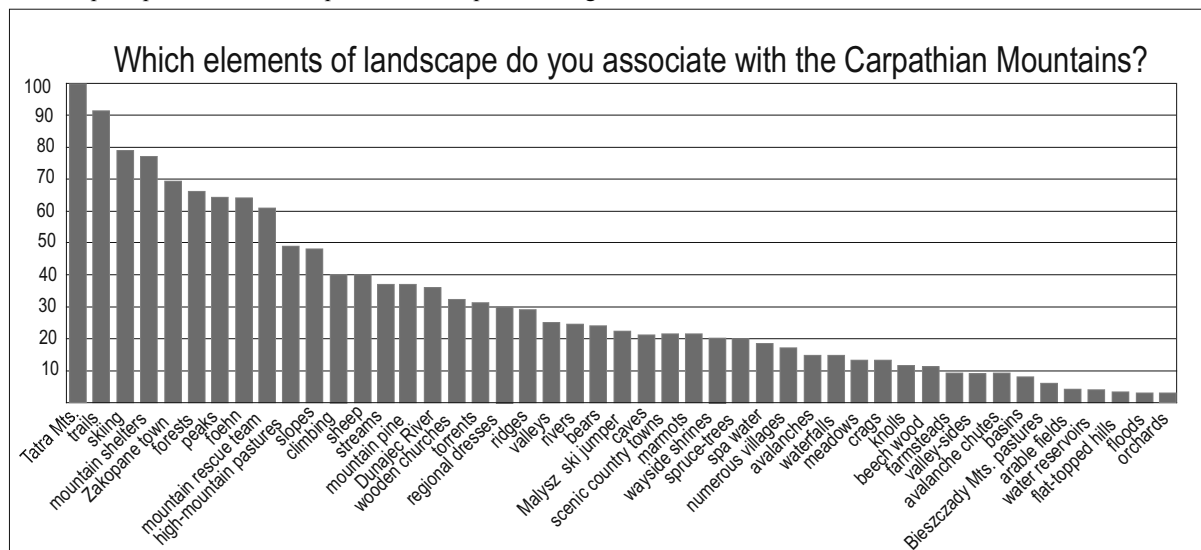
Due to tourist activity the Carpathian landscape is generally perceived as high mountains thus leading to associations with the Tatra Mts., the town of Zakopane, mountain peaks, slopes, woods and glades (Table 1). Interestingly, elements of landscape such as arable lands, orchards, farm-

(Table 2). It is worrying that most of the respondents omitted human settlement harmoniously blended with the environment. As a result there were no requests for the preservation of traditional villages, historical patterns of small towns or remains of ancient towns. It is interesting to observe the fact of human's exceptional responsibility for animals, forests, and all inanimate nature, together with the lack of care for the objects created by people themselves. Our attitude can be characterised as overprotective as far as nature is concerned and irresponsible when it comes to the outcomes of our actions.

The Usage of Historical GIS

The program ErdasImagine 8.7 was used to perform rectification, and the visualisation was done by means of the ArcScene program [23]. ArcScene lets users visualise their data in three-dimensional animations. Draping a scanned image of the First (1779) and Second (1861) Military Survey of Galicia over a modern LPIS DEM (with the terrain pixel size of 0,5) gives the old map a new look and immediacy (Fig. 1). GIS enables one to compare geo-referenced maps with modern maps by overlaying them. These layers can be added in any sequence the user prefers, and based upon the data available to the user, analyses or visualizations can be performed on that data [9,10]. Draping a geo-referenced ver-

Table 1. The perception of Polish Carpathian landscape according to the number of votes.



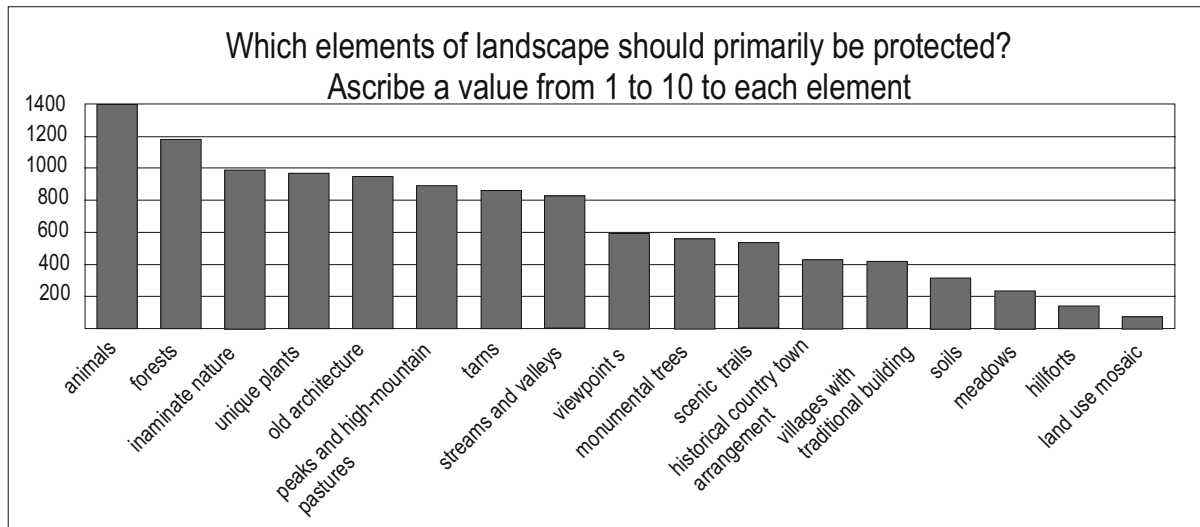
steads and numerous villages are seldom associated with the Carpathians, although presently over 52% of the area is covered with arable lands (forests 36,4%) and it is a place of 47 towns and as many as 1722 villages [25,26]. Moreover, long Carpathian villages and scattered hamlets, apart from a large number of fields, constitute one of the main characteristic features of the Carpathian landscape. Thus, it is clearly seen that our perception of the Carpathian landscape is a result of our expectations and the mode of our contact with nature, leaving in our memory the original parts, not the commonly featured elements.

More than 90 per cent of the surveyed would protect wildlife, rare vegetation, streams, lakes, peaks and glades

sion of historical map over a DEM shows more clearly the relative height of each hill, the valleys cut by streams, location of scattered hamlets and land use mosaic. The analysis of correctly rectified old map contents enables pointing out the areas of permanent landscape and valuable historic, cultural, architectural and compositional qualities [11–13].

The creation of compatible historical maps and DEM for a rural area completes and introduces new ideas into the methodology of architectural designs. Arc Scene can facilitate fast draping of the same DEM surface. Re-creating the animation of a flight over the village enables the present state to be compared with past one and design schemes allowing the village inhabitants to choose a suitable project. The advantages of project visualisation as a 3D model in-

Table 2. The perception of Polish Carpathian landscape according to the number of points.



clude the possibility of its assessment from various observer points, simple and fast preparation of alternative proposal. The advantage of ArcScene is the possibility to export animations as stand-alone AVI files, which can then be shown to people who do not have access to GIS software.

Conclusion

The essence of the continuity of natural heritage and culture depends on three issues: our knowledge, abilities, emotions. Contemporary technical potential, easy access to information, the possibility of spatial planning and visualising the projects with the use of GIS should make it easier to reach a state of harmony between economy and environment than it has ever been before. However, knowledge and abilities are not enough, equally important is the emotional attitude towards the changes that landscape undergoes as a result of human activity.

In the light of the results of the study, it seems that the reasons for protecting the landscape emerge from the 'overflow' of information and superficial education, and to a lesser extent of tradition and experience gained through maintaining close contact with landscape and perceiving the negative changes it undergoes. One cannot assess different outlooks on life, as everyone possesses their own personality reflected in noticing different elements of the

world. But a broader understanding of reality, could, and should, be taught. The same can be said of the need to perceive the relationships between human activity and natural environment, for example on the basis of analysing historical and contemporary maps of one's home area.

An insensitive person, without roots or any instilled care for nature and the heritage of their ancestors will not only fail to appreciate of the majesty of mountains, the murmur of streams, the diversity of rock formations, but also will be unable to notice the beauty of Polish manorial architecture, roadside shrines surrounded with lime trees, or the wisdom reflected in the situation of monasteries.

We should have the sense of responsibility and be watchful observers of natural and cultural heritage, understand what historical and contemporary contact between natural environment and human management is about. The observations of 'the past' carried out by means of historical map 3D visualisations help to learn about this heritage and contribute to retaining it. The contact with 3D historical maps enables some spatial understanding of the past. Numbers, names, dates and facts have a different appeal to people than does an image. An interactive map one can easily rotate, zoom in and out by changing the scale, provides a closer contact with the past. It is thanks to such a visualisation of historical maps from 18th and 19th centuries that it occurs to us that the layout of fields, numerous villages and small towns inscribed in Carpathian landscape constitute cultural heritage we should take care of.

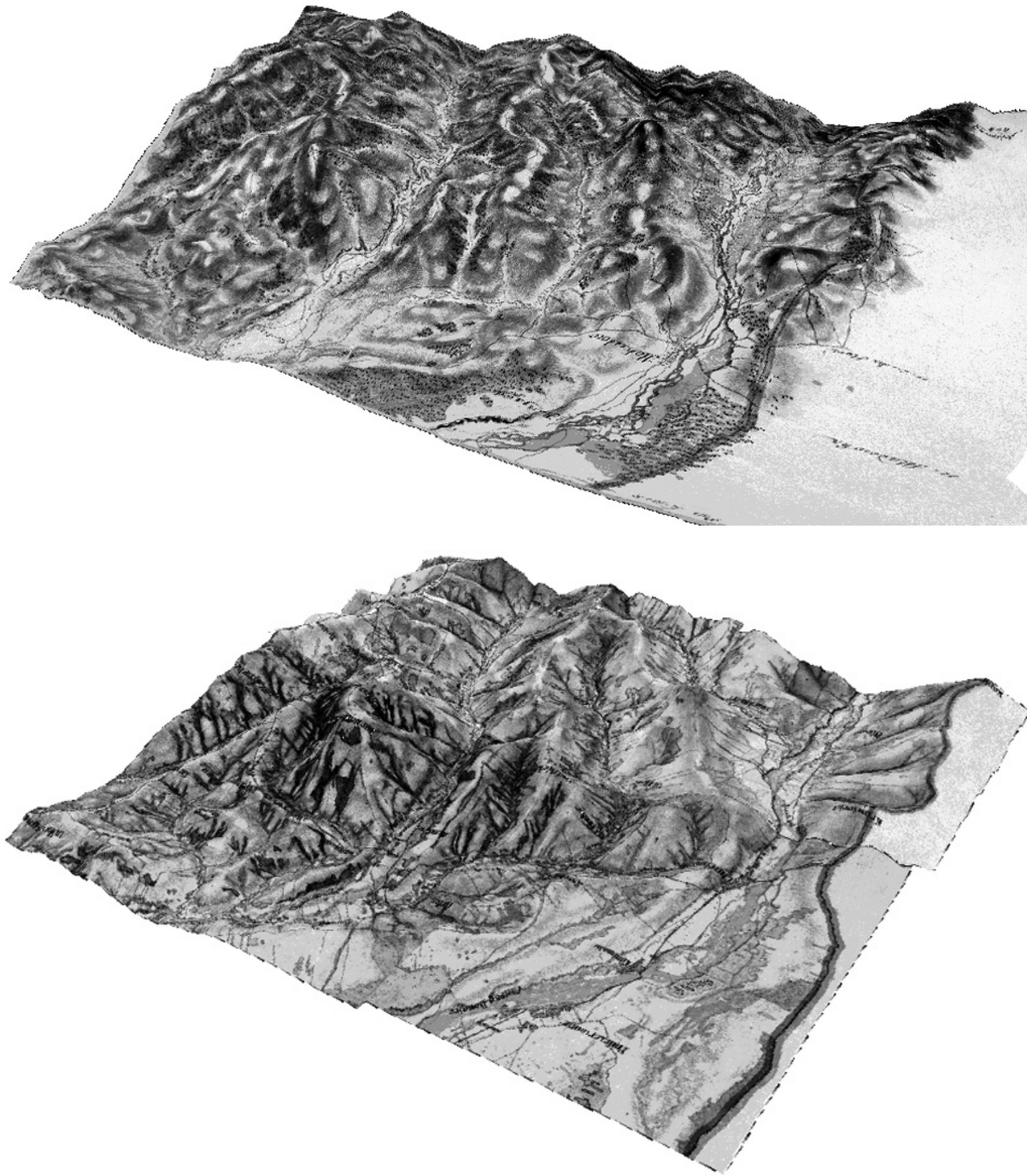


Fig. 1. Visualisation of rectified historical map in ArcScene - The Tatra Mountains Foreland.

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Eco–Tourism in Protected Areas – Chances and Threats

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Abstract

Nowadays, even protected areas are menaced by civilization. Considered as being very attractive, they attract tourists, which causes exposure to strong tourist penetration. On the other hand, good environmental education is a very important factor in nature protection and sustainable region development. Also, the local community should be well oriented in the region. That, in turn, coerces a compromise between protection and education.

Eco–tourism could show protected areas without harming them. Often not well prepared, it causes more threats than traditional tourism. The definition states that it is not for everybody. Moreover, tourists' and local communities' attitude to nature is still not very satisfying. Without improvement in this field, neither nature protection nor eco–tourism can be exercised efficiently.

The paper discusses some problems connected with eco–tourism in protected areas presented on a selected West Poland landscape parks case.

Keywords: eco–tourism, nature protection, ecological awareness, local community, landscape parks

Eco–tourism is a brand new branch of tourism in Poland. Its definition still causes problems and misunderstandings. Sometimes it is even mistaken with agrotourism or eco–agrotourism. Tourism events organized in nature are also often called soft tourism, green tourism, ecologically or environmentally friendly and sustainable tourism. The last term is connected with the concept of sustainable development, which means such a kind of management that secures a possibility of using the environment again in the future. Because of the misunderstandings, it is not so easy to find an eco–tourism event, which would be properly organized.

A definition proposed by Zaręba [1] seems to be the most suitable one. According to this definition, eco–tourism is a form of active and extensive sightseeing in a naturally and culturally valuable area – which protects harmony of ecosystems and local community's separateness. It provides financial means for effective protection of natural and cultural heritage and, at the same time, brings real social–economic benefits to local community.

In consequence, we can distinguish the three most important aims of eco–tourism:

1. Ecological – nature and environment protection in a long–term perspective (connected with sustainable development ideas).
2. Economic – support for sustainable development of the region, increase of local communities' incomes and – highly likely – decrease of unemployment.

3. Social – firstly – for tourists, such as interesting, valuable and relaxing stay in natural ecosystems with nice surroundings, sometimes with some educational aspects. Secondly – for the local community, for example better life conditions. There are also social aims for both groups, which stem from the increasing need for sustainable tourism as well as understanding of its ideas and rules, and also for its development followed by the increase of ecological awareness and education. A possibility of self–improvement of each participant, both inhabitants and tourists, is a very important factor of eco–tourism development. For example, dwellers can find themselves needed and attractive because they know their own surroundings best and they can show it to strangers. Likewise, tourists can experience something new, exciting, touching, educational etc.

Seen like this, eco–tourism should not be introduced to high–risk areas in order to prevent them from being devastated. It is inadmissible to organize an eco–tourism event in a harmful way – for example a case of “Ekspedycja Nadwarciańska” (Nadwarciański Landscape Park), promoted as an eco–tourism event and organized for 200 people visiting peat bogs area in one day!

When organizing an eco–tourism event, after choosing an area, it is necessary to win the local community's support, because without their permission to our idea, even the best plan could not be accomplished properly and with sat-

isfaction. The next step is to find answers to the following questions:

- **What** do we want to show – which species or what (e.g. ecosystem) will become our “hero”
- **Where** – a precise place where we can find it (sometimes it is also needed to find the answer to “when” it is possible)
- **Who** is this event organized for – it is understandable that it should be prepared differently for adults and for children or for students of biology and for non-professionals.

And – very important, often forgotten – how to make this event interesting and unique but also not harmful for nature and for our “hero”, which is usually the most crucial factor [2].

Among all law protected areas in Poland, landscape parks seem to be most frequently designated for tourism and eco-tourism. It is because the priority of nature protection and safety for ecological balance in visited ecosystem should be respected at all times and without any exceptions. On the other hand, landscape protected areas and even those, which are not protected, can be used as a place for eco-tourism event equally well.

As has been said, the local community attitude towards the event is a crucial factor. The scheme below (Fig. 1) shows two model situations. First – which occurs very often now – a local community does not appreciate the

surrounding nature. The inhabitants are not interested in knowing anything about it; they are not proud of and not responsible for nature. In this case, they – more or less consciously – can destroy the natural value, making the nature less attractive, and it confirms the local community in the conviction that this nature is worthless.

Second situation – more model like and desirable – the dwellers appreciate nature, take care of it and know very well that it could bring income, so they want it to be in good condition, they understand that nature is very important for them. This attitude obviously helps nature and keeps it in balance and allows functioning in long term.

Research carried out in Chair of Human Ecology, Faculty of Tourism and Recreation, AWF Poznań in selected landscape parks in western Poland, show that tourists mainly appreciate nature and its resources and values but only as “background”. They do not find it necessary to know something more about natural values of the surroundings, where they are resting. They also have difficulties with distinguishing concrete elements of nature in protected areas. Most of them know the name of the landscape park and are conscious of being in a protected area; however, it was not the main incentive to spend time in this place. They are still satisfied and they consider nature as the main and the most important element of the park [4].

Recapitulating then, there are limitations in creation of eco-tourism events and barriers of eco-tourism develop-

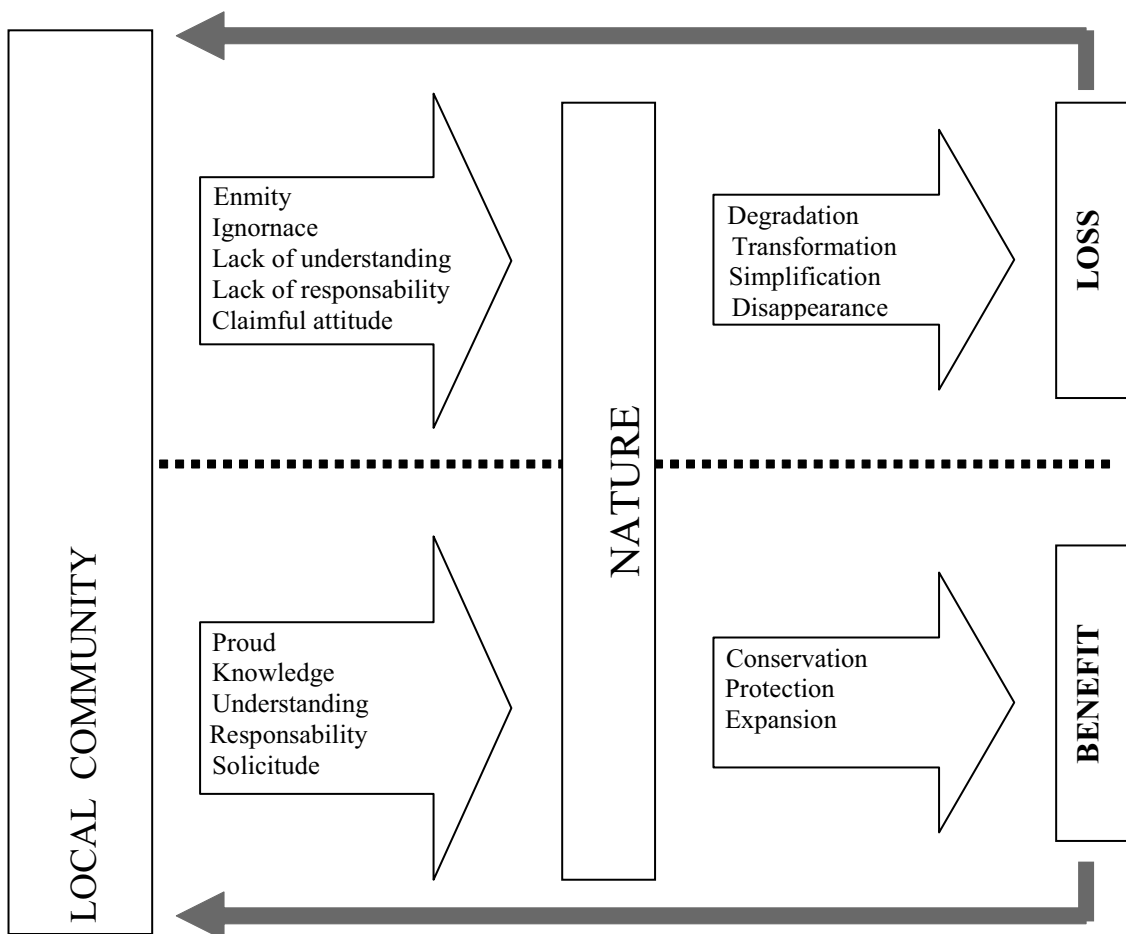


Fig. 1. Selected implication of relations between local community and nature [3].

ment. It is necessary to remember about an “ecological” means of transport and appropriate non-disturbing number of tourists taking part in a particular event. Its definition shows that eco-tourism is not a form of tourism for everybody, because there are many people who are simply not interested in it. This can cause more danger than they can experience. Event planning as well as the way sightseeing is going to be executed seem to be very important elements too. It is necessary that each person is adequately prepared for the event, also in the psychological and educational meaning. Sometimes limitations are connected with lack of financial means. In particular cases a well-organized eco-tourism event demands great costs, without which it could not be done in a proper way.

A crucial barrier is caused by the priority of nature protection and conservation, which is often forgotten and not realised nor respected. Important limiting factor could also form some local conflicts – for example between management of protected area and local community or – even more destructive – unfavourable attitude of local community to the event or tourists in general. Lack of specialised staff is not conducive to eco-tourism development. Natural habitats are more endangered by synantropisation or even extinction, when tourism is organized by people who have been chosen at random.

However, eco-tourism is a great chance for protected areas, in times when decrease of tourism is unavoidable. This form creates a possibility of better nature protection

and maintenance of natural balance in ecosystems. It allows believing that also knowledge, understanding and awareness will be more and more widespread. Nevertheless, it cannot be forgotten that complications connected with defining problems and misunderstandings are very dangerous. A situation when eco-tourism causes dangers for natural environment and for local community should be considered as inadmissible.

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The Possible Relationship Between Restoration of Cultural Heritage and Sustainable Development: Three Study Cases

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Abstract

This paper deals with three case studies as output of a research in which the common guideline is finding new opportunities of development of marginal rural areas through projects of eco-tourism. In this way the possible relationship between restoration of cultural heritage and sustainable development could be guaranteed through eco-tourism because it supports new models of management joining the protection of resources and natural and cultural heritage together with goals of economic and social growth.

Keywords: cultural heritage, eco-tourism, sustainable development

Introduction

In the field of the general debate about the limits of the development, the awareness that tourist development is not unlimited is more and more disseminated. First of all, this is because the policies and the politics individuating the tourism as a strategy for the development help interventions offering economic immediate advantages, and often represent a quantitative promotion and not a global and long term emphasis of the territory, and also represent a wild exploitation of environmental resources and not their safety and protection. On the long term, the consequences of these choices are more and more dangerous and sometimes tragic also from an economic point of view: it's well recognized that environmental assets, either natural than cultural are not reproducible resources, destined to finish if consumed and excessively exploited. On the other hand, tourism is a social phenomena in a continue evolution: the needs and the hopes of the tourists, the quality of the supply, the relationship with a more wide economic and cultural context change.

Tourism, in this innovative concept of environmental protection, could generate possibility of employment for young people, keep in seat the residents, either in the areas with consolidated tourist vocation than in the inner marginal areas, where new possibilities of employment are possible.

Furthermore, the consolidation of a real tourist development, could bring the seasonal flow of population at the margins of southern regions, representing an opportunity of economic global development for the whole Southern Italy.

Always more and more today, in function of the sustainable development of a region, we speak of a development through territorial systems. By this term we indicate a new modality of territory management by a system approach that is an integrated approach that finds in the naturalistic and cultural landscape peculiarities the key of development of territory, in function of the environmental compatibility.

Sustainable tourism for inner and protected areas. Three case study

Sustainable tourism means for inner areas a new opportunity to develop themselves: they usually are poor regions in which the not industrially development could represent an occasion to exalt alternative resources: these resources are localized in these areas and to be reached and consumed, in a sustainable tourist process, tourists have to move to reach inner areas and moving with them, they move money and business.

We try to demonstrate, through three different case studies how good projects supported by politics and policies of sustainable economic development could represents an opportunity either in terms of economic growth than in terms of protection for high natural and cultural value areas.

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What's the problematic approach that support these three case studies? The following case studies are all oriented to find an equilibrium among the local citizenship's needs and the tourists' needs and are oriented to have as main item the relationship, the linkage between nature and culture for the correct management of resources and for sustainable development. In this way eco tourism could mean the birth of more and more projects going on to give a satisfaction to all stakeholders' needs.

The case study of Cilento. Benecon Regional Centre of Competence

The first case study we are going to present is in Cilento (Southern Italy) a geographical territory rich in cultural, naturalistic, historical, artistic, archaeological items protected as National Park, inserted in the list of World Heritage of human kind and International Reserve of Biosphere. Joining satisfaction of conservation and valorisation of natural and cultural heritage purposes with social – economical development trough sustainable tourism has been possible trough the experience of Benecon, a Centre of Competence for Cultural Assets, Ecology and Economy with operative units from different Campania Region Universities and scientific instruments and technical tools realizing an upgrading of network for technological transferring and support for territorial stakeholders. What's in concrete has Benecon realising for sustainable tourism in Cilento? Benecon (especially the Operative Unit for "Biology and Ecology for protection of environment" (Scientific chief: Eugenia Aloj) has realised a system of green companies in the field of tourism and a system of evaluation of environmental performance of the same companies. To be defined a green company it's necessary to agree to a *Quality Chart* and a *discipliner* to guarantee customers and all stakeholder of companies the respect of some rules of low environmental impact during the production (minimising waste, pollution, resources consumption). After the agreement there is a step of evaluation of environmental performance of companies and the positive result could mean for the companies the concession of the registered trademark Benecon that means, in a territorial marketing point of view, a tourist brand for the competitiveness not only of the production (goods and services) but also of the territory. The system of green companies paints on the territory some routes of environmental quality, as an holistic model for eco-tourism to become attractive marginal not coastal rural areas to transfer flows of tourists from coast to rural areas and to assure a permanent flow of tourism and not only seasonal summer flows in the benefit of carrying capacity of a territory.

Caudina Valley. A network of cities for eco-tourism

The second case study deals with Caudina Valley, an area in Campania among the inner provinces of Avellino and Benevento. All proposals of eco-tourism have to be supported, to be more effective, trough a network of cities, in which each municipalities of the area is linked to the others:

in this way all are involved in the process of economic development trough eco-tourism protecting common interest and goals: goals of protection together with goals of prosperity. A cities' network has a potentiality of integration and of empowerment of the territory that finds the unifying item in the common history and in the linkage with the territory as common heritage on which all the cities of the valley have developed their identity. In this way the potentialities for eco tourism are all natural and cultural resources and all resources as direct expression of the territory and of the mankind's modification on the same territory.

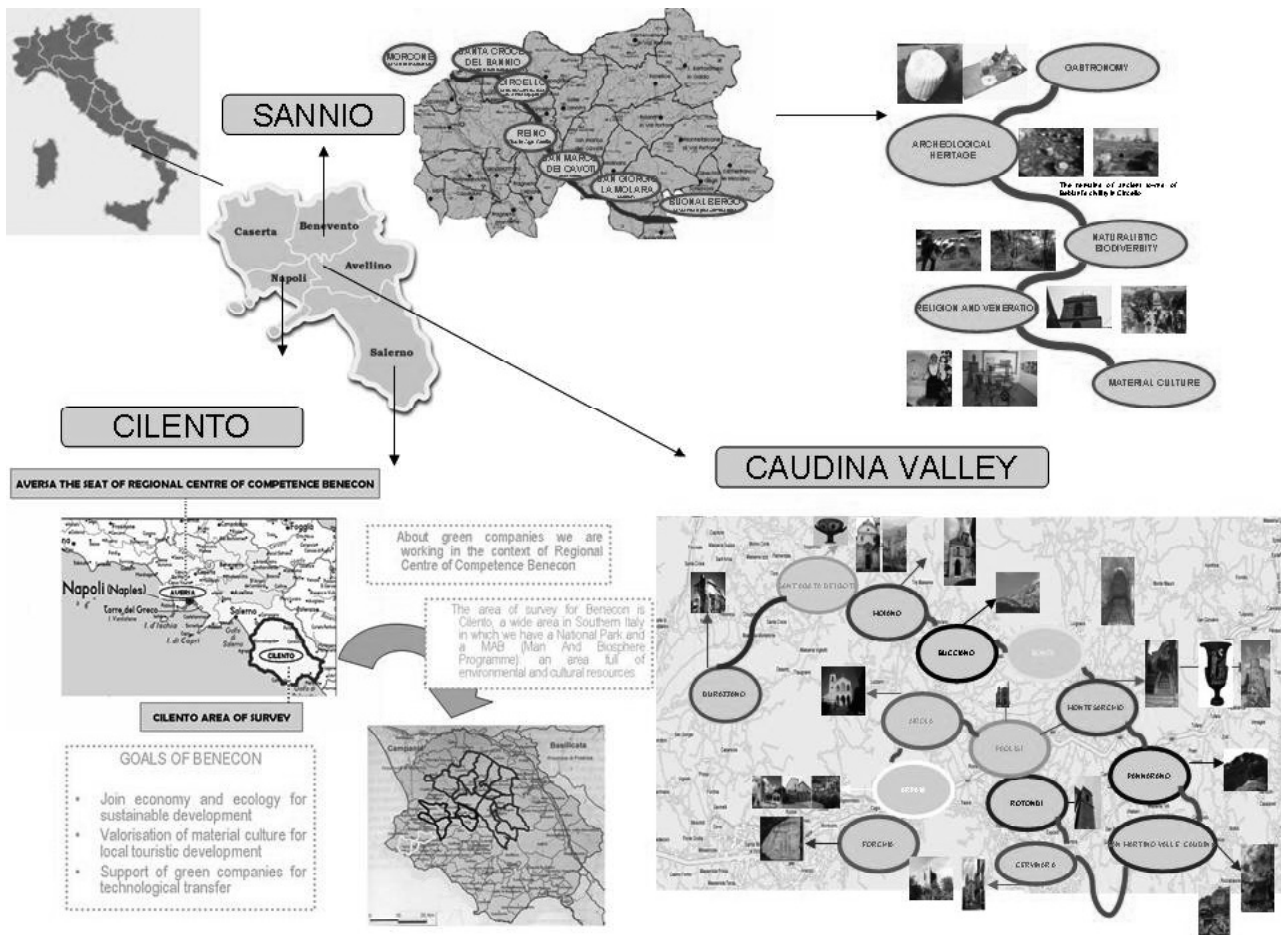
In the consideration of the relationship between nature and culture as a key to development and economic growth of area we try to explain some innovative proposals for eco-tourism we have made-up for this area, rich in cultural heritage. All proposals make the territory as an eco – museum in an holistic and dynamic point of view over passing the idea of protection by park as bond and giving a new identity to the seats trough a sustainable economy model intended as awareness of a local development. We have proposed the institution of a Museum of country folk (place for protection and promotion of ancient handcraft tradition: iron, wood, stone and so on), Production and distribution of officinal herbs of Taburno Mountain (the most important mountains of the area) in consideration of a new economic and commercial growth of this market linked to a new concept of health connected with the environmental quality of territory in which we live; again we have thought of some boat racing and sport water activities in the artificial lake of Montesarchio to satisfy the natural requirement of some tourists that choice an outdoor style of holiday as a simple behaviour in contact with nature; we have thought of historical cultural routes for tourism: Longobards' routes in the area of Arpaia and Romans' routes in Bonea, Montesarchio, and Forche Caudine: Caudina Valley is a concentrate of history and archaeological heritage; so this could be used as tourist appeal.

The case study of Sannio: transhumance as opportunity for eco-tourism

Finally the third output of our research deals with another different area crossed by the flows of sheep's going to mountain from plain and vice versa and in which the ancient shepherds' activity is evident in all the peculiarities of rural tradition: handcraft, gastronomic peculiarities for example.

We think of this strong linkage among the food and the environment in which it has been produced that we can speak about eco-gastronomy (by Aloj, 2004). By this term we speak about the characteristics of environmental quality of typical product, a new concept over passing the total quality because environmental quality indicates the characteristics connected with geographical, cultural, environmental and territorial origin. In this way eco-gastronomic system joins the same peculiarities, the same quality of products with all territorial components becoming key of economical growth trough rural tourism inspired by tradition of transhumance.

The territorial identity moulded during centuries and centuries of pastoral culture and economics could be object of local interests when becomes element of economic



and social development through eco tourism. In fact by eco tourism the territorial pastoral identity acquires a strategic value as mechanism of empowerment of all local territorial components as source of revenue and employment. Eco – gastronomy could mean new opportunity of market either in terms of selling of food products but, above all on the long period, in terms of building of a new model of eco-tourism developed around the typical food products and to the transformation processes of them, to start up a change in the tourist choices based on the heritage mix of gastronomy, art, culture, traditions. We have thought of *Taste – rooms* as museum of alimentary typical production (room of cheese, of oil, of meats, of bread products). In these rooms we think of tasting and direct selling of food products.

Conclusions

The valorisation of cultural heritage could allow the community of inhabitants the new use of it or an use of it in a better way, when the beneficiaries of intervention are the same inhabitants of the community; in a second way could allow the satisfaction of exigencies of subjects that are external to the community, or in a better way to satisfy the exigencies of an anonymous, abstract subject: the tourist market. Anyway it's required to pursue sustainable development.

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Qualified Tourism Transforming the Icelandic Experience in a *Flexible Approach*

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Abstract

Purpose of this paper is to introduce tourism development in Iceland as a pattern and a case study. Usually Iceland is defined as the land of fire and ice or the Ultima Thule. To look at Iceland as the land of small figures (surface 103.000 Km², 289.000 inhabitants) suggests a new socio-anthropological pattern.

It is only 30 to 40 years since Icelanders began to think of Nature as something more than simply land with vegetation for feeding livestock. Formerly very few people ventured into the Icelandic highlands. Such trips were seen as adventures, and people found the Nature they encountered there very, very spectacular; others found it remote and uncanny, even though it had for centuries been closely linked to our common heritage through the Icelandic sagas – the literature and memories which have made us Icelanders

Vigdís Finnbogadóttir (President of Iceland 1980-96)

Nordic Conference on the Environment

Skaftafell, Iceland, 1-6 May 2005

Keywords: client's satisfaction standards, tourism development, Iceland

Introduction

Iceland did not know tourism till the sixties of last century and started to face mass tourism only at the end of the Cold War. Iceland's geomorphological features, the *resilient landscape*, the short summer touristic season and the fragile and unusual tourist/population ratio represent some of the reasons of the high client's *satisfaction* standards in spite of the accommodation standard.

This paper focuses on the implications of the Icelandic *touristic approach*. Organizing tourism means to suggest and organize a *unique experience*. It means to transform a *move* into a *travel* which most important focus is the road instead of the destination. The travelling itself.

In 2005, during the Nordic Conference of the Environment, V. Finnbogadóttir stressed that *"People now go into the highlands on adventure trips in giant All Terrain Vehicles in order to enjoy themselves on snowmobiles and even motorcycles. They go to shoot game, with mobile phones and GPS equipment at the ready – making contact with the untamed environment at second hand, through satellites. Everything changes, so that today, thank goodness, people like to go on mountain hikes just because they find that it opens up for them the great natural beauty of the highlands. But there are still some who treat wild Nature as a challenging obstacle course, and go there not in search of beauty but to test their hi-tech equipment."*

With these words the former President of Iceland stressed the risks embedded in transforming Ice-land in a tourist *destination* (Fig. 1).

* The author teaches Geography at the University of Parma (SSIS).

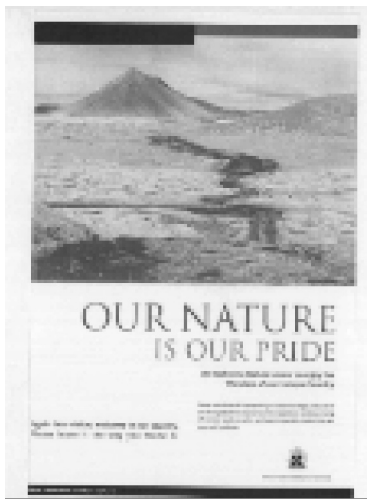


Fig. 1. Our Nature is our Pride.

“We Welcome Nature Lovers to enjoy the Wonders of our Unique Country Again dear visitor, welcome to our country. Please leave it the way you find it” Icelandic Ministry of Environment (Umhverfisdaduneyti) campaign 2006.

Iceland as a pattern for qualified tourism

During last century *speed* modified the relationship between *time* and *space*. Than the human relationship with *places* changed. This happened because speed affected both transportations and communications expanding *time*. New cultural and economic scenario arized from this changement. Travelling became popular and tourism soon evolved in mass tourism.

Tourism - from the organizational point of view - may be defined as a *complex action*. Intercultural exchanges are often experienced by means of tourism, specially by means of *qualified tourism* which generates a *cultural osmosis* between a place and its visitors. Due to this reason tourism cannot be considered only a good opportunity for a *young economy*. It should be the goal of *sustainable* planning activity. Tourism implies several responsibilities because *territories* and *landscapes* have to be considered within the limits of their *carrying capacities*.

Economy assume touristic experiences as marketing products. This allows to conceive Iceland as an economic pattern. Icelandic natural features and landscapes fit many programmes concerning *health/environment/energy sensitive* topics. In this frame *carrying capacity* and *qualified tourism* represent both *passive* and *active* concepts to which *resilient environments* planners have to pay attention.

Insularity plays a pivotal role in the economy of Iceland. Planning local touristic activities has always to pay a special attention to both internal and incoming flows to control *time* (calendar) and *space* (destinations). As a result it is possible to release specific programmes taylored on different cultural pattern's requirements and to develop the *Icelandic approach*.

The *Icelandic approach* is part of the *Scandinavian approach* to planning which pay attention to both binomious *functionalism/wellness* and *re-sources/re-use***.

** In Norway, for instance, the hotels builded up to be used during the 1990 Winter Olympic Games have been subsequently redistrib-

the ancient attitude toward *essentiality* acquires a special economic value in the contest of a *sustainable* touristic development. The Icelandic touristic accommodations are limited and the quality standard out of Reykjavik is frequently considered poor when compared to the european or american ones. To face the gap between offer and demand the school buildings (colleges) are frequently used in the touristic network as summer accommodations. This practice characterized the second half of the XXth century and it is still vivid as can be seen in the modern building of *ML* (college-hotel Edda) opened down town Akureyri, in summer 2003. Even if different in quality standard, a similar experience is the *re-use* as hotels accommodations or summer houses of the prefabricated buildings used to host workers during the construction of dams, hydropower plants (e.g. Búrfellsvirkjun, Sultartangavirkjun) and geothermal plants (e.g. Nesjavellir). Consequently Iceland, in spite of the well known resilience of its territory, enjoys both destinations and accommodations satisfying several touristic key elements:

- the like a spot presence on the territory
- the internal and incoming tourism needs
- the revised quality of areas surrounding the power plants
- the increased usage of public works necessary to install power plants (roads, artificial lakes, etc).

The geomorphological features, the position on the Mid-Atlantic Ridge as well the deriving abundance of energetic sources are part of the successful Icelandic economy. In this contest the versatility of the above mentioned destinations supports a rich touristic network.

The mass tourism market derives from the Icelandic *niche* several interesting thematic journeys concerning *history, health, literature, nature, renewable energy, geopolitics-industry, Unesco protected areas (Thingvellir)*. All of them tied by the thread of the Icelandic landscape. The rough volcanic, Mid-Atlantic and glacial landscape frames the territorial diacronic use and perception.

The Icelandic pattern is simple and effective. In Iceland landscape is very peculiar. Low density population is associated to a luck of visible architectural remains form the past. History and time layers are than recorded, as well than natural features, in the name of places, mountains and rivers. This means that places are sometimes not easily understood or decripted. There are places which need to be explained. To face this need Icelandic private and public institutions - generally energy related industries - edit divulgative posters and promote educational programs which can be easily included in classic touristic packages.

The Icelandic pattern pays attention to the *leisure* aspect (function) of infrastructures and their buildings. The Blu Lagoon geothermal pool, the most visited Icelandic destination, which ties his exhistance to the Reykjaness geothermal power plant and the trekking paths surrounding the Nesjavellir geothermal power plant (Fig. 2) are a good example of this approach.

This contest includes also to the *most controversial and extensive industrial operation in Iceland's history the Káranjúkar dam project* (Kaldal J., 2004). The construc-

uted along the Norwegian touristic destinations reseau. In Iceland school buildings are often used as tourists accommodations.

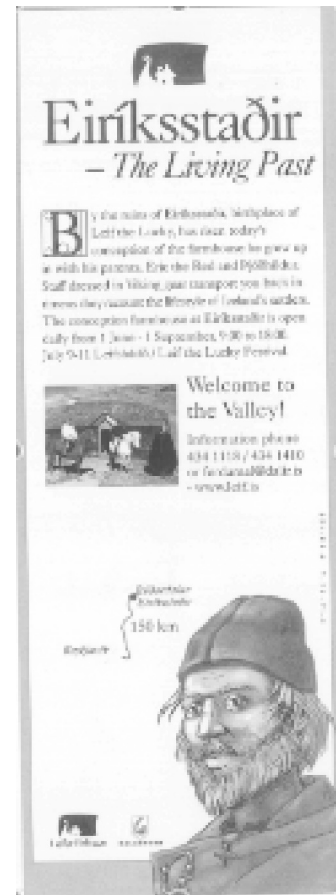


Fig. 2. Geothermal and history related destinations.

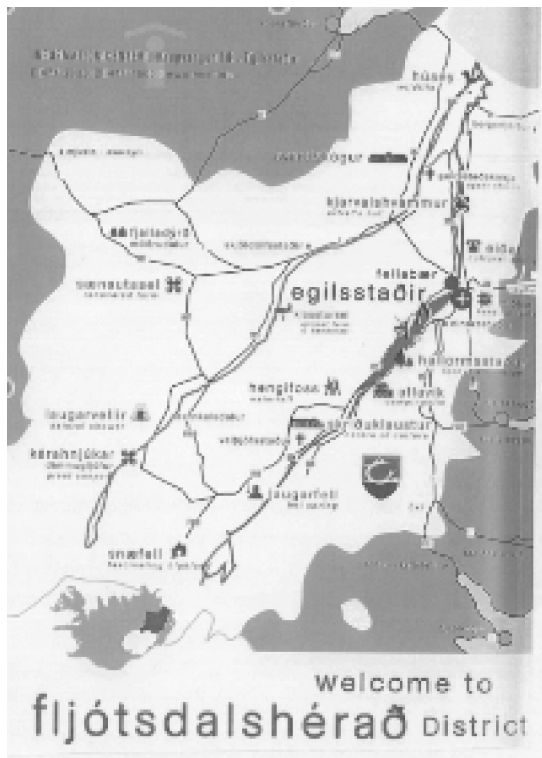


Fig. 3. Fljótsdalshérað District Map and Kárahnjúkar dam project.

tion project of the dam is well illustrated in posters shown in Egilstadir as well at the Káranjúkar visitors centre and in the educational offered by Landsvirkjun in the Fljotsdalur valley.

The Icelandic pattern turns over the restrictive impact of the island's limited *carrying capacity* and *vulnerability*. They are both faced and evaluated as a *plus*. Due to this reason both *carrying capacity* and *vulnerability* represent an added value. As a consequence *qualified tourism* standards avoid the negative impacts introduced by *mass tourism* and offer high client's *satisfaction* standards.

Conclusions

Carrying capacity and *qualified tourism* represent both *passive* and *active* concepts which *resilient environments* planners have to pay attention.

Iceland may be conceived as a *pattern* where to test several kind of experiences assumed as marketing products. Icelandic natural features and landscapes, fits many educational programmes on *health/environment/energy sensitive* topics.

Due to insularity, incoming tourism is in Iceland easily controlled and planned. This makes possible to release specific educational programmes tailored on different cultural pattern's requirements.

This kind of approach meets several needs. Considering the island's limited *carrying capacity* and *vulnerability* as a *plus*, *qualified tourism* standards will avoid the negative impacts introduced by *mass tourism* and offer high client's *satisfaction* standards.

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Role of Geo–Tourism in the Sustainable Development of Gorny Altai

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Abstract

Gorny Altai in Russia arouses interest with its nature originality, peculiar and picturesque landscapes. Various nature resources set up favourable conditions for the development of eco–tourism. The territory of Gorny Altai is characterized by the interesting geological structure, presence of many unique geological and geographical objects (geo–objects). This sets up the necessary prerequisites for the development of geological tourism (geo–tourism). Eco–tourism in Altai can become the base of general strategy of sustainable development. Geo–tourism is the one of factors of such development of this territory.

Keywords: geo–tourism, eco–tourism, geo–objects, Gorny Altai, sustainable development

Introduction



Fig. 1. Mountainous Altai location on the map.

World scientific, political and social organizations have been paying great attention to mountain problems lately. Mountainous Altai arouses intense interest in frame of Russia. Placing almost in the centre of Eurasia at the turn of two natural zones of northern hemisphere, namely, humid boreal and arid desert–steppe, the Altai Mountains are the part of the world watershed and the global mountain ecosystem (Fig. 1). Mountainous Altai has its unique nature, complicated structure of geological texture and relief as well as its multiform of nature complex, its originality and brilliance of landscapes. It has its great variety of flora and fauna. Natural recourses of the Altai Mountains create favourable conditions for eco–tourism development.

Results and Discussion

Almost all the territory of Mountainous Altai belongs to the Altai Republic administratively, which is situated in the south of West Siberia. Nature of the region is slightly affected by anthropogenic activity. The total population is near 200 thousand people, the republic area is 92,600 km², at that the most part of the population (about 25 %) lives in the capital of the Altai Republic, Gorno–Altaisk.

Right up till the nowadays the Altai Republic could avoid the harmful urbanization and save its unique landscape. However, the active commercial new land developing is being arisen and the republic now is under the threat of loss of some kinds of natural resources, the same way as the genotype part of flora and fauna. It is threatened with the destruction of the unique landscape and its varieties. In this connection the republic government carries out the program of region steady development, and one of the priority branches is tourism development including ecological tourism [1].

The territory of Mountainous Altai as a whole is very promising for many kinds of recreation: mountain and boating tourism, mountaineering, speleological tourism etc. There are many opportunities for creation of geological tourism (geo–tourism), which is a kind of eco–tourism. Geo–tourism is travelling with scientific, cognitive, entertaining and other purposes by using geological and geographical objects of nature.

The territory of Mountainous Altai can be characterized by special geological structure, existing of great many of

unique geologic–geographical objects (geo–objects), which determine the prospect of geo–tourism development. This kind of recreation can arouse geologists', geographers', geo–morphologists' and other specialists' interest as well as students' and simply nature–lovers'.

We carried out a complex evaluation of natural and socio–economic conditions on the territory of Altai Republic in geo–tourism purpose [2]. As a result the most perspective regions were marked out and arranged special routes within their bounds.

We would like to describe some of the most interesting places despite the abundance of other unique things on the territory of Altai.

The river valley Choulyshman (Fig. 2) represents a canyon of tectonic origin with about 1000m in depth. The



Fig. 2. “The Stone mushrooms” in the river valley Choulyshman.

middle and lower Choulyshman's flow represents a prompt and mountain stream with numerous rapids and waterfalls on its tributaries. In the valley's boards some rocks of different texture are being outcropped, that have been flexured under the action of the Earth's mighty inner energy. On the slopes of the Choulyshman's valley you can see the results of selective weathering processes in the form of intricate shapes of the relief, E.g. stone mushrooms (Fig. 2). In the Choulyshman's mouth there is a salubrious hydrogen–sulphides spring, which enjoyed wide popularity by natives.

The Teletskoe Lake (Fig. 3). This is a reservoir 78km. in length. It is considered a unique one due to its structure and



Fig. 3. The southern extremity of the Teletskoe Lake.

origin. This lake is one of the largest in Siberia. Its water area is 223 km², the average depth is 174m, and the maximum one is 325m. The lake basin formation is a groove fault being affected repeatedly in the Quaternary by a glacier. The lake

is a unique reservoir with pure ultra–sweet water. It is surrounded by the mountains from 600m. to 2400m. in height, the slopes of which are covered with medium–sized mountains landscape. These are taiga coniferous cedar woods with a touch of firs and spruces. The reservoir can be compared on some basis to the largest freshwater lake of Siberia – the Baikal (e.g. the basin genesis, hydrology, the water chemical composition, the regimen).

The Ukok plateau is situated on the south of the Altai Republic and takes special geo–place in the junction of Mountainous, South and Mongolian Altai. At the central–Asia and south–Siberian landscapes borders it especially stimulates the interest as well natural–ethnic as historical object. The most part of the plateau is a registered territory, a rest zone. High–mountainous landscapes of Ukok are the objects of special attraction and scientific importance. There are high–altitude zones with tundra–steppes landscapes, cryogenic and limno–glacial complexes.

Ukok is a region of ancient objects of historical epochs. There are more than 320 ancient monuments, more than 850 archaeological monuments, and also 50 rock paintings are discovered here. Ukok is the cult territory to maximize by Altaians and everything is permeated with history and mystery around [3].

Chouiskaya intermountain trough is one of the largest morphologic structures of South–Eastern Altai. It is a bowl–shaped object, 80km. in length and 35–40km. in width. Absolute marks of the central part are being changed from 1750m. to 1850m. The trough landscapes are arid steppe, semi–desert and desert.

During the Ice Age (Quaternary period near 800.000 years ago) there was a huge cold glacial–pond lake at the same place. Mighty glaciers flew down the lake from the adjacent mountains [4]. Now in the river valleys adjoining to Chouiskaya steppe on the outcrops you can observe the glacier's action tracks (furrows, scars and chips). In the western slope of the trough, in the boards of the Tchagan–Uzun valley are cropped out red igneous–sedimentary deposits of Devonian. These are natural pigments forming vivid impression (Fig. 4).

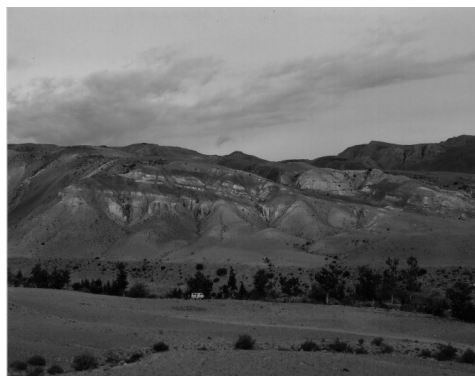


Fig. 4. Cropping out of weathering crust in the Tchagan-Uzun valley.

Conclusions

It is demanded that the composition of geological routs (geo–routs) on the base of these unique geo–objects and many other ones, but not less significant should be the factor of decreasing of the region ecological problems. The routs

composed with geo-object using, with taking into account their ecological features contribute to preservation of the environment, bring up a person to sense harmony with the nature to realize its vulnerability, organize his ecological consciousness and do not damage to natural ecosystems. Particularly it can be thoroughly comprehended by the example of geo-objects. It is them to have been recorded the "stone chronicle" of the Earth in collection to have been signed the activity of geological processes in the history of our planet from the present to retrospective for million and even billion years. Even their partial loss will become irreplaceable, since any methods of a "selection" are not able to recreate the geological conditions and the past processes having the same time duration and the same colossal scales.

Despite many disadvantages (difficult of access region, especially its separate parts, lack of infrastructure development, financial investment limit, poor staff training) eco-tourism in the Altai region can be a common basement for stable development. Geo-tourism is one of the factors of territory growth of such type.

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Polish Long–Term Interdisciplinary Co–Operation of Scientists, Youth and Local Communities for the Promotion of Eco–Tourism and Sustainable Development in Regions of Particular Natural and Cultural Values in Poland, Spain and Italy

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Abstract

Methodological experience of over 35 years of the co–operation of professors, young scholars, university students, local society and tourists supplemented by similar activity in Italy, Spain and other countries seems to be useful for the promotion of eco–tourism and sustainable development in similar regions. A crucial condition for the success in this field is linkage of problem solving training with the education of all the partners and the application of the up–to–date environmental engineering.

Keywords: sustainable development, eco–tourism, education, environmental engineering

The AGH – University of Science and Technology in Krakow has a long tradition in integrating scientists, scholars, decision makers and local communities in common action for sustainable development. This includes over 50 years of the tradition of Seminars on Sustainable Use of Natural Resources started in Poland by the rector of the AGH–UST– Prof. Walery Goetel. Our team continue this tradition referring to the sustainable development of national parks (including international parks). The leader of our team initiated (in 1968) Polish and international schools “Man and Environment” [1]. They were held in places of particular natural values, usually in national parks. A particular role

in sustainable development belongs to eco–tourism connected with sport activities of academic students, including the members of the International Alpinist Union).

Our team has methodological experience from the series of international and national summer schools referring to alternative forms of tourism and sustainable development in the regions of some Polish national parks. There were also visits to national parks in other countries (Spain, Great Britain, Romania, Italy). The international course of the sustainable development of protected regions in Europe was carried out in the Spanish National Park Coto Doñana [2].

We also carried out work on the state of environment in historical urban complexes in Poland and Italy (e.g. International Workshops in Florence in the co–operation with the Del Bianco Foundation). Recently we also completed the work within the European project connected with our participation in the project on the modern education of tourists and residents in eco–tourism and the sustainable

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development of the areas of exceptional natural and cultural values. The model area was the Cinque Terre National Park (Italy). The participants represented 11 countries [3].

The experience in the implementation of sustainable development in national parks of other countries was used, including work carried out in Poland since 1968. This includes the experience from the mountainous and sub-mountainous national parks like the Tatra N.P., the Pieniny N. P., the Bieszczady N.P, the Babia Góra N.P. and the Ojców National Park, as well as from the Baltic coastal region (e.g. the Wolin N.P. and Słowina N.P.). These parks face high tourist pressure, but at the same time in most cases human influence is necessary to keep their character – prevent meadows from being covered by forests in the process of natural succession. This feature is common with the Cinque Terre National Park, where human activities are necessary to prevent terrace vineyards from being overtaken by forests. A particular subject of the interest of the co-operating with us experts from the Department of Photogrammetry and Remote Sensing Informatic (Prof. J. Jachimski, Drs. A. Boroń, B. Hejmanowska, W. Drzewiecki, S. Mikrut) was related to GIS in the context of the needs of the national park, mainly the development of tourism and nature conservation. Remote sensing and photogrammetry techniques can be successfully implemented for the needs of the Park. A map of vegetation/land use was made based on satellite data [4]. This can make a starting point for the monitoring in the aspect of land use changes. Some examples of photogrammetric documentation of historical monuments in the Park were also made, including spherical panoramic images. During our visit in the Cinque Terre National Park and also to national parks in Poland we paid attention at certain deficiency of information in languages other than a native language. There were some notes in English, however this was insufficient taking into account a large number of tourists from different countries. Information on plant and animal species should include their images, names in native language, in English as well as scientific names.

The Region of the Cinque Terre Park was a model area for the consultation of experts and local decision makers as well as the residents in the cultivation of traditional forms of life, necessary to protect a unique cultural landscape. These activities can include production of wine, olive oil, but also perfumes and eau de cologne made from herb plants. Handcraft is not very popular in this area, but also can be revived.

The activities were directed towards the diminishing of the concentration of tourism at the coastal area by encouraging tourists to visit mountain areas. **Complementary experiences of professors, university youth, local stakeholders and managers from different regions in Europe support the idea of networking of experts (e.g. within the Union des Terres de Rivieres) for the promotion of eco-tourism, education and sustainable development.**

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Where is Eco–Tourism in Poland Heading for?

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Abstract

Eco–tourism is one of the forms whose development has been regarded as strategically relevant for tourism in Poland. The theoretical guidelines have been described for years, but they are not always put into practice. The first and biggest problem we face is with defining eco–tourism. Creating, preparing and adapting the areas for tourism make another thing. On one hand we pay special attention to promotion of rare and endangered species, while at the same time knowledge and eco–awareness of the society is very poor. Last but not least, training the staff for creating and preparing eco–tourism is equally important issue.

Keywords: eco–tourism, biodiversity, conservation

Introduction

Tourism has been one of the biggest threats for natural environment for many years. Its new forms have been causing problems but have also been challenging for the people who dealt with the destructive influence of tourism on natural environment. The idea of eco–tourism has brought hope for the change of a “selfish” image of tourism. Although it has been developing for many years all over the world, it still seems to be novelty in Poland. It is often just a part of eco–fad. However, it is one of the most dynamic forms of tourism, which has a relevant place on the market and which has been the topic of numerous scientific researches. The interest in and revenue from eco–tourism have led to a lot of misunderstandings and distortions of the idea of eco–tourism. Moreover, we can find some tourist offers which are called environment–friendly but in fact they aren’t. Worldwide and European examples should be for us both: a warning and help in taking the right direction. Because of the unique character and abundance of Polish natural environment we should also try to work out our own strategies for the development of eco–tourism.

Materials and Methods

This paper is a synthesis of the author’s research, carried out through the last years on both protected areas and rural and urban grounds. The research focuses on the analysis of using natural environment for the purposes of eco–tourism, the means of presenting it, and tourist – nature interaction. To analyse biodiversity, the author used cataloguing and zoological valorisation, especially species, habitats and functional biodiversity, understood through the concept of

ecological niche [1]. The results are also used to create active protection programmes.

Results and Discussion The Definition of Eco–Tourism

What is eco–tourism? We seem to know the answer to this question intuitively. But is it enough? It has been difficult to point one universal definition so far [2, 3]. Many organisations or tourist agencies engaged in eco–tourism create their own definitions [4]. Making a definition for one’s own use may either narrow down or widen the issue. On the other hand it allows justifying actions, which are doubtful or even harmful for the environment [2, 5, 6]. When we analyse different definitions, we can distinguish three common criteria that say what eco–tourism is [2, 4]:

1. It provides for conservation measures,
2. It includes meaningful community participation,
3. It is profitable and can sustain itself.

It seems that full definition should cover all the three points. However, we have to focus on one more thing. Eco–tourism is contrasted with mass tourism. Beside reducing the negative impact on the environment, eco–tourism should also influence the appropriate attitude of tourists. When it comes to environment, consumption and egoism should be replaced by the awareness and responsibility. However, this knowledge and awareness need to be common to improve the condition of environment. If we stress the exclusiveness of eco–tourism and condemn the mass tourism we cause conflict. Because of the fact that eco–tourism is becoming more and more popular, we can find a large number of tourist offers which seem to be eco–friendly but they aren’t in fact [7]. It leads to disorientation; tourist use such offers because

they follow “the eco-fad” (nobody wants to be the bad guy –the mass tourist). As a result we have masses of people in the most valuable enclaves, people who are not controlled [2, 4, 5, 8]. It’s obvious that you can’t separate tourism from environment, but it is its negative impact that we need to reduce. It can be done through making people eco-aware [2, 9]. To achieve that, we should make the eco-tourism ideas common and divide eco-tourism itself in different groups according to tourist’s needs which may depend on e.g. his or her knowledge, skills, age etc [3].

Eco-Tourism Creation

Proper future development of eco-tourism is another problem. It seems that if we are able to define the phenomenon, we outline the goals and all we have to do is to reach them. But the question is: how to do that? Tourism as an interdisciplinary phenomenon often uses the scientific methods characteristic for other sciences. Natural sciences couldn’t find their place in the development of eco-tourism for many years. Since The Earth Summit in Rio de Janeiro in 1992 the research on biodiversity has become one of the most crucial research carried out within the confines of natural sciences [1, 2, 10]. Because of its character it should also have application in appropriate form of Eco-tourism [5]. Biodiversity has a lot of categories [1], but from the point of view of tourist research, three of the categories are especially useful: habitats, species and functional. The first two have been broadly analysed, often in form of cataloguing and valorisation research [10]. But such an analysis is often connected only with giving figures or listing the species on different areas. When you design the educational paths, the information about the species in protected area is necessary. If you interfere in such grounds this is not only breaking the law but it also leads to decline in biodiversity and it lowers the importance and attractiveness of the region. It is a big and common mistake to draw tourist’s attention to rare and endangered species. The naturalists who work on active protection claim that it is necessary to keep the places with the species from Red Data Book in secret. It is common in Poland to think of natural rarities as important and valuable from the tourist’s point of view [10]. The problem lies in understanding the word ‘rarity’. For a naturalist every form of life is rarity, but people who deal with tourism use this term for rare and endangered species. Yet a lot of them are just unattractive because of difficulties with access, secretive lifestyle, small size, colours or behaviour, which are not impressive. The species which you can easily meet, which are less skittish can be the best example for the presentation which is supposed to influence sensitivity and eco-awareness. We do not need to be afraid that the tourist will be unhappy because majority of them do not recognize the basic plants or animals anyway. If you want to make people eco-aware you have to appeal to their sensitivity and not so much to their knowledge [9].

We can understand functional biodiversity through the concept of ecological niche, which describes the role of organism in biocenosis, taking its trophic relations, area preferences and interspecies interactions into consideration [1]. This category allows to make a thorough study of the area and is especially useful in making different forms of

environment presentations [9]. The knowledge about the natural environment is difficult to pass because different natural phenomena are unpredictable in time and space. That is why we pass “direct information” (name, information about the biology of species). From the point of view of a tourist it is hard to remember and often boring. What is the most interesting for a tourist is “a story about life”. Functional biodiversity provides knowledge about relevant areas, especially as far as the animals are concerned. It is the knowledge of mating time, raising offspring, feeding grounds, spending nights, passage etc. The analysis allows to specify the most appropriate place and time for observation, without making harm. What we can do is draw tourist’s attention to ecological and ethological observation. Instead of giving standard information we can talk about the meaning of colour, smell, hunting and escape strategies, communication, interactions etc. This category of biodiversity is complementing the other two and shows the whole situation which helps prepare the environment for tourism.

Staff Training

Separate but equally important issue is staff training. Variety of habitats and plants or animals living there puts Poland at the top of European countries that were able to preserve characteristic environment [2, 4]. Western Europe’s experience tells us that this situation does not have to last forever. That is why it is necessary to look for appropriate solutions. Therefore well-trained staff is essential. Meanwhile, there are people with education in tourism that cannot find job in the most precious places –in protected areas. Naturalists work in tourism but it is very often hard for them to get rid of a professional point of view and therefore to arouse laymen’s interest. It is still thought that anyone can work in tourist branch because it is not complicated at all. To meet the tourist market’s expectations we should also adapt syllabuses in tourist schools.

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The Eco–Tourist Product of The Beskid Sądecki Mts.

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Abstract

The introduction of the unique products into present tourist arena it's not only action to get the satisfaction of still growing demand of clients, it is also a stimulator of social–economic development areas of tourist reception. In this paper it is described an example of branch product – eco–tourism, such should be introduced and promoted on (into) the Beskid Sądecki Mts. This area is protecting as The Poprad River Landscape Park and posses uncommon assets: natural, cultural and human resources. The development of tourism may become a solution of existing social problems such as: unemployment, people migrations, no prospect for the future for young peoples; that process must execute due to the sustainable development rules, with full respect and protect the natural heritage, of course.

Keywords: Beskid Sądecki, eco–tourism, geotourism, sustainable development

Introduction

The tourist market is uncommon profitable and dynamic developing branch of contemporary economy. Due to World Tourism Organization [1] in 2005 has been noted the growth by 5.6% of total number international tourist arrivals, that transpose on 548 Euro billions. The most popular tourist continent is Europe (it is aim for 51% of total number of travel), now we are still observing a growth of arrivals into old continent (growth by 2,3% 2005–2004). Considering on social – economic transformation of communities which connection with grossness services in tourism, the organizers and sellers of tourist products have force to satisfaction more and more exquisite needs of themselves customers, principal by producing a new tourist offers or creating original new branch of tourism [2]. One of them, obtain more popular is eco–tourism, define on many ways [3]. Simple and adequate definition of eco–tourism is sentence by *The International Eco–tourism Society* (TIEC) as „responsible travel to natural areas, which conserves the environment and improves the welfare of local people [4]”. In the Quebec Declaration 132 representations of states describe the bases and direction of eco–tourism development, including – due to the sustainable development concept– economic, social and environmental foundation of evolution this branch of tourism [5]. In special way they concern preservation environment assets and natural herit-

age (animate nature and inanimate nature). The most suitable form of nature protect, as we can find in Polish law [6] to promotion eco–tourism, seems to be a Landscape Park. Let's analyze possibility of development eco–tourism and geotourism on example one of Polish landscape park.

Geotourist assets of the Beskid Sadecki Mts.

All area's of Beskid Sadecki is under law protection as the Poprad River Landscape Park (PPK), his surface is 54 000 ha. This region geological belong to the regional Unit of The Outer Carpathian and consist of two mountain ranges: Radziejowa and Jaworzyna. Mountains ranges are high, more then 1000 m a.s.l. This area is morphologically extremely diversified. The thick complexes of sandstones intercalated by clayey shale and grey mudstones are dissected by picturesque streams and rivers valleys (the biggest of them are: The Dunajec, Poprad and Kamienica Nawojowska River) providing a landscape of exceptional beauty. Currently, under law protection are [7]: 13 nature reserves, 85 monuments of animate nature and inanimate nature with botanical values, and 25 inanimate nature monuments. They illustrate the immense geodiversity of the Beskid Sadecki; including such features as [8]: sequences of sediments, landslide forms, sites of fossils, rocky forms, rocky fragments of river channels, waterfalls, caves, springs and accompanying sediments and phenomena. Valuable and natural assets of this area are: mineral water (chiefly acidic waters), peloids and exhalation of carbon dioxide

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(dry mofette and accompanying them ochre and travertine). This region is unique hydrochemical zone in Poland and call "the Poprad balneology basin" [9]. The discovery of mineral waters enabled the development of health resort in: Krynica, Szczawnica and Piwniczna, which gave rise to the intensive health and medical tourism – an example of proper utilization of natural resources. At presents on The Beskid Sadecki Mts. are locate six health resorts: Krynica, Muszyna, Piwniczna, Szczawnica, Złockie and Żegiestów. Four next health resorts are planning in: Tylicz, Wierchomla and Łomnica-Zdrój [10]. The profitable is localization of The Beskid Sadecki Mts. – nearness Polish-Slovakian border; in Leluchów, Piwniczna and Muszyna are border-crossing points.

The tourist activity in the Beskid Sadecki Mts.

Analyzing tourist activity during last two century its impossible not to see the avalanchly growth of arrival of tourists. In 1911 in Krynica was noted arrival of 990 tourists, but 30 years later this number growth to 4465 [11]. At the beginning of XX century 10 700 visitors had used medical therapy in Krynica resort, but in 2005 this number growth to 38 618 visitors. The total number of tourists arrival to the Beskid Sadecki Mts. in 2005 is calculated about 251 300, they spent about 1.5 million nights in accommodation of this area [12]. As main aims of arrival into Beskid Sadecki Mts. respondents have gave follow answers [13]: recreation (27%), for 16% main aim was health therapeutics, per 15% of respondents sport activity and visit the towns. Accordingly those statistics more than 73% of arrivals (directness and indirect way) are caused by natural velour. The frequently age of tourists who come to this region is located between 25 and 40 years old (38%), most of arrivals are short-terms, that's mean 2–3 days. In the Beskid Sadecki Mts. it can be observed double-seasons of tourism activity: summer season (since May to September) and winter season (since December to February). The most popular branches of tourism are: hiking, skiing, horse-riding, cycling, agrotourism, eco-tourism and more popular geotourism.

The Beskid Sadecki Mts. main problems and their solution?

The most important asset of the Beskid Sadecki Mts. is a nature, and her values, such as: landscape, climate, mineral waters, abundance of wildlife (animals and plants) and clean environment. Due to PIOŚ (Government Monitoring System) flow water in this region were classified to good or very good quality (class I and II), similarly situation relate the quality of air (due to both criterions: plant protection and health protection), concentration of dust doesn't cross the admissible values (due to Polish air law, the quality was classified to zone A). The main social-economic problems of Beskid Sadecki are [10]: unemployment (21% of total population), no prospects for the future for young peoples (62% of unemployed are peoples under 34 years old) and involved with that two factors migrations of peoples to the cities and abroad. The main environmental problems of this area are: – urban sewerage, only 23% of total houses

have connect with system, – water supply system, 40% of them have service line, – waste disposal sites (unauthorized dumping), and traffic – main roads cross the centres of cites, especially in health resorts. The local government is supposed to find the solutions of social-economic problems by creating a new programs, which create new place of employment and acquiesce in investment (private investors or big company) on this area. The perfect solution of describe problems seems to be the sustainable development of tourism, definition as "soft" or "least possible impact". The main aims this branch of tourism are: (i) reducing to quantities minimum waste disposal, (ii) to contribute ecological education of local community and (iii) provision welfare of local peoples with (iv) conservation of cultural diversity, (v) through protecting nature resources (inanimate and living nature).

Geotourism – the main aims

In the Beskid Sadecki region (on a big scale) one branch of sustainable tourism– geotourism is promoted. Geotourism has been defined due to Słomka and Kicińska-Świdarska as [14] „*a branch of cognitive tourism, oriented towards enhancing our experience and providing the tourist with an understanding of geotourist sites and processes as well as stimulating his aesthetic sensibilities*”. Geotourism can also be a branch of active tourism, if knowledge of a geological site requires special skills. It is also closely related to environmental protection, especially of inanimate object. The aims of geotourism are: (i) promote the region's geological heritage (on local and international scales, (ii) provide tourist with asses to geological object and processes as well as abandoned quarries, so that visitors can in facility way understand the genesis, structure and the role they have played in our economy and lives, (iii) take steps to preserves geodiversity and maintain the geotourists objects in good condition, (iv) to catalogue and asses the quality of geotourists objects (on local, regional and global scale), (v) construct working models that ensure tourists access to geological objects for whilst guaranteeing them protection for future generation, (vi) monitor changes and carry out scientific research with the aim of protecting sites from devastation or degradation, (vii) develop international co-operation in project aim at making regional and continental geological objects more accessible in way that respect the natural environment rather than political or administration division.

Further development of tourism in the region requires joint efforts of local government, communities and investors, witch would be ready to implement the new solutions provided by the sustainable tourism (geotourism) in order to protect the natural wealth of the Beskid Sadecki.

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The Initiative for the Saving of the Cultural Heritage of Carpathian Foothills in the Vicinity of Brzesko

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Abstract

The article presents an example of geographers, architects, agricultural advisers, and local government's cooperation in order to terminate the negative transformations of the cultural landscape of Carpathian Foothills' villages. The aim of the cooperation was to encourage the inhabitants of the Brzesko area to learn their architectural traditions, observe and register the variety of precious man-made historical objects, the arrangement of villages, the ways of furnishing gardens, as well as propose their own solutions related to the region's history. The initiative had a form of exhibition, a contest and a conference and it was greeted with a considerable interest on the part of the inhabitants of the Brzesko region, especially young people. This gives hope that by building new houses or modernizing the old ones and establishing gardens next to these houses, some typical elements, materials, and plants which were the basis of the former houses and their surroundings are going to be recalled.

Keywords: landscape architecture, cultural heritage, public awareness, identity, Carpathian Foothills

Introduction

The Polish Carpathian Mts. feature great variations in the land use being closely linked with the land relief diversification and the history of settlement. Centuries of harmonious existence of villages and towns in the diverse Carpathian geographical regions contrast harshly with the adverse landscape transformation the area experienced during the last fifty years, as a result of rapid settlement expansion (rural transformation; spill-over) [1–4]. The study area and the location where the cultural heritage protection initiative was carried out is situated across a typical agricultural region of the Carpathian Foothills in the vicinity of Brzesko (50 km East of Kraków). The average population density is 153 persons per km². and is very diversified, reaching 400 persons per sq. km². in suburban areas and 1429 persons per km². in Brzesko. In the Brzesko province (591 km²) 44% of the lands is covered with arable land, 18% is forests, 7% – pastures, 1% – orchards; built up areas

and fallows constitute 12% of the whole area [5]. Over the last two decades the studied region of the Carpathian Foothills have witnessed deconstruction, destruction or devastation of 70 to 80 % of traditional habitable buildings and over 90% of its agricultural facilities. Fortunately, not all that is old and beautiful is disappearing from the landscape of the foothills' villages – tens of shrines, figures and roadside crosses are still preserved and they perfectly fit into the foothills' hilly, agricultural landscape. The field layout also remains traditional: in the form of a large number of long, narrow fields (up to 167 plots per km². with the average size of 0.68 ha), dense road network, field terraces, furrows and wooded escarpments, all contributing to large biodiversity and low intensity of morphodynamic processes and the beauty of the landscape [6].

General and specific objectives

The originators and authors of the undertaking were geographers, an architect and an agricultural adviser, who decided to encourage the inhabitants to preserve their “lo-

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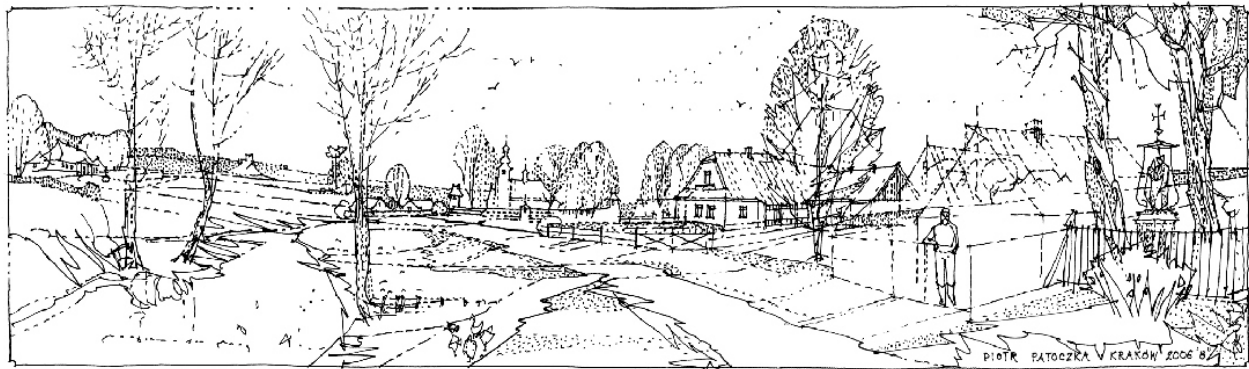


Fig. 1. The sketch present example of the village vista. In the skyline of the Carpathian village there are usually a dominant shape of the church surrounded by old trees, castle ruins on the remote hill and monumental manorhouse hidden in the park. Mosaic fields are marked with shrines, crosses and statues. Traditional farmsteads are compound of cottage, barn, byre surrounded by orchards, gardens and trees.

The photographs present examples of typical architectural details of traditional rural and manorial building from eastern parts of Kraków's region.

cal homeland" and to explain its necessity to introduce sustainable development policy. Their work was based on their previous studies and works across the Carpathians.

The main objective of the undertaking was to indicate the link between sound tourism and education of young generation about natural and cultural heritage. Another aim was the co-operation of experts (geographers, architects and agricultural advisors) and decision makers from local self governments and administrations in the area of sustainable development of historical region around city Brzesko as well as saving the environment and the cultural heritage of Carpathian Foothills around the town.

As far as specific objectives are concerned, one can discern three aims of greatest importance.

Firstly, there is an urgency for developing cultural awareness, that is, human's 'rooting' in their closest community, culture and territory, creating the sense of being at home and being oneself. Secondly, developing public awareness should be introduced and its consequences in human activity should be addressed. Some emphasis should also be put on understanding of one's duties and tasks as well as joining the life of one's environment. Finally, the idea of developing skills for creative thinking, problem solving and planning were also viewed as necessary for the implementation of proper architectural solutions.

Applied methods

The undertaking was organised by the Jagiellonian University, the Cracow University of Technology, and the Centre of Agricultural Advising in Małopolska and it was of cognitive nature as far as regional and ecological education is concerned. The undertaking was organised to activate co-inhabitants around common undertakings for the purpose of transferring cultural heritage. The goal was to revive tradition and the roots, that is, recall characteristic elements of the area (materials and plants which had created former houses and their surroundings) by means of building new houses and establishing gardens around them.

The whole course comprised of:

1. Exhibition under the title 'Polish Landscape in the Drawings of the Students of Architecture Department of Cracow University of Technology'.
2. The contest 'House Surrounded by Garden' addressed to the inhabitants of Brzesko area who find it precious and essential that the house's surroundings should recall tradition.
3. Conference putting forward a set of interesting solutions as far as architecture and organisation of the space around the house are concerned; and also presenting environmental and cultural qualities of the Carpathian landscape together with both causes and effects of adverse landscape transformations.

Results and discussion

As a result of the cooperation between geographers, architects, agricultural advisers and local government as well as state administration on a district level, the goals planned were successfully reached. The cultural landscape protection initiative was welcomed with much interest among the inhabitants of the Brzesko region. The exhibition was visited by many people. All the pupils of secondary schools from the Brzesko administrative district took part in the competition (high-schools from Brzesko, grammar, technical and vocational schools from Brzesko, Szczurowa, Czchów and Łysa Góra). During the meeting with local authorities and inhabitants of Brzesko's area, some attention was paid to the role of traditional building and land management forms in sustainable development. It was emphasized that one cannot miss traces of the past in the Polish countryside. Great natural value intervenes here with sustainable management. The village vista is always defined by a towering silhouette of the church encircled by trees, ruins of a castle emerge from the distance, and a tremendous outline of a manor house lies hidden in a park interior. A winter covert among the fields marked with the cross, a shrine or a statue proves to be a war cemetery. Traditional fences make low, squat cottages, sheds and barns harmonize with the surrounding gardens, green orchards and old tall trees. Forest paths along which cattle was driven, as well as vast fields divided in regular shapes surround villages and hamlets connecting them to the open landscape.

If we want to continue these forms of the countryside management and architectural development, we have to draw on the characteristics of the form, function and construction of traditional, wooden homesteads. From a wide, panoramic view the housing of a village should be dense, immersed in green orchards and gardens, nested along a river and accessible by a road (Fig. 1). As a rule of thumb we should build one-storey buildings with usable attics under sloping, symmetrical roofs, with jerkin heads and gables to add variety. When looking from the road, each homestead should have a flower and vegetable garden at the front and tall trees at the back of the house to constitute the background of crowns. Rustic style could be emphasized with wooden fencing (Fig. 1). At the same time, the colours and materials used for dwelling houses can relate to old homesteads, even though their structure and equipment are completely modern, providing comfortable living, being also up to safety and usage regulations. Therefore, the old homesteads conservation and alteration as well as the design and construction of new countryside development should draw on the beauty of the form, rich contents and functional utility.

The cultural heritage and natural values of the countryside require protection and shaping based on the continuation objective. Hence the educational effort to install the respect for tradition, as well as the work to document traces of wooden architecture, and also to popularise the disappearing crafts and the revival of a decent life in the countryside. However, it is difficult to introduce these values in far-flung corners, distant settlements and hamlets, and at times it proves to be impossible. Therefore a request to banks should be made to favour loans for these conver-

sion projects and new developments, which relate to the features of regional culture. It is equally important to legally support the conservation of wooden architecture as well as culture and nature monuments, especially old trees surrounding churches, rural cemeteries and those growing in parks and gardens. The Catholic Church should play a special part in protecting the cultural heritage. Once nature and culture values are accentuated during the education of priests, the Polish countryside can greatly benefit from that, preserving its values and passing them on.

Conclusion

The area around Brzesko has retained numerous instances of constructions created in harmony with surrounding environment, manifesting a sort of *genius loci* of their designers and users. The region features typical architectural details of traditional rural and manorial building from eastern parts of Krakow's region: windows, doors, wells, staircases... Shrines and roadside figures are also characteristic of the area – objects that are the heritage of rural culture and a part of folklore. All these sites constitute a richness of a hidden treasure and, hence, should be exposed and popularised to be practically used in contemporary building in the region of Brzesko.

Every single element of landscape possesses its own history and properties, which determine the range of possibilities for the development and transforming of landscape. The transformations highly affect the image of Carpathian Foothills' landscape. These changes are not always positive, desirable or purposeful. They are often an outcome of organisational chaos, lack of proper knowledge or awareness on the part of both people living there, as well as local authorities. Rural landscape is being deprived of spatial and aesthetic order. If the changes are going into the wrong direction – as it is in the case of development of villages across Wiśnickie Foothills – these activities will in time end up in a failure, and the ones to suffer the losses will be the people: both inhabitants of the land and guests who will not find any beauty there.

In order to preserve the beauty and environmental-cultural character of Polish Carpathians, it is priceless that the society is educated as far as regional, cultural and ecological matters are concerned. This should be started with the youngest children, in kindergartens, schools, family homes. It should be fostered by local authorities, scientific centres, mass media. It is to concern children, the youth and adults – but most of all, it should concern local governments. At present, the awareness of the existence of magnificent environmental-cultural richness across the region is lamentably poor. This hidden treasure needs to be exposed through some sensible education. This is an opportunity for local communities but also their obligation towards future generations. Both the inhabitants, aware of their identity, and the tourists will reap its benefits and so will the beautiful Carpathian land, worth continuous exploring and affection.

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Eco–Tourism Development in Poland (the Example of Eco–Tourism Farms Belonging to ECEAT Poland)

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Abstract

Eco–tourism is an environmentally–friendly rural activity, which is based on natural methods of production. Thanks to land tilling without chemical fertilizers, it causes biodiversity and rural resource preservation. The aim of the survey was to analyze eco–tourism development in Poland. Moreover, the author compares farms belonging to ECEAT Poland, which is an organization focusing on farms offering the best quality of eco–tourism services. The largest eco–tourism farming area was in Mazovia (50.3 ha) and the smallest is in the Carpathian Mountain (4.4 ha) region.

Keywords: eco–tourism, development, farms, environment, farm attractions

Introduction

Eco–tourism is a form of sustainable tourism. This kind of tourism is particularly important for its high environmental and natural values. Moreover, eco–tourism is environmentally–friendly and it contributes to natural environmental protection. Eco–tourism is connected with rural tourism, sightseeing, and both rural and environmental preservation [1]. Eco–tourists are environmentally conscious about the consequences of natural exploitation and damage and they are concerned about its well–being [2]. They want to experience the beauty of the environment, protect it, to know more about the country, its natural features and ecological food. Eco–tourists are interested in history and visiting archaeological and historical sites and generally enjoy spending their nights under a farmhouse roof. According to the American Eco–tourism Society, eco–tourism is a conscious journey to natural places, which helps to protect the natural environment and support farmers' incomes.

Eco–tourism is an activity, which helps farmers to increase their income in accordance with the natural environment. This activity helps to generate income from renting rooms on a farm, employing a free labour force and it also enables farmers to meet and talk with people from cities [3]. On the other hand, eco–tourism has many advantages for tourists as well. It is a way to spend free

time, which is relatively cheap in comparison to traditional tourism. A farm holiday can be adjusted to meet tourists' needs and it also improves their knowledge of traditional customs.

Experiments and method of analysis

The aim of this paper is to present chosen aspects of eco–tourism farms' development in Poland. The group of 76 farms, which belong to the European Centre for Ecological Agriculture and Tourism in Poland (ECEAT–Poland), was characterized. The basic information included: farm's area, main tourism attraction, numbers of rooms and the prices of bed and breakfast, dinner and supper. The group was divided into six regions, according to ECEAT–Poland division: Pomerania, Mazury, Wielkopolska, Mazovia, Sudety Mountains, Carpathian Mountains. The collected material proved, that most of farmers prepare food for their tourists mainly from own produced commodities. They help in organizing countryside walks and teach tourist how to bake bread and to do other manual works.

The main aim of ECEAT–Poland is to promote ecological agriculture in eco–tourism farms and educate young children and adolescents. This organization was registered in 1994 and is still very popular among other European Union Countries. All farms belonging to this organization are certified and they guarantee a high level of service.

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Results and discussion

The European Union integration process has created a chance for Polish farmers to finance existing eco-tourism farms and to develop ecological markets [2]. Rural ecological development is stimulated by agro-environmental programs, which aim to preserve the environment and cultural heritage and to stimulate the eco-tourism development of farms.

Eco-tourism farm enlargement is very important because it determines the extent of increasing natural production. The survey found that the largest average eco-tourism farm areas were in Mazovia (50.3 ha), Wielkopolska (29.5 ha) and Mazury (25.8 ha). On the contrary, the smallest eco-tourism farm areas were in the Carpathian Mountains (4.4 ha) and the Sudety Mountains (11.5 ha).

Table 1. Eco-tourism farm characteristics.

Region	Number of farms	Average farm area [ha]	Average rooms number	Average night places number
Pomerania	4	16.2	3.3	8
Mazury	10	25.8	4.1	10.8
Wielkopolska	6	29.5	2.5	7.5
Mazovia	3	50.3	3.7	9.33
The Sudety Mountains	23	11.5	3.0	10.7
The Carpathian Mountains	30	4.4	2.9	9.2

Another important eco-tourism farm characteristic is the average room number. The largest average room number on eco-tourism farms was in Mazury (4.1) and Mazovia (3.7) regions. However, the smallest average room number for eco-tourism was in the Carpathian Mountains (2.9) and

the average room number and sleeping places on eco-tourism farms.

Eco-tourism farms offer many attractions, which are the effect of the natural environment and the beauty of using the countryside. The survey showed that many farms offered a campsite for their tourists. This tendency is particularly visible in Pomerania (75%), and Mazury (60%) (Table 2.). However, the smallest number of eco-tourism farms in Mazovia and Wielkopolska offered campsites. This is probably a result of the effect of the small number of farms from Mazovia, which took part in the survey.

Another attraction offered by farmers is ecological food prepared mainly from home-grown vegetables. Ecological production in farms has great meaning for the sustainable development of rural areas. As Polish society becomes richer, the demand for ecological products will increase [4].

Ecological production is a chance for smaller and less productive farms to develop, compete and deliver high value, healthy products. The survey showed that all farmers in Pomerania, Mazury, Wielkopolska and Mazovia offered their tourist ecological food. In the Sudety Mountains (82.6%)

Table 2. Eco-tourism farm attractions (%).

Region	Campsite	Bike hire possibility	Ecological food	Horse riding
Pomerania	75.0	75.0	100.0	25.0
Mazury	60.0	40.0	100.0	40.0
Wielkopolska	33.3	83.3	100.0	50.0
Mazovia	33.3	33.3	100.0	33.3
The Sudety Mountains	43.5	56.5	82.6	34.8
The Carpathian Mountains	23.3	50.0	80.0	43.3

Wielkopolska (2.5) regions. The largest places number on eco-tourism farms was found in Mazovia (10.8) and the Sudety Mountains (10.7) regions. However, the lowest average places number was in Pomerania (8) and Wielkopolska (7.5) regions. The survey showed that eco-tourism farms in the Sudety Mountains region offer rooms with the largest number of sleeping places. The result also showed that the increasing of farm area had a negative impact on

and the Carpathian Mountains (80%) most rural producers offered ecological food, but some farmers could not offer ecological food because their farms did not contain arable land.

Some eco-tourism farms, particularly in Wielkopolska (50%), offered horse riding. This attraction is attracting new customers to eco-tourism farms and can be used as health therapy.

Table 3. Eco-tourism farm average prices for meals (PLN).

Region	Accommodation	Breakfast	Dinner and supper	Super
Pomerania	28.7	10.0	20.5	20
Mazury	31.5	9.8	19.2	10.4
Wielkopolska	18.3	10.7	18.5	10.7
Mazovia	30.0	11.7	20.0	11.7
The Sudety Mountains	25.2	8.7	15.8	8.6
The Carpathian Mountains	27.3	8.4	17.6	9.4

Eco-tourism farms, which produce healthy food, will create jobs for farmers and their families and will be an element of rural multifunctional development in ecological areas. The best ecological farms will provide regions with ecological food and will be able to compete effectively on EU markets. Their strong feature will be their healthy environment and unique environmental quality. They will offer ecological and healthy food sold at reasonable prices.

The survey showed that bed and breakfast prices were not so high in comparison to traditional tourism prices. The most expensive accommodation prices were found on Mazury (31.5 PLN), Mazovia (30 PLN) and Pomerania (28.7 PLN) farms. Eco-tourism farms operating in these regions have a great advantage. They offer the natural countryside, for example, forests and lakes that are part of the countryside.

Generally, tourists who want to visit ecological farms are rich and stay for a long time on a farm. They are prepared to pay high prices for the experience they try, and prefer, tourism within Poland and its natural environment and attractions.

Conclusions

The collected data show a significant increase in eco-tourism farms in Poland. It means that traditional tourism is being replaced by more specialized ecological tourism. It is a growing segment of tourism and is expected to continue in the future.

Eco-tourism development creates many advantages for people, tourists and rural areas – for example, infrastructure development, job creation, local products and protection of natural areas. Thanks to the many attractions offered by eco-tourism farms, they supply customers with an unexpected experience, unforgettable vacations and natural countryside unaffected by civilization

The main reasons for eco-tourism development in Poland are: an increase in social consciousness, demand for eco-tourism and natural conditions, which promote this kind of tourism. This product can become a Polish specialty on EU markets because agricultural methods are not intensive and there is huge labour force employed in Polish agriculture.

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Spatial and Structural Transformations in the Carpathian Protected Areas, Against a Background of Qualitative Changes of the Water Environment

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Abstract

The objective of this paper is an ever-increasing environmental impact of land use and structural transformations on water cleanliness in the Upper Dunajec basin. The analyses showed a decrease of arable lands and an increase in grasslands and tree cover. Against a background of those transformations, the concentrations of N-NH₄, N-NO₃, PO₄, Cl, Na, SO₄ and K components were analysed. As the result, it was found agriculturally related pollution dropped, but there has been an increase in urban (atmospheric)/water contamination, mainly anthropogenic. The studies respond to a social demand of sustainable development of mountain regions.

Keywords: structural transformations, the Carpathians, protected areas, water cleanliness

Introduction

For many years a significant spatial structural transformations were taking place in the Carpathian areas, and are referred mainly to the agriculture/forest areas. The area of arable lands is subjected to a considerable reduction. Permanent grasslands that are presently extensively utilised, and are prone to the natural forest succession [1]. Also a number of livestock farms have been reduced to some extent. Those changes resulted from lesser exploitation in agriculture production. On the other hand, as tourism industry thrives, it transforms the character of anthropopressure on the environment [2].

The objective of this work was to compare the qualitative features of the water environment with spatial – structural alterations which are going on in the mountain rural areas. Specifically it refers to examining an impact (initiated in the 90s) of spatial land use transformations on the surface water quality.

5 chemical components, i.e.: N-NH₄, N-NO₃, PO₄, Cl, and SO₄. The chemical analyses were made in the Malopolska Research Centre IMUZ laboratory in Krakow. The structural changes, which took place in 1980–2004, were determined on the base of the statistical data derived from the Main and Regional Statistical Offices (GUS, WUS).

For purpose of mathematical description of the structural changes so called land use index W was established, as a weighted average for land use category evaluation. This index describes the basin retention, and the higher value W ; the lesser the retention ability in the studied area [3, 4]. The indicators were calculated for the two cases: (i) for all land use categories (W), (ii) excluding built up areas and wastelands (W_{pl}). The value of W index was referred then to the average concentrations through relational analysis. As a result the regression relations $W = f(C)$ were obtained, where W stands for the value of land use indicator, and C is the average concentration of given chemical components in the surface waters [5].

Experimental procedures

The hydrochemical monitoring was conducted in the 7 stations in the area of the Upper Dunajec basin. It included

Results

The average concentrations of studied chemical components showed that in comparison to the 1970s, an improvement of surface water quality had followed, particularly in the aspect of biogenic compounds. The concentrations of

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ammonium ions have significantly decreased. The highest concentrations, particularly nitrogen nitrate and potassium, were detected in the Bialy Dunajec basin. The maximum concentrations of PO_4 and N-NH_4 occurred at the mouth of the Bialka River (Table 1).

The analysis of the land use structure in the Upper Dunajec basin has shown that till the 1990 the changes

versed falling of the concentrations in surface waters. The significant relationship between land use and water quality was supported by regression analysis, where the high correlation levels were obtained. As an example for chlorite ions and potassium following equations were calculated:

for Cl: $y = 0.38 + 0,196 x^{1,37}$ gives (with) $R = 0.95$; for K: $y = 0.73 + 0.59 \log(x)$ gives (with) $R = 0.91$

Table 1. The concentrations of the chemical components in surface waters of the Upper Dunajec basin – the changes between 2004 water year and 1970s [$\text{mg}\cdot\text{dm}^{-3}$].

Sampling points at rivers	1 Grajcarek	2 Bialka Mouth	3 Bialka Trybsz	4 Czarny Dunajec	5 Bialy Dunajec	6 Dunajec Niedzica	7 Dunajec Kroszienko
Chemical components	2004/2005 water year						
N- NH_4	0.11	0.09	0.12	0.07	0.08	0.08	0.05
N- NO_3	0.98	0.29	0.57	0.73	1.08	0.80	0.90
PO_4	0.08	0.16	0.03	0.03	0.09	0.03	0.02
K	0.60	0.56	0.40	0.70	0.73	0.66	0.64
Cl	3.5	6.1	3.0	7.9	8.5	7.4	7.9
SO_4	13.6	13.2	10.8	11.6	13.7	12.1	15.0
	Average from the 1970s [6, 7]						
N- NH_4	0.21	—	—	0.51	0.91	0.47	0.29
N- NO_3	1.09	—	—	1.15	0.89	0.78	—
PO_4	0.09	—	—	0.01	0.21	0.06	0.08
K	1.02	—	—	2.0	3.0	2.7	—
Cl	3.1	—	—	9.0	11.0	10.0	13.0
SO_4	19.1	—	—	25.0	25.0	27.0	31.0

were insignificant. Arable land figures have slightly dipped (from 33.1 to 31.5%), and grasslands have increased. In the case of meadows it rose from 7.8 to 8.5%, and pasture from 7.2 to 7.5%. However, the forest area has not changed at all. The significant changes in land use were not observed until the middle of 1990s. As a result the area of arable land, in relation to 1980, has plummeted from 33.1 to 18.0%, and pastures figures have gone down from 7.5 to 5.5%. But the area of the meadows has soared from 7.8 to 20.0%. There was an increase in the rural area development and wastelands which resulted from the abandonment in agriculture use [8]. Within agricultural land (Fig. 1) the highest fall occurred in case of arable lands and stood at about 46%, in the period of 1980–2004. The first gradual changes have begun already in the beginning of 1990s, and their intensification culminated after year 2000. At that time the mainly area of meadows has increased by 53%. By taking into consideration all categories of land use, the value of W indicators in some cases has decreased by the end of the 1990s in order to increase at the beginning of 21 century. In the case of agro-forest indicators, their levels have decreased down successively to the present state (Fig. 2).

Agro-forest index (W_{rf}) has been characterised by the constant lowering of its value, through continuous expansion of grass-forest area in the mountains. The significant increase of W index after the year 2002 has not caused re-

Discussion of results

In the past years the significant structural transformations took place in the Upper Dunajec basin. The area of arable lands has decreased in favour of grasslands, mainly meadows. The area allocated for residential built up and for linear-technical infrastructure has also increased. Therefore, the changes in agro-forest land use structure are favourable for the water environment, while a dynamic urban development and an increase in tourist traffic numbers /leisure activities/ are deteriorating the quality of the environment [9]. The relationship between the fall of W index and lowered concentrations of pollutants in surface waters has been observed. An increase in the built up is indirectly contributing in the reduction of agricultural pollution in favour of localized contaminations, particularly of municipal character [10].

Hence, the water quality deterioration is only reported locally, whereas on the basin scale an improvement has been observed. One of the reasons is a greater and greater number of towns and communes, have regulated wastewater and waste management processes.

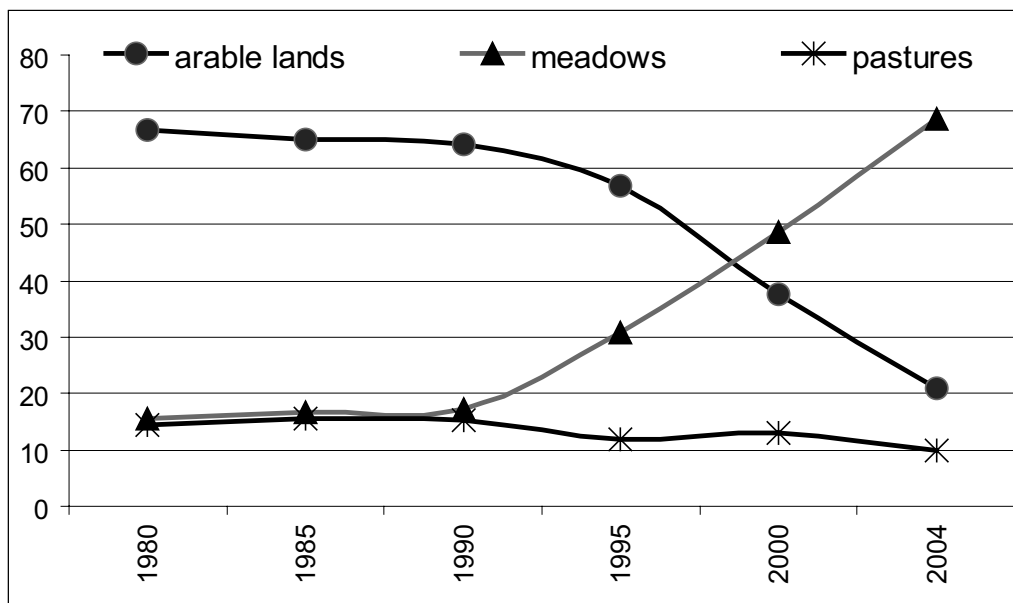


Fig. 1. The changes in land use of agriculture lands [%] in the Upper Dunajec basin (years 1980 – 2004).

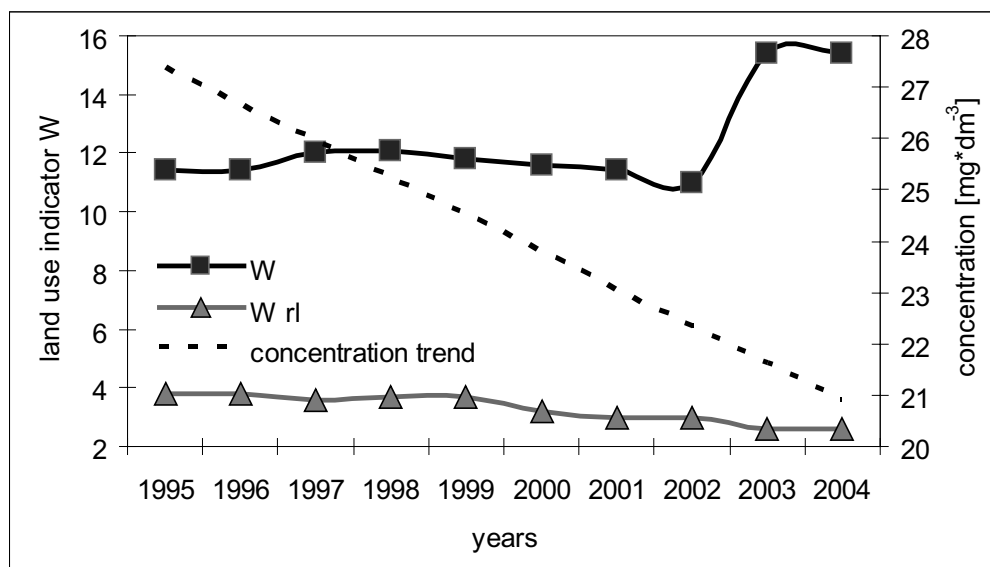


Fig. 2. The variability of the total average concentrations (Σ - N-NH₄, N-NO₃, PO₄, K, Cl, SO₄) and W indicators in the Upper Dunajec basin (years 1995 – 2004)

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The Seasonal Changes of Surface Water Quality in the Tourist Areas of the Podhale (the Western Carpathians)

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Abstract

The changes in concentration levels associated with presence of N-NH₄, N-NO₃ and PO₄ were analysed in waters of Bialy and Czarny Dunajec Rivers in the period of 2001-2003, at two months intervals. In the Bialy Dunajec River an average concentration of N-NH₄ have reached 0.40 [mg·dm⁻³] and in latter one the amount of N-NH₄ substance arrived at 0.08 mg·dm⁻³. The similar differences were reported in the case of PO₄ and their concentrations have been measured at 0.35 and 0.04 mg·dm⁻³ respectively. In view of N-NO₃ the variations were much lower (1.38 and 1.09 mg·dm⁻³) respectively. The high difference of concentration levels, particularly of N-NH₄ and PO₄ in above-mentioned rivers might be a result of intensive anthropopressure caused by an influx of tourists to the area of Bialy Dunajec basin.

Keywords: Nitrate Nitrogen, Ammonium Nitrogen, Phosphate, water quality classes

Introduction

The chemical composition of surface waters depends on a geological structure as well as on land use [1, 2]. In the case of chemical substance contents, which have biogenic character (nitrogen and phosphorus compounds); the main factor is an intensity of anthropopressure, and for the most part, the emission level of atmospheric, liquid and solid wastes from an urban region [3, 4]. Particularly bothersome are untreated wastewaters, which are dumped to the natural streams, especially in an attractive tourist basin of the Bialy Dunajec River (BDR) [5]. Solving environmental problems in that region is more difficult than many people believe because of infrastructure adjustment that protects natural environment for permanent residents. Furthermore an even greater number of tourists and holidaymakers arrive there for holidays each year. Population density in the studied area has reached relatively high level. The administrative units in Bialy Dunajec basin make up 330 inhabitants per km², 188 inhabitants per km² in Bialy Dunajec, and 125 inhabitants per km² in Poronin. At Czarny Dunajec commune population was considerably lower (95 inhabitants per km²) due to an agricultural and rural character [6]. In the area of Bialy Dunajec basin the number of holidaymakers during the tourist season may constitute about 40% of the permanent inhabitants [6].

The purpose of this study was to assess and investigate between years 2001–2003, the concentration dynamic of selected chemical substances in Bialy and Czarny Dunajec Rivers– (BDR, CDR). Special attention was paid to the differences in content of biogenic substances in the areas where escalating tourism has been prevalent and where holidaymakers didn't arrive frequently.

Experimental procedures

The changes of the concentrations of soluble substances, which have biogenic character, were investigated in the waters of the Bialy and Czarny Dunajec, based on the laboratory analyses conducted at the 2 month intervals, beginning January 2001.

The Regional Inspectorate of Environmental Protection Agency in Nowy Sącz made the results of water analyses available, and samples were taken from the Bialy Dunajec River (at Poronin 17.7 km of river course) and from the Czarny Dunajec River at Ludzmierz (205.0 km). In the collected samples of water, the concentrations of N-NO₃, N-NH₄, and PO₄ were determined, according to the methodology at the Environmental Monitoring Protecting Agency. The mean of measured data had been well documented for the particular months and years.

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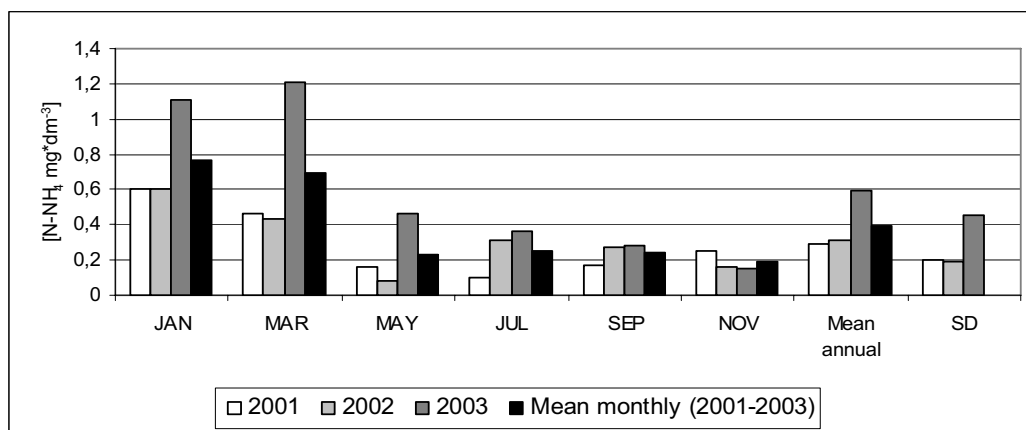


Fig. 1. The concentrations of N-NH₄ (monthly, mean monthly, and annual means) in waters of Biały Dunajec in the period of 2001-2003 as well the standard deviation values (\pm SD) [mg·dm⁻³].

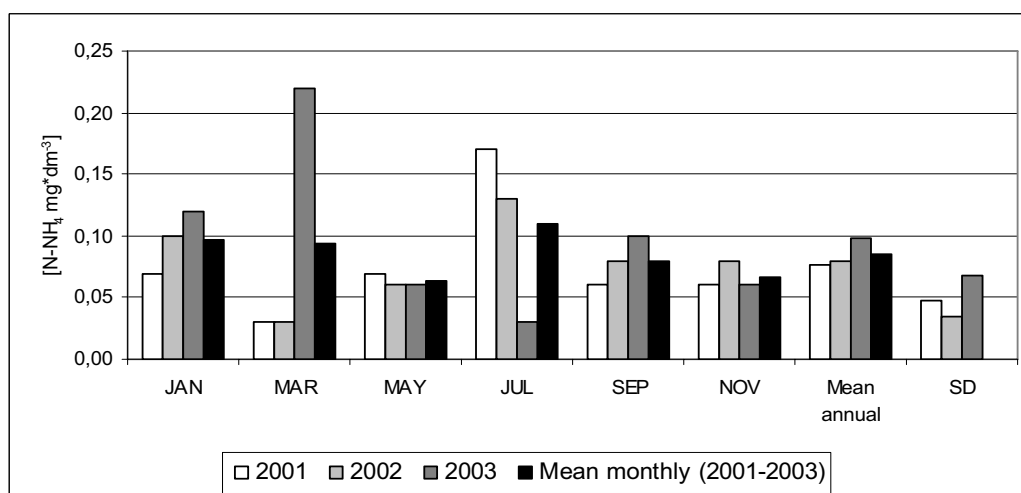


Fig. 2. The concentrations of N-NH₄ (monthly, mean monthly, and annual means) in waters of Czarny Dunajec in the period of 2001-2003 as well the standard deviation values (\pm SD) [mg·dm⁻³].

Results

The concentrations of chemical substances showed considerable differences in outflowing waters from the area under discussion. The highest concentrations of N-NH₄ and PO₄ were detected in the Biały Dunajec River and had been significantly lower in the Czarny Dunajec River. In the Biały Dunajec River the highest contents of N-NH₄ were in the winter period namely in January, March and contained 0.77 and 0.70 mg·dm⁻³ respectively (Fig. 1). But these readings fell lower in November and May (to 0.19 and 0.23 mg·dm⁻³).

In the Czarny Dunajec River data showed several times lower concentrations of N-NH₄ component, which hasn't exceeded 0.10 mg·dm⁻³ level in January. Thus differences were there considerably lower (Fig. 2). The highest average annual concentration of N-NH₄ recorded in waters had occurred in 2003 (BDR – 0.60, and CDR – 0.10 mg N-NH₄·dm⁻³), whereas the lowest values were monitored in 2001 (0.29 and 0.08 mg N-NH₄·dm⁻³ respectively).

The higher concentrations of N-NO₃ were also reported in January and in March, which at the Biały Dunajec River had level 2.0, at the Czarny Dunajec River reached 1.4 mg·dm⁻³ level (Figs. 3, 4). In month of May pollutants reached the lowest level – 0.92 and 0.74 [mg·dm⁻³] respectively. The highest values of the average annual concentrations of N-NO₃ were recorded in 2003 (BDR – 1.68 and CDR – 1.09 mg·dm⁻³). The Biały Dunajec River indicated the highest difference of phosphate concentrations, whereas the average annual values varied in the range between 0.27–0.58 mg·dm⁻³ of PO₄, but in the Czarny Dunajec River they were over eight-fold lower (Figs. 5, 6). In the Biały Dunajec River the low concentrations of PO₄ (from 0.25 to 0.27 mg·dm⁻³) were reported in the months of: May, Sep and Nov. However evaluated data greatly increased in: Jan, Mar and July (from 0.34 to 0.58 mg PO₄·dm⁻³). In the Czarny Dunajec River differences of the average concentrations in the water quality between particular months were not significant and had been in the range of 0.04–0.05 mg PO₄·dm⁻³. In waters of the Biały

Dunajec River an annual increase of average concentrations of the above component have been observed from 0.22 in 2001 yr, to 0.47 mg $\text{PO}_4 \cdot \text{dm}^{-3}$ (level in 2003 yr), but in the Czarny Dunajec River the concentration quantities had been equalized and were maintained in the analysed period at almost unchanged level.

Discussion of results

The analyses of investigated components in the waters of the Biały and Czarny Dunajec Rivers showed their considerable difference between particular sampling points as well as the collecting periods of research material. It refers specifically to the Biały Dunajec River, which flows through tourist areas of the Dunajec basin. Much higher concentration of analysed components in the Biały Dunajec River resulted, probably from the larger population as well as from a considerable number of tourists and persons, who are seasonally staying for holidays. It concerns particularly the winter months (Jan and Mar), as well as summer (Jul). In May and from September till November, i.e. in the

months characterised by an insignificant tourist movement, these concentrations reached lower values. Thus conclusion can be drawn, that man-made pollutants discharged into rivers by permanent residents generate much higher concentration level. Therefore, average concentration of PO_4 in July was about 1/3 higher than in May. The waters of the Czarny Dunajec River, which are flowing through the areas with minimal tourist traffic, were characterised by better quality, and the concentrations of PO_4 in relation to the Biały Dunajec River were clearly lower several times. The concentration of investigated components was inversely proportional to the precipitation amounts in studied years. According to the river quality classification standards lawfully valid in Poland, mean that the cleanest waters occurs in the Czarny Dunajec River, and belong to the 1st and 2nd quality class. In the Biały Dunajec River, considering the content of PO_4 it can be categorised in the 2nd and 3rd class, and the remaining components most frequently in the 2nd class of river quality.

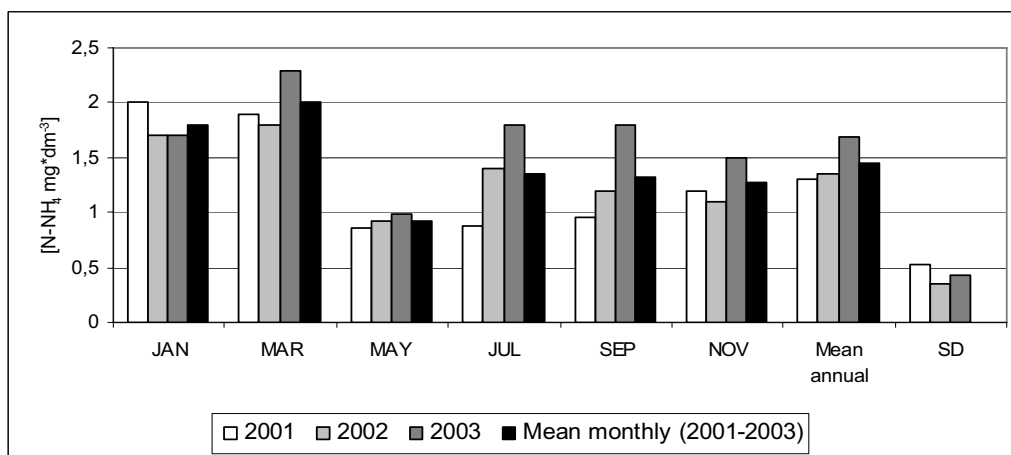


Fig. 3. The concentrations of N- NO_3 (monthly, mean monthly, and annual means) in waters of Biały Dunajec in the period of 2001-2003 as well the standard deviation values (\pm SD) [$\text{mg} \cdot \text{dm}^{-3}$].

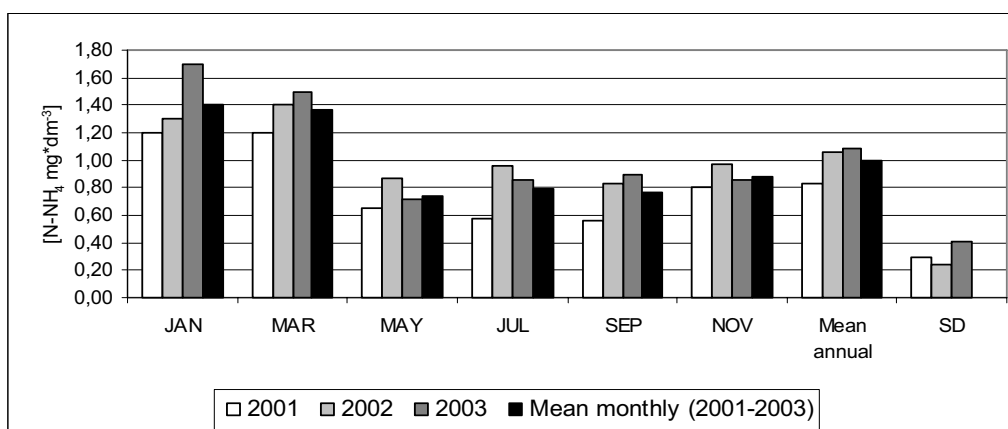


Fig. 4. The concentrations of N- NO_3 (monthly, mean monthly, and annual means) in waters of Czarny Dunajec in the period of 2001-2003 as well the standard deviation values (\pm SD) [$\text{mg} \cdot \text{dm}^{-3}$].

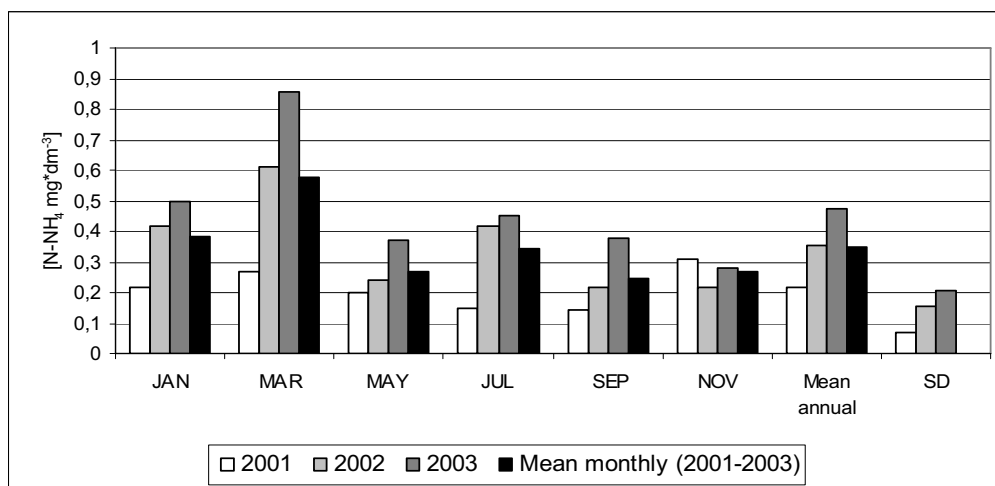


Fig. 5. The concentrations of PO_4 (monthly, mean monthly, and annual means) in waters of Biały Dunajec in the period of 2001-2003 as well the standard deviation values ($\pm\text{SD}$) [$\text{mg}\cdot\text{dm}^{-3}$].

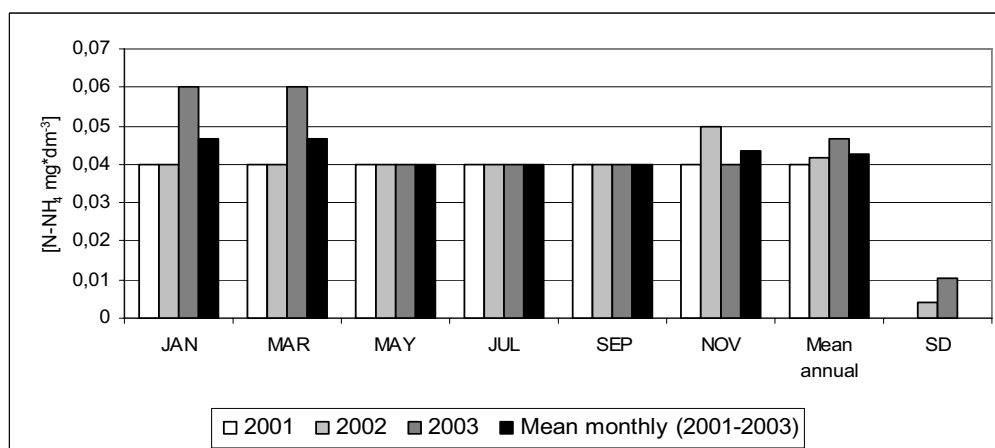


Fig. 6. The concentrations of PO_4 (monthly, mean monthly, and annual means) in waters of Czarny Dunajec in the period of 2001-2003 as well the standard deviation values ($\pm\text{SD}$) [$\text{mg}\cdot\text{dm}^{-3}$].

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Sanitas per Aquam – A Symbol of Luxury or a Chance for Health Resorts of the Beskid Sądecki Mts.?

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Abstract

In the Beskid Sądecki Mts. the 5 statutory health resorts exist: Krynica, Muszyna, Żegiestów, Szczawnica and Piwniczna [1]. All of them have a centuries-long tradition of hydrotherapy due to rich mineral water resources, which, together with scenic landscape and specific microclimate provide exceptional opportunities for health restoration, recovery of physical strength, convalescence of disabled, etc. The Polish health resorts are in deep crisis after cessation of state funding of sanatorium treatments by the National Health Fund [2]. The chance for the resorts may provide the upgrade of former state-owned sanatoriums in to high-standard SPA centres and expected changes in legislation.

Keywords: health resorts, Beskid Sądecki, SPA

Introduction

The tourism market is an extremely dynamic branch of recent global economy. Development of new, quality products aims to meet the changing demands of still growing number of tourists. As revealed by the WTO report, the number of tourists will increase by 5–6% per year, which will result in 800 millions of travels per year [3]. Since 1998 in Poland a gradual decrease in number of domestic tourists has been observed in the health resorts together with slowly increasing number of foreign visitors. Recently, only 2% of foreign tourists visiting Poland declare the health treatment as a purpose of arrival [4]. In 2005 these tourists spent only about 211 USD per capita for health services. This group is dominated by Germans and citizens of other EU countries. The largest increase (15–30%) was observed in the number of tourists from Canada, Australia, Great Britain, Japan and Greece. These customers are looking for comfortable offer combine a health service with care of appearance [5].

SPA – Sanitas Per Aquam

The SPA (translate as health through waters) is a revitalizing, refreshing and invigorating therapy, popular espe-

cially in the Southern Europe. This kind of service could be a chance for the Polish health resorts. In 2006 on the Beskid Sądecki area was made a research in popular SPA centres: Geovita, Klimek and Dr Irena Eris, about profile of customers. The most frequency group of customer was people “age 30–50”. Decidedly most of them (85%) were women. In all of the centres the clients have got a higher education and they belong to the prosperous people. But for the last two years the more frequency appeared customers from the middle class. Be rooted in execute in offer cheaper packet e.g. SPA-weekend, which cost is among 150 to 300 Euro, this kind of product is more popular, especially for Polish customers from Mazowieckie, Łódzkie, Śląskie and Pomorskie regions. Very popular are also 10 and 14– days packet, they price is higher about 900 Euro, especially in foreign tourists from: Ukraine, North America, German or even France. They buy a beauty treatment on face and body, making revitalizing, refreshing and invigorating therapy in special capsules and use luxury apparatus and cosmetics. For all of the SPA centres in Beskid Sądecki Mts. very imported are the tradition with water-therapy and mineral waters wealthy. For the visitors in this region significance fact is exists of The Poprad River Landscape Park and specific microclimate. On the questions: was the changes profitable? and was observed the growth of sell product? The answers were: DEFINITLY YES in all centres. One of luxury SPA – centre, noted in 2006 growth by 225% of sell.

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Conclusion

The upgrade of former state-owned sanatoriums into high-standard SPA centres, acceptable for the new group of visitors requires significant investments including the strategic investors and the bank credits as well as the new legislation. All these changes may bring the economic and social success and prosperity to the region of long therapeutic traditions. The crucial factor is the implementation of sustainable development principles accepted by the local communities and the resulting, proper utilization of natural resources [6].

Acknowledgements

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The Role of Water Reservoirs in Historical Cities – the Possibilities of Eco–Tourism. The Case Study in the Cracow Region

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Abstract

The paper presents the role of water reservoirs in historical cities such as Cracow. Water bodies increase the attractiveness of the area by improving the landscape and increasing the biodiversity of the area, which can make these places interesting for eco–tourists. Especially interesting from environmental point of view are different bird and amphibian species. Questionnaire studies were presented.

Keywords: water bodies, eco–tourism, questionnaire, recreation

Introduction

Tourist visiting various regions appreciate different values of these regions. The most important features tourist pay attention to are: scenery, possibility of recreation, cultural monuments and natural beauty. Very often it is the combination of all these values. Taking care about nature does not exclude taking care about human–made elements. On the contrary: threats to nature (such as are usually pollution and uncontrolled development of transport and land use) make also threats to cultural heritage of the area. On the other hand there is a tendency to separate the issues of nature and wildlife from the issues of historical monuments. Most people either do not expect any wildlife in urban environment, including historic cities or think that even if there are any elements of flora or fauna they are not worth attention, because they cannot compete with other tourist attractions. This traditional approach can be changed if some facts are better presented. It has been well known among ecologists that many organisms chose urban environment as their habitats. The main reasons are: better access to food, smaller number of predators, better shelters and higher temperature in winter. Information about urban fauna can make an interesting supplementation of standard tourist information. For instance in the Forum Romanum (Rome), apart from information on ancient monuments

a table with the names and pictures of species (birds and reptiles) that could be found in Rome were put (personal observation of the author on 10th May 2005).

The goal of this paper was to present the role of plant and animal species in increasing the attractiveness of a historical city of Cracow. The particular focus was on water bodies as places significantly increasing biodiversity of the area and the attractiveness of the landscape [1, 2]. Water bodies, increase the attractiveness of the area by improving the landscape and increasing the biodiversity of the area, which can make these places interesting for eco–tourists. Especially interesting from environmental point of view are different bird species. The need for the protection of birds was expressed in the programme Nature 2000 as well in the European Bird Directive [3]. Another important group of animals are amphibians and reptiles, because they have decreased in number over the last decades. All the amphibians and reptiles are protected by law in Poland.

Study Area and Methods

The water bodies include the Vistula River situated below the Wawel Hill with the Royal Castle and Cathedral. The River makes the area attractive for waterfowl, especially in winter. There are also other water bodies situated near the city centre, among which the most important are

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the pond in Dąbie made after the exploitation of clay (the only in Cracow site of the yellow water lily (*Nuphar luteum*) [1,4] and the ponds in Płaszów (Staw Płaszowski and Bagry) made after the exploitation of gravel.

Methods included personal observations, interviews and a questionnaires made among the visitors of the water bodies in Cracow. The questionnaire referred to the visitors to water bodies of Dąbie and Bagry in Cracow. Visitors were asked if they had seen any interesting plants or animals, the activities they perform and their proposal of improvements.

area. Visitors of Dąbie are also much less interested in the presence of rescuers, police or city guards. This is because the pond is officially not available for swimming. Some visitors, however, violate this regulation.

The author's observations, questionnaires and literature data show the presence of several bird species in Dąbie (mallard *Anas platyrhynchos*, tufted duck – *Aythya fuligula*, pochard – *Aythya ferina*, coot *Fulica atra*, wood sandpiper – *Tringa glareola*, little ringed plover – *Charadrius dubius*, common tern – *Sterna hirundo*, common kingfisher – *Alcedo atthis*, mute swan – *Cygnus olor*) and Bagry (great

Table 1. The results of the questionnaire referring to the water ponds in Cracow.

No.	Question	Visitors of Bagry		Visitors of Dąbie		Statistical significance
		58 respondents		65 respondents		
		number	%	number	%	
1.	Way of recreation					
a)	a) bathing	46	79.3	43	66.2	not significant
a.	b) angling	9	15.5	8	12.3	not significant
a)	c) sun-bathing	43	74.1	47	72.3	not significant
a)	d) sailing or rowing	4	6.9	2	3.1	not significant
a)	e) motorboat	1	1.7	1	1.5	not significant
a)	f) other	10	17.2	11	16.9	not significant
2.	Have you seen any animals in the area?	number	%	number	%	
	YES	46	79.3	55	84.6	not significant
	NO	12	20.7	10	15.4	
3.	Have you seen any interesting plants in the area?	number	%	number	%	
	YES	29	50.0	45	69.2	$\chi^2 = 4.73, p < 0.05$
	NO	29	50.0	20	30.8	
4.	Proposed improvements	number	%	number	%	
	a) more dustbins	32	55.2	44	67.7	not significant
	b) sanitary facilities	28	48.3	34	52.3	not significant
	c) selling food	26	44.8	16	24.6	$\chi^2 = 5.57, p < 0.02$
	d) hiring sports equipment	16	27.6	14	21.5	not significant
	e) more rescuers	20	34.5	11	16.9	$\chi^2 = 5.01, p < 0.05$
	f) more police or city guards	15	25.9	5	7.7	$\chi^2 = 7.43, p < 0.01$
	g) more trees	4	6.9	2	3.1	not significant
	h) more car parks	8	13.8	0	0	$\chi^2 = 9.59, p < 0.01$
	i) other	10	17.2	24	36.9	$\chi^2 = 5.93, p < 0.02$

Results and Discussion

The results of the questionnaire are put in Table 1. Statistically important were the following differences: more visitors of Dąbie than Bagry paid attention to interesting plants, which is understandable, because of the presence of yellow water lilies in Dąbie. Visitors of Bagry were more interested in places selling food and car parks. In Dąbie these facilities are available because of the presence of the Commercial and Entertainment Centre "Plaza". On the other hand more visitors of Dąbie mention "other" improvements. In this category are critical opinions about the Centre understood as place spoiling the character of the

crested grebe – *Podiceps cristatus*, little grebe – *Tachybaptus ruficollis*, coot, great cormorant – *Phalacrocorax carbo*, mallard – *Anas platyrhynchos*, tufted duck, pochard, greylag goose – *Anser anser*, mute swan, loon (*Gavia* sp.), black headed gull – *Larus ridibundus*, swallows and martins – *Hirundinidae*). There are also amphibian species such as common frog (*Rana temporaria*) and green frogs (*Rana esculenta* complex). Reptiles are represented by grass snake – *Natrix natrix*. Visitors were aware of the richness of biodiversity, however they often unable to name the species.

Acknowledgements

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Cracow as a Balneotherapeutic Centre

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Abstract

Cracow, as a cultural and scientific centre of the Cracow Metropolitan Area, has balneotherapeutic merits, which predispose it to be a centre of such therapy. Cracow is situated in a region, which has numerous kinds of natural balneological resources. Those resources have been used in therapeutic and preventive treatment for a long time. It has a special meaning nowadays, when improvement of environmental condition has not a reflection in improvement of physical condition of the society. This state is connected with a fast rate of developing and increasing of the civilizing hazards. In such a situation a therapeutic treatment in the health resorts is of a considerable importance within the health system as it combines the function of prophylaxis, treatment and rehabilitation.

Keywords: Balneotherapeutic Centre, rehabilitation, Cracow

Introduction

Research project, which was to help create Cracow as the Balneotherapeutic Centre, was accomplished in 2002 at the Mineral and Energy Economy Research Institute in Polish Academy of Science. The effect of this project was a publication entitled “The complex utilization and protection of balneological resources in the region of Cracow – a model study”. Four years passed and none of the activities were put into practice. On this account the authors would like to present the idea of Cracow and its environs development as the Balneotherapeutic Centre.

The circumstances which force to broaden the existing therapy offers are: fast civilizing development, and connected with it increase of civilization-related diseases among younger population and also greater interest of society in good physical and psychical form. Development of active tourism and increasing of ecological consciousness among society has created a new type of recipient of balneotherapeutic services. A demand for easily accessible balneotherapeutic products and services has increased. Positive aspect of this increase is to indicate the chances of development of these kinds of balneotherapeutic service in places, which do not fulfil requirements of classical health resort, but can offer its inhabitants various types of balneological resources.

Cracow is situated in a region, which has great natural and spatial values, abundant in historical monuments

of international rank. It is a metropolis with secular scientific, cultural and balneotherapeutic traditions. Within its precincts and in its nearest surroundings there are mineral and therapeutic waters, acratopegae and mining aerosols. In connection with that Cracow stands a perfect chance of becoming the Balneotherapeutic Centre for the Southern Poland [1]. Not without the reason, the monument of doctor Jozef Dietl – “Father of Polish balneology” stands in front of the City Council Hall.

Utilization of Balneological Resources of Cracow and Its Environs

Cracow owns the resources of various mineral waters and acratopegae. The most valuable mineral waters are found in Mateczny and Swoszowice (Table 1.), and acratopegae – in Cracow springs (“Nadzieja”, “Krolewski”, “Lajkonik”, “Jagiellonski” and “Dobry Pasterz”) [2]. Mineral waters are utilized for balneological treatments also in Krzeszowice, the town situated about 30 km west of Cracow. In Wieliczka and Bochnia there are mining aerosols, which are utilized in the treatment of allergies and bronchial asthma, especially in the paediatric patients [3]. Moreover, Cracow, as a capital of voivodship and the Cracow Metropolitan Area, is an emerging base to other health resorts located in the South of the voivodship (Fig. 1) which complement the treatment and prophylactic offer.

In Swoszowice, on the basis of mineral water, a health resort functions started its activity in the 14th century. The best time of its prosperity occurred in the 19th century. The

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Table 1. Physico-chemical analyses of mineral waters from Swoszowice, Mateczny, Krzeszowice and Cracow springs [mg/dm³] [3].

	Swoszowice		Mateczny		Krzeszowice	Cracow springs				
	Glowne spring	Napoleon spring	Drill-hole M-4	Drill-hole M-3	Glowny spring	Nadzieja spring	Krolewski spring	Jagiellonski spring	Dobry Pasterz spring	Lajkonik spring
Date	1996	1996	1996	1996	1999	1997	1997	1977	1977	1997
Temp. °C	10.2	10.1	11.0	10.7		15.0	11.5	12.5	11.7	14.0
pH	6.7	6.8	7.3	7.3	7.0	7.6	7.6	8.2	7.9	7.6
H ₂ S	62.8	61.1	2.2	1.27	4.1	0.2	0.2	0.76	0.3	0.51
TDS	2635.0	2552.9	2845.1	3583.7	2953.7	810.0	853.0	1000.0	1280.0	1000.0
Na ⁺	46.8	72.3	462.0	526.0	32.6	72.5	60.6	240.4	204.7	159.4
K ⁺	8.5	8.9	16.0	23.3	14.0	4.0	1.7	8.8	9.4	7.9
Li ⁺	0.09	0.09	0.11	0.13	0.07	0.03	0.05	0.09	0.07	0.09
NH ₄ ⁺	1.0	1.2	2.3	3.1						
Ca ²⁺	547.0	497.0	238.5	312.7	614.5	69.0	79.3	20.9	48.3	53.1
Mg ²⁺	92.0	97.3	129.8	189.0	20.0	60.5	72.1	27.5	37.8	57.6
Sr ²⁺	6.0	4.2	4.6	5.0	13.8	2.4	3.4	0.7	1.3	1.6
Fe ²⁺	0.01	0.01	0.26	1.13	0.53	4.60	4.40	0.30	7.70	0.70
Mn ²⁺	0.25	0.26	0.02	0.03						
F ⁻	0.58	0.61	0.68	0.87	1.50					
Cl ⁻	62.1	62.1	425.5	514.1	15.5	69.4	68.1	91.2	23.8	91.2
SO ₄ ²⁻	1277.8	1247.8	1212.8	1673.1	1645.0	199.3	255.9	352.0	338.8	347.1
HCO ₃ ⁻	564.4	533.9	335.6	314.3	488.8	317.2	299.0	244.0	402.6	269.6
NO ₃ ⁻	0.08	0.22	0.08	0.22						
Br					0.5					
J					0.01					
H ₂ SiO ₃	26.6	25.3	11.6	14.2						
HBO ₂	1.5	1.8	3.9	5.1						
SiO ₂						8.9	8.3	8.5	8.8	8.4

health resort has two mineral water intakes “Glowne Spring” and “Napoleon”. At present water from “Glowne Spring” (Table 1.) is used for treatment of: rheumatic diseases, locomotor system injuries, metabolism, food poisonings and dermatitis. The natural therapy centre is located in an old building of baths, and the physiotherapeutic treatments are performed in a modernized pavilion “Parkowa”. The health resort provides treatments in a traditional inpatient (sanatorium) setting as well as an outpatient setting. Annually, 21,600 outpatient treatments and 3,700 sanatoriums are carried out. The values of natural therapy are not fully utilized because of negligence towards modernization and development of Natural Therapy Centre and balneological and recreational back-up facilities. The investments, which were started at the end of 20th century, progress very slowly, mainly because of the lack of funds. Meanwhile the health resort, which has such a great potential of therapeutic values and long balneological tradition, should provide therapeutic and prophylactic services not only for its inhabitants, but also for native and foreign tourists, who visit Cracow.

In Mateczny, almost in the centre of Cracow, until 2000, there was an outpatient health resort. In 2003 it was taken over by IPR Polska Ltd., and in 2005 – by Relax Care Company. On the basis of two mineral water intakes (Table 1) the new health resort provides beauty, cosmetic and rehabilitation services. Old balneological installations were replaced by modern equipment, the building was redecorated and modernized, and the park, which surrounds the building, was rearranged. Before the privatisation of Mateczny, mineral water (“Krakowianka”) was bottled there.

In Krzeszowice there is a well-known centre of mineral water occurrence and its utilization (Table 1). Intake “Glowny Spring” became accessible for therapeutic needs in 1779. This date is the beginning of the foundation of a health resort in Krzeszowice. Therapeutic activity was provided up to the outbreak of World War II, and later in the 1960’s, when local water was used for balneological needs of one of Polish coal mine. But unfortunately, this health resort was not so popular as in 19th century. The Motor Organs Rehabilitation Centre Krzeszowice Ltd., which provides inpatient and outpatient treatment at local range, was created in 2000.

The oldest salt mines – Wieliczka and Bochnia, lead a therapeutic activity on the basis of mining aerosols. Wieliczka Mine has a health resort status and its activity has sanatorium and outpatients functions. Salt Mine Bochnia Health Resort Ltd. provides recreational and therapeutic as well as rehabilitation and cosmetic treatments. Previously, brine used to be utilized in mines but this activity was discontinued in favour of subterranean therapy.

Possibilities of Creation the Balneotherapeutic Centre in Cracow

Cracow as the capital of Malopolskie voivodship and Cracow Metropolitan Area is an important communication junction of the Southern Poland. Cracow is known as a big cultural centre with magnificent monuments of art and architecture and as one of the oldest scientific centre with

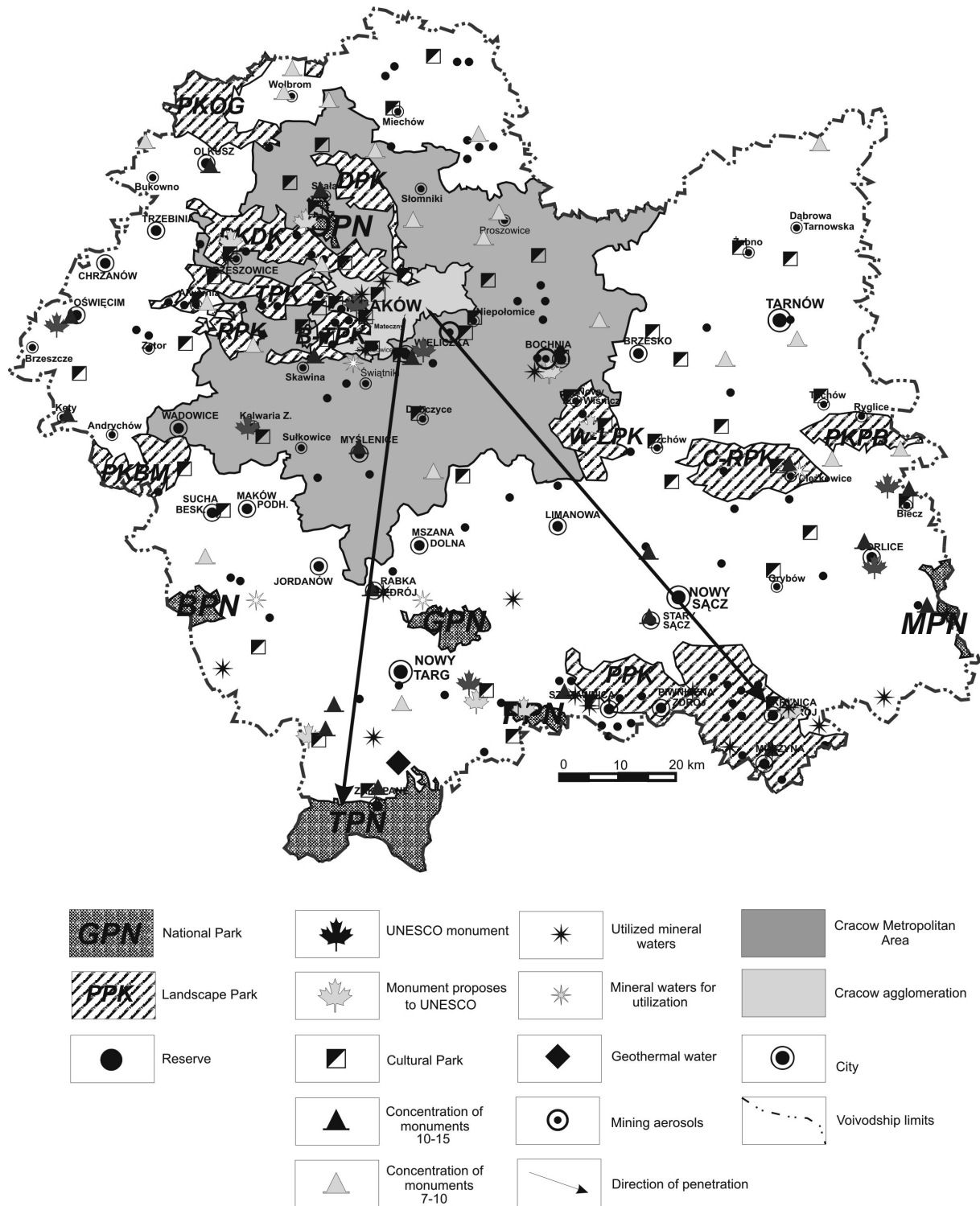


Fig.1 Cracow as a Balneotherapeutic Centre.

wide experience. Its localization in the Cracow–Czestochowa Upland makes the numerous tourists from Poland and abroad visit this place [3]. The rich tourist offers could be widened by balneological services. The basis of this activity could be balneological resources, existing balneological infrastructure, secular tradition of existing health resorts and scientific and medical back-up facilities. Cracow offers accommodation with the different standards and para-tourist back-up facilities.

The privatisation of the health resorts and therapeutic centres promotes their transformation into medical and recreational complexes of different standards, which besides

rehabilitation, offer prophylactic treatment and complex regeneration (for example Mieczyslaw, Bochnia). The health resorts in Swoszowice, Wieliczka and Krzeszowice, which are situated in the periphery of Cracow, require modernization work of an accommodation and balneological infrastructure. An accommodation should be provided in form of the pensions and private lodgings, in which all tourist's family can stay, while the inhabitants of agglomeration can take advantage of the outpatient services. It is necessary to take care of balneological resources, which have to be protected by complex utilization. Complex utilization should consist of complementing offers by particular therapeutic

and recreational centres [4]. For that purpose, health resorts should collaborate on the basis of “healthy competition” rules. It is necessary to start the special municipal transport services lines, which will facilitate the access to therapeutic centres. The advertising and promotion for these centres are indispensable in tourist information points. They should inform about range of their services, prices and para-tourist provisions. For the suitable level of services, it is necessary to use the new methods and therapeutic profiles, for example: parodontosis, geriatrics and not only from balneological range but also in related spheres.

In Cracow, points of acratopegae water scoop are available to inhabitants (Fig. 1). Healthy features of this water should be publicized and number of intakes should increase by re-opening the idle drill-holes [3]. Bottling of mineral water from Mateczny should be renewed, because of its unique therapeutic properties (Table 1). Moreover, mineral water from existing but not available intakes should be utilized, after re-examination of its values from the point of view of chemical constitution and balneological usability [3]. Those examinations could increase a range of services and their attractiveness.

Conclusions

Balneological resources of Cracow and its environs in connection with monuments, landscape and its natural variety decide about high tourist attractiveness of the region and form the possibility to create the Balneotherapeutic Centre in Cracow. All analysis of balneological resources utilization and therapeutic infrastructure point out their predisposition to perform functions based on:

- considerable and not fully utilized mineral water resources and mining aerosols, position in radius of meaningful health resorts (Rabka, Krynica, Szczawnica);

- extra-balneological infrastructure;
- convenient location of the transport facilities and tourist attractive regions (the Cracow–Czestochowa Upland, the Beskid Mts., the Pieniny Mts., the Tatras);
- high level landscape and natural values (protected by law regions);
- numerous art and architecture monuments (include monuments from the World Heritage list);
- scientific and medical back-up facilities and balneological traditions.

To create the Balneolotherapeutic Centre it is necessary to carry out: modernization of a therapeutic infrastructure, renovation of the monumental health resort buildings (in Swoszowice, Wieliczka, Krzeszowice); development of an accommodation and para-tourist base; broadening of the therapeutic and regenerative services (new methods and therapeutic profiles); advertising and promotion.

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Sustainable Development of Urban Drainage Systems

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Abstract

Conventional pipe and curb systems, with their efficient ability to convey runoff rapidly to receiving waters, do not take into consideration these effects and new approaches have been developed in recent years to address these concerns. Control and management near the source is now being promoted intensively and it is viewed in many countries as comprising an appropriate suite of techniques facilitating the similarity of natural processes and minimizing the hydrologic impacts. The paper presents a case studies of Augustenborg (Malmoe) in which a successful combination of BMPs is used in an open stormwater system to control inner-city flows.

Keywords: urban drainage, sustainable development, Best Management Practices

Introduction

The comprehensive approach to stormwater management is relatively new. Prior to the late 1960's the primary goal was to rapidly drain streets and to convey stormwater to the nearest natural waterway. This practice evolved into the use of detention when the municipal engineers began to recognize that the cost of urban drainage systems became prohibitive as more and more of the watershed urbanized. Also, some began to recognize the destructive effects that uncontrolled urban drainage had on the stability of the receiving streams, reduced groundwater recharge and downstream flooding (Urbonas). Rising frequency of the flood, causing serious damage to property, required the immediate improving of the channels, their renovation or replacement. Currently, the designer and the planner have to think in terms of how to best manage stormwater runoff in order to limit damage to downstream properties, reduce stream erosion, limit the effects on the flora and fauna of the receiving streams and integrate stormwater systems into the landscape (Urbonas) In the new concepts the stormwater is regarded as a resource to be managed on a catchment scale and is stored, treated or reused locally, close to its point of generation.

Comprehensive and sustainable development of urban drainage system

The literature is full of terms such as “smart growth”, “low impact development”, “source control”, “water sensi-

tive urban design”, “sustainable development”, etc. All of these terms refer to a family of stormwater management practices that promote the reduction of runoff volume and pollution loads from urban areas, but the most popular term is Best Management Practices (BMP). BMP as applied to urban runoff management, is a term adopted to represent actions and practices that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner.

Sustainable approach to the stormwater management have the advantage of (Butler):

- a greater ability to attenuate flows and re-establish flow conditions similar to those prior to development,
- the pollutants remain distributed across the catchment rather than accumulating at single location,
- lower capital cost and, in many instances, maintenance costs,
- provision of aesthetically please landscaping features within urban catchment.

BMPs can be classified as structural and non-structural. It is beyond the scope of this paper to describe all structural BMPs that can be used to control the water-quality aspects of urban stormwater runoff but the selected ones are primary and represent the predominant removal mechanisms: bioretention, dry wells, infiltration trenches

Design of each type of structural BMPs require careful analysis of many factors according to general scheme showed on figure X. For existing built-up areas especially important is to fit the proper facility to the site conditions. Some BMPs constrains are difficult to meet in densely areas i.e.: minimal distance of infiltration trenches from build-

ings is recommended to 3m; minimal infiltration rate of soil for bioretention purpose is $2 \cdot 10^{-6}$ m/s, minimal longitudinal slope for swale is 1% etc.

The integration of these facilities into the landscape throughout the site offers more opportunities to mimic the natural hydrologic functions, and add aesthetic value. Small-distributed systems offers also a major technical advantage: one or more of the systems can fail without undermining the overall integrity of the site flow control.

For newly developed sites the possibilities to integrate of drainage facilities to the landscape and buildings is significantly easier than for existing sites. On the planning stage some quantity impacts can be reduced through minimal disturbance techniques that include the following:

- reduce paving and compaction of permeable soils,
- siting building layout, clearing and grading to avoid removal of existing trees,
- minimizing imperviousness by reducing the total area of paved surfaces,
- disconnecting as much impervious area as possible to reduce runoff,
- maintaining existing topography and associated drainage flow paths,
- if possible increase and lengthen flow paths, flatten site and lot slopes, maximize overland sheet flow and use of open swale systems
- minimizing the influence of the equipment construction and material storage areas during building phase.

The most effective way to maintain clean surface waters is to eliminate the sources of pollution, not to remove pollution once it has gotten into the system. Thus, non-structural BMPs include a variety of institutional and educational practices that result in behavioural changes, which reduce the amount of pollutants entering to the stormwater system (i.e. disconnect illicit wastewater connections, control accidental spills, and enforce violations of ordinances designed to water protection). Important part of non-structural activities is education of the public to modify behaviour that contributes to prevent pollutant deposition on urban landscapes and its uncontrolled transport to receiving waters. The changes in activities, behaviours and attitudes of people are very difficult to achieve and require sustained efforts on the part of those attempting to implement them [4]. The main advantage is that non-structural practices are less expensive than structural ones, although it's very hard to measure their efficiency.

Successful implementation of sustainable urban drainage concept – Augustenborg, Malmö

Augustenborg is a highly populated inner-city suburb in Malmö, it covers over 32 hectares and was built in the 1950s. The buildings are 3÷4 stories high, situated close together, as well as 1÷2 stories. There are about 1,900 apartments in the area, as well as various 1÷2 story industrial buildings. Stormwater from the area was originally drained via a combined sewer system (pipe diameters between 225 and 750mm). During heavy rainstorms, CSO and flooding in basements and garages occurred causing material damage and nuisance. In an effort to solve those problems, it

was proposed that Augustenborg be disconnected from the existing combined sewer and drained by means of an open stormwater system. The main intention was to reduce flooding by an ideal of 70% and eliminate combined sewer overflows completely by both lowering the total volume of stormwater reaching pipes and reducing the peak flows. Today the stormwater from half the area has been separated from the sewers and the water is taken into an open system instead. According to the plans all stormwater from Augustenborg should be separated from the sewer system and run into the open system instead. The open system was found to have three main tasks: reduction of runoff response, conservation of open space, and reduction of total runoff. The new drainage system consists of a complex arrangement of BMPs and has been operational since May 2001. Stormwater is now led through a complex arrangement of green-roofs, swales, shallow channels (400÷700 mm deep), ponds and small wetlands. The modelling research made by Villareal found that the system is likely to be able to handle runoff volumes locally for all the return periods (1, 2, 5 and 10 years) considered, as well as considerably attenuate peak flows. Results showed that the total annual runoff volume is reduced by about 20% compared to the conventional system.

The new approach used in the city of Malmö leads to more interaction among the different city departments – a policy was written for the concept of sustainable stormwater management. The policy's main objective is to obtain a common reference point and consensus among the city's departments on the concept of stormwater development. The policy document does not include precise design guidelines for technical solutions – practical questions are left to the engineers to solve. Two departments – Water and Wastewater and Park and City Environment – are the most involved in the implementation of the concept of sustainable urban drainage management. The experts from each department work together on water facilities at each stage – planning, design and financing. Successful implementation relies greatly on the recognition by all departments of the positive value of the new concept. For each facility, a discussion to determine how much of a facility is a park and how much of it is drainage helps determine the investment and maintenance costs.

The development of a typical sustainable stormwater project in the city of Malmö has the following steps (ACWWP):

- Common vision – must be actively and clearly developed by two or three departments.
- Physical planning – vision must be involved in the planning process.
- Consultation with additional partners (i.e. developers).
- Promotion – public outreach is important for project acceptance.
- Design – based on the multiple purposes defined in previous stages.
- Financing – costs are shared among the involved parties according to their benefits.
- Realization. Before construction, the maintenance responsibilities must be decided.

The experience of Malmö shows that the main difficulties due to sustainable development are not technical.

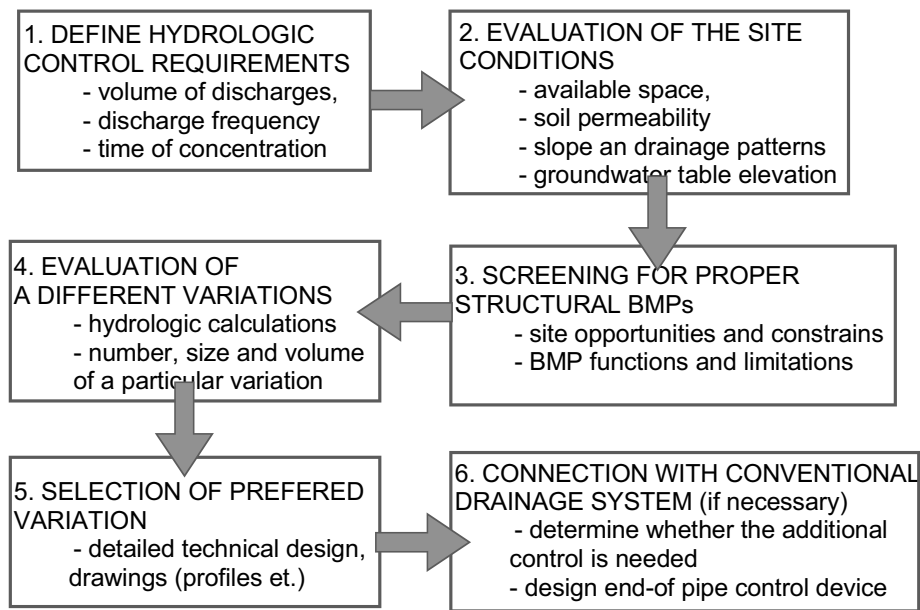


Fig. 1. Scheme of BMPs selection and design.



Fig. 2. Structural BMPs in Augustenborg: a) wet pond located between block of flats, b) dry retention basin located at quadrangle (Photos: M. Mrowiec).

The major problems arising in the implementation are more institutional and are focused on cooperation among different departments of the administration. It took several years to break the barriers among the departments to plan and implement jointly owned and operated water facilities. In addition, the new and difficult element in sustainable stormwater projects is the integrated approach where hydraulic criteria are combined with ecology, biology, and aesthetics considerations. (ACWWP).

Conclusions

Traditionally, most stormwater management has focused on large end-of-pipe systems and there has been a tendency to overlook the consideration of small catchment-scale solutions. In sustainable approach every urban landscape or infrastructure feature (roof, streets, parking, sidewalks, and green spaces) can be designed to be multifunctional,

incorporating detention, retention, infiltration, or runoff use. Best Management Practices applied to urban drainage systems offer flow control and pollution removal, as well as secondary benefits of to integrate urban forms, giving the development an integral, more aesthetically pleasing relationship to the natural features of the site. Moreover, in being effective in terms of performance, they also can be cost-effective in terms of investment and maintenance, when compared with conventional systems.

Even if source control measures for urban drainage are gaining popularity in many countries, there are still many uncertainties attached to them in a widespread use. The perceived research needs are: Performance indicators to qualify the sustainability of such systems in socio-economic aspects, environmental and technical terms and development of more general efficiency criteria for source controls evaluation.



Fig. 3. Open channel system in Augustenborg. (Photos: M. Mrowiec).

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Contribution to the Methodology of the Evaluation of Harm to Human Health and the Environment Resulting from Heavy Gas Releases in Industrial Plants to the Atmosphere

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Abstract

In this article firstly main legislation acts concerning the major hazard plants in European Union and in Poland are listed and special documents which have to be prepared for these industrial plants are named. Then some aspects of the methodology of the evaluation of harm to human health and the environment resulting from the heavy gas releases in industry plants to the atmosphere are discussed. In particular a group of heavy gas dispersion models that might be used in the consequence assessment in Poland is characterised.

Keywords: heavy gases, dispersion models, consequence analysis, industrial plants

Introduction

Many dangerous substances are used in the industry all over the world. Releases of the dangerous substances to the atmosphere may lead to adverse consequences to human health and the environment. Systems of control for major hazard plants have been established based on legislation acts in Europe, US and in many other countries. In the European Union the Control of Major Accident Hazard Involving Dangerous Substances Directive and its amendment (86/82/EC, 2003/105/EC) plays this role. In each of the Member countries the Directive is transposed to national regulations. In Poland the Directive is adapted within the Act on Environmental Protection Law (Dz.U.2001.62.627) and the Regulations of the Ministry of Economy (Dz.U.2003.131.1219, Dz.U.2003.104.970 Dz.U.2005.197.1632, Dz.U.2002.58.535). According to these legislation acts companies operating major hazard plants which use or store certain substances in excess of specific threshold quantities are obliged to prevent major accidents with dangerous substances and limit their consequences for man and the environment. Duties are required from operators depending upon the type and amount of dangerous substance present. An operator may fall outside the Directive, be subject to lower-tier duties or upper-tier

duties. The operators subject to lower-tier duties must prepare major accident prevention policy (MAPP). Operators subject to upper-tier duties must prepare: i) the safety report which would demonstrate that MAPP has been prepared and the safety management plan for implementing it is put into place and ii) the on-site emergency plan which has to be supplied to the local authority to enable to draw up external emergency plan. Minimum data and information required for the safety report is specified in the Directive under Annex II and Environmental Protection Law under the item 253 point 2. Similar data for emergency plans are specified in the Directive under Annex IV and Environmental Polish Law under the item 260 point 2.

Of direct relevance to this article is the more specific requirement of the safety report specified in the Annex II under the item IVB and in the Regulations concerning the safety report under the item 5.1. point 2. It states that among many other requirements the assessment of the extent and severity of the consequences of major accidents have to be included in the safety report. A similar requirement concerning the emergency plans is specified in the Regulations concerning the emergency plans under the item 4 point 1.

Many toxic and flammable gases are characterised by negative buoyancy either because of their high molecular weight, or being cold, or forming an aerosol, or reacting with water vapour in the atmosphere. They are called heavy or dense gases. Dispersion of heavy gases differs in relation to

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dispersion of passive or positively buoyant gases. Special air pollution dispersion models are developed to describe it.

This paper's intention is to discuss some matters related to the methodology of the evaluation of harm to human health and the environment due to accidental heavy gas releases in industrial plants. Attention is focused on heavy gas dispersion models and computer software that might be used in Poland in the evaluation procedure.

Comments on the methodology of the evaluation of harm to human health and the environment resulting from accidental releases of heavy gases in major hazard plants

Evaluation of harm to human health and the environment resulting from releases of dangerous substances from industrial plants to the atmosphere is known as consequence assessment. The consequence assessment in the context of this article is a part of the assessment of risk associated with plant installations. The quantified risk assessment is the most favoured and presently most frequently used scheme for the risk analysis of chemical plants. The consequence analysis is the aspect of quantified risk assessment that is growing most rapidly. It includes: i) source term description, ii) dispersion calculations for toxic gases and iii) calculations of thermal radiation or overpressure for flammable or explosive gases, iv) conversion of dose into harm. In this analysis the mathematical models referred to as source models, dispersion models, effects models, vulnerability models are used.

There are two possible approaches in the ways of carrying out the consequence assessment. Either to leave experts the free choice of the methods, techniques and harm criteria or to indicate some reference methodology for standard situations, from which experts would have the right to diverge if it did not suit the case studied or if a more proper solution was available. In the guidelines of risk assessment both approaches have been used [1–4]. For the time being in Poland the more general approach functions [1]. This concerns also the heavy gas dispersion modelling focused upon in this article. The question is whether to follow this line or try to review the modelling methods used for specific release scenarios in order to indicate some reference methodology. To answer this basic question it seems worth to discuss some more detail issues and find answers to the following questions: i) What are the advantages and limitations of the two approaches? ii) Are there many mathematical methods of heavy gas dispersion calculations? iii) Which of the heavy gas dispersion models can be applied in the routine calculations? iv) What is known about the quality of the models? v) What is the current state of knowledge in this area and how quickly does it develop? The following answers are suggested: i) Both approaches of carrying out consequence assessment have advantages and limitations. The first option gives flexibility. However it can bring about confusion as starting from the same assumptions one may obtain different results. The second solution giving standards guarantees some consistency as adopting a similar approach in similar circumstances similar results will be achieved. However one has to take into account that it is not possible to indicate for each situation a ready recipe. ii) There are many heavy gas dispersion models and they differ a lot. A review of models can be found for example in [5, 6]. Based on mathematical principles the models can be

divided into: phenomenological models, intermediate models and computational fluid dynamic models. In the first group the dispersion of heavy gas clouds for instantaneous or continuous releases from the ground level is described by a series of nomograms or simple correlations. In the second group five subgroups are distinguished. Four groups of simpler intermediate models are based on the integration of ordinary differential equations describing the conservation principles of mass, substance, energy and momentum. Here belong the box models used for ground level instantaneous releases, steady state plume models used for ground level continuous releases, generalised plume models used for instantaneous or continuous ground level releases and one-dimensional integral plume models known as jet models for continuous elevated releases. The most complex group of the intermediate models known as shallow layer models are based on the solution of partial differential equations averaged over the cloud depth. They differ from other models of this group in the dimensionality and in the ability to treat effects of topography. The research models are the three dimensional models, in which a full set of partial differential equations depended on time and three space co-ordinates describing the principles of conservation of mass, momentum, energy and substance are solved. These models can be applied to any type of the emission scenario, terrain or meteorological conditions. iii) In consequence assessment calculations phenomenological or engineering models can be used. Input data needed by these models are easy to obtain, they have low or reasonable computer costs and it is easy to run them. The fluid dynamic models are used for the research purposes to get to know better the dispersion process. iv) The quality evaluation of heavy gas dispersion models is of great importance. It is obvious that in the consequence assessment the models, which perform well in the quality evaluation should be used. The guidance on how the models should be evaluated has been prepared [6]. Based on the results of the evaluation of several models belonging to the group of phenomenological and intermediate models it can be seen that none of the models demonstrate much better results than others. The performance of any model appears not to be related to its cost or complexity. It has to be stressed that in this analysis the measurement data were collected from flat terrain in neutral meteorological conditions [7]. v) Despite considerable achievements and constant progress in the area of heavy gas dispersion modelling, in particular in the research of dispersion of dense gas plumes over rough surfaces typical of industrial sites and in stable or unstable meteorological conditions carried out in tunnels and in the field, there is still much to be done. The results of these measurements have to be inserted to the models [8]. In addition the dispersion of multi-component and multi-phase mixtures should be studied.

Conclusions

It seems that in the current situation it is more practical to keep the option giving the expert free choice of the methods of heavy gas dispersion calculations. However in time it would be worth to undertake the effort to indicate the reference method of the heavy gas dispersion calculations and

later the reference methodology of the evaluation of harm to human health and the environment. It is important to add that despite a large number of the existing heavy gas dispersion models, there are few computer programs available to carry out the consequence assessment if the minimum criteria of covering fire, explosion and releases to the atmosphere and of the “user friendliness” are put on them for convenience. The only ones are: ARCHIE, BREEZEHAZ, EFFECTS, PHAST, SEVEX and FRED [4] of which only the first one is offered for free.

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A Multidisciplinary Approach to Assess Adverse Effects of Air Pollution on Asthma in Cracow (Southern Poland)

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Abstract

Validation of a Geographic Information System–epidemiological study related to asthma as a risk–assessment methodology in an urban area such as Kraków (Poland), requires the determination of spatio–temporal dispersion of sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and particulate matter smaller than 10 µm in diameter (PM₁₀) and the integration of meteorological conditions. For this purpose, mesoscale classification of circulation types over southern Poland by T. Niedźwiedź was used. Analysis of pollutant data collected in Kraków from 8 air quality monitoring stations and 5 consecutive years (2000–2004) shows the presence of low amounts of SO₂ and NO₂ over the city that do not exceed values of EU air quality norms (at the exception of NO₂ in the centre of the city) as in contrast, PM₁₀ level is found to overtake limit of air quality standard. Only the central part of the city was affected by this pollutant and both non advection situation types and advection types mainly from the South sector, are shown to be associated with exceeding PM₁₀ level. These results show the importance of meteorological conditions in the elaboration of an integrative study that can connect the anthropogenic uses of urban areas, the state of air pollution with the occurrence of asthma.

Keywords: urban air pollution, asthma, sulphur dioxide, nitrogen dioxide, particulate matter, GIS, atmospheric circulation, Kraków

Introduction

Modifications of occupational land uses as well as increases of anthropogenic activities in urban areas have considerably altered air quality through the release of numerous toxic pollutants. Poor quality of air has led to multiple alterations of urban environment and of citizen's health status. Air pollutants, such as sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and particulate matter (PM) cause multiple damages on monuments and buildings and alter urban housing quality as well as patrimonial resources. Moreover, exposure to most of those pollutants was shown to be associated with the occurrence of cardiovascular and respi-

ratory diseases [1–9], including asthma [10–14]. This latter pathology constitutes a real health issue as the incidence and the severity of asthma have steadily increased over the last two decades in many European countries and represents as such, a serious cause of morbidity. In Poland, a consistent rise of asthma has also been observed and prevalence of this pathology and daily mortality were shown to be related with polluted areas of cities such as Kraków [15–19]. Numerous epidemiological studies have pointed out the association between asthma and SO₂, NO₂ and particulate matter smaller than 10 µm in diameter (PM₁₀) and their aggravating effects on the airway inflammatory reactivity in asthmatics [10–14]. Because prevalence of asthma is disproportionately high in most urban areas and reaches 4 to 10% of residents, this category of population constitutes one group whose risk–assessment associated with air

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pollution is urgently needed. Although several air pollutants have been shown to be associated with asthma in a temporal manner, few studies have however explored the spatio-temporal relationship of these associations or have taken into account complex interactions between climatic, meteorological and anthropogenic parameters. Moreover, degradations of health and patrimonial resources observed in most large European cities due to air pollution, have lead national and international communities to introduce drastic norms for air quality as well as recommendations for the promotion of a sustainable development in order to preserve quality of life and of environment. However, establishment of such development requires the settlement and the validation of a risk-assessment methodology that can integrate and connect the anthropogenic uses of urban areas, the state of air pollution with the alteration of patrimonial buildings and of human health. For this latter matter, validation of a multidisciplinary and integrative methodology using geographical and epidemiological approaches should fulfil this requirement [20–21]. Use of Geographic Information System (GIS) constitutes for example, a relevant tool not only in the characterization of the spatio-temporal dispersion of air pollutants, as it can take into account atmospheric circulation and topographical (elements) with urban anthropogenic activities, but also in the identification of each source of air pollution and their involvements in routes of

exposure (Fig. 1). Additionally, because air pollutants are rarely present as single but rather as a complex mixture, GIS can both delimitate more polluted and less polluted areas taking into consideration one or several pollutants and determine a single or a global degree of exposure of human population. Moreover, one additional property of GIS is its ability to overlay and merge several layers of information such as anthropogenic sources and air pollutants data with layers of epidemiological data in order to establish in an integrated way, a spatio-temporal association between air pollution and asthma (Fig. 1). Constitution of maps of epidemiological risks in relation with urban spatial management can then be deduced from such integrating property. We propose to develop a multidisciplinary and an integrative risk-assessment methodology combining both geographical and epidemiological approaches as a mean to study the incidence of urban spatial management and the resulting anthropogenic air pollution on the occurrence of asthma. For this purpose, we have selected the urban area of Kraków for the implementation of such study as air quality was shown to be greatly affected with time by several phases of SO₂, NO₂, PM emissions either from industrial activities (thermal power and metal processing plants) surrounding the city or from the domestic/household coal-heating activities [22–25]. Although the introduction of economic and domestic changes (decentralization, privatisation, shut

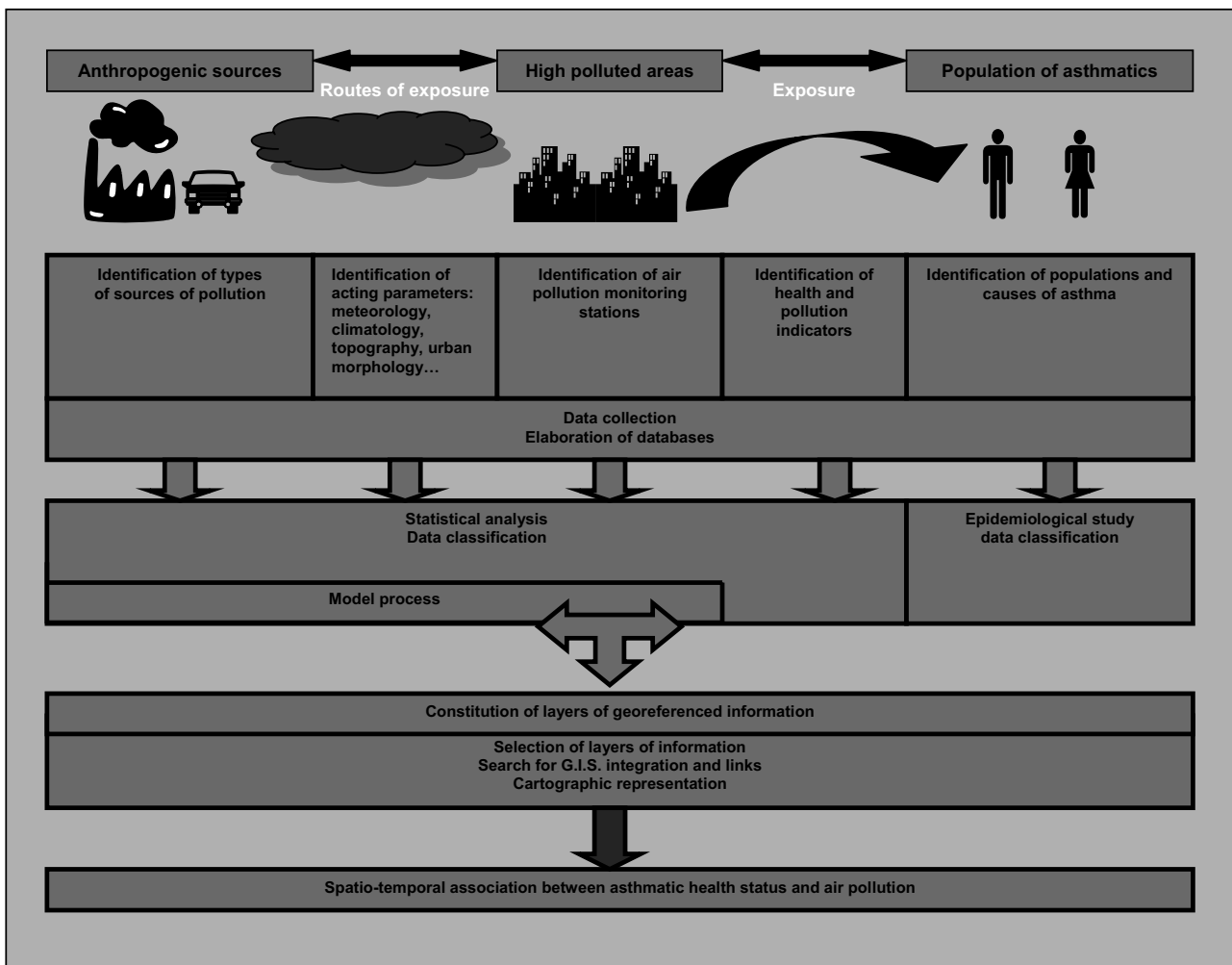


Fig. 1. Representation of the general principle of Geographic Information System (GIS) for the risk-assessment of adverse health effects on asthma related to air pollution and anthropogenic sources in the urban area of Kraków (Poland).



Fig. 2. Location of air quality monitoring stations in Cracow.

down of high polluting emitters, decreased use of coal heating system) and of restrictive laws on industrial emissions have considerably reduced the emissions of most pollutants to EU air quality standards during the 1990s, it should be pointed out that the emissions of some traffic-related pollut-

anthropogenic air pollution and health effects on asthmatics through GIS integration of several parameters, we have studied in a first step the influence of atmospheric circulation (pressure pattern type and direction of air mass advection) on the levels of SO_2 , NO_2 and PM_{10} pollutants in Kraków. Our

Table 1. SO_2 , NO_2 and PM_{10} concentrations collected from each monitoring station and expressed either in $\mu\text{g}/\text{m}^3$ or reported as % of thresholds of EU air quality standard values for SO_2 , NO_2 , PM_{10} , respectively equal to $125 \mu\text{g}/\text{m}^3$, $52 \mu\text{g}/\text{m}^3$ and $50 \mu\text{g}/\text{m}^3$. Daily mean values and Std.dev. of each pollutant collected for the period of time 2000 – 2004 are given.

Station number	SO_2			NO_2			PM_{10}		
	Concentr. [$\mu\text{g}/\text{m}^3$]	Std.dev. [$\mu\text{g}/\text{m}^3$]	% of threshold	Concentr. [$\mu\text{g}/\text{m}^3$]	Std.dev. [$\mu\text{g}/\text{m}^3$]	% of threshold	Concentr. [$\mu\text{g}/\text{m}^3$]	Std.dev. [$\mu\text{g}/\text{m}^3$]	% of threshold
0	17.4	17.4	13.9	26.9	11.5	51.8	47.0	33.6	94.0
1	16.1	13.9	12.9	31.0	11.9	59.6	44.3	31.6	88.7
2	19.6	19.0	15.7	33.8	14.0	64.9	49.2	35.3	98.5
3	22.4	15.6	17.9	67.6	19.5	130.0	65.6	48.7	131.1
4	14.5	13.2	11.6	30.8	11.6	59.3	51.0	36.6	102.0
5	15.6	15.3	12.5	50.1	25.9	96.4	-	-	-
6	21.2	25.3	17.0	35.6	24.6	68.5	-	-	-
7	13.3	12.0	10.6	28.7	10.1	55.1	36.2	21.3	72.4

ants (NO_2 , PM, lead) have, in contrast, strongly increased for 15 years ago. As a result, levels of NO_2 in Kraków were reported among the highest as compared to other Polish cities [25]. In an attempt to establish a spatial association between

main results show that several circulation types are associated with exceeding permissible air quality standard values of PM_{10} as compared to SO_2 and NO_2 and that this affects air quality on some specific parts of the city.

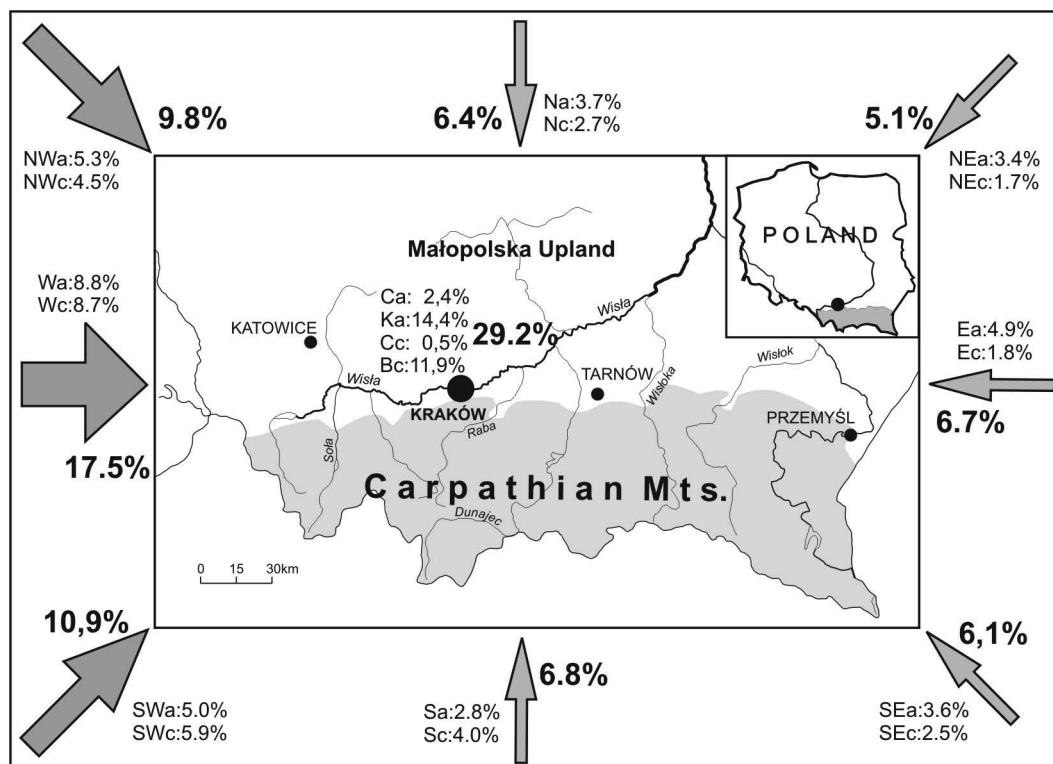


Fig 3. Frequency (%) of air circulation types over South Poland (2000–2004).

Experimental procedures

Daily measurements of SO_2 , NO_2 and PM_{10} were provided by Główny Inspektorat Ochrony Środowiska (<http://www.gios.gov.pl>) and were collected for the period 2000–2004 from 8 fixed air quality monitoring stations numbered 0 to 7 and located in Kraków as represented in Fig. 2. SO_2 and NO_2 concentrations were determined respectively by UV-fluorescence and by chemiluminescence using Thermoenvironmental Instruments analyzers and are expressed in $\mu\text{g}/\text{m}^3$ and average for 24-hrs. PM_{10} mass values were determined on filter-based samples following 24-hrs collection and analysed following beta radiation absorption; concentrations are expressed in $\mu\text{g}/\text{m}^3$ per 24-hr average. For each air monitoring station, levels of pollutants are estimated by averaging daily values over the period of time of 5 years and then expressed as percentage of thresholds of EU air quality norms by calculating the ratio of each mean value to EU standard values respectively, 125 $\mu\text{g}/\text{m}^3$ for SO_2 , 52 $\mu\text{g}/\text{m}^3$ for NO_2 and 50 $\mu\text{g}/\text{m}^3$ for PM_{10} .

In order to assess the influence of meteorological conditions on levels of pollutants, typical cases of circulation types were determined through the association of percentage of SO_2 , NO_2 and PM_{10} thresholds of air quality norms with particular types of circulation established by T. Niedźwiedz [27]. This classification represents the dynamics of atmospheric processes over southern Poland. The most important elements of the defined circulation types are air-advection direction or no advection, and the air–pressure pattern type. In total, T. Niedźwiedz defined 20 types of atmospheric circulation including 16 advection types and denoted them with the advection direction letter labels now commonly used in meteorology, adding the index “a” for anticyclonic systems: Na, NEa, Ea, SEa, Sa, SWa, Wa and NWa and the index “c” for cyclonic systems:

Nc, NEc, Ec, SEc, Sc, SWc, Wc and NWc. The remaining four types concern no–advection situations or situations with various advection directions: Ca – central anticyclonic situation, lack of advection, centre of high pressure, Ka – anticyclonic wedge, sometimes a few non–definite centres or unconstrained area of higher pressure, axis of high pressure ridge, Cc – central cyclonic situation, centre of low pressure, Bc – cyclonic trough or unconstrained areas of low pressure, or axis of the low pressure trough, with various advection directions and systems of fronts separating different air masses and X – col and situations which cannot be classified.

Results

Comparison of SO_2 levels collected from 8 air quality monitoring stations for the period of time 2000–2004 reveals a homogenous range of values and very low amounts of this pollutant within the urban area of Kraków (table 1). When reported to EU air quality standard value for SO_2 , a similar low range of % threshold from 10.6 to 17.9 is found with a low variability; suggesting that emissions of this pollutant from several sources do not participate or to a weak level, in the general state of air pollution in the city. In contrast to stations 0, 1, 2, 5, 6, 7, station 3 located in the central part of the city constitutes one of the highest multi–polluted spot in NO_2 and PM_{10} as their averaged levels exceed by 130 and 131.1 % the EU air quality standard of these two pollutants. A highly dense traffic road located close to this station and/or house heating may represent the anthropogenic sources responsible for the introduction of these 2 pollutants at elevated levels into this area. It should be pointed out that despite a large variability in PM_{10} measurements, station 4 located near the steel processing plant

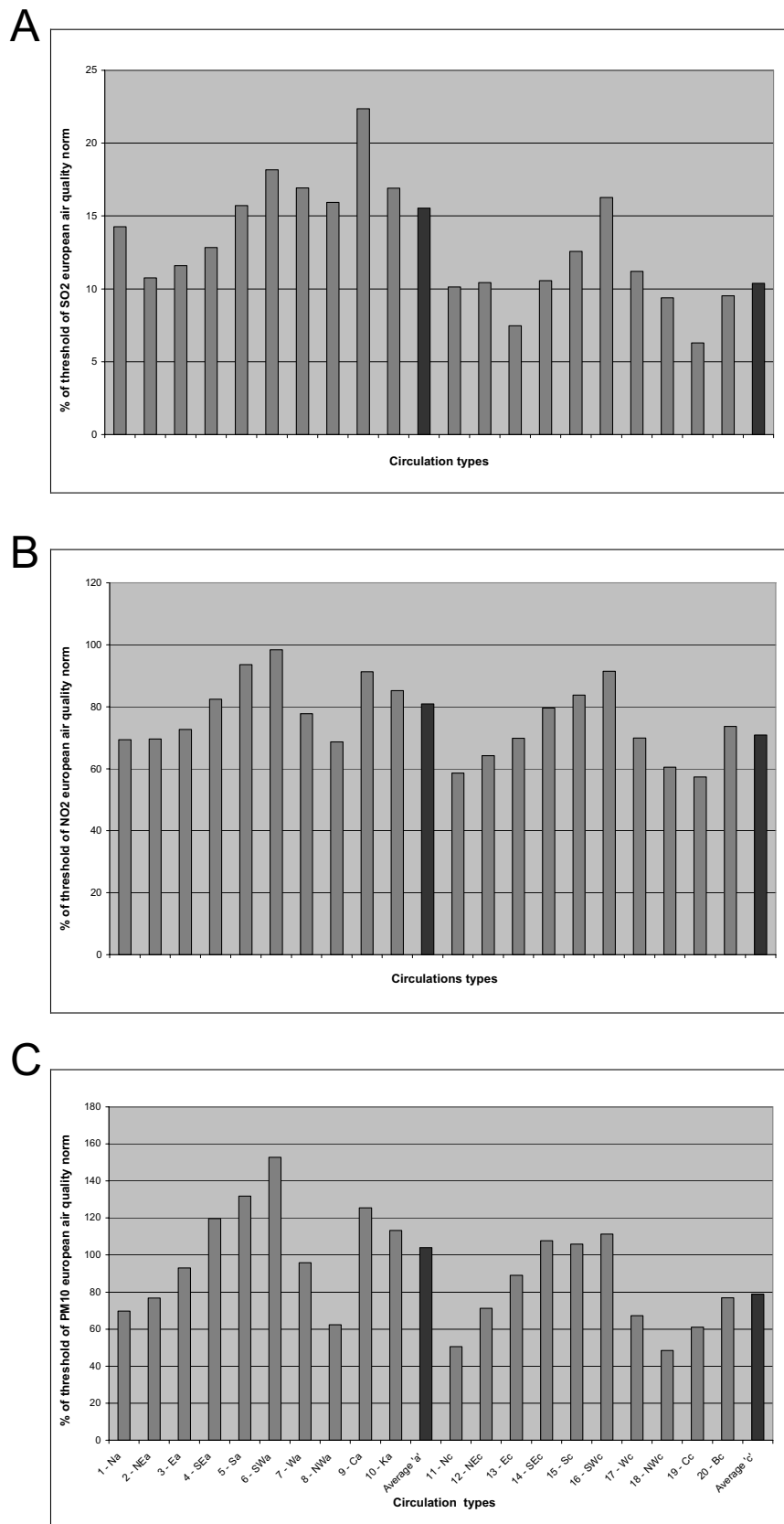


Fig. 4 : Representation in A, B, C of the average % threshold of SO₂, NO₂, PM₁₀ EU air quality norms with each of the 20 circulation types considering whole air monitoring stations (from 0 to 7) for the 2000–2004 period of time (grey bar). For each pollutant, mean of % of thresholds to air quality norms is represented and calculated by averaging values from the 8 stations. « Average 'a' » represents average of % threshold values calculated for each pollutant from the 10 following anticyclonic synoptic situations : Na, NEa, Ea, SEa, Sa, SWa, Wa, NWa, Ca, Ka; « Average 'c' » represents average of % threshold values calculated for each pollutant from the 10 following cyclonic synoptic situations : Nc, NEc, Ec, SEc, Sc, SWc, Wc, NWc, Cc, Ec (black bar).

of Nowa Huta may be considered as a polluted spot as the calculated % of threshold of this particulate pollutant reaches the limit of EU air quality norm. Study of frequency of days according to particular circulation types over southern Poland shows that anticyclonic types are rather more frequently observed (a : 54%) than cyclonic types (c : 44.5 %) during the selected period of time of our study. Of the 20 circulation types under study the most frequent were those linked to western advection (Wa + Wc: 17.5%), to no-advection situation for anticyclonic wedge (Ka: 14.4%) and as well as for cyclonic trough (Bc: 11.9%) (Fig. 3). These four types occurred on 43.8% of days on average. In order to relate circulation factors with levels of SO₂, NO₂, PM₁₀, the average percentage of threshold of each pollutant calculated for whole air monitoring stations are represented with each of the 20 described circulation types for 5 years. Figure 4 A, B, C shows that in average anticyclonic types are associated with more elevated % of threshold for the 3 pollutants than those determined in cyclonic types (average 'a' for SO₂: 15.5%, NO₂: 80.9%, PM₁₀: 104.1% vs. average 'c' for SO₂: 10.4%, NO₂: 70.9%, PM₁₀: 78.9%). Analysis of circulation with PM₁₀ (Fig. 4C) reveals that this pollutant is the only one out of three pollutants that exceeds EU air quality norms with the following types: SEa, Sa, SWa, Ca, Ka and SEc, Sc, SWc, while in contrast % threshold reach values below or close to air quality norms with the circulation types Na, NEa, Ea, Wa, NWA and Nc, NEc, Ec, NWC, Cc, Bc. It should be pointed out that if the variability of % threshold for SO₂ and NO₂ shows similar patterns of variations with most of these circulation types (Fig. 4A, B), none of these situations are associated with any exceeding air quality standards levels of these two pollutants. These results suggest that several circulation types can be associated with both gaseous and particulate air pollutants fluctuations in Kraków but only PM₁₀ has to be taken into consideration as first, its level overtakes EU air quality norm and second, mortality cases were estimated recently to be attributable to the exposure of this pollutant in this city [30].

Discussion

Poor quality of urban air due to the release of SO₂, NO₂ and PM₁₀ by anthropogenic sources is responsible for the alterations of urban housing and patrimonial buildings as well as of the aggravation of respiratory pathologies such as asthma. Understanding the relationship between urban land uses, state of air pollution and consequences on asthma requires the development of a multidisciplinary approach that could take into account multiple parameters (anthropogenic, meteorological, climatic, health and biological) that interact in a complex way with each others and influence dispersion of pollutants and affect human health. The use of geographic tool such as GIS combined with epidemiological approach constitutes a promising risk-assessment methodology as it can integrate and connect urban anthropogenic activities with spatio-temporal dispersion of air pollutants and alterations of health status among asthmatics (Fig. 1). We have chosen to elaborate and validate such approach in Kraków as air quality was shown to be affected by several industrial and domestic/household (heating) sources located

in and around the city and by the recent occurrence of an increased density of road traffic. In order to introduce pressure pattern type (anticyclonic, cyclonic) and directions of air masses advection into the elaboration of a GIS-epidemiological study related to asthma, we started to establish the effects of these meteorological conditions on SO₂, NO₂ and PM₁₀ levels collected from 8 air quality monitoring stations and 5 consecutive years (2000–2004). Results of average values of gaseous pollutants for each station reveal the presence of low amounts of SO₂ and NO₂ over the city that do not exceed values of EU air quality norms (at the exception of station 3 for NO₂). These results are in agreement with the general and continuous downward trends of both pollutants levels observed in Poland and Kraków since 1990s and with a real improvement of air quality due to the introduction of Polish and EU Environmental Protection regulations as well as the use of low emissions industrial processes or the shut down of some emitters [23–25]. In contrast, exceeding value of NO₂ found in Station 3 may be attributed to the high traffic volume of car emissions located in the neighbourhood of this station, as this source of pollution prevails for Kraków and represents an increasing threat in the alteration of air quality. Considering PM₁₀, two polluted areas respectively located in the central part of the city (Station 3) and in Nowa Huta district (Station 4) can be characterized as the average % of threshold for 5 years overtake respectively by 131.1 and 102% the permissive limit of air quality norms. It should be pointed out that over years, numerous reports [22–24] have already described these two areas as highly polluted and that they can still be considered nowadays as having a poor quality of air, although the overall pollutant levels have been considerably reduced to close or below limit values of air quality norms. Moreover, long term exposure of inhabitants to SO₂ and PM within these two areas was shown not to be without any sanitary consequences. Since for the period 1968–1981, chronic respiratory symptoms and lung function were shown to be affected by these two pollutants [29]. Analysis of atmospheric circulation during 5 consecutive years 2000–2004 shows that anticyclonic types are more frequent than cyclonic types and that a trend of more elevated NO₂, SO₂, PM₁₀ levels is found for anticyclonic types than for the cyclonic ones (see average "a" vs average "c" in Fig. 4 A,B,C). These results highlight the influence of pressure pattern type on pollutant levels as high-pressure systems constitute conditions which favor the maintenance of air pollutants near the soil whereas in contrast, the cyclonic ones disperse them. Our results on the frequency of circulation types over southern Poland show that non advection situations (Ka) and circulation from the West (Wa and Wc) as well as cyclonic trough (Bc) predominate mostly as it represents respectively 43.8% of total cases. It is quite remarkable to note that our results are in a very close agreement to the frequency of air advection direction established by R. Twardosz and T. Niedzwiedz [28] over Southern Poland for more than a hundred years (1873–1999); suggesting a very long term consistency of atmospheric circulation over study period 2000–2004. When percentage of threshold for each pollutant is represented in regard to particular types of circulation, only the analysis with PM₁₀ has to be considered and discussed because this pollutant is found to be the only one which displays values that overtake the permissive value of

air quality norm and that this may lead to deleterious effects on health. Whatever is the pressure pattern type the circulation types from the South sector (SE, S, SW) and no advection situations such as Ka and Ca appear to be related with exceeding levels of PM₁₀. It is quite noticeable that the two less frequent advectations from SE and S are found to be associated with high levels of PM₁₀, while more frequent air masses coming from W is not. In contrast, the least frequent air masses advection coming from N, E and NE are associated with % of threshold that are below or close to air quality standard for PM₁₀. In conclusion, our study shows the importance of atmospheric circulation on the levels of pollutants within the urban area of Kraków and reinforces the fact that these elements have to be taken into account and integrated in the elaboration of a GIS-epidemiological study related to asthma.

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Urban Air Pollution and Its Health Effects

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Abstract

Poor urban air quality has been causing health problems since the middle of the 19th century. Currently human exposure to increased pollutant concentrations in densely populated urban areas is still high. Air quality limit values as well as World Health Organisation (WHO) guidelines are frequently exceeded in urban hotspots, while evidence of the adverse health effects of air pollutants, especially fine particulates and ground-level ozone is continuously rising. The worst air quality is registered in Asian and Latin American megacities. However, strong episodes of high pollutant concentrations are noted in European and Northern American cities as well. This paper presents the historical view of the problem, the specific of urban air pollution, the current urban air quality as well as possible influences of air pollution on human health.

Keywords: Urban Air Pollution, Health effects

Introduction

Air pollution and its health effects are the issues considered for centuries. The particulate pollution effects on human health were studied already in XVI century in the book „*De re metalica*” by Georgius Agricola. The industrial revolution in Europe resulted in the intense fuel – especially coal – use. Burning of coal used by industry and in homes for domestic heating resulted in high levels of air pollutants, especially of sulphur dioxide (SO₂) and particulates (PM). During the 19th century high levels of urban air pollution were frequently experienced throughout the cities in Europe. During periods of stable weather, temperature inversion and low wind speeds smog episodes experienced in cities for a considerable number of days caused death rates to rise dramatically. The effects of this pollution on buildings and vegetation also became evident. During the famous London smog in December 1952 a daily average SO₂ and PM concentrations of about 5000 µg/m³ each was measured, which is probably a world record. The most known episodes of winter black smog are summarised in Table 1.

During 1950–1980 in almost every country in Europe as well as in North America and Japan serious urban air pollution episodes occurred. This led to introduction of air pollution control legislation as well as to designation of Smog Alarm Systems (SAS) in cities, where air pollution episodes was observed. The idea of installing special

alarm systems emerged in Japan and USA at the end of 1960's. The main objectives of SAS are warning the people by spreading information about the danger and temporary action to limit the duration of smog episodes as well as to extenuate its effects. Nowadays such systems are present in Europe as well – they work in Germany, Austria, Italy, Switzerland and The Netherlands. In the UK the Great London Smog from 1952 led to introduction of the first Clean Air Act in 1956. West Germany adopted Federal Air Purity Act in 1959, the United States of America – the Clean Air Act in 1963 (last amended in 1990) and the Netherlands – the Air Pollution Act in 1970. In Russia the first in the world air pollution standards were published in 1958 (for 96 species). In Poland the limit values for priority air pollutants were stated in 1966. Nowadays the 1996 Framework Directive 96/62/EC on ambient air quality assessment and management as well as so-called Daughter Directives from 1999–2005, provides a comprehensive framework for air quality improvement at the EU countries. In September 2005, the European Commission (IP/05/1170) adopted the Thematic Strategy on air pollution. The Strategy establishes ambitious, cost-effective targets for improving human health and environmental quality over the period up to 2020.

According to the UN data (*United Nations Population Division, World Urbanization Prospects: The 2001 Revision*) the world's urban population reached 2.9 billion in 2000 (47% of world population) and is expected to rise to 5 billion by 2030 (attaining 60% of world population). At current rates of change, the number of urban dwellers will equal the number of rural dwellers in the world in 2007. The urban population of the more developed regions is expected to in-

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Table 1. Excess deaths associated with air pollution episodes from 1873 to 2006 (modified after [1]).

Place	Date	Excess deaths
London, UK	December 1873	270-700
London, UK	December 1892	1000
Mouse Valley, Belgium	December 1930	63
London, UK	December 1952	4000
New York, USA	November 1953	250
London, UK	December 1962	340-700
New York City, USA	January-February 1963	200-405
New York City, USA	November 1966	168
The Ruhr Area, Germany	January 1979	no data
The Ruhr Area, Germany	January 1985	no data
East Germany	December 1989	no data
London, UK	December 1991	160
Northern Bohemia, Czech Republic	February 1993	no data
Poland	January 2006	no data

crease slowly, while population growth will be particularly rapid in the urban areas of less developed regions. These statistics indicate that urban air quality has great significance for health condition of the world's population.

Specific of the Urban Air Pollution

Air pollution in urban areas is the multi-scale phenomenon. The state of air quality is influenced by natural and regional background concentrations as well as by emissions from urban sources. Main emission sources in most cities throughout the world are road traffic, small-scale power/heat generation (from large buildings down to single houses/apartments, e.g. small stoves burning coal, wood, and other energy sources), and industrial applications. Number, type, strength and localization of emission sources as well as weather conditions, urban geographical location and its topography influence the state of air pollution. Mesoscale wind circulations have a significant influence on urban air quality, while atmospheric circulations created by the city itself may affect strongly pollutant dispersion [2]. Vehicle emissions are responsible for peak concentrations due to specific of urban transport (traffic congestion, parking). The urban architecture, frequently narrow streets and very close proximity between sources (e.g. cars in streets) and the population result in potentially high levels of exposure. When the city is surrounded by hills the air pollution episodes occurred more often. At the same time as weather conditions are stable, usually during periods of high-pressure and light winds, the level of pollution in the air can rise to very high levels. In winter this is generally due to an inversion, which results in very little mixing of the air. Furthermore, increasing frequency of extreme weather events, as very low winter air temperatures, results in increase of heat demand and increase in air pollutants' emissions. Such situation took place in Poland in January-February 2006, when extremely low temperatures resulted in extensive coal use and very high PM and SO₂ emissions. Together with existing periods with high pressure, temperature inversion and low wind speed this resulted in extremely high pollutants' concentrations in Polish cities. The highest PM₁₀ levels were measured in southern Poland

in Cracow, Rybnik and Żywiec. The highest daily average PM₁₀ concentration (of about 700 µg/m³) exceeded the EU limit value 14 times and was measured in Rybnik (Upper Silesia region), while one-hour concentration raised up to 1000 µg/m³. In case of SO₂ levels the highest daily value of about 370 µg/m³ (3 times the EU limit value) was measured in Żywiec (Upper Silesia region). Such a situation hadn't been observed in Poland for years.

In summer, the concentrations of various air pollutants, especially photochemical ones, can become exceptionally high during periods of fine weather, when a high-pressure front is stable over the same area for a long time. Photochemical pollution, among them ground-level ozone (O₃), the major photochemical pollutant, is formed from emissions of primary pollutants: nitrogen oxides (NO_x), methane (CH₄), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO) in the presence of sunlight. Emissions of NO_x, CO and CH₄ are responsible for background ozone levels. More reactive species as NMVOC are responsible for ozone formation in more densely populated regions, in particular close to cities. Formation of ozone is exaggerated in cities located at the coast, where the effect of land-sea breeze strongly aggravates atmospheric circulations and pollutant dispersion. It is worth mentioning here that out of the 20 biggest cities in the world, 15 are located at the seaside.

The specific urban "aerosol" is built from particulate matters (PM), primary gaseous pollutants: SO₂, NO_x, CO, volatile organic compounds (VOC), specific air pollutants, e.g.: benzene and polyaromatic hydrocarbons (PAH) and secondary air pollutants. e.g.: O₃, PAN. Most PM mass in urban and non-urban areas is composed of a combination of the following chemical components: oxides of Al, Si, Ca, Ti as well as Fe and other heavy metals, which are toxic to people as: As, Pb, Cd and Zn; sulphate; nitrate; ammonium; NaCl; organic carbon (OC); elemental carbon (EC) and liquid water. Also PAH compounds are often bound to PM.

In urban environments, road traffic and small-scale power/heat generation are usually the dominant sources of harmful air pollutants. Improvements in urban air quality are now being threatened by vehicle emissions caused by

growth in the transport sector. By 2020 more than 1 billion cars will drive on the world's roads, compared with the 400 million cars that exist today. In developed countries, enhancements in fuel efficiency, new types of engine and fuel can improve the air quality. However, these measures are not expected to reduce emissions sufficiently to cancel out increased number of vehicles and increased use of them throughout the world.

Current urban air quality

While air quality in European cities has improved since 1980, the air pollution in Asian and Latin American cities has grown with the progressing industrialization and urbanization. Levels of urbanization vary quite significantly by region. Most Latin American countries are as urbanized as Europe, with 74 percent of the population living in urban areas. But South Asia, East Asia, and Sub-Saharan Africa remain predominantly rural, though they are urbanizing rapidly [3]. Asia's particular style of urbanization – toward megacities – is likely to further exacerbate environmental and social stresses. This recent experience in Asia is predated by similar problems in the western countries at early stages of their economic development. Many Asian and Latin American cities, and almost all megacities experience very high PM concentrations at winter and ground-level O_3 in spring–summer; another pollutants under concern in urban areas are NO_2 , SO_2 and lead (Pb). According to the latest WHO estimates more than 2 million premature deaths each year are attributed to urban outdoor air pollution and indoor air pollution from the burning of solid fuels, and more than half of this burden is borne by the populations of developing countries [4]. In São Paulo and Rio de Janeiro, air pollution is estimated to cause 4 000 premature deaths a year [5]. According to World Bank prognosis for 2001–2020 period, the biggest number of premature deaths caused by air pollution will happen in India (approximately 900,000 excess deaths) and China (approximately 700,000 excess deaths) [3]. In many Chinese cities air quality is so poor that nationwide, the costs of excess morbidity and mortality for urban residents are estimated at 5 percent of GDP [5]. The air in Asia's cities is amongst the most polluted in the world. Out of the 15 cities in the world with the highest concentrations of PM, 12 are located in Asia. Moreover, six of these cities also have the highest levels of SO_2 . Cities such as Beijing, Calcutta, Jakarta, New Delhi, Shanghai and Tehran are notorious for high levels of PM. Despite existing policies dealing with transport and poor quality coal, it is expected that emissions of PM may increase in central Asia in conjunction with increases in energy use in the near future.

In Europe current air quality is much better than until 1980. Significant improvements in Europe's air quality was driven both by legislation and by economic restructuring and abatement measures introduced in Central and East European countries. However, air pollution remains a problem in most cities, particularly high levels of PM_{10} , O_3 and NO_2 . According to latest estimates concentrations of PM_{10} in most urban areas in the EU will remain well above limit values up to 2010, causing largest potential health problem

from air pollution [6]. Short-term peak ground-level O_3 concentrations are falling, while long-term average concentrations continue to increase. In 1999, air concentrations of ground level O_3 exceeded the health-related limit value in about 30% of cities in EU. Exposure parameters (such as the SOMO35 used to assess health damage) are generally highest for southern countries (Italy, Spain, Greece, Bulgaria) [6]. Exposures to concentrations of NO_2 and SO_2 above health-related limit values have fallen since 1990 and further remarkable reductions are expected. However, at present the annual NO_2 limit value is exceeded in about 30 European cities, which report data. Since 1995, less than 20% of the European population has been exposed to SO_2 concentrations above the health-related limit value, and the number of exceedances days continues to fall. Nevertheless, exposure to SO_2 concentrations above the limit value remains a problem in central and Eastern Europe, mainly due to extensive use of coal.

In the European Union, the biggest problems from the health perspective are fine particulates ($PM_{2.5}$) and O_3 . Current levels of $PM_{2.5}$ and O_3 cause severe health impacts in the EU, resulting in some 370,000 premature deaths each year. The loss of statistical life expectancy in the EU attributable to the identified anthropogenic contributions of $PM_{2.5}$ was estimated in 2000 at approximately 9 months (*EC Thematic Strategy on air pollution, IP/05/1170*). Spatial analysis suggests that there are several hot spots in central Europe where the statistical loss of life expectancy in 2000 was particularly high. Moreover, there is widespread and significant damage to ecosystems, agricultural crops, materials, and cultural heritage. Benefits from the introduction of the EC Thematic Strategy on air pollution are estimated as at least €42 billion per year through fewer premature deaths, less sickness, fewer hospital admissions, improved labour productivity etc. This is more than five times higher than the cost of implementing the Strategy, which is estimated at around €7.1 billion per year, or about 0.05% of EU-25 GDP in 2020 (IP/05/1170). The environmental benefits of reduced air pollution will be also significant, however there is no agreed way to express damage to ecosystems in monetary terms.

Air pollutants' effects on human health

The impact of air pollutants on human health is a risk factor mainly at local and urban scales, where air pollutants may affect the sensitive parts of the population. Short-term as well as long-term effects occur. The effects of breathing toxic substances may range from a slight feeling of discomfort to premature death. Sensitivity varies very widely, from one individual to another. Those most at risk are children, the elderly, asthmatics and persons with heart and circulatory problems. Since the most recent update of the WHO Air Quality Guidelines, completed in 1997 and printed as a WHO publication in 2000 [7], there has been an increasing awareness among scientists and policy makers of the global nature of the public health problems posed by exposure to air pollution. Hundreds of new studies have been published on the health effects of air pollution in the scientific literature, including important new research in low- and mid-

dle-income countries. This led to forming updated health-based guidelines for PM, O₃, NO₂ and SO₂ [4].

Out of all known air pollutants (excluding dioxins), the strongest health effects are currently assigned to PM. A large number of studies made both in the US and in Europe have shown that when the concentration of small particles in air rises, even from low levels, there is a rise in mortalities from respiratory, cardiac and circulatory diseases as well as a rise in the number of bronchitis and asthma attacks. It is not known exactly how these particles cause damage, but they are thought likely to excite and aggravate inflammations of the airways. Even exposure to low levels for long periods is considered harmful. The long-term effects have not yet been so well researched, but living in regions where there are high concentrations of PM is believed to reduce life expectancy. Particulates differ with their size, shape and chemical as well as mineralogical composition. Their shape and chemical composition as well as their size are thought to influence their harmfulness, as do the substances that adhere to their surface (as PAH for example). Particles are now generally measured as PM₁₀ (PM of so called surrogate diameter below 10 µm), however the levels of finer fraction – PM_{2,5} – give a better indication of the effects on health. Additionally, PM are classed as either primary or secondary. Primary PM are formed during combustion, but may also consist of dust, small soot flakes, pollen, etc. Major sources are coal combustion processes (industrial and small-scale burning) and internal combustion engines (primarily diesel engines). Secondary particles consist mainly of sulphate and nitrate salts that are formed in the air from SO₂ and NO_x. They belong to the PM_{2,5} fraction and can remain suspended in the air for long periods due to their quite long residence time (weeks–months). In average PM_{2,5} represent 30% of PM₁₀ concentration in the air. Particles containing As, Cr, Ni, Pb or those with bound PAH compounds (e.g. BaP) may be carcinogenic. Among the nitrated polyaromatic hydrocarbons (nitro-PAH) are some of the most carcinogenic substances known to man, several of which are present in diesel exhaust fumes. PM_{2,5} are believed to be the most harmful, because when they are inhaled they can penetrate deep into the lungs. WHO summarizes the current state of knowledge as follows [8]:

- Particles (PM) in general increases the risk of respiratory death in infants younger than one year, affects the rate of lung function development, aggravates asthma and causes other respiratory symptoms such as coughs and bronchitis in children.
- Fine particles (PM_{2,5}) seriously affect health, increasing deaths from cardiovascular and respiratory diseases and lung cancer. Increased PM_{2,5} concentrations increase the risk of emergency hospital admissions for cardiovascular and respiratory causes.
- Coarse particles (PM₁₀) affect respiratory morbidity, as indicated by hospital admissions for respiratory illness.

The effects of long-term exposure include increases in lower respiratory tract symptoms and chronic obstructive pulmonary disease (COPD). These effects are demonstrable even at levels well below the limit values. PM_{2,5} shows the strongest association with mortality: an increase in long-term concentration of PM_{2,5} by 10 µg/m³ increases the risk of deaths from all causes by 6% [8].

Other pollutants, which are important when assessing urban air quality, are ground level O₃, SO₂ and NO₂. Ozone causes eye irritations and irritations of the airways that lead to a reduction in lung capacity, even at relatively low concentrations. Because of its low solubility in water it can penetrate deep into the lungs. Long-term exposure, even to relatively low concentrations, can lead to permanent lung damage. As the amount of O₃ to which an individual is exposed depend on time spend outdoors, the most at risk are children and people working outside buildings. SO₂ also causes irritation of the airways. It was proved that SO₂ and PM have synergetic effect on health. The third pollutant, NO₂, can penetrate relatively deep into the airways, where it can cause irritation and damage to tissue. It can also exacerbate both asthma and allergic reactions. Additionally, NO₂ impairs the defence mechanisms of the lungs against bacteria, viruses, and other air pollutants such as ozone and particulate carcinogens. Repeated exposure to NO₂, either alone or in combination with other factors, is suspected of starting off asthma in children. What is more, NO₂ has significant indirect effects on health through its contribution to the formation of O₃, and both NO₂ and SO₂ through their contribution to the formation of secondary PM (PM_{2,5}).

Conclusions

Urban air pollution episodes have caused serious health impacts in Europe and North America over last 150 years. Currently, the concentrations of air pollutants are generally falling in developed countries, however in low- and middle-income countries air pollution levels are growing. Due to increasing knowledge about health effects of air pollution, these effects are a bigger issue today throughout the world than they were in the 20th century. The health problems are in particular connected with urban fine particulates (PM_{2,5}) and ground-level ozone concentrations. Both pollutants cause severe health impacts, resulting in premature deaths, increased hospital admissions, extra medication, and lost of working days. Moreover, there is widespread and significant damage to waters, soils and ecosystems (mainly due to deposition of acidifying/eutrophying species), damage to vegetation and crops (mainly due to exposure to ground-level ozone) as well as damage to materials and cultural heritage (mainly due to exposure to acidifying compounds and ozone). In urban environments, road traffic as well as small-scale power/heat generation (in particular burning of coal) are usually the dominant source of harmful air pollutants. Increasing frequency of extreme weather events makes the air pollution episodes more probable. In European Union estimated benefits from the introduction of the EC Thematic Strategy on air pollution from 2005 are much higher than the costs of implementing the Strategy. However, all existing regulations: the EU Thematic Strategy, the US Clean Air Act amended in 1990 as well as existing policies in developing countries are not expected to reduce air emissions sufficiently to cancel out increased energy use, increased number of vehicles and increased use of them. Much more have to be done in order to reduce urban air pollution and the public health problems posed by exposure to it. Moreover, modern Smog Alarm Systems,

protecting the urban population from the consequences of air pollution episodes are definitely needed in densely populated urban areas throughout the world.

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Assessing the Winter Time Air Pollution in Cracow (Poland) in Relation with Possible Influences on Human Health and Cultural Heritage

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Abstract

During last fifteen years Poland has been done much toward its sustainable development, which led to the decrease of atmospheric emissions and to the significant improvement in the air quality. However, in some locations in Poland, including urban areas, air quality problems still persist, in particular in wintertime. This paper discusses the wintertime air pollution in Cracow, the old capital of Poland, with a population of 741,000. Analyses of available monitoring data from the last 20 years are presented. Special attention is given to the winter air pollution in 2006, when the strong episodes of black smoke occurred due to severe winter. The air pollution levels in Cracow are compared with levels in other big cities in the country as well as with European Union (EU) and World Health Organization (WHO) Air Quality Standards. The assessment of possible influences of wintertime air pollution on human health and cultural heritage in Cracow is presented.

Keywords: Urban Air Pollution, Health and cultural heritage effects, Sulphur dioxide, Particulate matter, Poland; Cracow

Introduction

Air quality in cities is determined by many factors. As was presented in previous paper [1], the state of air pollution in urban areas is influenced by natural and regional background concentrations, emissions from urban sources, urban geographical location and its topography as well as by meso-scale and local atmospheric circulations. Emissions to the air are directly connected with the composition of energy supplies. Poland is among the countries in which hard and brown coal are the primary energy sources. Burning the coal for energetic or municipal purposes results in emission to the air of the whole group of primary pollutants as carbon oxides (CO₂ and CO), sulphur dioxide (SO₂), nitrogen oxides (NO_x) and particulates (PMs) as well as specific pollutants as polyaromatic hydrocarbons (PAH), heavy metals and dioxins/furans (PCDD/F). During the last twenty years coal consumption in Poland was reduced by 18% from approximately 80% in 1984 to approximately 62% in 2004. Starting from 1990, Polish environmental policy has been shifted toward sustainable development. These include basic restruc-

ture and modernization of industry, the implementation of abatement technologies, introduction of a broad energy-saving programme as well as alteration of the composition of energy supplies. Despite this, air pollutants' emissions in Poland are still considerable, especially SO₂, CO₂ and PM emissions, which place Poland among the biggest European polluters. As a result the overall air quality in Poland, particularly urban winter air pollution is still unsatisfactory, particularly regarding PM10 (PM2.5) concentrations.

Cracow, the capital of Małopolskie voivodeship and former capital of Poland is located in the Southern part of the country. With its 1300 years of history, Cracow is the biggest after Warsaw Polish centre of science and culture. Unfortunately, its geographical location as well as local climate conditions and existing emission sources are unfavourable to air quality. The air pollution in Cracow is mainly due to local sources: the space heating in wintertime (municipal sources), the road transport and various industrial activities. In addition there is the secondary component, originating both from other national and trans-boundary sources that emit the pollutants.

In order to assess the air quality in Cracow a number of projects have been realised. The first air pollution-monitoring project (MONAT-84) led by Warsaw University of

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Technology, was carried out in February 1984 [2]. Within a framework of a European air pollution and health projects APHEA-1 research programme (*Short-term effects of Air Pollution on Health: a European Approach using epidemiological time-series*) began in 1993, followed by APHEA-2 project. In both projects participated Polish National Institute of Hygiene. The health impact assessment (HIA) in 26 European cities located in 12 European countries was performed, among them in Cracow [3]. Cracow is also included in created in 1999 Europe-wide epidemiological observation system APHEIS (*Air Pollution and Health: a European Information System*) [4, 5]. Recently two new project concerning air pollution and health in Cracow has been initiated [6, 7]. The main objective of the first one (2004–2006): *From toxic emissions to health effects: An integrated emissions, air quality and health impacts case study in Cracow (Krakow Project)*, coordinated by the Joint Research Centre of the European Commission (JRC) was to apply an integrated methodology for the design of adequate emission abatement strategies to tackle the problems of toxic emissions, the resulting air quality and their impacts on human health [6]. The second one – just initiated French–Polish pilot study – has as objective to investigate adult asthmatics exposure to air pollution, based on a combined use of a biomarker, for characterization of human exposure to one or a mixture of pollutants and of Geographical Information Systems (G.I.S.) which integrates climatic and urban anthropogenic parameters in the assessment of spatio-temporal dispersion of air pollutants [7]. Simultaneously, the air monitoring in Poland has been developed. In 1992, the National Network of Basic Stations was set. Tightening of air quality standards has led to increasing attention to assessment of air quality management in voivodeships, hence Regional Networks of automatic stations has been created during 2000–2004 for 11 (from 16) voivodeships in Poland, including Małopolskie voivodeship. On the base of the existing data, this paper presents the past and the current wintertime air quality in Cracow and its possible effects on human health and cultural monuments.

Factors influencing Air Quality in Cracow

Cracow with 741,000 inhabitants is fourth the most populated Polish city. This old capital of Poland is a treasury of inestimable monuments and objects of Polish history and culture as well as a scientific centre. Cracow's unique Historic Centre has been declared a UNESCO World Heritage Site since 1978.

Air quality in Cracow is influenced by four main factors: geographical location, city microclimate and topography, air pollution sources in city itself and in its surroundings. Cracow's microclimate and air quality are influenced to a high degree by disadvantageous geographical location. From the west side St. Bronisława Hills and Tenczyn Bank surround Cracow, which form a barrier aggravating atmospheric circulations. The most frequent airflow is from west NW–W–SW, which often brings air pollutants from neighbouring Upper Silesian region, the most polluted region in the country (emitting 22% particulate pollutants and 31,5%

gaseous pollutants of Polish total emission). The Cracow's microclimate is unfavourable, characterized by large cloudiness (68–70% yearly) and high moisture, accompanied by the long period of very low wind speeds. An inversion of temperature is extremely frequent – it happens usually for 185 days within a year. The topography of the city is also unfavourable – medieval system of the central part of the city and narrow streets strongly aggravate pollutant dispersion. The industry localization in Małopolskie voivodeship is uneven. The biggest industrial and energetic air pollution sources are located in Cracow and its surroundings. The main air pollution sources are: Mittal Steel Poland S.A. (metallurgical processing plant), heat and power generating plants in Cracow and power-generating plant in Skawina. Moreover, the large number of municipal sources (the separate coal fired stoves, used for warming up buildings) as well as growing number of vehicles constitute significant sources of air pollution in the city. All these factors cause favourable conditions for rising air pollutants' concentrations and formation of the smog, especially black smog in wintertime [1].

Winter air pollutants' effects on human health, materials and cultural heritage

The possible health problems connected with urban air pollution have been presented in previous paper [1]. Biological effects of air pollutants were established from a large number of epidemiological studies which demonstrated that exposure to most of them was related with respiratory and cardiovascular diseases [8, 9]. Concerning winter air pollution, the biggest health problems are connected with particulates concentrations (PM10 and PM2.5). Exposure to high PM levels may results in severe health impacts up to premature death. Another pollutants under concern in winter are SO₂ and NO₂, both causing severe health impacts and significant indirect effects on health through their contribution to the formation of secondary PM (the PM2.5 fraction). Nowadays, among respiratory health diseases, asthma as well as chronic obstructive pulmonary disease (COPD) represent a considerable health problems in many European cities. A consistent rise in the occurrence of asthma has also been recorded in Poland [10]. Findings from the European projects APHEA-1, APHEA-2 and APHEIS dedicated to urban air pollution's health effects (research was carried out also in Cracow) show strong association between short- and long-term exposure to PM and mortality as well as hospital admission for respiratory and cardiovascular diseases [3, 4, 5]. The results of conducted in 2004–2006 JRC *Krakow project* confirmed and strengthened the evidence for impact of PM on health [11].

Increased deterioration of building materials and cultural monuments caused by air pollutants is another risk factor of significance. Air pollutants are accelerating the processes of corrosion and deterioration caused by weather conditions. Among the cultural resources, buildings and monuments made of carbonate stone are the most sensitive to damage and the least amenable to protective treatments. Other materials of cultural importance sensitive to damage include bronze, mortal, and cooper [12]. Anthropogenic

acidic deposition is responsible for a large part of the current material's damage. Dry deposition is considered to be more damaging than wet, since it can dissolve in the film of condensation on various surfaces and remain there for a long time. This can lead to high concentrations that are highly corrosive, since the pollutant is dissolved in such a small quantity of water [13]. From the acidifying substances the greatest damage is caused by SO_2 , which has a strong effect on the deterioration processes, both directly and when converted into sulphuric acid. NO_x is another pollutant contributing to materials damage, mainly through the formation of corrosive nitric acid. Oxidants, as ozone, are causing damage mainly to organic substances, as textiles, leather and rubber. Ozone can also increase the corrosiveness of acidifying compounds.

The corrosion rates of most materials have decreased in Europe and North America as a result of decreases in SO_2 emissions and thus its levels in many urban areas. However it is still estimated that corrosion over large parts of Europe is at least twice as rapid as the natural background rate [13]. Extensive damage, in many cases irreversible, that air pollutants cause to urban cultural heritage, is of special attention, as these effects have no material value.

Field experiments were widely undertaken in Europe and North America (see e.g. [14]) in order to derive so-called dose-response functions (DRF), by which deterioration of a specific material under influence of different air pollutants and meteorological conditions is described. In the DRF mass loss (ML) or surface recession (SR) are related to species annual average air concentrations (SO_2 , NO_2 , O_3), species rain concentrations (H^+ , Cl^-) as well as meteorological parameters (relative humidity, temperature and amount of precipitation). Current findings indicate that all studied materials, except for tin and "glass M3" (representative of medieval stained glass windows) have DRF containing SO_2 levels. The NO_2 levels are included only in DRF for glass M3. Tin has DRF containing only O_3 levels. Merely copper has DRF containing both SO_2 and O_3 concentrations.

Analysis of the Winter Air Pollution in Cracow

The first air pollution-monitoring project in Cracow, called MONAT-84, was carried out in February 1984 [2]. Prof. Jan Juda and Prof. Maciej Nowicki from Warsaw University of Technology (WUT) coordinated the project. At that time Cracow was one of the most polluted cities in Poland with yearly average SO_2 concentration reaching $100 \mu\text{g}/\text{m}^3$, which is 2 times bigger than Air Quality Guideline set by WHO (WHO AQG, 2000). The main objectives of the project were: determination of the SO_2 emission, assessing the air quality, identification of air pollution episodes/ meteorological conditions, identification the contribution of the various sources to ambient levels, verification of air pollution models and science based support to the decision makers [2, 15]. Both pollutants concentration (SO_2 , PM) and meteorological parameters were measured. The great number of important experimental data was collected, which provided valuable information on the specific meteorological conditions influencing the city of Cracow. High

frequency of occurrence of easterly winds in the morning hours, usually changed to north-easterly during afternoon and evening, had been registered. Upper temperature inversions at ~ 330 m in the morning and ~ 480 in the afternoon always associated with easterly winds have been noted. Lower temperature inversion had no correlation with wind direction, but the wind speed was always very low during them. The highest short-term SO_2 concentrations in the city centre reached $1000 \mu\text{g}/\text{m}^3$ (2 times WHO AQG from 2000). Emission from small area sources (individual domestic heating, with coal as main energy source) appeared to be the main contributor to the pollution load over Old City. Intensive black smog, with very high PM levels in the city centre occurred on frosty days with easterly winds.

Cracow was the first Polish city in which the Smog Alarm System (SAS) have been created. For winter season the SAS has been in operation from 1992. Unfortunately its operation has been suspended at the moment. Until 1998 the warning has been announced many times, for 3–5 days a year, due to exceedances of daily average PM10 warning level set to $200 \mu\text{g}/\text{m}^3$ or SO_2 daily average warning level set to $250 \mu\text{g}/\text{m}^3$. The longest episode, 11 days, was noted in 1995. Comparing these warning levels to updated last year WHO AQG [16] set to $50 \mu\text{g}/\text{m}^3$ for PM10 and to $20 \mu\text{g}/\text{m}^3$ for SO_2 (for daily averages), we can conclude, that during 90% of the 20th century updated WHO guideline values were exceeded in Cracow more than 4 times for PM10 and more than 13 times for SO_2 .

The adoption of environmental legislation transposing EU directives relating to air quality, has led to increasing attention to assessment of air quality management in voivodeships, hence after year 2000, Regional Networks of automatic stations has been put into operation in Poland. Małopolska air pollution monitoring network consists of 10 automatic stations, among them is 8 urban stations, 1 rural station and 1 roadside station. Additionally there are 65 stations, among them 46 with passive measurements and 19 with manual measurements. The daily, monthly and yearly results of measurement are available by web side from November 2004. In Cracow three automatic stations are situated: urban stations at Krowodrza and Nowa Huta (industrial area), and roadside station at Krasieńskiego street. The concentrations of following pollutants are measured: NO_2 , NO , SO_2 , O_3 , PM10 and CO. The program of PM2.5 measurements has started in 2003 at Nowa Huta station, but the data from 2003–2005 are incomplete. In Table 1 the summary of measurements made in Cracow for 2003–2006 are given for three main winter pollutants: PM10, NO_2 and SO_2 .

As can be seen from the above table the highest levels and the highest number of days with exceedances of LV were noted for PM10. The LV for NO_2 was exceeded only at roadside station, where the concentrations are the highest due to vehicle emissions. The LV for SO_2 was exceeded sporadically. For the period of 2003–2005 the worst pollution was noted in 2005.

In January 2005 the measurement campaign lasted for 3 weeks was performed as a part of coordinated by EC JRC *Krakow Project* [6]. Very interesting results have been obtained about particle size distribution: during the campaign ultra fine particles PM1.0 (with diameter smaller than $1 \mu\text{m}$)

Table1. Concentrations of selected air pollutants in Cracow (2003-2006). Data are given for cases of exceedances of the EU health-related limit values (LV). S_a denotes yearly mean concentration in [$\mu\text{g}/\text{m}^3$], NELV denotes the number of exceedances of daily LV in the year and $S_{24,max}$ denotes maximum daily average concentration in the year [$\mu\text{g}/\text{m}^3$]. Data are taken from Małopolskie voivodeship's Air Pollution Quality on-line and Air Pollution in Poland reports (2003, 2004).

Pollutant	Station	Year							
		2003		2004		2005		Jan-Feb 2006	
		S_a	NELV $S_{24,max}$	S_a	NELV $S_{24,max}$	S_a	NELV $S_{24,max}$	$S_a^{2)}$	NELV ³⁾ $S_{24,max}$
PM10	urban	50-55	77-106 224	48-55	69-81 205	55-60	127-154 354	115-144	52 592
	roadside	80	176 364	69	108 296	86	227 574	175	51 351
NO ₂	urban	<LV	no limit	<LV	no limit	<LV	no limit	50-53	no limit value
	roadside	66	value	66	value	63	value	73	
SO ₂	urban	no limit value	0	no limit value	0 101	no limit value	2 ¹⁾ 135	no limit value	1-4 134
	roadside		no data		0 50		0 101		3 140

¹⁾ daily LV is allowed to be exceeded 3 times a year

²⁾ average value for January-February 2006

³⁾ number of exceedances of daily LV for January-February 2006 (the period of 59 days)

accounted for 90% of the PM10 mass. Moreover the chemical composition of PM10 shows a high level of certain toxic organic compounds in the air, e.g. Benzo(a)Pyrene. However, the levels of heavy metals in Cracow such as Pb, As, Cd and Ni do not exceed the EU thresholds [11]. The epidemiological research, performed by the Jagiellonian University in collaboration with the JRC, showed a clear correlation between the high level of PM levels and an increase in respiratory diseases (chronic cough, child asthma, COPD). In particular, inhabitants who live in apartments heated with coal stoves, e.g. in the old districts of the town, were more exposed to the harmful effects of air pollution [11].

In the beginning of 2006 the air pollution in Poland was extremely high – during January–February the strong black smoke episodes occurred in many cities in Poland, in particular those situated in central and south part of the country. The LVs for SO₂ and PM10 have been widely and largely exceeded. Very high concentrations were measured in the biggest towns with the number of inhabitants above 500,000 (Cracow, Warsaw, Wrocław) as well as in less populated cities in Upper Silesia region: Katowice, Zabrze, Tychy, Dąbrowa Górnicza and Gliwice. The highest PM10 and SO₂ levels were recorded in Rybnik and Żywiec (Upper Silesia region) as well as in Cracow. The LV for PM10 has been exceeded much more and more often than the LV for SO₂. In Cracow at both urban and roadside stations the LV for PM10 was exceeded for 88% days during January–February 2006. The LVs for NO₂ and CO have been exceeded periodically. In Fig.1 the comparison of daily average PM10 levels measured in the biggest Polish cities (for which data were available) in January 2006 is given.

Among the biggest Polish cities air quality in Cracow was the worst. For all January 2006 SO₂ concentrations in Cracow were high and exceeded LV from time to time. PM10 levels were extremely high, reaching values 12 times exceeding the LV ($S_{24,max}$ (PM10)=592 $\mu\text{g}/\text{m}^3$).

Applying PM2.5/PM10 conversion factor used for Cracow under APHEIS study [5] and equal to 0.8 we obtain $S_{24,max}$ (PM2.5)=474 $\mu\text{g}/\text{m}^3$, which is 19 times bigger than updated WHO AQG [16] for daily PM2.5 levels (25 $\mu\text{g}/\text{m}^3$). The similar situation was during first decade of February 2006. The concentration patterns analysis showed that the black smog situation had lasted for over a month, that is January and the first decade of February 2006. During that period four black smog episodes were registered: 7.01.–13.01, 15.01.–19.01, 22.01.–30.01 and 04.02.–08.02. The main source of the appearance of these episodes was high emission of the main smog components (SO₂, PM10), caused by increased fuel (coal) combustion for domestic heating purposes due to severe winter, as well as increased vehicle emissions as a result of slower transport due to meteorological conditions such as increased snowfall. Moreover during those four periods the weather conditions were strongly unfavourable in Cracow, with stable high–pressure front, low air temperature (the lowest average temperature measured daily reached –27°C) and average daily wind speeds dropping to 0,1 m/s. From among these four episodes the second one (between the 15th and the 19th of January 2006) may be considered the less serious. The other three episodes were quite similar to each other, although it may be stated that the period between 22nd and 30th of January was the worst in respect of the air pollutants' concentrations and meteorological conditions. Within that period the lowest temperatures and the highest concentration levels of SO₂ and PM10 were recorded. It was also the longest of all the four episodes. Such poor air quality hadn't been observed in Poland and other European countries for years. Extremely high PM10 levels, together with high SO₂ levels (both pollutants act synergetic) certainly strongly affected human health.

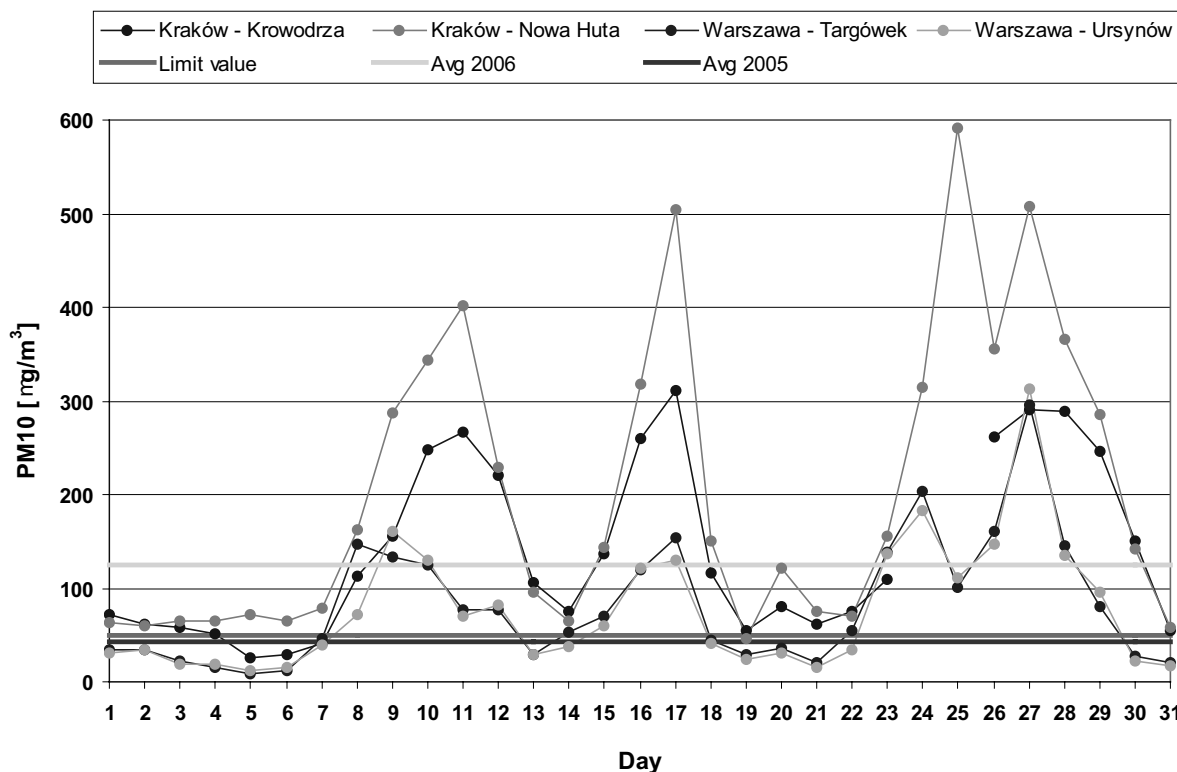


Fig. 1. PM10 daily average concentrations during January 2006 in Polish cities with number of inhabitants above 500,000 (for cities with available data; data from web pages of voivodeships Air Pollution Networks).

Discussion of Results

Unfortunately, the data concerning increased disease prevalence and mortality, which might have been connected with the black smog incidents in Poland in the beginning of 2006, are not available at the moment. However, health impact assessment (HIA) results are available from APHEIS studies for Cracow for the year 2000, when 6576 inhabitants died in the city. The annual PM10 level was equal to $32.1 \mu\text{g}/\text{m}^3$, but for 265 days daily mean level exceeded $20 \mu\text{g}/\text{m}^3$. This was associated with 29 to 50 short-term deaths per year that could be prevented, depending on dose-response function applied [4]. Note, that in January–February 2006, recorded concentrations were much higher and daily LV for PM10 ($50 \mu\text{g}/\text{m}^3$) was exceeded for 52 from 59 days. In the APHEIS-3 study the public health impact of long-term exposure to PM2.5 in terms of attributable number of deaths and the potential gain in life expectancy in 23 European cities were quantified [5]. For most cities, PM2.5 levels were calculated from PM10 measurements using a local or European conversion factor (equal to 0,7). For Cracow local conversion factor for PM2.5/PM10 ratio was applied (equal to 0,8). The HIA estimated that 16,926 premature deaths from all causes, including 11,612 cardiopulmonary deaths and 1901 lung-cancer deaths, could be prevented annually if long-term exposure to PM2.5 levels were reduced to $15 \mu\text{g}/\text{m}^3$ in each city. In terms of life expectancy, it was estimated that if the annual mean of converted PM2.5 did not exceed $15 \mu\text{g}/\text{m}^3$, the potential gain in life expectancy of a 30-year-old person would average between one month and more than two years in the APHEIS cities, due to the reduction in total mortality. For

Cracow this value was equal to one year [5]. The mean for January 2006 PM10 level in Cracow, was equal to $138,62 \mu\text{g}/\text{m}^3$ (urban station: Krowodrza). Converting this value to PM2.5 levels (using $\text{PM2.5}/\text{PM10} = 0,8$) we obtain $S_{\text{Jan } 2006}(\text{PM2.5}) = 110,89 \mu\text{g}/\text{m}^3$, which is 4,4 times bigger than updated WHO AQG [15] for daily PM2.5 levels ($25 \mu\text{g}/\text{m}^3$). Applying PM0.1/PM10 ratio gained during 2005 measurement campaign (*Krakow Project* [11]) and equal to 0.9 we obtain $S_{\text{Jan } 2006}(\text{PM1.0}) = 124,76 \mu\text{g}/\text{m}^3$. Both measured and recalculated PMs levels are extremely high and certainly were associated with increased disease occurrence and considerable number of premature deaths. Definitely, in January 2006 smog alarm should have been announced in Cracow and other Polish cities and there should have been actions performed in order to decrease health effects. Unfortunately such activities were not undertaken.

Conclusions

The air pollution in Cracow has been analysed starting from 1984 up to the beginning of 2006. It was demonstrated how Cracow's unfavourable microclimate, geographical location, urban topography and existing emission sources strongly influence urban air quality. The high air pollutants' concentrations, especially high PM10 and SO_2 levels, were measured in 1984, in nineties of the 20th century and in the beginning of the 21st century (2005, 2006). In January–February 2006 the air pollution was exceptionally high due to severe winter, increased coal combustion for heating purposes, increased vehicle emissions and unfavourable weather conditions. Strong black smog episodes occurred in January 2006, with daily PM10 levels exceed-

ing up to 12 times EU health-related limit value, and converted daily PM_{2.5} levels exceeding up to 19 times updated WHO AQG. The effects of human exposure to black smog episode are presently impossible to determine, due to the lack of relevant medical statistics. However measured PM₁₀ levels were so high (subsequently also PM_{2.5} levels) that according to the newest APHEIS health impact assessments, significant rise in mortalities from respiratory, cardiac and circulatory diseases is highly probable. Due to high levels of SO₂ and high relative humidity, Cracow's historical buildings'/monuments' deterioration is highly expected as well. Increasing frequency of extreme winter conditions may increase the occurrence of air pollution episodes in Cracow, thus affecting strongly both human health and cultural heritage of the city in the future. The severe air pollution in Cracow in the beginning of 2006 and lack of actions performed in order to decrease its health effects incline to postulate that modern Smog Alarm System is critically needed for Cracow. Moreover, there is a necessity for introduction of alert threshold for PM (PM₁₀, PM_{2.5}) in the EU legislation (at present alert thresholds are set only for SO₂, NO₂ and O₃), as current levels of PM₁₀ throughout the European urban areas are frequently exceeding EU limit value.

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The Accountability Effect of Forests Fires

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Abstract

The multiple consequences of forest fires in sustainable development and environmental responsibility are well known, in a country like Portugal where Tourism is one of the principal economic activities. The aim of this research is to study the forests protection and its social, economic and environmental effects in Tourism. Consequently, the research analyse the accountability effect of forest fires. Therefore, the results suggest a need of the trilogy prevention–detection–surveillance in the forest protection and in the environment preservation, with view to the maintenance of the biodiversity in a role of the Government and Citizens.

Keywords: tourism, forests fires, sustainable development, social responsibility

Introduction

The Paragliding World Cup promoted by the Paragliding World Cup Association in the 2005 tour had five events in Sopot (Bulgaria), Bourg St Maurice (France), Nis/Sicevo (Serbia), Monte Cornizzolo (Italy) and Serra da Estrela (Portugal). In the last event, the competition has been cancelled for several days because *wind and the forest fires are still not under control* [1]. So, Portugal had reached a critical stage of the emergency in terms of forests fires. The disrespect for the environment is more than an ethical problem that is placed in the society, has profound consequences at the political, social and economic level. However, at the same time and paradoxically, the authors confirmed the increase of an ethic sense of the Society and firms, as well Citizens, recognize each one more the importance and the value of ethical and socially responsible behaviours, as well as the risks and costs that the deviations as regards to ethics per times involve.

Despite all of these, tourism entities cannot flourish in detriment of the environment destruction. In these fights against forests fires, the corporate social responsibility (CSR) should be treated as an investment, not a cost. Thus, the CSR strategy is staying in syntony with the local environment and in the context of the global economy [2]. In countries where the trilogy prevention–detection–surveillance in the forest protection and in the environment preservation is financed through the public spending, the problem of the orientation of the all system is fundamental. In those entities an economic conception of the CSR as a global corporate citizenship and stakeholder management practices will emerge as an alternative to traditional management practices [3].

This research presents dual theoretical frameworks for the accountability effect of forests fires. The first is based in accounting theory and disclosure information, providing explanations for economic and social decisions [4, 5]. The second theoretical framework as is origins in organisational and sociological theory [6] that will assure the link of CSR as a fundamental objective to influence the forest protection and the environment preservation.

Experimental procedures

In a wide dimension, the United Nations Millennium Declaration establishes that of the fundamental values for the 21st century is part, among others: **Respect for nature.** *Prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development.* **Shared responsibility.** *Responsibility for managing worldwide economic and social development, as well as threats to international peace and security, must be shared among the nations of the world and should be exercised multilateral* [7]. Effectively, the sustainability principle of CSR [8] has a significant role to play in the economic and social development, in general, and in the eco–tourism sector, in particular, and in the relationship between the Government and Society.

Consequently, fits to Governments, as well as to Citizens, the important task of caring for a better place to live, where everybody adjusts its actions socially to responsible behaviours, contributing to the competitiveness of its area and the well–being of the society in that they interfere, in an efficient, productive and socially responsible way. Thus, the destruction of the forest and the significant increase,

year after year, of the forest fires has alert Governments and Citizens for the need of a larger involvement and permanent responsibility in relation to the environment.

The European Union thought the *Green Paper* [9] understands that *being socially responsible means not only fulfilling legal expectations, but also going beyond compliance and investing 'more' into human capital, the environment and the relations with stakeholders*. Actually, many factors justify the evolution of the CSR [9]: new concerns and expectations from citizens, consumers, public authorities and investors in the context of globalisation and large scale industrial change; social criteria are increasingly influencing the investment decisions of individuals and institutions both as consumers and as investors; transparency of business activities brought about by the media and modern information and communication technologies; and increased concern about the damage caused by economic activity to the environment for example with view to fight against forests fires.

Also, the Treaty establishing a Constitution for Europe reflect the Community concern in the definition of a strategy at the level of the forest and of the biodiversity, when defending in the article III-119 [10] that *environmental protection requirements must be integrated into the definition and implementation of the policies and activities referred to in this Part, in particular with a view to promoting sustainable development*.

In this context, the Report of the EU Forest Strategy [COM(2005) 84 final] reinforces that the forests protection is one of the Community concerns, especially in what relates to the fires as cause of the forests destruction, in parallel with the atmospheric pollution and other factors: biological; economic; social; and political [11]. Thus, at an operational level, fomenting the cooperation among the States-members, EU has been developing a politic of forests protection against the forest fires and the atmospheric pollution through the publication of several legislations that are example the Regulation (EC) n^o 2152/2003 (*Forest Focus*) that concerns to the monitoring of forests and environmental interactions in the Community [12] and the Regulation (EC) n^o 2121/2004 related to the protection of the Community's forests against fire and the protection of the Community's forests against atmospheric pollution [13].

Also at Community level, two of most important Directives in the ambit of the conservation of the nature links with the process of creation of the Natura 2000 Network: Council Directive 79/409/EEC [14] and Commission Directive 91/244/EEC [15] on the conservation of wild birds. The Natura 2000 Network is a European project developed by eleven BirdLife Partners of the BirdLife International and co-financed by the European Commission for the environment, whose beginnings base in the conservation birds, their habitats and global biodiversity, working with people towards sustainability in the use of natural resources. This Network in Portugal is composed by the group of the Special Zones of Conservation (SZC) and of the Zones of Special Protection (ZSP) that correspond to 12,8% of the Portuguese territory or 1.137.836 hectare [16].

The forest activity carries out, also, a primordial paper in the execution of the objectives of the United Nations Convention to Combat Desertification (UNCCD). This con-

vention, celebrated in Paris 1994, established an extremely wide and ambitious objective that is centred in the combats to the desertification and the mitigation of the effects of the drought serious and/or desertification, particularly in Africa through the adoption of effective measures in all the levels, supported in agreements of international cooperation and partnership. Effectively, the international community has long recognized that desertification is a major economic, social and environmental problem of concern to many countries in all regions of the world. Following this, the UNCCD recommends the increase of the productivity of the Earth and its rehabilitation, as well as the conservation and sustainable management of resources of the earth and hydrous, as orientations to improve the conditions of communities' life [17]. In the Portuguese case, the fomentation of a maintainable forest management, supported in the expansion and improvement of the forest area, associated to the fomentation of its use for several ends and to the development of the forest infrastructures network, passes for: the forest measures in the agriculture and eco-tourism; the program of forest development; the law of the forest politics; the plan of maintainable development of the Portuguese forest; and oriented lines of the structural reform of forests sector.

The authors want to promote the development of pioneering practices that will bring greater accountability, improve transparency and increase the sustainability of the forests' practices in Eco-tourism. Despite all the definitions presented in the literature [18, 19], usually, it does not mention the responsibility of the eco-tourism industry for environmental conservation [3]. However, Blamey [20] specifies that in the *eco-tourism experience the primary intention being to study, admire, or appreciate the scenery and its wild plants and animals, as well as any existing cultural manifestations (both past and present) found in these areas*.

Results

In the practical context, the economic evaluation of the environmental slope, supported in the proposal of Pearce & Markandya [1], is justified through different parameters associated to its value. The research analyse the accountability effect of forest fires in Portugal, Spain, France, Italy and Greece based in the DGRF [21] data, because all of these countries face the same disaster that will present in Table 1. However, since policy-makers are actively designing and modifying accountability effects of forest fires, the authors believe that conveying currently available information about how they seem to be working, even if that information is preliminary, is worthwhile.

In Table 1 is possible to observe a strong disequilibrium between 1995-2005 and 1985-1995 that implies greater costs and, in 2005, in some unfortunately circumstances even the lost of 13 human life's being 10 fire-fighters. Moreover, the Portuguese effects of forests fires hold even when evaluated in a global effect. During all the period of 1980-2005, each year the number increases and at the same time represents more than 500 mil hectare of burn area of forests, that involve more or less than 2% of the forest surface in the South of Europe and more than 60% of

Table 1. Central tendency measures of forests fires in Spain, France, Italy, Greece.

Forests Fires	Central tendency measures	Portugal, Spain, France, Italy and Greece			Portugal		
		1980-2005	1985-1995	1995-2005	1980-2005	1985-1995	1995-2005
		(26 years)	(10 years)	(10 years)	(26 years)	(10 years)	(10 years)
Number	Average	50.318	47.621	65.065	17.738	14.052	28.847
	Standard deviation	16.774	13.921	8.936	11.117	8.676	4.832
	Maximum	76.234	75.305	76.234	35.212	34.116	35.212
	Minimum	22.877	26.741	53.849	2.349	4.348	21.970
	Sum	1.308.256	523.831	715.711	461.199	154.567	317.312
Burn Area (ha)	Average	494.691	564.065	419.377	117.059	104.033	163.149
	Standard deviation	183.644	189.962	170.929	90.060	52.088	114.970
	Maximum	983.447	983.447	739.379	425.706	182.486	425.706
	Minimum	239.014	356.001	239.014	22.435	22.435	30.535
	Sum	12.861.978	6.204.713	4.613.150	3.043.531	1.144.363	1.794.640

the European Union Forest Area [22]. About forests fires in the State–Members of European Union, similar trends were confirmed in this research and in San–Miguel–Ayanz [23].

On one side, the fires are part of the natural cycle of the forests, assuring the maintenance of the reproduction of the insects and plants. On the other side, starting from the moment in that the Man has a active participation in that phenomenon, the forest fires stop happening spontaneously to assume uncontrollable dimensions and of alarming proportions, contributing to the loss of the biodiversity and for reduction forest production, not being in many possible cases of restoring, getting lost hopelessly. Thus, in the ambit of economic evaluation in the environmental slope, imports state the ‘existence value’, which does not depend on its use actual or future but of the factor of that asset to be extinct. These perspectives are proposed as the normative principles that should be used to anchor organizational and professional ethical standard setting. However, each of the criteria utilizes different moral concepts, and each one emphasizes aspects of ethical behaviour that are not emphasized by the others.

The process of ethical decision–making requires that behaviours be assessed against standards or norms of acceptability. Velasquez et al. [24] presented a schematic for ethical decision making that focuses on whether an action or decision meets three ethical criteria: utility, rights and justice. *Utility* judged behaviour in terms of its effects on the welfare of everyone. *Rights* express the requirements of ethics form the standpoint of the individuals, in other words ethical decisions must project the individual’s legal and moral entitlements [25]. *Justice* is essentially a condition characterized by an equitable distribution of the benefits and burdens of working together requiring that all citizens be guided by fairness, equity, and impartiality.

These values form part of the organizational culture and they should be incorporated in an explicit way in the corporate objectives through the definition of the corporate mission especially in eco–tourism area [26]. The ethics influences the CSR assumed by organizations and entities in eco–tourism, elevating the acceptable minimum previously above the fastened by the organizations’ groups of interests.

Discussion

The results suggest a need of the trilogy prevention–detection–surveillance in the forest protection and in the environment preservation, with view to the maintenance of the biodiversity in a role that each Government and Citizens must play in global society. According to the Report of The State of the Environment 1999 [16], elaborated by the *Instituto do Ambiente de Portugal*, the importance of the biological biodiversity *assumes a crucial paper for the human species, once approximately 40% of the world economy and 80% of the needs of the people depend on the biological resources*. The economic objective of the tourism strategy faces several problems around the world. For example, several countries as Portugal have special characteristics as hospitality, safety, good weather conditions and with forest protection improvements, as well as in infrastructures, in human resources, in training and in research and development could be promoted the forests inside the eco–tourism with important economic influences. The increase level of regulation and laws made by the National Government and the International entities in the field of forest protection show a very passive role, suggesting that it will be more a multi–dimensional problem that requires an awareness of knowledge and cultural changes. This discussion generates a consensus that emerges among governments, firms, entities and citizens that the concepts of forest and eco–tourism can be framed in the context of management goals and objectives [27]. All efforts to develop an understanding of the capability of land to produce good environment have been an inherent element of forest management for more than a century. Sustainable development is essential need to improve quality in eco–tourism, but the accountability effects of forests fires influence the performance of eco–tourism economic activity.

In summary, to influence the forest protection and the environment preservation is an essential need of the society and the transparency, sustainability and accountability that yields better policy to be promoted by policy–makers. The forests exist as a fundamental element that assures life and quality of living and it should be available to everybody and for everybody. More than the discussion about the forests and fires, it is important to seeds for growing up the

new forest. However, seed presence on the forest floor does not necessarily guarantee species' success in a germination and survival process. So, tourism based on ecological principles is also more likely to assure forest sustainability and the promotion must be made between the Society and Citizens.

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Applicability of Biotechnology for Remediation of Grounds Contaminated with Hydrocarbons from City Areas

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Abstract

In the first half of the 20th century, coalbed gas was used for lighting streets and squares as well as for heating housing and production objects. In the course of its production the ground-water environment was considerably contaminated, mainly with mono- and polycyclic aromatics and mineral oils. Even after so long, these areas still create a serious hazard for human health and groundwater, which has to be treated.

At present these areas can be found between the city objects with numerous underground technical and communal utilities. This considerably hinders the selection of efficient treatment methods used nowadays.

A unique, patented method of cleaning ground environment was presented in the paper. It lies introducing autochthonous bacteria in the form of an aerosol in the aeration zone. This method is applicable in all geological-technical conditions and enables cleaning ground environment from hydrocarbon contaminations. The efficiency of this method can be significantly increased by modelling the remediation process.

Keywords: environmental pollution, hydrocarbons, bioremediation, modelling remediation processes, bioaerosol

Introduction

With the growing industrial demand for gas at the turn of the 19th and 20th century, the existing installments for coalbed gas production started to be used at a large scale. Apart from gas and coke, there were also produced by-products, i.e. tar, ammonia water, ammonium sulfate, neutral oil, carbolic acid, mud oil, PAK (Polizyklische Aromatische Kohlenwasserstoffe) from dehydrated tar as well as purified and non-purified benzene. Most of these by-products were sold. However, owing to the rapid development of chemical and petrochemical industry, the demand for these products gradually started to considerably decrease. The surplus was stored, and then when the production definitely stopped, it was frequently deposited underground at the gas field area, creating hazard for ground and water environment. The magnitude of the contamination also depended on failures of the operational gas systems and damage done during the World War II period.

The presence of these substances in the environment is hazardous both for the living organisms inhabiting water and land ecosystems, and also for human health [1, 2]. Chemical compounds making up the by-products and waste products of gasification processes are toxic, mutagenic and cancerous in character [3].

Substances responsible for environmental pollution in the area of “abandoned gas-works”

For assessing the state of environment in the area of “abandoned gas-works”, the range and degree of ground and water pollution should be specified, and the contaminants identified. Among the substances most hazardous for ground and water environment is tar from the gas production processes. It contains small quantities of light oils, phenols, cresols, naphthalene, anthracene, pyridine base, and the dominating components, i.e. average and heavy oils as well as PAK. PAK is composed of polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Benzene contains hazardous benzene and its derivatives, i.e. xylene and toluene.

Toxic character of hydrocarbons and their hazardous influence on human health is mainly connected with their ability to penetrate the food chain [2–4]. Among the particularly dangerous aromatics are benzene, which is proved to be cancerous for human beings, and genotoxic polycyclic aromatic hydrocarbons. Moreover, oils composed of polycyclic aromatic hydrocarbons are proved to be cancerous, and some of them are co-carcinogenic [2, 3].

A chemical characteristic of tar being a by-product of gas production is presented in Table 1, and a quantitative composition of benzene produced in the course of coal gasification is given in Table 2.

Analysis of ground and water environmental hazards

The presence of coal products in the ground and water environment creates a number of hazards which may be caused by:

ones are: existence of active sources of contamination in the form of filled underground spaces, chambers and remains of installation, geologic conditions, hydrogeologic conditions, existence of underground utilities, neighbourhood of water courses and groundwater intakes, as well as

Table 1. Characteristic of tar, a gas by-product [5].

Properties	Value
Density	1.07 – 1.35
Group composition, %	
paraffins and naphthenes	ca. 6.5
aromatics	ca. 23
phenols	0.3 – 20
organic bases	0.2 – 2.5
naphthalene	2 – 7
solid paraffin	0 – 5
Elemental composition, %	
carbon C	85 – 93
hydrogen H	5 – 8
nitrogen N	0.5 – 1.0
sulphur S	0.5 – 1.0
oxygen O	1.0 – 2.5

Table 2. Quantitative composition of benzole produced during coal gasification [5].

Components	Content [%]
low-boiling	0 – 0.2
paraffins	0.1 – 17.4
benzene	27.0 – 55.0
toluene	11.6 – 18.1
xylene	3.0 – 7.1
solvent naphtha	1.9 – 11.1
phenols	3.2 – 4.9
post-distillation remains	1.1 – 2.8
refinery losses	11.2 – 18.4
distillation losses	0.5 – 0.8

- migration of hydrocarbons in the ground and water environment
- migration of the contaminated ground to other places which are not fit for their deposition during repair and investment operations
- contamination of machines, equipment and work clothing
- migration of volatile aromatics through underground infrastructure to objects inhabited by human beings

The magnitude of potential hazard in a specific place is influenced by a number of factors. The most important

present mode in which the area is managed and planned [6–9].

The procedure of reducing the effects of environmental pollution should focus on finding, opening, analyzing and emptying the underground reservoirs and remains of installations. This should be followed by cleaning the ground and groundwaters. In some cases, it may be advisable to limit the migration of contaminations beyond the polluted area by applying special filtration protecting screens.

Cleaning areas contaminated with coal products is a difficult task because of heavy oil fractions. Owing to the gravity forces, they move to the bottom of the water-bearing strata, slowly migrating with the groundwaters.

Evaluation of biodegradability of hydrocarbons

For assessing the usability and efficiency of biological remediation methods for ground and water environment contaminated with coal products, it is essential to know the qualitative composition of hydrocarbons. The analysis of available literature data reveals that specific hydrocarbons considerably differ in their biodegradability. One of the most important factors determining the biodegradability is the chemical composition of the specific xenobiotics, in that [6, 7, 10]:

- presence of oxygen in a hydrocarbon particle
- length of chain
- branching
- presence and location of substituents (halogens, nitro, amine, sulfo groups)
- ring structure and number of rings
- degree of polymerization
- cross-linking with other particles to limit the access of enzymes (e.g., lignin, cellulose)

Oil and coal products which penetrated the environment begin to age almost immediately in the process of evaporation, dissolution in groundwaters and surface waters, oxidation, emulsification, dispersion, sedimentation adsorption and biodegradation. The course of these processes greatly depends on volatility, solubility and biodegradability of components present in the liberated materials. The biodegradability of hydrocarbons depends, among others, on their chemical structure.

Among the most important factors determining the speed and efficiency of hydrocarbon degradability in the ground and water environment are chemical, environmental and biological factors [4, 8, 9]. The biodegradation process is correct only when the introduced microorganisms are provided optimal growth and reproduction conditions. Among environmental factors which significantly influence the rate of hydrocarbon biodegradation are: oxidation, temperature, pH, nitrogen and phosphorus content, elimination of toxic compounds and appropriate water content.

Selection of a ground cleaning method

In the past 20 years, the biological methods have been more and more commonly used for cleaning the ground from contaminations.

When selecting a bioremediation method for cleaning the ground contaminated with hydrocarbons it is crucial to know a number of parameters, e.g. type and magnitude of contamination penetration in the ground, geologic conditions and detailed hydrogeologic conditions. Among the most important factors, determining the applicability of a biological method are [3, 4, 7]:

- presence of biodegradable hydrocarbons in the contaminated environment
- presence of microorganisms liable to the required catabolic processes

- lack of mutagenic metabolites in the process of microbiological decomposition of hydrocarbons
- ability to create conditions favorable to the development and activity of microorganisms in the cleaned environment
- ability to lower the hydrocarbon content to the required level

Simulation of the ground cleaning process with a biological method in the aeration area

The ground contaminated with hydrocarbons in the aeration area can be efficiently cleaned with the use of a biological method. It lies in introducing microorganisms in an aerosol form to the environment [11]. The biodegradation process can be simulated by intense aeration, introduction of biogenic substances and inoculation of the ground with microorganisms [3, 4]. This method is especially recommended for cleaning grounds contaminated with coal gasification products.

A technological scheme of the process of ground cleaning in the aeration area with microorganisms introduced in the form of an aerosol is presented in Fig. 1. [11].

For presenting the course of such a method of cleaning ground in the aeration area, a forecast was made on the basis of a 3D analytical model worked out by Domenico [6, 12, 13].

There was assumed an area of 25 m x 50 m, i.e. 1250 m² of efficient removal of hydrocarbons from the ground; there were also planned 12 injection wells.

The plot in Fig. 2. represents the cleaning process of ground environment in the aeration area with the use of a microbiological method, where the microorganisms were introduced with an aerosol [11]. The presented plot was made on the basis of the Domenico model, accounting for an empirical dependence for the biodegradation process [6, 12, 13].

Conclusions

1. Chemical compound making up by-products and waste products of the coal gasification process have mutagenic and cancerous properties. Their presence in the environment is hazardous for human health.
2. Operations related to cleaning the ground and water environment contaminated with coal products should be preceded by evaluation of risk, with special emphasis on the type and degree of ground environment contamination, geologic conditions and present underground utilities.
3. Prior to designing cleaning operations in the aeration area a mathematical modeling of the process should be each time. A digital model of geologic conditions of the analyzed area shall enable one optimally distribute injection and pump wells.
4. The efficiency of biological cleaning in the aeration area can be considerably improved by a novel technology lying in introducing a biopreparation in an aerosol form.

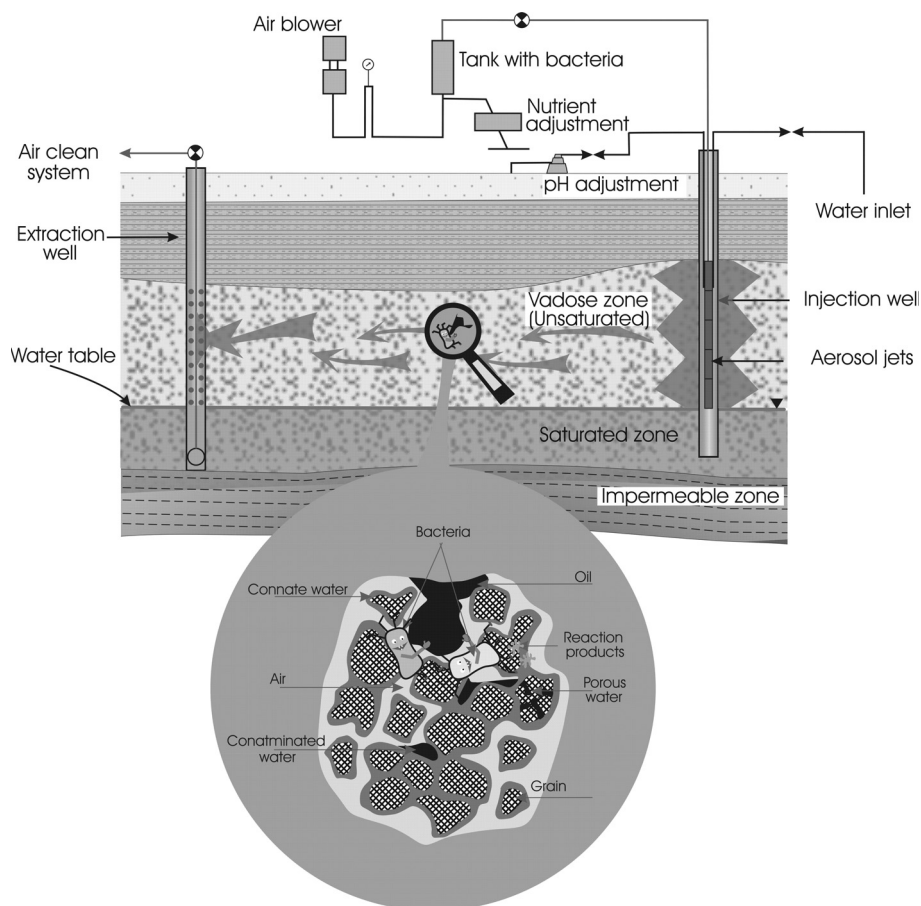


Fig. 1. Technological diagram of treating ground environment in the aeration area.

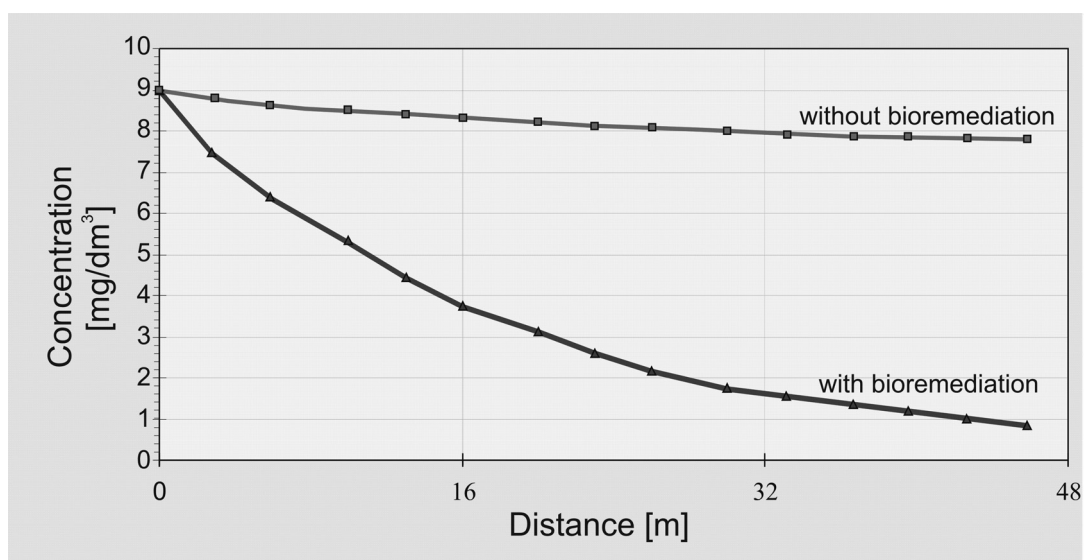


Fig. 2. The hypothetical range of hydrocarbon biodegradation process during 1 year.

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Protection of Urbanized Mining Areas in the Mine's Closing Processes

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Abstract

Closing of coal mines, especially stopping the process of mine's water pumping, results in a reconstruction of the Carboniferous water-bearing horizon, leading to the intensification of gas flux to the near-surface zone. Stopping the fans considerably enhances the movement of mine's gases towards the surface in closed mines.

The results of geochemical analyses performed in the urbanized mining area of the hard coal mine „Niwka-Modrzejów” are presented in the paper. The obtained results and their comparison with the existing geological-reservoir model prove that intensification of mine's gases flow towards the surface continues through the zones of tectonic discontinuities, crackings, loosened zones in the Upper-Carboniferous sedimentary rocks. The thickness and lithology of the underlying overburden, plays a decisive role in the limitation of mine's gases migration.

Keywords: closing of coal mines, geological-reservoir model, migration of mine's gases, environmental protection

Introduction

Closing of coal mines, particularly stopping pumping mine's waters restructures the Carboniferous water-bearing horizon, which in turn, is related with intensification of gas flow to the surface zone (the so-called „piston effect”). The movement of mine's gases towards surface in abandoned workings also considerably intensifies owing to the stopped operation of fans.

The method of surface geochemical mapping is especially useful for detecting migration of methane and toxic gases in hard coal mines that are being closed [1–3].

Geochemical analyses in the coal mine „Niwka-Modrzejów” were devoted to evaluation of the scale of occurrence of formation gases in the surface zone of the analyzed area.

Geochemical researches

On the surface of some coal mines, especially the closed ones, the increased content of mine's gases is observed, mainly of methane and carbon dioxide. The emission of these gases depends on a number of factors:

- geological conditions of the area,
- methane content of the beds and methane content in old workings,
- tectonic of the Carboniferous strata and its overburden,
- thickness of the overburden and its filtration properties,

- connection of workings and the surface with shafts and drilling wells,
- flooding of old workings.

The above factors decide about the permeability of the rock mass and possible pathways for the mine's gases.

The migration of mine's gases to the surface in closed mines is intensified owing to the stopped operation of fans. The gases are accumulated in old workings. The lack of air circulation in abandoned workings spurs out gas migration under the influence of gradients of pressure, temperature and natural depression. This is a two-phase process. At the first stage the gas is desorbed from the coal, then it flows to the old workings. The consecutive gas migration to the surface depends on the thickness and permeability of the rocks.

The process of gas outflow can be intensified by flooding of abandoned workings when the water pushes the atmosphere upwards. On the other hand, flooding of specific levels also cuts off the levels, thus disabling further desorption of methane.

Gas hazard in the post-mining areas is possible especially in mines having a permeable overburden. Moreover, it may also occur in the area of shafts and drilling wells. This effect will be probably limited to the time in which the mine is being closed [2, 3].

The closed mine „Niwka-Modrzejów” is localized in the NE part of the Upper Silesian Coal Basin. The mining area covers 19.8 km². The surface is nearly flat, and the height datums range between +240 m asl to +260 m asl [2, 3].

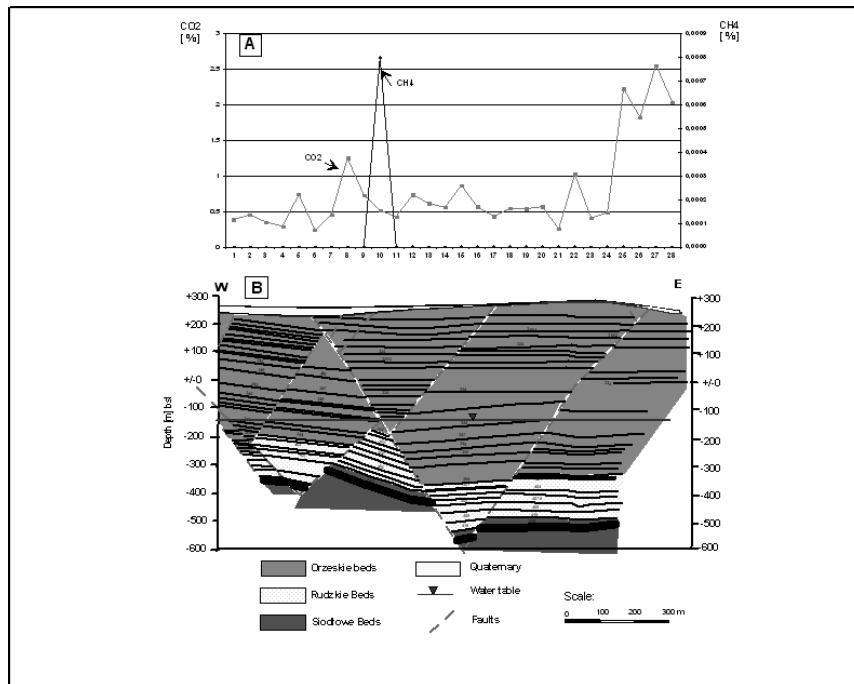


Fig. 1. (A) Methane and carbon dioxide content along the analyzed profile I-I', and (B) Geological cross-section along profile I-I' in the area of closed coal mine „Niwka-Modrzejów”.

In the area of the former coal mine „Niwka-Modrzejów” the Carboniferous beds are covered with a thin later of Quaternary sediments, i.e. 1 m to ca. 52 m. The Quaternary sediments in the form of sands and gravels are locally interbedded with clays.

The surface geochemical analyses were divided into two stages: reconnaissance (stage I) and detailed analyses (stage II).

Reconnaissance geochemical analyses were made along two selected profiles I-I' and II-II' of total length of 3450 m,

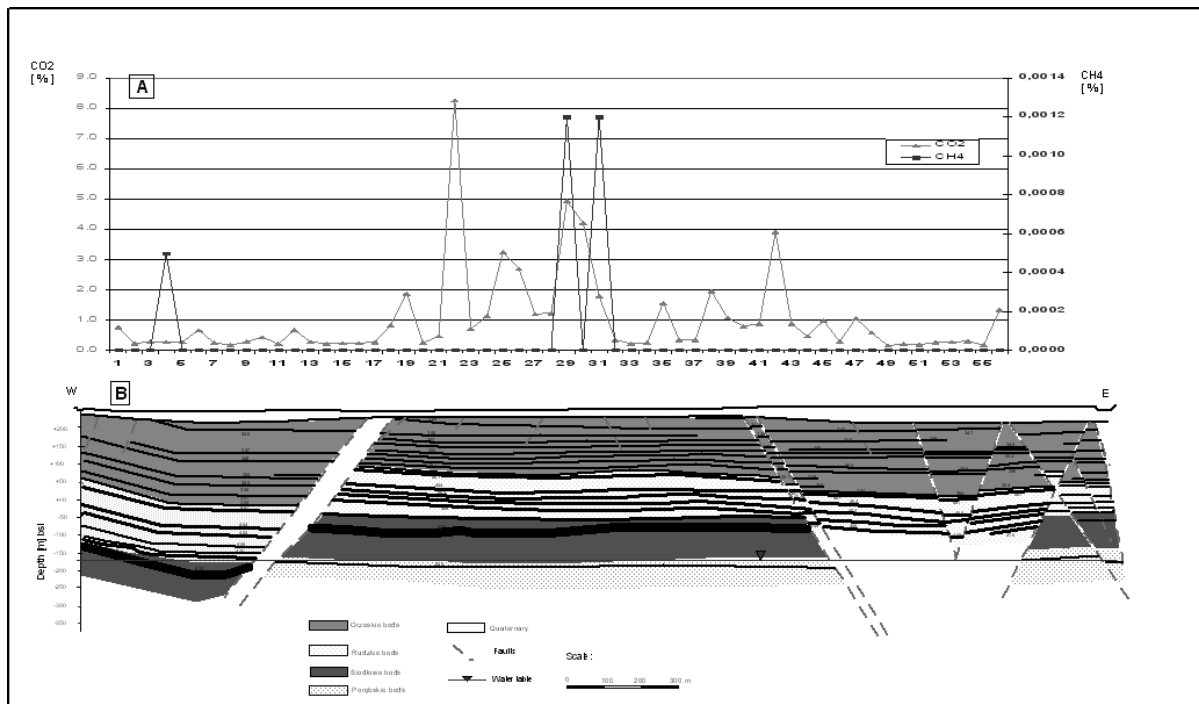


Fig. 2. (A) Methane and carbon dioxide content along the analyzed profile II-II', and (B) Geological cross-section along profile II-II' in the area of closed coal mine „Niwka-Modrzejów”.

The methane content in the coal beds in the coal mine „Niwka-Modrzejów” ranges from 0.0 m³ CH₄/Mg csw to 5.5 m³ CH₄/Mg csw. Unlike the N part of the area which has a low methane content, the SE and S parts have an increased methane content from 2.0 m³ CH₄/Mg csw to 5.5 m³ CH₄/Mg csw.

as well as analyses in the immediate vicinity of the shafts (Figs. 1, 2). Basing on the results of reconnaissance geochemical analyses of the surface along the selected profiles, detailed analyses of surface were made for areas, where increased formation gas flux to the surface was expected.

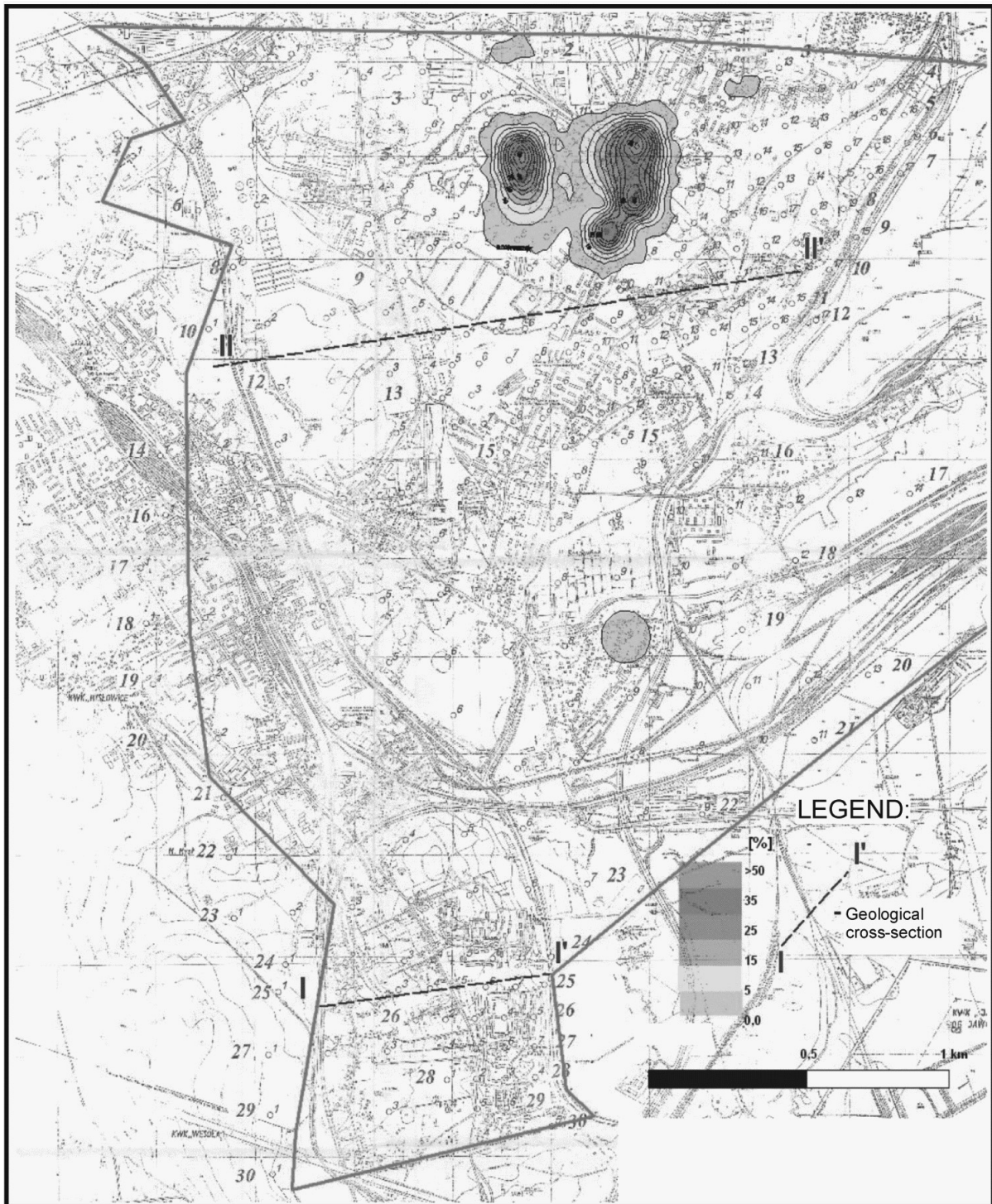


Fig. 3. Map of methane concentrations in the near-surface zone of the coal mine „Niwka – Modrzejów”.

The course of reconnaissance analyses of the selected profiles was determined on the basis of all the existing geological and hydrogeological data on methane and carbon dioxide content in the coal beds, mining data, topographic data and city plans. Profiles were localized along lines perpendicular to the Carboniferous outcrop and to the course of large tectonic dislocations. Moreover, they were localized in the areas considerably varying in thickness of the overburden and in coal-bed methane content [2, 3]. The free gas method was employed for the reconnaissance. The measurement step was 25 m. The probes were disposed at about 2 m of depth.

Detailed geochemical analyses were made for selected subareas within the mining areas of specific coal mines. The sampling places were localized within the basic and densified grid. Piezometers (probes) disposed in a regular square grid of a measurement step of 50 m were localized in the nodes of the basic grid. The probes were installed at about 2 m of depth. Detailed geochemical analyses were performed by the profile method in the direct vicinity of mine's shafts. Their task was to establish the degassing role of the shafts (Figs. 3, 4).

In all soil gas samples the gas content was measured for: CH_4 , C_2H_6 , C_3H_8 , $\Sigma \text{C}_n\text{H}_{2n+2}$, O_2 , N_2 , H_2 , He, Ar, CO, CO_2 , H_2S .

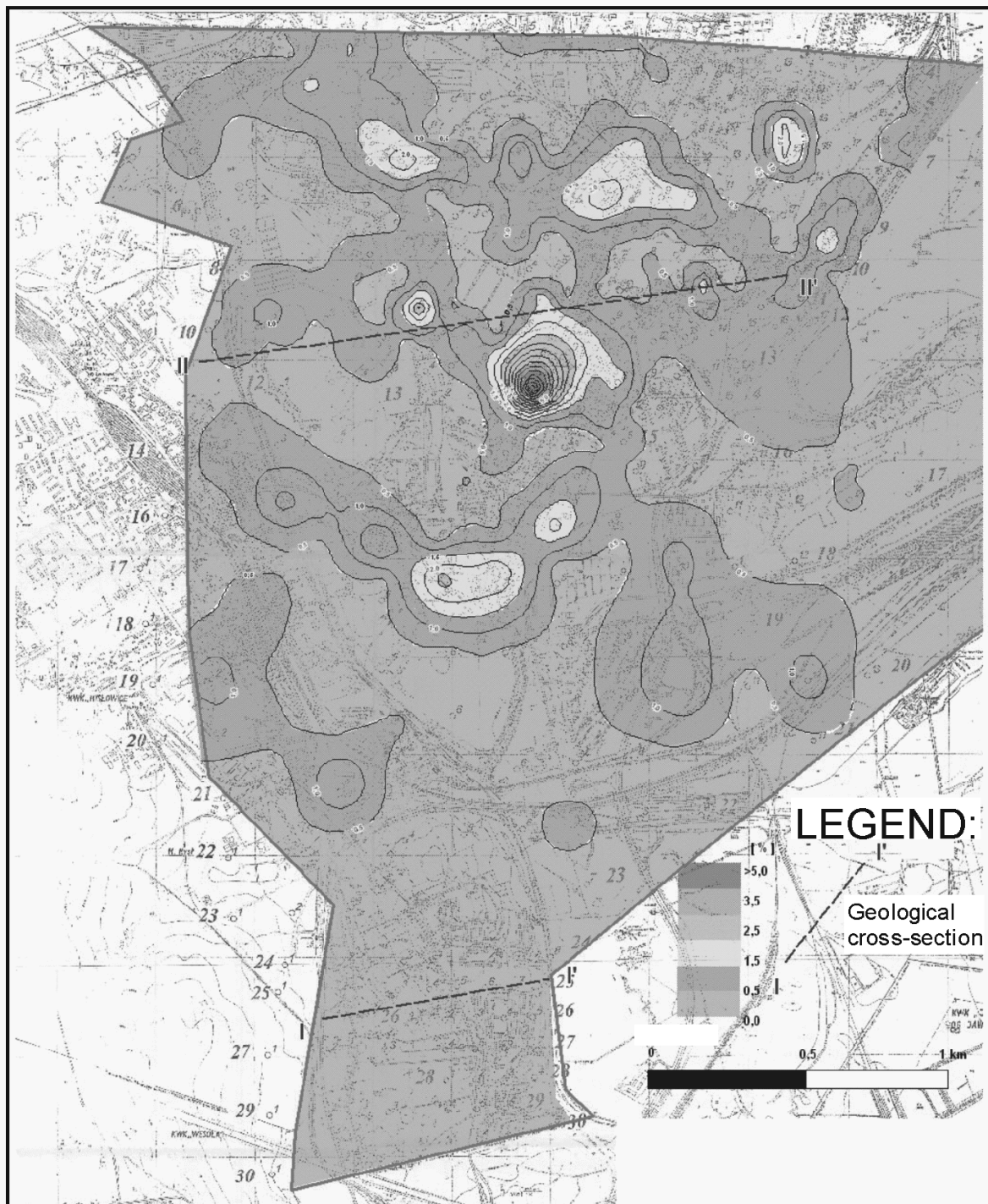


Fig. 4. Map of carbon dioxide concentration in the near-surface zone of the mine „Niwka – Modrzejów”.

Interpretation of geochemical results

The obtained results of geochemical analyses and their relation with respect to the existing geological-formation model prove that the formation gas flow to the surface intensifies through the zones of tectonic discontinuities, cracks and loosening in the Upper Carboniferous sedimentary rocks. The range and intensity of surface gaseous exhalations depends on the structure, compactness and thickness of the near-surface layers (Figs. 1–4).

Figs. 1 and 2 illustrate surface changes of methane and carbon dioxide concentration along profiles I-I' and II-II', on the background of geological cross-sections.

The maximum methane concentration in profile I-I' was about 0.0008%, and of carbon dioxide about 2.68%. Evidently anomalous gas concentrations in near-surface zone are related with the faults. The highest increase of carbon dioxide in the near-surface zone can be observed in the east part of the profile (Fig. 1).

The maximal methane concentration in profile II-II' was about 0.0012%, and carbon dioxide about 8.3%. The apparently anomalous gas concentrations in the surface zone are related with faults. The highest methane and carbon dioxide concentrations can be observed in the central part of the profile, in the area of thin Quaternary beds and intensive tectonics in the Carboniferous series (Fig. 2).

The results of detailed geochemical analyses in the area of the coal mine „Niwka-Modrzejów” are presented in maps of methane and carbon dioxide concentrations (Figs. 3 and 4).

It follows from the methane concentration in Fig. 3 for the area of the hard coal mine „Niwka-Modrzejów” that the maximal methane concentration is observed in the north part of the area and equals to over 60.00% (64.981%). The Quaternary overburden thickness in this area is below 5.0 m. The observed anomaly is related with a rapid expulsion of gas caused by inoperational mine’s ventilation system. Stopping the ventilation causes gas accumulations in old workings. The lack of the air in old workings enhances a laminar movement of gases under the influence of gradients of pressure, temperature and natural depression. This is a two-phase process. First, the gas is desorbed from the coal, then it flows to the old workings. The resulting gas migration to the surface depends on the thickness and permeability of the rocks.

The map of carbon dioxide concentration (Fig. 4) shows that maximal concentration of carbon dioxide occurs in the north part and central parts of the analyzed area, in a zone of thin Quaternary overburden. The carbon dioxide concentration ranges from 0.00 to over 8.00% (8.258%). Moreover, the high carbon dioxide concentration is observed near the shafts Bobrek (4.833%), Henryk (5.752%), Jerzy (4.655%), Mieczysław (7.629%).

The highest increases of methane and carbon dioxide concentrations can be observed in the north and central part of the area, in the zone of thin Quaternary overburden.

In the course of geochemical analyses, the water table was at –140 m on datum.

Conclusions

1. Closing of coal mines, especially stopping pumping of mine’s waters, results in reconstructing of the Carboniferous water-bearing horizon, which in turn, is related with the intensification of gas flux to the near-surface

zone (the so-called “piston effect”). The movement of mine’s gases to the surface in old mines intensifies owing to the stopped operation of ventilation systems.

2. The method of geochemical mapping of surface is especially useful for detecting migration methane and toxic gases in coal mines under closing.
3. The obtained results of geochemical analyses and their relation with respect to the existing geological-formation model prove that the formation gas flow to the surface intensifies through the zones of tectonic discontinuities, cracks and loosening in the Upper Carboniferous sedimentary rocks. The range and intensity of surface gaseous exhalations depends on the structure, compactness and thickness of the near-surface layers.
4. Gas hazard in the post-mining areas is possible especially in mines having a permeable overburden, e.g. in the coal mine „Niwka-Modrzejów”, occurs in the area of shafts and drilling wells. This effect will be probably limited to the time in which the mine is being closed.

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Management of Research and Development of Renewable Solar Energy Technologies

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Abstract

Our paper include the analysis of aspects of the management of new ideas of development and application of solar energy technologies in Germany. With a reduction objective of 21%, Germany has taken responsibility for the largest part of the EU obligation of Kyoto Agreement (the reduction of environmental pollution by 8 per cent by 2008–2012 compared with 1990 level). It is shown that the most profitable and very promising applications in Germany and Finland are: burning of grain [4], potatoes [5], white beets [6] and wood [1].

Considering the income tax, it is already now more profitable to use own grain as fuel in heating own premises, than to sell the said grain, pay income tax and buy heating oil with the earned money. It means burning of grain is a very attractive option, however unethical it may sound. This ethical problem doesn't exist in the case of burning of white beets, potatoes or woods, which are even much more cheaper sources of renewable energy [6] with production costs of 0,007€ [5], 0,008€ [5] and 0,009 € [1] respectively.

Keywords: solar energy technologies, production cost, Germany

Introduction

“It is impossible to solve a problem with the same methods that caused this problem” (Albert Einstein). It was the reason, why the Parliament of FRG with Renewable Energy Sources Act – EEG supports the research, development and applications of the new technologies connected with the generating of energy from:

- biomass [1–5]
- photovoltaic systems
- solar thermal systems
- hydroenergy
- geothermal power

The sun is a gigantic power plant. The continents of this planet are supplied over 219,000 thousand billion kWh of energy, year after year, which is 2,500 times the energy used by the entire world population. Therefore, in its “White Paper on Renewable Energy” of 1997, the European Union envisaged a total installed area of 100 km² in Europe by the year 2010. For Germany it means hard work to manage and provide attractive and innovative products and to ensure that this target will be met. Since 1998, around €15 billion has been invested in the R&D in the field and construction of solar factories and solar power plants in Germany alone. Although Germany is hardly an ideal solar energy country due to its geographic position and its mediocre sunlight, the largest market for solar en-

ergy in Europe has developed in here. Recently Germany takes second place after Japan in the world when it comes to photovoltaic power generation. At the end of 2005, German roofs boasted just less than 6.7 million m² of collector surface with a heat output of 4,700 megawatts. At present 4 % of German homes use environmentally friendly, sustainable solar thermal energy. This saves 270 million litres of heating oil every year. It should be noted that in Germany, a surface area of 12,200 km² is available for the installation of solar collectors. It is estimated that, in the long term, solar energy could cover 80 times today's energy requirements in Germany. According to rather conservative forecasts by the European Commission and the Federal German Government, European Community and Germany will need in the area of solar technologies, between 2007 and 2017, 2 millions and 1 million specialists and executive employees respectively. The most actively involved with solar technology R&D in Europe are regions of civilisation of Lake Constance (Bodenseezivilisation). For the regions of Bodenseezivilisation: Baden-Württemberg, Bavaria, Hesse, North Rhine-Westphalia, Switzerland, Piedmont and Lombardy, the development and application of the solar technologies are very important parts of technological-cultural phenomenon.

The following facts explain the dynamism presented by the regions of civilisation of Lake Constance:

- development of high tech technologies in the greatest R&D houses in the Europe: Shell Solar GmbH München, Martin Bucher Projektentwicklungen, Stuttgart, Swiss UNAXIS S.A.;
- globally leading company in the area of thin-film and vacuum technology), Siemens, IBM-Europe, Bosch, Hewlett Packard Europe, Daimler Chrysler, ALCA-TEL-SEL, BASF, Bayer AG, Novartis, AUDI, Porsche, BMW, Boehringer AG, DEC, SAP;
- highest number of patent solutions in the world (1000 per 1 million inhabitants);
- highest levels of future investment in the R&D sector in the world at 4% of GDP;
- more than 3 million SMEs (small and medium-sized enterprises) developing, implementing and applying technologies of the 21st Century.

The management of application of Renewable Energy Technologies

The German Act on Granting Priority to Renewable Energy Sources provides early-stage funding and enterprise development activities to entrepreneurs, helping build successful businesses that supply renewable solar energy technologies and services. The support include securing investment financing, training and hands-on business development assistance. Generally the EEG Act deals with the purchase of, and the compensation to be paid for, electricity generated exclusively from hydrodynamic power, wind energy, solar radiation energy, geothermal energy, gas from sanitary landfills, sewage treatment plants, mines, or biomass. According to the Act, Compensation Rates [6–7] to be Paid for Electricity Generated from:

- electricity from biomass between 8,70 Eurocent and 10,23 Eurocent/kWh,
- photovoltaic systems with min. 48,1 Eurocent/kWh,
- solar thermal systems with 1 Eurocent/kWh,
- wind power between 6,19 Eurocent and 9,10 Eurocent/kWh,
- hydroelectricity min. 7,76 Eurocent/kWh,
- geothermal power between 7,16 Eurocent und 8,95 Eurocent/kWh.

The first four sources of the renewable energies are of solar nature, the last one is of nuclear nature. From today's geothermic power stations, 1 kWh electricity is produced for about € 0.04 to € 0.08. It means that in the case of geothermic power stations the subvention is higher than the productions costs. It makes the geothermic sources of energy the most profitable business worldwide. Unfortunately the resources of geothermic energy in Germany are limited. The same is true for the wind power and hydroelectricity, which can supply less than 10% of energy used by the world population. Therefore we concentrate us in the present paper on the analysis of the tree first sources of the renewable energy.

Energy and Electricity from biomass

The most profitable and very promising applications in Germany and Finland are: burning of grain [4], potatoes [5], white beets [6] and wood [1].

At present market prices in Germany, heating oil is 55 ECU/MWh (VAT 0%) or 64ECU/MWh (VAT 16%). Respective figures for fodder grain are 0,03–0,035€/kWh [4] calculated from the market price of fodder grain, and from an average useful energy yield of 2,9 MWh/ton grain. Considering the income tax, it is already now more profitable to use own grain as fuel in heating own premises, than to sell the said grain, pay income tax and buy heating oil with the earned money. It means burning of grain is a very attractive option, however unethical it may sound. This ethical problem doesn't exist in the case of burning of white beets, potatoes or woods, which are even much more cheaper sources of renewable energy [6] with production costs of 0,007€ [5], 0,008€ [5] and 0,009 € [1] respectively.

Photovoltaic Technology

Recently is in Germany the direct generation of electricity from the sun the most promising and booming industrial sector. In 2005, more photovoltaic systems were installed in Germany than anywhere else in the world. 75,000 solar power systems with an output of 600 MW were connected to the grid, increasing the total installed solar power output to 1,500 MW.

For the coming years, it is expected to see two-digit growth rates in Germany. The German photovoltaic industry has acquired vast technical expertise on the basis of a strong domestic market, and a leading position on the international market thanks to its high quality standards. It is therefore an interesting partner for the growing number of countries where the utilisation of solar energy is rapidly gaining in importance.

Most photovoltaic systems installed in Germany today are grid-connected. From solar roofs with capacities of a few kilowatts to solar power plants with several megawatts, these installations contribute to the environmentally sound supply of power and, in their flexibility, represent enormous potential for the energy industry. In remote or rural regions, stand-alone photovoltaic systems enable a self-sufficient supply of power far away from the power grid.

Generally photovoltaic systems can be divided into three main groups. 40 % of the system output is installed at private dwellings. These systems are mounted above the roof tiles (roof-mounted systems) and have a peak output of up to 10 kilowatts, averaging around 3 kilowatts.

Larger systems with up to several hundred kilowatts of output are installed mainly on factory, office, agricultural and public buildings. These account for approximately 50 % of the market. Investors include companies, farmers, syndicates and funds.

Large-scale PV systems of more than one megawatt have a 10 % share in the market, and they usually comprise ground-mounted systems in the open countryside. In 2004, the world's largest solar power station at the time, with a capacity of 5 megawatts, began operation in Espenhain, Germany. Its capacity is sufficient to supply 1,800 households with solar power. The system comprises some 33,500 solar modules manufactured at a German production plant. PV systems such as this give an outlook today on the power station technology of tomorrow.

In addition to these standard systems, there is an increasing number of solar power systems that can be integrated very attractively from an architectural point of view with roof areas or building facades.

Even in smaller capacity ranges there is ample opportunity for the use of solar modules. Solar cells are successfully employed in pocket calculators, measuring instruments and many other mobile applications. Parking ticket machines driven by solar modules are not only more economical in terms of their installation, since there is no electrical connection, but also because they can continue to run without incurring electricity supply costs. Lighting systems for outdoor installations, which up to now could not be realised because energy costs were too high or the grid connection was too expensive, have since become achievable with integrated solutions at favourable prices.

In developing countries, where an inadequate supply of power traditionally represents a serious problem, self-sufficient solar home systems, solar water pumps, telecommunications devices, street lamps and cooling units for medicine all find use.

Photovoltaic–Cost reduction through further technical development

Only in case Photovoltaic Systems (PVS) the continuing technical development of product components and production processes has paved the way for cost reductions by 60% in recent years. The energy yield of modern photovoltaic systems has increased significantly.

Research and industry are working intensively on the development of even more cost-efficient cell materials, especially for thin-film cells. The industry estimates that the anticipated expansion of the market will result in an average cost reduction of 15 % per annum.

Photovoltaic–Market development through the Management of PVS by Renewable Energy Sources Act

The Renewable Energy Sources Act (EEG) was adopted in Germany in 2000 and has contributed substantially accelerate the development of the photovoltaic market. It guarantees remuneration to the operators of solar plants for energy supply and in this way creates secure conditions for investment. The law was accompanied by the 100,000 Roofs Programme, which offered yet another market incentive by providing low-interest credits for the operators of solar systems, thus furthering the expansion of photovoltaics.

Since 2004, the EEG alone has promoted solar power systems. It provides different payment rates for solar power fed into the mains grid depending on the size of the system (up to 30 kW, up to 100 kW, over 100 kW) and the installation location (on buildings, integrated into the facade, on the green field).

The planning security provided in conjunction with this act afforded the PV industry investments, at the billion level, in the research, development and construction of new production facilities. As a result of this political framework, it's not only silicon, solar wafers, solar cells

and solar modules that have shown high growth rates. The sale of inverters, required for converting the DC voltage generated by the photovoltaic cells to AC voltage and feeding this into the power grid, has actually tripled, with every fourth inverter exported.

The German solar thermal industry

The thermal utilisation of sunlight is a technology that has been proven for decades and is a permanent component of the heating systems in millions of homes. With the help of solar thermal collectors, even at moderate latitudes a yearly average of over 60 % of domestic water can be heated using solar energy, and space heating can be supported during the heating period. At the end of 2005, German roofs boasted just less than 6.7 million m² of collector surface with a heat output of 4,700 megawatts. Already, 4 % of German homes use environmentally friendly, sustainable solar thermal energy. This saves 270 million litres of heating oil every year. In Germany, a surface area of 9200 km² is available for the installation of solar collectors. At present, only 6.7 km² are in use. It is estimated that, in the long term, solar heating could cover a twice (200%) of today's heating requirements in Germany.

The German government supports the expansion of solar thermal energy use with various promotion programmes. Investors receive grants and low-interest loans for small systems, while the installation of large solar thermal systems for local heat supply is supported by a pilot and demonstration programme.

Glazed solar collectors represent the greatest contribution to the use of solar thermal energy in the low-temperature range (up to 100°C). Unglazed collectors are mainly used for heating swimming pools, but sometimes also for drying agricultural products. The thermal utilisation of solar energy therefore contributes significantly to climate protection. In Germany, since solar thermal power came into use back in the 1970s, vast experience has been gained in the development, production, planning and installation of solar thermal systems. This is reflected in an extensive range of attractive and efficient systems.

Growth in industry and reduction in manufacturing costs

The promotion for solar thermal energy that has been in place for many years ensures continued market growth in Germany. For the year 2005, the industry posted a sales growth of approximately 25 %. Total sales rose to 750 million euros. In 2005, the 12,500 people employed in the industry installed 95,000 systems. This represents a new collector surface area of 950,000 m², which brings the German total to 6.7 million m².

In the past 10 years, the cost of manufacturing solar thermal systems has consequently reduced and their efficiency has increased, while fossil fuels have risen in price. These factors have clearly boosted the attractiveness of solar thermal installations.

The further development of systems engineering and particularly the improved integration of the systems with

conventional heating technology make solar thermal systems a permanent component of the heating systems on offer in Germany today. Flat plate collectors are used primarily, although in recent years innovative evacuated tube collectors were also introduced on the market.

Until now, the solar thermal market was dominated by systems that only heated drinking water. However, due to the dramatic rise in heating costs and special support from the German government, last year saw a significant increase in the fitting of systems that also support space heating with solar thermal energy during the heating period. More than 50 % of the newly fitted solar collectors are installed in what we call combined systems.

Promotion gives a competitive edge in technology

Continuous market expansion since the beginning of the 1990s has led to the development of an innovative solar thermal industry, which acquired a considerable technological advantage in many areas.

Solar thermal technologies developed in Germany are being used more and more in other countries. Solar thermal system solutions from Germany use environmentally friendly, sustainable energy to provide a range of options, from heating domestic water and heating rooms to solar cooling. Selective absorber coatings and intelligent controllers are only two examples, which have made German industry the European leader in the area of solar thermal energy.

To dynamically expand the solar thermal market, the introduction of a regenerative heat act is being discussed in Germany, the objective of which would be to make the installation of solar or biomass systems for heat generation mandatory. This act is intended to significantly increase the proportion of renewable energy for the provision of heat by the year 2020.

In Germany, a surface area of 2,300 km² is available for the installation of solar collectors. At present, only 6.7 km² are in use. It is estimated that, in the long term, solar heating could cover about half of today's heating requirements in Germany.

A basic requirement for the utilisation of solar energy in concentrated residential areas is the construction of local heating networks that can be fed by large solar collector arrays. In Germany, intensive work has been undertaken on such projects. Sometimes large seasonal heat storage systems are used – these systems store the solar heat generated during the summer months and then, in the winter months, use it to heat all the system-connected homes. These storage systems have a water content of several 10,000 m³.

Another very promising area of application is solar thermal cooling, whereby the heat generated by solar collectors is used to power absorption or adsorption cooling machines. Many companies and research facilities are working on the further development of this technology, which has already been used successfully in different demonstration systems. It is expected that, before long, German manufacturers will be launching complete systems on the market.

Conclusions

The most profitable applications in Germany and Finland are: burning of grain[4], potatoes[5], white beets [6] and wood [1] with production costs of 0,007€ /kWh[5], 0,008€ /kWh[5] and 0,009 € /kWh [1], respectively.

The most promising future oriented applications of solar energy are : Photovoltaic Technology, solar thermal systems and most recently also thermal utilisation of sunlight and solar thermal cooling, whereby the heat generated by solar collectors is used to power.

Due to the technological lead position it has achieved in recent years, the German photovoltaic industry:

- is an ideal partner in international markets.
- shows competitive edge in technology secures export opportunities
- its average global growth rate of 33 % in the last 10 years underscores the expectation that,
- in the future, photovoltaics will also gain huge importance outside of Germany.
- the presently offered diversity of its, technologies has the potential to make a most significant global and versatile contribution to the supply of energy.

The solar industry has developed into a new industrial sector in Germany. Since 1998 alone, about €5bn has been invested in the construction of solar factories and power plants. The production of solar cells in German factories has risen 156-fold since 1998. Marked growth in production is also expected for 2006. Turnover in the German solar technology sector has increased more than tenfold from 1999 to 2005 – from €0.35bn to €3.7bn. Today, more than 42,500 people are employed in the solar energy branch. (Source: Bundesverband Solarwirtschaft BSW – German Solar Industry Federation, as at: February 2006). Although Germany is in no way an ideal solar energy country due to its geographical position, which means it only receives moderate solar radiation, it has developed into Europe's largest solar thermal market. When it comes to photovoltaic power generation, Germany even takes second place in the world after Japan. The export services and deliveries of Germany's solar industry comprise planning, construction, equipment, systems engineering, operation, monitoring, financing packages, and training. In addition, there are also cross-sectoral advisory services, such as technical consultation, feasibility studies, environmental impact analyses and audits as well as the provision of measurement technology.

Today about one million solar energy plants have been installed in Germany. That means more than three million people use solar energy to generate heat and power. In the year 2005 alone, a good 175,000 plants were installed for the very first time. In Germany, solar thermic plants are predominantly used to generate warm water and to augment the heating system in private households, but are also increasingly being used in larger community facilities, such as open-air swimming pools. The popularity of solar thermic as well as photovoltaic heat and power generation, despite the relatively high initial outlay, can be explained by state support programmes – especially for photovoltaic plants – and by increased environmental awareness, especially of the private consumer.

Recently, the German PV industry is offering many jobs. In Germany alone, there are around 50 manufacturers dealing with all levels of production, including silicon, wafers, solar cells, solar modules and inverters. 30,000 people are employed in the production, sale, planning and installation of photovoltaic systems.

In 2005, the industry achieved a yearly turnover of 3 billion euros. As a result of many years of product optimisation and fruitful cooperation between research, manufacturing and trade, the wealth of quality and experience that the industry has achieved is setting international standards.

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Application of Resonant Absorption of Radiation Energy to the Protection of Environment

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Abstract

The presented project should advance the understanding of the processes of resonant interaction of radiation and biologic systems. The building of the general model of the resonant absorption of energy will be proposed by systematically exploring the region with following radiation sources: electromagnetic, acoustic (from infra up to hyper-ultra-sound). The developing and promotion of following, environmentally friendly, technologies has been discussed in some details:

1. The preparation of resonant absorption based cancer treatment like photodynamic therapy PDT, a double resonant, two-step procedure that is done on an outpatient basis,

2. “Insect killing sound weapons” – **a new hope also in the fight against the *Anopheles mosquito***. Our calculations show that the resonant frequencies, which can destroy (rupture) internal organs of mosquitoes are lying between 2000Hz and 8,000Hz. *Anopheles* mosquito is the deadliest creature on earth. It is SIT resistant and responsible for more than 300 million cases of malaria and causes three million deaths each year.

Keywords: resonant absorption, radiation energy, environment protection

Introduction

The aim of this paper is to propose the building of the microscopic imaging of resonant absorption of energy in the biologic systems and subsystems. The presented ideas are basis for sustainable management of resonant absorption of energy. Generally the resonant absorption of energy appears to be built and used for a variety of applications, many of these were unfortunately, military in nature others civilian. The earliest account in the literature about the resonant absorption of the energy in physical system can be found in the Bible and describes the first military application. As detailed, Joshua (circa 1400 BC) [1] leads an attack on the city of Jericho during which he commands his people, outside the walled city, to remain in total silence for seven days. On the seventh day, seven trumpets made from ram's horns give a “long blast”, the people shout... and the walls of Jericho come crashing down. (It is significant that silence is used as well as noise and perhaps even ultrasound).

The next military projects seem to have originated ca. 3300 years later in the field of deadly resonant absorption of infrasound by French researcher Dr Gavreau in the early '70s. After abandoning his official research, Gavreau devoted himself to studying the effects of infrasound on hu-

mans and designing sonic weapons. The first was a sort of giant infrasound ‘organ’ with pipes some six feet (1.8m) in diameter and 75ft (23m) in length. On starting the device, the entire test building was shaken and nearly destroyed, while the hapless researchers were gripped in an “envelope of death” and Gavreau and his team were dangerously ill for days, their internal organs wracked with painful spasms as a result of their body cavities having resonated at the deadly frequency.

A more civil classic demonstration of resonant energy absorption is the Tacoma Narrows bridge incident. Long span bridges are now all designed with open cross section struts to dissipate some of the wind's force. The former Paramount Communications building on Columbus Circle converted by Donald Trump into luxury apartments in the late 1990s provides a contemporary example. The base of the building, which is a long narrow prism, was wrapped in scaffolding for the better part of five years. Because of a structural flaw that allowed the top floors to twist, windows were prying loose from their casements. A degree of flexibility is needed in large buildings, but it was feared that gale force winds would pop the windows out violently, showering the streets below with plate glass. Part of the building's renovation included structural repairs to dampen this motion.

We see great promise for this application of our ideas in many fields, like improvement of the state of human environment and the promotion of civil, environmentally friendly technologies (incl. the industrial, biological and biomedical applications in area of protection of the human environment and health, aside from any military applications).

Objectives and expected achievements

Present and rapidly increasing future applications of the processes of resonant absorption of radiation necessitate preventive as well as reactive research. The ideas of present paper follow a streamline of increasing complexity from bio-molecules to cells, e.g. membranes, chromosomal and DNA integrity. The proposals of the project are to analyse the physical mechanisms of resonant interaction, to assess risk of potential damage to biological activity, both functional and morphological, and to guide and accompany the development of microscopic imaging for industrial, biological and biomedical applications of the resonant absorption of any kind of energy. The fundamental goal of the project is to trigger the development of Science and Technology in the integration of technical, natural, social, economical and other sciences for sustainable management of natural resources. It should be done in linkage with the protection of the human environment, health for the improvement of the state of human environment and the promotion of environmentally friendly technologies the computer simulation of the absorption processes. The project will also bridge the existing gap of knowledge regarding the effects of Terahertz (THz) radiation on biological systems. THz radiation covers the frequency range between 100 GHz and 20 THz (i.e. a wavelength between 3 mm and 15 μm), which spans the spectral interval between the microwave- and the infrared regions of the electromagnetic spectrum. Recent technological break-through of electromagnetic radiation sources, components and devices, in the THz region, has triggered new applications in the field of material science, biology and biomedicine. Particularly, biological applications are based on the specific spectroscopic fingerprints of biological matter in the far infrared (FIR) and THz spectral regions, due to the high density of electronic, vibration and rotational states. In addition, the different values of the absorption coefficient and index of refraction of the water and the tissue-carbonated proteins at such frequencies, provide a unique contrast mechanism for biomedical imaging applications.

Surveys are to be conducted simultaneously, in fourth principle disciplines:

- Preparation of models of new cheaper and less invasive methods of therapy. The final aim is focused on the selective struggle against tumour and genetic defects removal.
- Protection of healthy cells from harmful results of resonance absorption radiation and inelastic distraction of energy in biological systems.
- Implementing of the resonant energy absorption technology in biomedical diagnostics.

The simplest model of the resonant absorption – the driven, harmonic oscillator

A simple realistic physical model for the resonant absorption of the energy is the **driven, damped harmonic oscillator**. For the sake of simplicity, assume that any dissipative force is directly proportional to the velocity of the mass and in the opposite direction. This is a good approximation of the behaviour of air resistance and produces differential equation with an exact solution. The most important case is that of a force that oscillates in a sinusoidal manner. If the driving force is of the form $F(t) = F_0 \cos(\omega t + \varphi_0)$ then the differential equation has the following form:

$$m\ddot{x} + b\dot{x} + kx = F_0 \cos(\omega t + \varphi_0)$$

with the solution:

$$x = A e^{-\gamma t} \cos(\omega_1 t + \varphi) + \frac{F_0}{m} \sin(\omega t + \varphi_0 + \beta) \quad (1)$$

$$\sqrt{[(\omega_0^2 - \omega^2)^2 + 4\gamma^2\omega^2]}$$

where

F_0 = maximum driving force, φ_0 = driving phase, k = elastic constant, b = drag coefficient, $\gamma = b/2m$ damping factor, $\omega_1 = \omega_0 = \sqrt{(\omega_0^2 - \gamma^2)}$ damped frequency, $\omega_0 = \sqrt{k/m}$,

$$\beta = \tan^{-1}[(\omega_0^2 - \omega^2)/2\gamma\omega] \quad (1a)$$

Resonant absorption and resonant scattering of radiation

For resonances to have an important effect on biology, the system must absorb energy in excess of the damping from thermal noise. For elements acting incoherently, that noise energy will be approximately equal to kT , in which k is Boltzmann's constant and T is the Kelvin temperature. Such a significant energy transfer requirement demands long relaxation times and significant coupling strengths to the absorbed radiation. Generally the dissipation mechanisms have been studied extensively (Grundler and Keilman, 1983*; Dorfman and Van Zandt, 1983*; Van Zandt, 1981*, 1986*) [2–5]. Let us to describe here in some detail the damping mechanism in the case of the electromagnetic couplings. In the case of interaction with short-wave (high energy) electromagnetic radiation the dimensions of the biological systems that we consider is of the same order as the wavelength of electromagnetic radiation. The absorption of energy by a resonant system from an electromagnetic plane wave through a dipole interaction can be expressed in terms of an absorption cross-section, σ_a defined as the power absorption per unit incident power flux and has the dimensions of by Blatt and Weiskopf [6] as:

$$\sigma_a(\nu) = 3 \frac{\lambda^2}{\pi} \frac{\Gamma_s \Gamma_a}{(\nu - \nu_r)^2 + \Gamma^2/4} \quad (2)$$

where Γ_a , Γ_s and $\Gamma = \Gamma_a + \Gamma_s$ are the absorption width, the scattering or emission width and the total width, respectively. The resonant frequency is ν_r and $\lambda = c/\nu$ is the wavelength of the radiation. The power, P_a , absorbed by

the system is given as a product of the incident power flux I [W/m^2] and cross section by:

$$P_a = I\sigma_a \quad (3)$$

which will generate an increase in energy, Δw , of the resonant system where,

$$\Delta w = P_a \times \tau = \frac{I \times \sigma_a}{\Gamma_a} \quad \text{for } \Gamma_a \gg \Gamma_s \quad (4)$$

The condition, $\Gamma_a > \Gamma_s$ will generally true for biological systems and long wave electromagnetic radiation.

Maximal Cross-section and energy transfer

The case of strong damping, $\Gamma_a > \Gamma_s$,

the maximal absorption cross-section for the resonant absorption i.e. at $\nu = \nu_r$ will be

$$\sigma_{\max} = 12 \frac{\lambda^2}{\pi} \frac{\Gamma_s}{\Gamma_a} \quad \text{and} \quad \Delta w = 12 \frac{I\lambda^2}{\pi} \frac{\Gamma_s}{\Gamma_a^2} \quad (4)$$

There are both theoretical conjectures [5, 7] and experimental results [2, 8] that suggest that low intensity microwaves fluxes might affect biology through the excitation of elastic resonances in biological systems. We extend analyses that suggest that the damping of the vibratory motion by biological fluids restrict such possibilities [4, 5] by showing that typical systems will not be coupled to the electromagnetic fields with sufficient strength to allow significant energy transfers although the damping constraint be somewhat relaxed.

The case of the resonance (weak damping)

$$\Gamma_a < \Gamma_s$$

$$\sigma_{\max} = 12 (\lambda^2 \Gamma_a) / (\pi \Gamma_s) \quad (8)$$

Resonant absorption of very long-wave electromagnetic radiation (also called EMR) has been linked with numerous health effects, including immune system problems. For example it is well known that even small amounts of microwave energy has been found to cause oscillation (vibration) of the DNA and genes without our cells. This research was conducted in 1984 at the National Center for Devices and Radiological Health at the Food & Drug Administration in Rockville, Maryland. According to Dr. Earl Prohofsky at Purdue University in Indiana, "That's worrisome because that's about the worst place in the body you'd want resonant absorption (vibration) – right in the DNA." [8]. Other research has shown that microwave [9], or laser [10] energy can actually cause the chromosomes to uncoil. In tests with laboratory rats at the Veterans Administration Hospital in

Loma Linda, California, as little as 60 hertz of non-ionizing energy (about what escapes from a leaky microwave) adversely affected immune response.

A 1984 Environmental Protection Agency report stated there was a detrimental link between radiation and immunity including negative changes in blood count, immunity and overall health among animals exposed to radio waves. In effect the U.S. government has set standards allowing the public to be exposed to microwave levels of 10 milliwatts per square centimetre [11]. Many European countries permit far less than this to their public. In a 1979 Soviet study, very low intensity microwaves about 60 times less than what the U.S. government allows, caused "inhibition of neutrophils phagocytic activity." This means that the neutrophils were not consuming foreign substances in the blood as effectively as before the microwave exposure.

Results, conclusions and innovation aspects

Project is regarded as a step directed at creating bases for the understanding of the resonant interaction of any kind of radiation and biologic systems. The building of a general model of the resonant absorption of energy will be suggested by systematically exploring the region with following radiation sources: electromagnetic (from lowest "power-line" frequency over: waves absorbed in NMR, EPR, laser, free electron lasers (FEL), to γ and X rays), acoustic (from infra up to hyperultrasound), corpuscular radiation (e.g. electron or neutron beams etc.). Most of the waves mentioned above are recently produced with power and tunability capabilities not previously available. The project follows a streamline of increasing complexity from bio-molecules over cells (e.g. membranes, chromosomal and DNA integrity) to human species. It is shown that present, rapidly increasing number of applications necessitate preventive as well as reactive research to assess risk of potential damage of ecosystem (including biological activity, both functional and morphological). The developing and promotion of following, environmentally friendly, technologies is possible:

1. the preparation of resonant absorption based cancer treatment like photodynamic therapy (PDT). PDT is a double resonant, two-step procedure that is done on an outpatient basis. After an injection with a resonant absorption of light-activated drug, which targets cancerous cells, a laser light is directed onto tumour cells.
2. "insect killing sound weapons" – a new hope also in the fight against the *Anopheles mosquito*. *Anopheles mosquito*, the deadliest creature on earth is SIT resistant, responsible for more than 300 million cases of malaria and causes three million deaths each year. **It should be noted that resonant frequency depends on the individual parameters of the biologic system (or subsystem) and can be used to selective killing one concrete insect type, only.** The calculations based of the simple harmonic oscillator model (1) shown that the resonant frequencies ($1a$), ω_0 which can destroy (rupture internal organs of mosquitoes are lying between 2000Hz and 8,000Hz. i.e. in the range of human auditory. These surprising results explain

why tests on devices, using ultrasound frequency show that they don't kill or repel mosquitoes. For more precise calculating of deadly resonant frequencies are necessary the measurements of the dynamical (elastic), electric and magnetic parameters of each body parts of insect (head, thorax, and abdomen). It should be noted that in the case of mosquitoes the estimated frequencies of same thousand Hz correspond just to resonant frequencies of infrasounds destroying the internal organs of human body: (0.5 – 4Hz), (4Hz – 7Hz), (7Hz – 12Hz), and (13Hz – 30Hz). A worldwide application of resonant absorption of radiation in the fight against insects can considerably reduce the environmental costs of pesticides estimated at US \$120 billion per year.

3. resonant absorption based technologies like Sterile Insect Technique (SIT). The SIT helped to farm the most fertile parts of Africa by eliminating the tsetse fly causing the sleeping sickness disease. The economic effects of SIT are estimated by FAO at US\$ 10 billion per year.
4. the phenomena in the existing gap of knowledge regarding the effects of Terahertz (THz) radiation on biological systems, which covers the frequency range between 100 GHz and 20 THz (i.e. a wavelength between 3 mm and 15 μm). THz biological applications should be based on the specific spectroscopic fingerprints of biological matter in the far infrared (FIR) and THz spectral regions, due to the high density of electronic, vibration and rotational states.

The general objectives of the future experimental research will be realised by:

- Creation of general model of resonance absorption of all types of radiation in physical inanimate systems and animate organisms as well as its widening process on chaos phenomena.
- calculating the resonant frequencies and the intensity of the radiation absorption, which might induce damages on biological systems, and to determine the spectral regions for optimal contrast in imaging applications.
- providing a spectroscopic database for selected biological systems and subsystems (for example enzymes, proteins, biological membranes and cells in the frequency range from 100 GHz to 20 THz (the so-called "THz gap") under irradiation conditions that preserve the integrity and functionality of the biological samples.
- computer simulation of above mentioned processes.

- experimental surveys conducted on the basis of the above mentioned bases.
- To assess risk of potential damage to biological activity, both functional and morphological, due to the exposure of biological systems and their biological macro and microsubsystems like: internal organs, membranes, cells, and DNA to pulsed and CW radiation.
- clinical and initiated researches.
- partial and final results patenting at the European Patent Office.

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Optical and Olfactory Sensors as Tools to Support Sustainable Development

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Abstract

Regarding an ecosystem or a society as some sort of ‘meta-organism’, sensors may be seen as an equivalent to biological receptors, allowing an organism to sustain and develop under homeostatic conditions and with self-control. Sensor technology and appropriate interpretation of the data collected, thus are essential for sustainable development. Probably Galileo Galilei in this context was the first advocate of sustainability as he demanded: ‘‘Measure everything, that can be measured, find a way to measure what cannot be measured yet.’’ Due to progress in science and technology, technical sensors are copying almost all biological receptors, even the sense of smell, which will be introduced here for monitoring of air and water. Also many sensors, previously regarded as bulky and expensive, become more and more affordable and smaller in size, allowing using e.g. spectroscopy in agriculture for decentralized quality control of vegetable oil. Thus olfactory and optical sensors, like other types of sensors, contribute to develop a sustainable, agricultural based, industry and sustainable development.

Keywords: sensor, spectroscopy, electronic nose, gas-sensors, quality control, sustainable development

Air is essential to support our life. Besides pollution consisting of particles and defined chemicals, smell can be a significant pollutant of air. In many cases smell is also associated with a process harmful to the environment. The sensation of odour in most cases is induced basically by carbohydrates having a vapour pressure >0 . The human nose is attributed to habituation, a neurophysiological process that could be described as a permanently changing sensitivity of smell perception. An intensive focus on detecting smell can be a very exhausting work for the human nose. Also the human nose must not be exposed to potentially harmful smells or gases. Therefore the human nose is of very limited use in continuous monitoring of smell intensities. More detailed information on the functionality of the sense of smell is given [1]. Metal oxide based gas sensors, first described around 1955, now can be found in a multitude of applications ranging from gas-leak detectors to detection of bad breath. Metal oxide gas sensors are also one option to design so called electronic noses, devices that are consisting of an array of electronic gas-sensors of limited selectivity in combination with pattern recognition capable to identify simple and complex smells [2].

To test the applicability of metal-oxide-type gas-sensors (MOX) for continuous monitoring of smell intensity, a single sensor was used. The signal was filtered to compensate for drift effects of the sensor. Prior to the test, the sensor was op-

erated for a week under ambient conditions to allow for equilibration. Data were recorded for extended periods of time under various conditions. As an example the recording of exhaust fumes of a gasoline engine (lawnmower, passing by in approx. 20 meters distance in rural area, wind speed less than 1m/s away from sensor) is shown in figure one. On the x-axis the time in minutes is given; on the y axis the signal intensity in arbitrary units is provided. After 225 minutes of ‘fresh air’ providing no olfactory signals to the human nose at signal levels below 110, three peaks of signals exceeding a value of 110 are clearly detectable. These peaks have been produced by three passages of a gasoline engine in approx. 20-meter distance from the detector. The smell was detectable also by the human nose, but not very prominent.

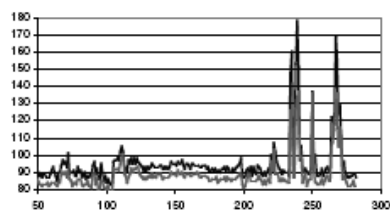


Fig. 1. Smell intensity (arbitrary units) as a function of time (minutes).

To test if the sensor reading of electronic gas sensors may be correlated with the perception of a human nose, the perception of an olfactory panel (4 persons) is compared with the reading of a MOX-sensor of the same type as it has been used in the previous experiment. Acetone at various low concentrations (ppm) was used as a test gas. In Fig. 2. the sensor reading (x-axis) is plotted versus the perception of the olfactory panel (y-axis: decipol, a measure of the intensity of smell). The data show a fair correlation, probably most of the scatter is attributable to the human nose (data courtesy of F. Bitter, Herman-Rietschel-Institute – Technical University of Berlin, Germany).

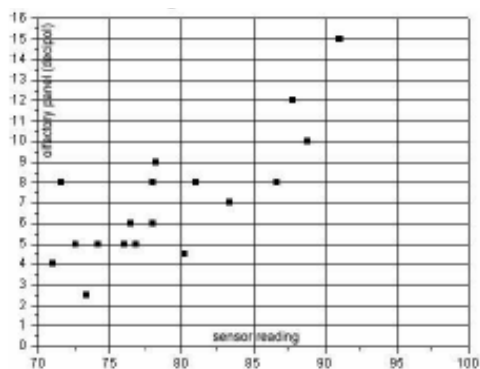


Fig. 2. Sensor reading (arbitrary units) versus perception of olfactory panel (decipol).

An electronic nose (KAMINA, Forschungszentrum Karlsruhe, Germany) was used to transform odours by means of a sensor array, consisting of 38 sensitive MOX-elements into electronic signals and data-patterns. The response to chemicals is a little different in every single sensor-element due to a temperature gradient. These data-patterns are characteristic for specific odours – every odour has its electronic ‘fingerprint’. To generate such fingerprints the compounds making up such odours do not have to be known. If the chemical composition of an odour is relevant for an application, the electronic patterns may be ‘calibrated’ with odour samples of known composition. In figure 3 the data patterns from an electronic nose of various samples of contaminated water are shown.

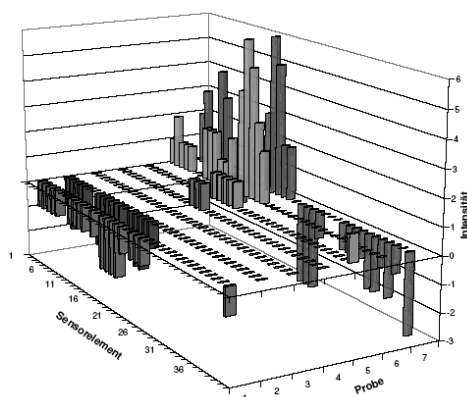


Fig. 3. Visualisation of olfactory patterns of various samples of contaminated water

The x-axis represents the 38 elements of the sensor chip (sensor-element); on the z-axis seven different water samples are given (Probe). The intensity of the Signal is given on the y-axis (Intensität). Every row of 38 values given for the eight different samples represents the olfactory ‘fingerprint’ of that sample as recorded by the electronic nose.

Sample no. 1 and 2 have been produced artificially. For this purpose distilled water had been mixed with various organic compounds (dichloromethane, dichloromethane, tetrachloromethane, 1,2-dichlorethane, benzole, vinylchloride etc. (sum of all compounds < 1 ppm). Sample no 3 to 8 are ‘real’ samples (3–5 = contaminated ground water; 6–8 from the sewerage of a chemical plant. The flat plane (intensity=0) corresponds to the electronic fingerprint of distilled water, which served as reference in this experiments. The raw data have been acquired every 5 seconds by exposing the sensor elements continuously for a couple of days to the dynamic headspace of the various water-samples. No gas-trap or other enhancement techniques have been used. Geometric mean and variance have been calculated for the data. The numeric mean values for distilled water have been subtracted from all sample data. The data have been divided by the triple value of the variance of distilled water, non-integer parts of the resulting numbers were discarded (e.g. 0.999=0; 1,333=1 etc.). The resulting numbers have been plotted in the diagram. These very ‘harsh’ criteria led to the fact that sample no.3 showed no significant features compared to distilled water. In Fig. 3. all samples (except no.3) are clearly distinguishable in terms of olfactory data pattern of the various samples. This approach was chosen to demonstrate, that even discarding far more than noise levels and choosing robust, but not very sophisticated data evaluation, still provides meaningful results, which is regarded as essential for practical application of the electronic nose technology in ‘real life’ applications. The advantage of such a system to monitor wastewater is, that it provides continuous monitoring irrespectively of unpleasantness or toxicity of the analysed samples. Also any kind of change in the data pattern, which indicates a change in chemical composition, will be detected instantly, irrespectively if known or unknown compounds are involved in that change. Electronic noses do not habituate (adapt) to a certain smell or smell intensity – the recorded patterns remain stable as long as the composition of the odour remains the same. The chemical composition of a sample correlates with the data pattern of an electronic nose [3].

Using ‘fingerprinting’ may not only applied to data from gas-sensors but also for optical spectroscopy. Optical ‘fingerprinting’ is a well-established procedure in infrared and Mid-Infra-Red (MIR)spectroscopy to compare characteristic absorption bands of compounds with actual measurement data. With decreasing cost and size and increasing robustness of UV-VIS Spectrometers, similar procedures become interesting also for this wavelength. Although UV-VIS provides less information concerning chemical composition and binding structure than MIR Spectroscopy, a correlation between chemical composition and spectral features is given also for UVVIS Spectroscopy. Product quality is directly related to chemical composition, thus spectroscopy is a potential tool for quality control. Industrial mass production has to rely on quality control, since

a defined and known quality of raw materials is essential for an undisturbed production process. In the near future an increasing fraction of industrial raw materials has to be provided from renewable sources, which means agriculture in many cases. To fully integrate agriculture in industrial production, improved procedures for quality control in agriculture are required. Spectroscopy with small, smart, robust and cost-efficient spectrometers has the potential to provide the required methods to agriculture, thus enabling agriculture to become a key factor for sustainable industry. In the following the application of spectroscopy in quality control of rapeseed oil may serve as an example of spectroscopy supporting agriculture. Rapeseed oil has become popular as renewable substitute for diesel fuel. In order not to cause damage to the engine, a few precautions in using rapeseed oil have to be observed. This includes the definition and control of a sufficient oil-quality in terms of chemical admixtures, acidity, water content, viscosity and con-

least one parameter of the quality standards. The median and mean spectra were calculated for both groups. Also median and mean were calculated for all spectra.

In Fig. 4. the mean spectrum (signal as a function of wavelength) of rapeseed oil fulfilling (upper curve) or not fulfilling (lower curve) the quality standard is plotted (referenced to mean spectrum of all samples). In the spectral range around 475nm and 675nm features in the spectrum are present, which correlate with oil quality. Repeating this procedure using the more robust median provides comparable results. These findings indicate, that UV-VIS spectroscopy could be used as a cost efficient and fast method solving the problem of decentralised quality control for oil mills. All required materials fit in a small case, are quite robust and will also allow testing other products for homogeneity and/or quality.

The examples described above do not claim to be scientifically sophisticated and they do not claim to substitute precise chemical analysis. The examples are given to dem-

Table 1. Quality standards and parameters of rapeseed oil to be used as engine fuel.

Standard	Parameter	H ₂ O(%)	P(mg/kg)	Contamination(mg/kg)	NZ(mg KOH/g)	OxStab(h)	S(mg/kg)	Sum Ca, Mg
PK-Qualitätsstandard 05/2000		0,075	15	25	2	5	20	20
E DIN 51605 2005-06		0,075	12	24,0	2	6	10	

tamination of the oil. The standard procedure to test these parameters is laboratory analysis, which takes up to two days to be reported back to the oil mill and cost up to a few hundred euros per analysis. This is quite unfavourable for decentralised oil milling and decentralised oil consumption by agricultural machinery. Samples of rapeseed oil from

onstrate, that 'non-parametric' or 'semi-parametric' sensors can be useful for environmental monitoring, process-control and to provide some sort of 'subconscious sensors' that will attract attention when necessary, by detecting changes and comparing different states. The sensors described are (potentially) low cost, allowing using them abundantly.

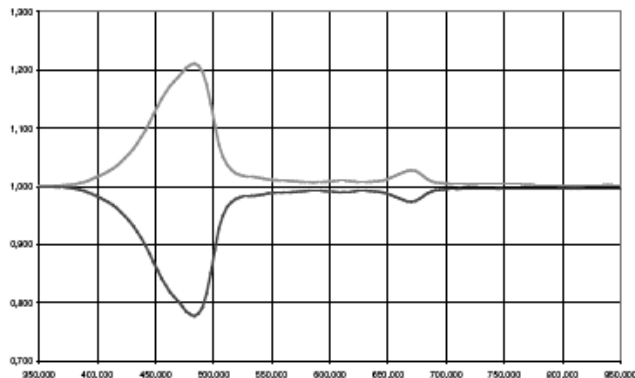


Fig. 4. Mean spectrum of rapeseed oil fulfilling (upper curve) or not fulfilling (lower curve) the quality standard referenced to average spectrum of all samples.

the '100 tractor programme' (Fachagentur Nachwachsende Rohstoffe www.fnr.de, samples kindly provided by Dr. U. Schümann, Universität Rostock Germany, FB Maschinenbau/Schiffstechnik) have been reinvestigated using UV-VIS spectrometry in the range of 350nm to 850nm. Spectra were taken using standard cuvettes (1 cm transmission layer) as well as using a special submersible probe (2*4 mm optical pathway, diffuse reflector). Raw spectroscopic data were sorted according to results of previous chemical analysis into two groups. Group 1: oil samples with all parameters within the limits of the quality standards (according to the most restrictive value). Group 2: oil samples, which failed to fulfil at

This concept abundant use of receptors has a biological origin. Looking at the thermo receptors of the skin, we will find many of them. Mostly being 'silent' they will send an alert, when hot or cold spots are detected or when the ambient temperature does not fit the needs of the organism. Compared to a technical approach, having one thermometer and measuring a precise temperature, the biological concept seems to be archaic, but it has some advantages, concerning the ease of achieving homeostatic conditions. Also there is no hideaway for errors – temperature receptors are everywhere in the skin. Imagine you would have to adjust your body temperature using a single, expensive

thermometer. But the biological way of monitoring processes requires cost efficient sensors. Ubiquity of sensors counts, if a single sensor is 'cheap'. And cost effectiveness is what technical sensors now achieve. Gas-sensors, Spectrometers and many more not necessarily have to be confined to laboratory use under supervision of highly specialised personnel, in terms of costs we could use sensor technology more abundant, dispersed, decentralised providing the sensory input for sustainable development.

The examples of electronic nose applications, smell intensity detection or quality control for rapeseed oil are given to demonstrate the potential of these sensors for sustainable development in various manners. If its smell that is affecting the air we breathe, or smell that is associated with contaminations of water, there are sensors to monitor such problems. Also spectroscopy is on its way from the research laboratory to the farm, to support agricultural production. And not only improved environmental monitoring, but also cleaner and more efficient production plants, especially in the bioenergy- and biorefinery sector, may be assisted by innovative sensor technology. The production and quality of raw material and biofuels from renewable sources may be improved by sensor technology, which

might consequently improve the economy in rural and agricultural areas. In general innovative sensor technology can provide the sensory input for a sustainable economy. Drawing the correct conclusions from sensory input will be another task, but without sensor-information a sustainable development would be 'blind'. Development and fabrication of sensor applications not necessarily require large and expensive urban infrastructure. Sensor application development can be performed in rural areas or historic cities, providing additional, clean and future-oriented economic perspectives in these areas, which is essential for a sustainable development.

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Sustainable Energy Systems

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Abstract

Sustainable development is a multifarious approach focusing on the specific feedback and balance between social, economic and environmental aspects of a given problem. With regard to the energy systems the term acquires very specific meaning. Sustainable energy system balances its environmental impact with the socio-economic implications. This paper presents why this specific approach is needed and how to indicate it.

Keywords: sustainable development, environmental protection, energy systems

Sustainable energy systems – what does it mean?

Sustainable development (SD) is a multifarious approach focusing on the specific feedback and balance between social, economic and environmental aspects of a given problem. Sustainable development should improve quality of life in a way that can be sustained, economically and environmentally, over the long term. Sustainable energy contains – in general – three main elements: is environmentally friendly, more efficient from the economic point of view and produced with consideration of the social aspect (on the basis and with help of local community). It makes energy supply and use cleaner, more productive and more secure without compromising the social, economic and environmental needs of future generations.

From the social point of view availability of energy has a direct impact on poverty, employment opportunities, education, demographic transition, indoor pollution and health, and has gender- and age-related implications [1]. To be more precise, the relationship between energy and social issues is two-way. The ability to pay for energy services and knowledge of what is available and how best to apply it will affect the level of demand and type of energy services used. Conversely, the quality (cleanliness, reliability and convenience) and level of access (availability, affordability, and variety) of energy services have an effect on social issues [2]. These dimensions of sustainable energy are relevant for poor countries where the accessibility and affordability of energy are problematic but the aspect of availability is also present in developed areas. Establishing rural nodes with mechanical power and electricity services within rural communities would also dramatically reduce the cost of additional grid connections and extensions in the immediate vicinity, unlocking local capital and opening new opportunities for small-scale, private investment at the local level [3].

Economy depends on a reliable and adequate energy supply, and developing countries need to secure this as a prerequisite for industrialization. Energy alone is not sufficient for creating the conditions for economic growth, but it is certainly necessary. It is impossible to operate a factory or run a shop, grow crops or deliver goods to consumers without using some form of energy. Economic growth almost always leads to increased energy use, at least in the early stages of economic development [4]. The way energy is produced, distributed, and consumed affects the local, regional, and global environment through land degradation, local air pollution, acidification of water and soils, or greenhouse gas emissions. Biomass harvesting without sustainable agro-forestry management can lead to land degradation, including soil and water resources, and vegetative cover. Fossil fuel use, exploration, transportation, and distribution will have some unavoidable detrimental effects on the environment [5].

Presented above description of features of sustainable energy systems areas is typical for United Nations. Definitions of sustainable energy systems vary and are more precise when put in specific context. Energy is understood broadly and results of its use are implicated in each of the economic, social and environmental dimensions of human development in concrete region of the world. While main aspects of energy production according the UN consider such problems as reduction of poverty and hunger or providing better education services [6], in the European Community the term is defined in a different way because of the different conditions of life. It results in other priorities for the EU. Among main goals to mention is not only achievement of environmental sustainability but also independence of conventional sources.

The strategic and policy objectives regarding **sustainable energy systems** in the European Union focus on problems

defined in *Kyoto Protocol*, improving energy efficiency, increasing the use of renewable energy, and improving quality of life both within the EU and globally (Johannesburg follow-up). The additional goals – absent in the definition of UN – include increasing the security of energy supplies, as well as enhancing the competitiveness of European industry. The definition of “sustainability” formulated in the *Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy* is very similar. The goal of achieving sustainable energy is defined as: developing competitive renewable sources of energy and other low carbon energy sources and carriers, particularly alternative transport fuels, curbing energy demand within Europe and leading global efforts to halt climate change and improve local quality [7].

Initiatives concerning achievement of sustainable energy in the Community – in practice – focus on renewable energy. The reason is simple – renewables contain all of the sustainable energy features: are environmentally friendly and obviously positive from the socio-economic point of view. Main means of converting EU policy for smart energy use and more renewables into action on the ground while promoting business opportunities and new technologies are supported by many actions such as e.g. “Intelligent Energy – Europe” [8] or “Sustainable Energy Europe” 2005–2008 [9]. Promising future energy systems concern also hydrogen technologies developed through research projects carried out within Framework Programmes of the European Commission.

How to measure if an energy system is sustainable?

In order to measure sustainability within an energy system, we should assess the possible impact of such system and set areas of influence and interaction. In accordance with priorities of sustainable development the process will affect environment, and the socio-economic sphere. There are many tools and methodologies designed to measure and communicate progress towards SD. Some of the most popular tools are indicators and indices, an index being an amalgam of more than one indicator. With regard to the energy systems SDI show appropriate progress.

It is hard to define sustainable energy systems in general, but it's much harder to find features that indicate the sustainability within. Firstly because we have different approaches e.g.: global, strictly European or other. Secondly because of different types of dimension; we can assess an energy system from the socio-economic point of view, but also from the ecological. Thirdly not irrelevant is here also the purpose of evaluation and its later utilization. Just to add that different accessible resources or extension of a project will play an important role. There is no one correct or fully acceptable example of sustainable energy indicators, because the type of indicators will depend on the specific conditions. Therefore there is no one universal description of SDI.

Exemplary set of Energy Indicators for Sustainable Development and corresponding methodologies has been provided by the International Atomic Energy Agency in cooperation with the United Nations Department of Economic and Social Affairs, the International Energy Agency,

Eurostat and the European Environment Agency. Indicators here are also divided in 3 main themes: 1. social: equity (accessibility, affordability, disparities), health (safety), 2. economic: use and production patterns (overall use, overall productivity, supply efficiency, production, end use, diversification of fuels, prices), security (imports, strategic fuel stocks), 3. environmental: atmosphere (climate change, air quality), water (water quality), land (soil quality, forest, solid waste generation and management).

These indicators present impact of energy systems on different areas; taken together in specific context give a good picture of a country's energy system. But there is one, primary condition – they need to be read in context of each country's economy and energy resources. The use of indicators can help answer questions about external costs [10]. They are very useful in order to assess desirable effect and measure progress within energy systems.

Another example of Energy Indicators for Sustainable Development has been set up by Natural Resources Canada. In its first Sustainable Development Strategy the main objective was to assess progress towards sustainability in energy. The specific approach focuses on monitoring a suite of indicators that serve as guideposts to the issues that will likely require attention from decision makers as energy policy is developed [11]. The types of indicators are divided in 3 spheres. The economic indicators show the importance of energy, both as primary industry, and as input into overall economy. The environmental indicators present improvement in energy's impact on the environment. Measured are: greenhouse gas emissions per unit of energy consumed and the GHG emissions intensity of the economy. Indicators of the social impact of energy production and use consider employment, energy prices and households disposable incomes on energy.

Sustainable Energy Watch has created a baseline set of indicators from which to infer progression towards or regression from energy-related sustainability. The indicators cover the following aspects: 1. environmental: CO₂ emissions per capita (global pollution), ambient energy-related emissions (local pollution), 2. social: guaranteed access to electricity, investments in clean energy, 3. economic: energy resilience, burden of public energy investments, 4. technological: energy intensity, renewable energy deployment [12].

All of 3 types of presented methodologies regarding sustainable energy indicators concern characteristic groups of SD. These will appeal to the social, economic and environmental sphere with exception of the Sustainable Energy Watch that provides indicators also for technological progress.

Sustainability within an energy system will be described with different features depending on the entity preparing the assessment. Main common feature remain the areas of influence and interaction.

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Quality Assessment of the Rivers System in the Vicinity of the Nitric Plant in Tarnów, Poland

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Abstract

Quality of the river system in the vicinity of the industrial waste disposal site of the Nitric Plant in Tarnów was examined. The concentration of selected anions and trace metals in water of four rivers were studied and quality assessment with respect to obtained factors took place on the basis of polish surface water classification. Concentration of metals in the suspended matter and bottom sediments were determined using microwave digestion (conc. nitric acid), following ICPMS analysis. LAWA classification was used to evaluate the metal contaminations of the suspended matter and bottom sediments. Impact of the waste disposal site on the elevated metal concentrations especially of Cd in the rivers solids is evident. Generally the highest concentration was stated in the rivers section located in the closer vicinity of the waste disposal sites.

Keywords: Tarnów, waste disposal site, water quality, sediment, suspended matter, trace metals

Introduction

The Nitric Plant is situated in the city Tarnów in southern Poland. The industrial waste disposal sites „Czajki” and „Za Rzeką Białą” are located at the distance of 0,5 km from the northeastern side of the Nitric Plant and close to the sewage treatment plant of the city Tarnów. The waste disposal site Czajki I, II is located in gravel pit in old river meander exist from 1961 and from west, south and east sites it borders on the Klikowski Stream [1]. The waste disposal „Za Rzeką Białą” began its activity in 1955 and is located close to the Biała Tarnowska River and the Chyszowski Drainage Ditch (Fig. 1). On the site are deposited the following types of wastes: the fly ash and slag from power plant, slug and other wastes from sewage treatment plant, asbestos and inorganic wastes. Waste disposal site has a direct contact with subsurface waters and for many years wastes were stored there without any barrier. Within the last few years of site disposal exploitation, the bottom of several sections was covered by power plant fly ash layer and geomembrane [1, 2].

In the framework of a state monitoring carried by the Voivodeship Inspectorate for Environmental Protection (WIOŚ), only general physico-chemical parameters of the Dunajec River and Biała Tarnowska River in Tarnów region were measured; the quality classes III and IV, respectively were confirmed in the years 2004 and 2005 [3, 4]. With respect to trace metals in both suspended matter and bottom sediments samples of mentioned rivers no data are available.

The aim of our studies was to evaluate the concentration of selected trace metals in the river systems. To achieve this, metals concentration in water, suspended matter and sediments were analysed. Study of the selected physicochemical parameters (pH, Eh, anions) were also conducted.

Materials and analytical procedures

Samples of water with suspended particulate matter (SPM) were taken from 17 sampling points and 15 bottom sediment samples for four rivers (Fig. 1) were taken according to PN-ISO 5667-6:2003 and PN-ISO 5667-15:2004. Water samples were filtrated (<0,45 µm) and the suspended matter samples were collected. From the bottom sediment samples the grain size fraction <63 µm was separated. Bottom sediments and SPM samples followed microwave digestion (conc. nitric acid) using modified SW 3051 EPA procedure [5]. The trace metals concentration was determined using ICPMS and/or AAS methods.

To describe random errors, Robust Analysis of Variance, with Robcoop3 programme application was carried out [6]. Percentage of the analytical and technical variances was satisfying and did not exceed 8% of the total variances. To estimate accuracy of analytical method, reagent blanks and certified reference material of soil and sediment (LSKD4) were used.

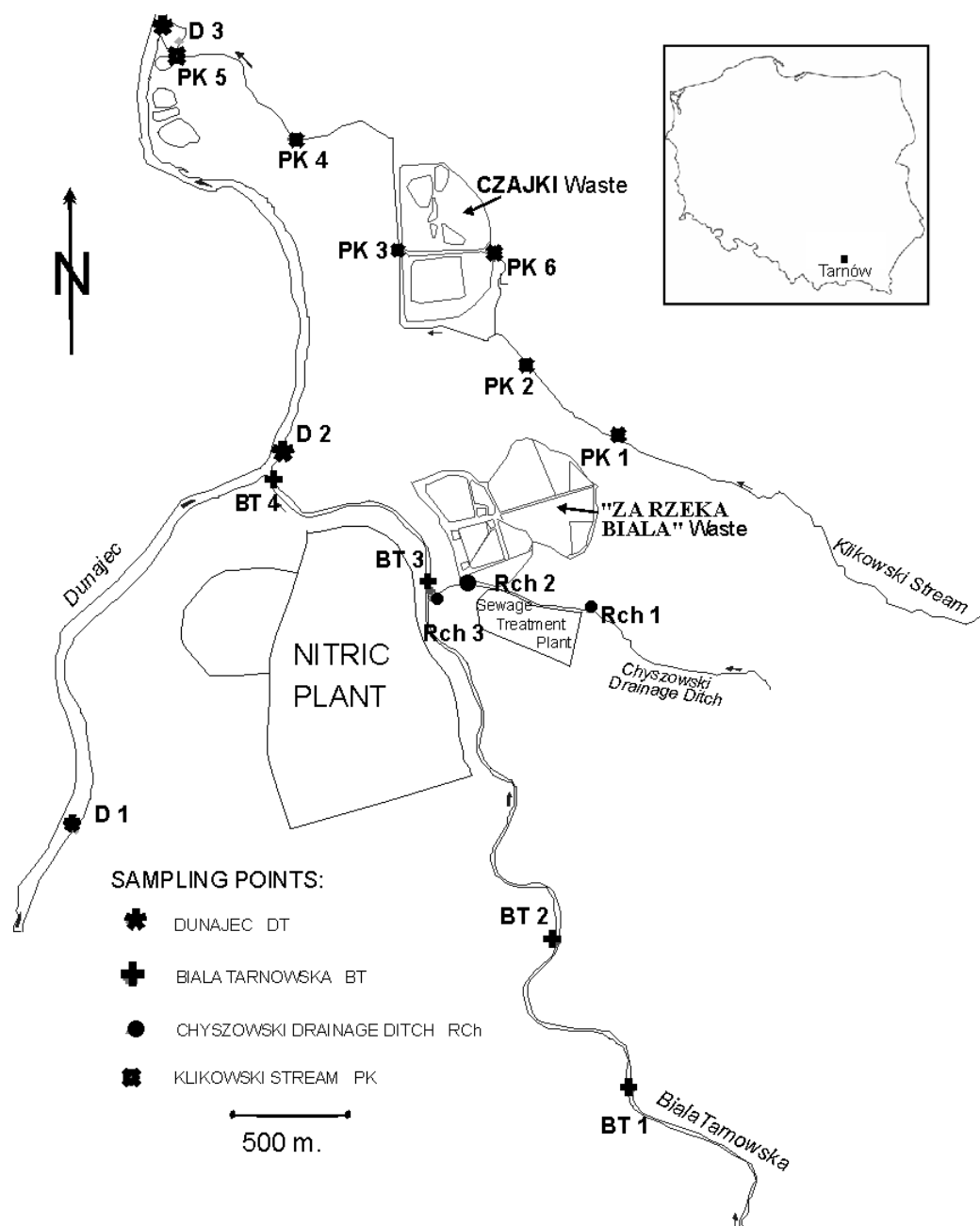


Fig. 1. Location of the studied area and the sampling points.

Results and Discussion

Rivers Water Quality Physico-Chemical Parameters

The obtained results showed that pH parameter of all rivers met the I Quality Class and was within the slightly alkaline range from 7.14 to 8.57 (mean value 7.8). pH of Potok Klikowski water was higher (7.50 – 8.57) in comparison with the other rivers. The all stream waters showed oxidizing conditions and Eh values ranged between 137 and 224. The electrolytic conductivity was in the range of 314 – 1145 $\mu\text{S cm}^{-1}$ with highest values in the Klikowski stream.

The rivers water showed negligible concentrations with respect to F^- ions ($< 0.5 \text{ mg/dm}^3$), which reached the highest amount up to 0.77 in the Klikowski stream (II qual-

ity class). Concentration of Cl^- ions (mg/dm^3) ranged from 5.21 to 64.97 (I Class of Surface Water Quality).

With respect to NO_3^- anions, 50% of the studied water samples i.e. from the Biała Tarnowska and Klikowski rivers met the I surface water quality criteria ($< 5.0 \text{ mg/dm}^3$), however rest of the samples revealed high concentration of NO_3^- fitting the II or III quality class (max. 17 mg/dm^3).

Water of the Biała Tarnowska River, the Dunajec River and the Chyszowski Ditch were uncontaminated (I class) with respect to SO_4^- anions, with exception to one sample from Chyszowski Ditch, which was classified within the III class (170 mg/dm^3).

Trace metals in river water

The concentration of investigated metals (Cd, Cu, Co, Cr, Ni, Pb and Mn) in the studied rivers water was low (Ta-

ble 1.). Cadmium concentration (0,0003 – 0,0191 mg/dm³) rank within the I, II and III purity class, however the highest concentration was found for the Klikowski stream. Amount of Co was on the similar level as Cd. Concentration of Cu was very low (I class). Concentration of Pb and Cr was on the similar level and ranged from 0.0010 to 0,0055 mg/dm³. The highest concentrations of Mn up to 15,44 mg/dm³ were found in the Klikowski stream, whereas only in two samples from Chyszowski Ditch presence of Fe was detected (0,0154 and 3.1140 mg/dm³).

samples; this amount is variable and ranged from 3 to 84 weight percent (36 % mean value).

Investigation of bottom sediments size fraction <63 µm of the Dunajec River and the Biała Tarnowska River showed that concentration of Zn and Pb was similar or elevated if compare with geochemical background (GB) (95 of Zn and 20 of Pb mg/kg) values given by Turekian and Wedephol [11], and ranged for Zn 73–140 and for Pb 19–40 mg/kg. Concentration of Mn, Ni, Cr and Cu was below GB values and ranged: 460–790, 16–26, 1,4–2,7 and

Table 1. Statistical parameters of trace metal concentration in the bottom sediments and water of studied rivers.

metal [mg/kg]	BOTTOM SEDIMENT (n=15)					GB* [11]
	Min	Max	Mean	Median	SD	
Cd	1.03	22.5	7.03	4	7	0.3
Cr	0.25	21.9	5.05	2	7	90
Ni	16.3	42	26.4	25	10	68
Cu	7.96	123	53.9	54	34	45
Pb	18.7	171	69.4	58	49	20
Zn	27.3	1156	364	144	358	95
Mn	286	19908	2391	856	4780	850
WATER (n=17)						
[mg/dm ³]	Min	Max	Mean	Median	SD	SWQS**
Cd	0.0003	0.0191	0.0018	0.0006	0.0046	0.0005
Cr	0.0010	0.0054	0.0038	0.0036	0.0010	0.0500
Cu	0.0109	0.0349	0.0214	0.0196	0.0072	0.0200
Pb	0.0010	0.0055	0.0018	0.0014	0.0011	0.0100
Mn	0.0004	15.4400	1.8092	0.1310	3.9160	0.0500
Co	0.0001	0.0020	0.0006	0.0005	0.0005	-
Ni	nd***	nd	nd	nd	nd	0.01

* Geochemical Background

** Surface Water Quality Standards in Poland (Dz.U. Nr 32, poz.284)

*** not detected

Suspended Matter Quality

Results showed very low concentration of SPM, reaching the maximum of 0.92 mg/dm³. Samples were taken in the summer season and because of very low water flow more than 50 % of SPM samples were excluded from further analysis because of high analytical error associated with negligible mass of residue accumulated on the filter. According to the LAWA classification introduced by Irmer [7] SPM from the Dunajec River and the Biała Tarnowska River were classified as unpolluted and moderately polluted meeting I and II class, respectively. The SPM samples from the Chyszowski Drainage Ditch and the Klikowski Stream were classified as moderately polluted with Cr and Cu (class II–III) and moderately to highly polluted with respect to Ni and Zn (classes II and II–III).

Bottom Sediments Quality

The assessment of metal pollution level in the bottom sediments plays an important role in detecting sources of contamination in the rivers at the industrial region, even long after the input has taken place [8], [9], [10]. The size fraction <63 µm was separated from the bottom sediment

19–33 mg/kg respectively. Only Cd concentration was up to 10 times higher (1,44–3,60 mg/kg) than GB value of 0,3 mg/kg. Table 1 presents statistical parameters of <63 µm size fraction and metal concentrations.

Bottom sediments of the Chyszowski Ditch and the Klikowski Stream were significantly contaminated with respect to Cu (up to 123 mg/kg), Pb (up to 170 mg/kg) and Zn (up to 1156 mg/kg) in particular with Cd, which ranged from 4,26 to 22,91 mg/kg. Concentrations of Ni and Cr remained low, 23–36 mg/kg and 1–22 mg/kg respectively. Fig. 2. shows distribution of metals content in bottom sediments of the studied rivers..

According to the LAWA classification sediments of the Dunajec River and the Biała Tarnowska River are uncontaminated with respect to almost all investigated metals. Only concentration of Cd indicates the II–III and III classes, i.e. moderately and strongly contaminated. Sediments of the Klikowski Stream and Chyszowski Ditch were classified as unpolluted and slightly polluted with Ni and Cr (class I–II), moderately and strongly contaminated with Cu, Pb and Zn (classes II, II–III, III) and very strongly contaminated with Cd (classes III and III–IV).

The Klikowski Stream is the most contaminated mainly because of the very high concentration of Cd in all bot-

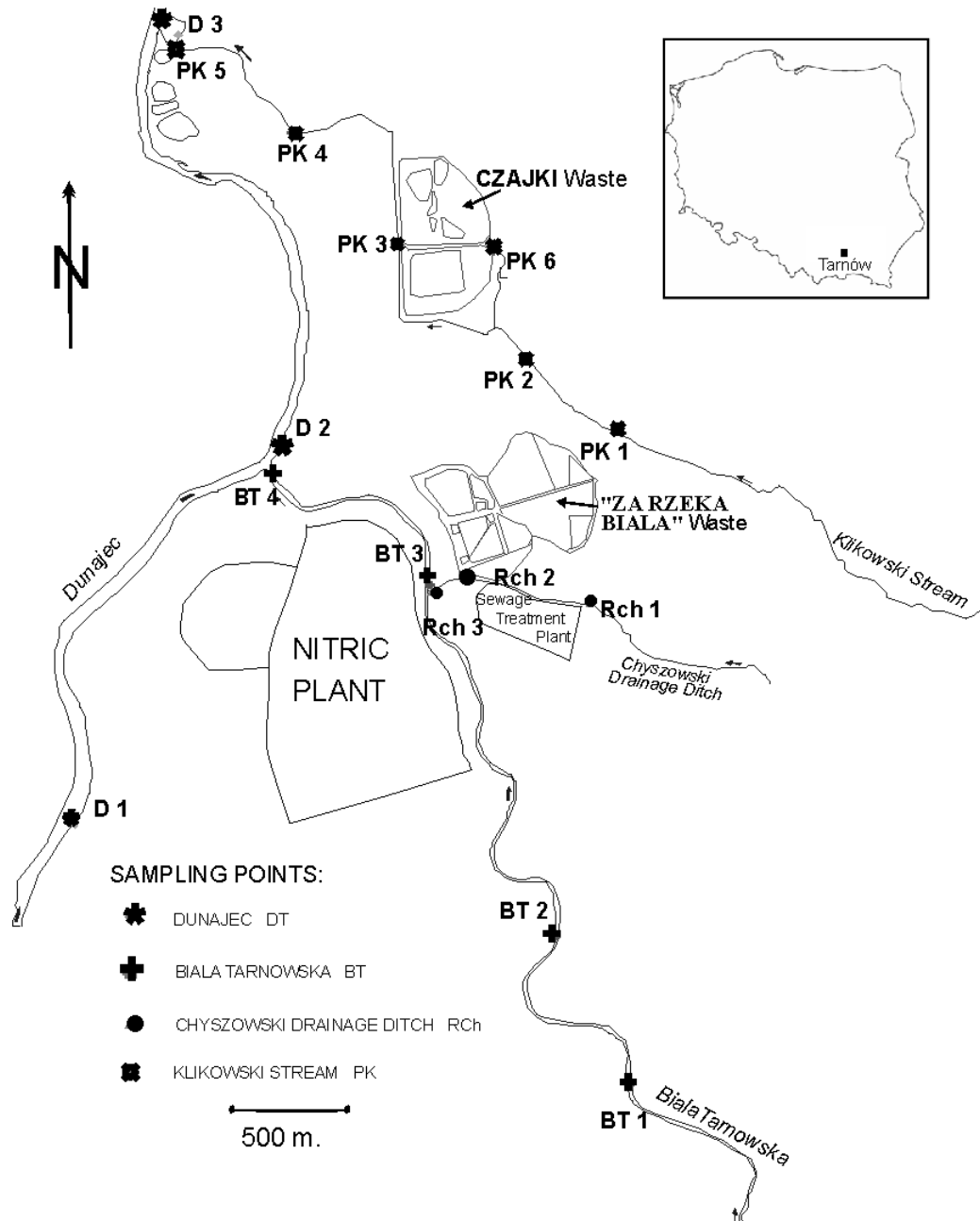


Fig. 2. Distribution of metals concentrations; Ni, Cr, Cd (a) and Pb, Cu (b) in the bottom sediments (size fraction $<63 \mu\text{m}$) of the studied rivers.

tom sediment samples (12–22,5 mg/kg) and higher, than in sediment samples from other rivers, concentration of Cu, Zn and Pb. This stream flows in direct neighbourhood to both waste disposal sites, where the highest concentration of metals was found.

Conclusions

Obtained results lead to conclusion that investigated physical–chemical parameters of rivers water generally met the I and II Polish Surface Water Quality Class with an exception of NO_3 anions concentration fitting the II or III quality class. The higher concentration of trace metals were found in the Chyszowski Ditch and the Klikowski Stream, situated closer to the waste disposal sites. In the Dunajec River and the Biała Tarnowska River higher metal concentration was stated in the samples taken close to their

outlet. Especially Cd in bottom sediments seems to be of particular concern, because of its high amount. Its highest concentration was detected especially in the river systems located in the closer vicinity to the waste disposal sites. The impact of waste disposal sites on the elevated metals especially of Cd in the rivers solids is evident. Cadmium as very mobile metal is leached out from the waste particles and migrates to the river system, where because of pH and Eh changes, can be bound to the solid particles.

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Distribution of Zn and Pb in Soils in the Vicinity of Non Ferrous Industrial Waste Sites at the Examples of Bukowno (Poland) and Mansfeld (Germany)

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Abstract

Intensive mining and smelting processes at the Bukowno (Poland) area started in 19th century, while at the Mansfeld (Germany) region in 18th century. High concentrations of heavy metals were stated in soils in an area of contemporary and extensive historical mining and smelting of Zn and Pb near Bukowno and Olkusz in Poland. There is a lack of data which characterize the impact of the fine grained flotation wastes in Bukowno and the flue dust wastes in Mansfeld on soil contamination. Concentration of Zn and Pb in the soil samples in the vicinity of the flotation waste site ranges from 490 to 4400 and from 120 to 1600 mg/kg, respectively whereas in the trees samples from 500 to 1981 and from 36 to 460 mg/kg, respectively. In Mansfeld region concentration of Zn and Pb in soils in the vicinity of the flue dust waste site ranges from 807 to 25200 and from 511 to 55400 mg/kg, respectively. Concentration of Zn and Pb in the trees samples growing in the vicinity of the flue dust waste site ranges from 51 to 2500 mg/kg and from 2 to 9 mg/kg, respectively. Contamination levels of Pb and Zn generally decreased with the distance from the waste sites.

The BCR Three-Stage Extraction Procedure analyses showed that for soils in Bukowno region up to 10% of Pb and 18% of Zn are present in the exchangeable and acid soluble fraction, while in the soils from Mansfeld up to 9% and 27%, respectively. The considerable portions of oxidizable forms of Pb (15-29%) and of Zn (up to 16%) were stated in the soils from both regions.

Keywords: heavy metals; soils, trees, contamination; industrial waste sites, wind direction

Introduction

Mining and metal ores processing operations introduces a variety of chemicals to the mine waste sites, thus to the aquatic and soil systems, including e.g. metals, colloidal suspended solids and thiosalts (thiosulphate), which on further oxidation cause acidification of the systems.

Intensive Zn-Pb mining and smelting processes in the Bukowno region started in 19th century. Disposal of the flotation wastes in the Bukowno region began in 1973 and is still going on. The area of the flotation waste site is 108 ha, while the area of the active site is 37 ha [1]. The town of Bukowno, which is located in east to Silesia, is a community living also in close proximity to a large Zn-Pb smelting complex that has smelted an estimated over 0.1 million tonnes of Pb and 2.2 million tonnes of Zn since it started operation in 1952. The smelter currently emits considerable amount of metal dust through the flue gas of the Zn smelter

(the prevailing wind direction is dominantly westerly, with significant proportion of easterly) and this fact should be also taken in consideration as an important source of heavy metals in the soils from the studied area.

The flue dust site in the Mansfeld region is arisen from disposing wastes after scrubbing processes of the pyrometallurgical activities of the Cu ores. Disposal of the flue dust waste (named Theisen sludge) took place between 1978 and 1992. The area of the flue dust site is around 100 ha, with a total amount of these wastes of approx. 220 000 tons [2].

The characteristics of the flotation wastes from Bukowno and the flue dust wastes from Mansfeld are presented in Table 1. The fines size fraction <20 µm make 28 wt.% of the total amount of flotation wastes. The dominant minerals present in the flotation wastes are dolomite (about 70%), sulphides (marcasite, pyrite, sphalerite, galena), quartz, gypsum and hydrated iron oxide. Very important

mineral phase is melnikovite which has been defined as banded substance composed spheres build up of sulphides, thiosulphates, dithionates of Fe, Pb, Zn, As etc. [3]. The total concentrations of Zn and Pb in this wastes are 1,13 wt.% and 0,31 wt.%, respectively [4].

In the vicinity of the flotation waste site there are sandy soils with the content (wt. %) of sand fraction 77, of the silt 19, of the floatable particles 7, and with 7 of organic matter [5]. The pH of soils in the Bukowno region ranges between 5 and 8,4. The mean concentration of Zn and Pb in the topsoils from Bukowno was 2175 and 545 mg/kg, respectively [6].

The flue dust wastes contain about 70 wt. % of the very fine fraction <2,5 μm . The dominant minerals are: wurzite, sphalerite, galena, anglesite, quartz and amorphous substance. The total Zn concentration in flue dust wastes is 19,3 wt.% and the Pb concentration 14,3 wt.% [7, 8].

In the vicinity of the flue dust site in Mansfeld the soil type are luvisols, which contain the following amount (wt. %) of the size fractions: 12 of sand fraction, 54 of silt and 29 of the floatable particles. The pH of this soils ranges between 6 and 7 [9]. Our study showed very wide ranges of metal concentrations (mg/kg): 807 – 25200 of Zn and 511-55400 of Pb.

The previous studies have showed metal concentration of soils in the general vicinity of the smelting complex in Bukowno [10] but also in the soils around the Bukowno smelter site [6, 11]. There is a lack of data showing the impact of the fine grained flotation waste in Bukowno and the flue dust waste in Mansfeld on the soils contamination. Our observation showed that during dry periods an intensive dusting around the waste site in Bukowno could reach relative far distances. In the present study Zn and Pb in soils at the vicinity of the Bukowno flotation waste and of the Mansfeld flue dust sites were analyzed. Soil samples were taken in the transects according to prevailing wind direction. Additionally we have estimated the chemical forms of Zn and Pb in the selected soil samples to assess the metal's potential mobility and bioavailability.

Materials and analytical procedures

The soil samples in the vicinity of the flotation waste site in Bukowno (12 samples) and the flue dust site in Mansfeld (10 samples) were taken from transects of length from 70 to 1500 m to assess the concentrations of Zn and Pb closer to the prevailing wind directions; soil transects' courses were SW-NE, W-E and NW-SE (Fig. 1). The samples were generally taken at 100 – 150 m intervals, but considering the field conditions also irregular, from 22 sites in total. Additionally the trees samples were also taken (were it was possible) - in Bukowno region two samples of *Betula pendula* leaves and two samples of *Pinus silvestris* needles and in Mansfeld region two samples of *Fraxinus excelsior* leaves and two samples of *Betula pendula* leaves. Metals from soil samples were extracted according to the DIN ISO 11466:1995-03-01. The trees samples were treated with 65% HNO_3 and H_2O_2 and digested in Microwave oven. Binding forms of Zn and Pb in soils were determined using the BCR Three-Stage Sequential Extraction Procedure,

originally developed for sediments [12, 13]. Concentrations of Zn and Pb in all samples were analysed by ICP-MS method in the UFZ-Centre for Environmental Research laboratory in Leipzig (Germany).

Results

There was evidence of elevated concentrations of heavy metals in soil samples taken from the vicinity of the flotation wastes site in Bukowno (Tab. 2). In particular, significant contamination by Zn and Pb was found. The concentration ranges from 490 to 4400 mg/kg for Zn and from 120 to 1600 mg/kg for Pb. Higher contamination with these two metals have been found in the soils at Bukowno in the vicinity of Zn smelter [6]. The contamination level in soils close to the flotation waste site consistently exceed the Dutch B level and Polish class III and IV for Zn and Pb, excepting one of the sample (BK21) which exceed the Dutch C level and Polish class V (Table 3) [14, 15]. The concentration of Zn and Pb in the trees samples is relatively high and ranges from 500 to 1980 and from 36 to 460 mg/kg respectively.

In soils from the Mansfeld region very high concentrations of Pb and Zn were found, their range concentrations varied from 807 to 25200 and from 511 to 55400 mg/kg, respectively (Table 2) The investigated metals contamination level is much higher than stated for the soils from Bukowno region, considerably exceeding in almost all soil samples the Dutch C level and polish classes IV or V for Pb, but for Zn Dutch B - C level and Polish classes IV – V (Table 3). The concentrations of Zn in the trees samples in the vicinity of the flue dust waste site were also high and ranged from 51 to 2500 mg/kg, while of Pb were low from 2 to 9 mg/kg.

The main objective of sequential extraction was to assess the potential mobility and bioavailability of zinc and lead. It was also expected that a differences among samples from two different regions may have helped to assess the potential environmental risk. The BCR Three-Stage Extraction Procedure of metals from the various mineral phases of soils is shown as percentage of their total concentration (Fig. 2). The obtained results for the Bukowno soil samples taken at the distance of 300m (BK5) and 1500m (BK21) from flotation waste site showed, that up to 10% of Pb and 18% of Zn was present in the exchangeable and acid soluble fraction, 6% of each Pb and Zn in the reducible, and up to 29% of Pb and 16% of Zn in the oxidizable fraction.

Sequential extraction results of the Mansfeld soils, taken at the distance of 500m (MF7) and 700m (MF12) from flue dusts site showed that about 8% of Pb and 25% of Zn was associated with exchangeable and acid soluble fraction, about 15% of Pb and up to 10% of Zn with reducible fraction and up to 20% of Pb and 15% of Zn with oxidizable fraction. In the heavy contaminated soil sample from Bukowno and both samples from Mansfeld about 60% of Pb and of Zn was insoluble in the used three extraction steps, whereas in the less polluted soil from Bukowno this insoluble portion of Pb and Zn reached above 80% (Fig. 2).

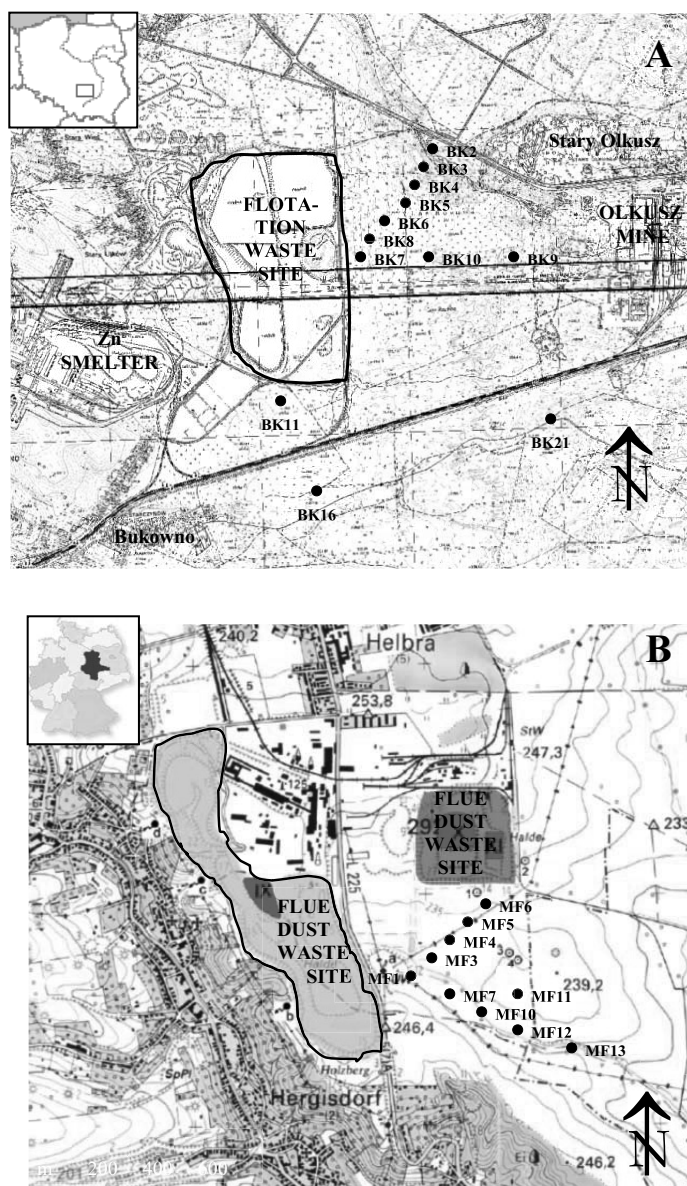


Fig. 1. Sampling sites of soils in the transects with the different distances (see tab. 2) from the flotation waste site in Bukowno (A) and from the flue dust site in Mansfeld (B).

Discussion

The above results have shown that there are significant differences in the Zn and Pb concentrations in between two studied areas and less between sampling points intervals in each. The higher concentration of Zn and Pb than in Bukowno soils was found in Mansfeld soils. Contamination levels of Pb and Zn generally decreased with distance from the waste sites. This trend has been observed in many other mining and smelting operations regions [16, 6]. The best relationship between the prevailing wind direction and concentration of Zn and Pb in soils was found in transect SW-NE for both investigated regions. High concentrations of Zn and Pb were also found at the distance of 300 m from the flotation waste site in Bukowno, and at the distance of 700 – 800 m from the flue dust site in Mansfeld, both in the transect of the course SW-NE.

The highest contamination “hot spots” are observed in one sample from Bukowno at the distance of 1500m

(WNW-ESE) from waste site and in three samples from Mansfeld at the distance of 500 m (W-E, NW-SE) and 700 m (NW-SE). This might be explained by the mechanical mixing of so cold the anthropogenic soils during the remediation attempts.

The highest Zn and Pb concentration in the trees samples were found at the distance of 300 m from the flotation waste site in Bukowno, and at the distance of 700 m from the waste site in Mansfeld; this correlate with the highest concentration of Zn and Pb in soils. From three analysed tree species the highest concentration of metals make the following sequence: *Betula pendula* leaves > *Pinus sylvestris* needles > *Fraxinus excelsior* leaves. The highest concentration of Zn were stated in the *Betula pendula* leaves, regardless to investigated region, type of wastes and the distance from the main waste site.

The results of three steps sequential extraction of metals from the various mineral phases of soils are shown as percentage of their total concentration (Fig. 2). The propor-

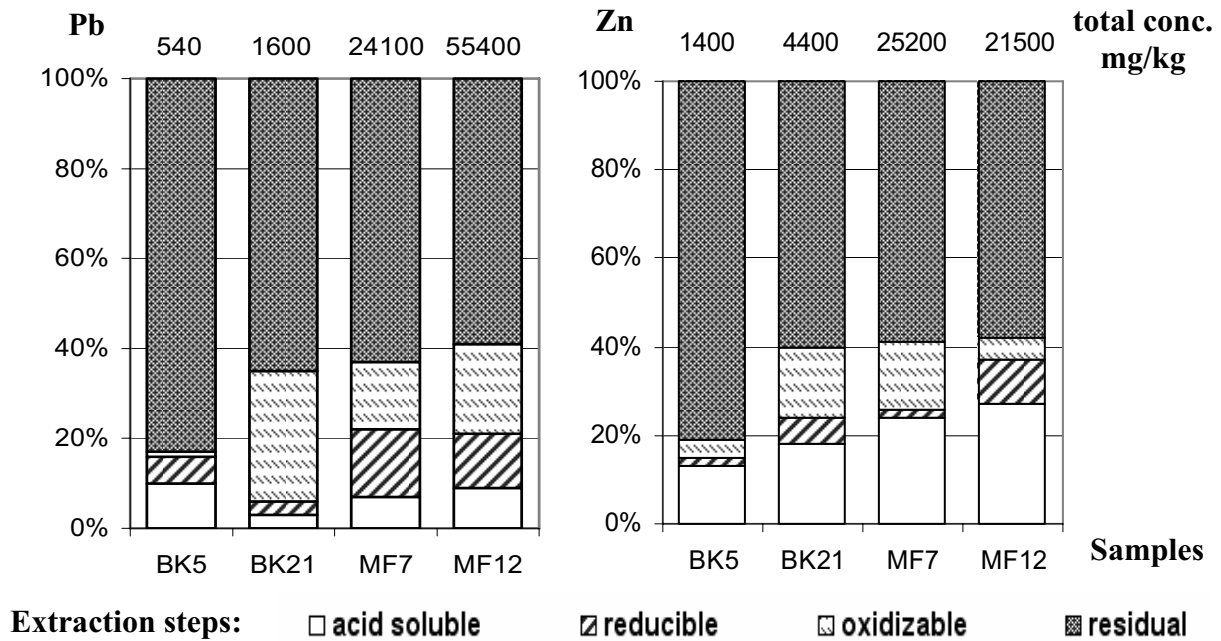


Fig. 2. Relative concentrations of Zn and Pb in each of sequential extraction step of soils from Bukowno and from Mansfeld.

tion of exchangeable and acid soluble Pb (up to 10%) and Zn (13 - 18%) in the soils from Bukowno was significantly lower than in the source - flotation waste (53% of Pb and 38% of Zn) stated by Helios Rybicka and Wójcik [4]. Relative portions of Pb and Zn in the oxidizable fraction decreased (1% and 4%, respectively) in the soil sample taken at the distance of 300 m from the flotation waste site in Bukowno if compared to the source i.e. flotation wastes (3% and 10%, respectively). On the contrary in the soil which contains the highest total amount of Pb and Zn (1600 and 4400 mg/kg, respectively) (Table 2.), taken at the distance of 1500 m from flotation waste site, the oxidizable portions of these metals are considerable higher (29% of Pb and 16% of Zn) than in the flotation waste (3% and 10%, respectively). Our findings confirmed the statement of Ver-

ner et al., [6] that the weathering processes are likely to be responsible for the decrease in the exchangeable and acid soluble and oxidizable fractions and are effectively performing a natural remediation process.

The previous [6] and present results describing the chemical forms of Zn and Pb in source flotation wastes and soils from the Bukowno region correspond with the findings of Kucha and Jędrzejczyk [17]. In the Zn-Pb deposits of the flotation wastes from Bukowno they stated melnikovite which shows wide range of compositions, includes various sulphur valencies, and may sometimes contain more Pb than Fe. According to these authors melnikovite dissolves much faster than pyrite and marcasite. It suggests that the acidic solutions will cause mobilization of some metals especially lead, thus results obtained

Table 1. Characteristics of the flotation wastes and soils from Bukowno and of the flue dusts and soils from Mansfeld.

Parameter	Bukowno	Mansfeld
	flotation wastes ^[3]	flue dust wastes ^[2]
Grain size fractions [wt. %]	< 20 µm - 28 20-60 µm - 34 > 60 µm - 38	< 1.5 µm- 35 1.5-2.5 µm- 38 2.5-10 µm- 27
Mineralogical composition	dolomite, marcasite, pyrite, sphalerite, quartz, calcite, gypsum, hydrated iron oxides, galena	wurtzite, sphalerite, galena, anglesite, quartz and amorphous substance
Zn [wt. %]	1,13	18
Pb [wt. %]	0,31	14
Soils		
Grain size fractions [wt. %]		
gravel	-	8
sand	76	12
silt	18	67
floatable	6 ^[4]	13
pH ^{I/}	5,4 - 8,3	6,2-7,5
Range conc. in soils ^{I/} [mg/kg]		
Zn	490 - 4400	807 - 25200
Pb	120 - 1600	511 - 55400

^{I/} present study

Table 2. Total concentration of Pb and Zn and pH in soils from Bukowno and from Mansfeld.

Transect	Sample	Distance from waste site [m]	Soil		pH
			Pb [mg/kg]	Zn [mg/kg]	
BUKOWNO					
SW-NE	BK7*	70	450	600	8,3
	BK8	150	380	1100	7,2
	BK6	200	270	740	7,1
	BK5	300	540	1400	7,4
	BK4	450	230	630	7,4
	BK3	600	370	950	7,3
	BK2	750	270	780	6,9
W-E	BK7*	70	450	600	8,3
	BK10	700	120	490	7,2
	BK9	1500	160	620	6,1
N-S	BK11*	250	370	1200	7,1
	BK16	900	780	980	5,4
WNW-ESE	BK11*	250	370	1200	7,1
	BK21	1500	1600	4400	6,5
MANSFELD					
SW-NE	MF1*	400	4730	6090	7,5
	MF3	500	768	836	7,5
	MF4	700	938	1970	7,2
	MF5	800	899	2160	7,0
	MF6	900	1070	1330	7,1
	W-E	MF1*	400	4730	6090
MF7		500	24100	25200	6,2
MF11		800	511	807	6,8
NW-SE	MF1*	400	4730	6090	7,5
	MF7	500	24100	25200	6,2
	MF10	600	2630	3380	6,9
	MF12	700	55400	21500	7,0
	MF13	800	3060	3850	6,9

* - beginning of the transect

in our study, i.e. lower portion of Pb in the exchangeable and acidic soluble fraction in the soils than in the flotation wastes, confirmed the above findings. However, high pH controlled by high dolomite content in flotation wastes and also in the soils from the vicinity of waste site can decrease the release of metals.

rich et al., [7] describing the chemical forms of Pb in the Mansfeld flue dust showed that the exchangeable and acid soluble portion of lead (9%) is similar to this chemical fraction in soils (7% - 9%) from Mansfeld, while the oxidizable portion of Pb in the flue dust is considerable higher (84%) compared to soils (15% - 20%) we have got from

Table 3. Zinc and lead contamination levels (mg/kg) of soils in this study compared with concentrations suggested in the Netherlands [14], and in Poland [15].

Metals	Mansfeld		Bukowno		Dutch level*			Polish contamination standards**					
	range	med.	range	med.	A	B	C	0	I	II	III	IV	V
Zn	807-25200	2175	490-4400	865	200	500	3000	0-50	50-100	100-300	300-700	700-3000	>3000
Pb	511-55400	1850	120-1600	370	50	150	600	0-30	30-70	70-100	100-500	500-2500	>2500

* A - uncontaminated or background values, B - require further investigation, C - require remediation; ** 0 = natural (background values), I = slightly elevated content, II = weak pollution, III = medium heavy pollution, IV = Heavy pollution, V = very heavy pollution (should be remediated).

The portions of exchangeable and acid soluble Pb (up to 10%) were similar in soils from both studied regions, but of Zn were higher in the Mansfeld (24 - 27%) than in Bukowno soils (13 - 18%). The available data of Wen-

this region. The last statement again may be the result of weathering process. Additional factors responsible for the metal distribution among different soil fractions are: soil type (sandy soils in Bukowno and luvisols in Mansfeld),

very wide ranges of total concentration of metals (1400-25200 mg/kg of Zn and 540-55400 mg/kg of Pb) and pH which ranged from 6.2 to 7.4.

Conclusions

The soils from the vicinity of the flotation waste site in Bukowno and the flue dusts site in Mansfeld are contaminated with Zn and Pb. The contamination level with Pb and Zn of soils from the last region was much higher than stated for the soils from Bukowno – mostly above the level requiring remediation by both Dutch and Polish criteria. Generally the metals concentrations decrease with the distance from the waste sites, but there are sections of considerable metal contents in soils and trees at the 300 and 700 m distance from waste sites. The highest concentrations of Zn were stated in the *Betula pendula* leaves, regardless to investigated region, type of wastes and the distance from the main waste site.

Obtained results showed that the dusting particles, particularly the finest size fractions, from the flotation waste and flue dust sites are the main sources of metal contamination in the studied soils. The stack emission from the Zn smelter in Bukowno should be also considered as source.

The weathering processes of the wastes and soils change the mineralogy of heavy metals main carriers, as showed the results of sequential extraction. The exchangeable and acid soluble fraction of Pb is lower than of Zn in soils from both regions but similar if compare with results of the Mansfeld flue dust or considerable lower if compare with flotation wastes from Bukowno.

Presented studies gave us the preliminary results of soil pollution with heavy metals in the strongly polluted two industrial areas. The further on going investigations, will result in making the complete environmental risk assessment of the contamination with heavy metals.

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The Application of the Methods of the Computer Image Analysis in the Biotest Based on Common Duckweed *Lemna minor*

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Abstract

In classic biotests on common duckweed (*Lemna minor*) the biomass growth is measured by the comparison of the dry mass of the control and experimental samples of duckweed. This method does not allow the continuation of the experiment. Another method is manual counting the thalli, regardless their size. More accurate method is the determination of the biomass growth by the measurement of the surface of thalli in experimental and control samples. This is a non-invasive method allowing the continuation of the experiment. To achieve this goal the attempt to build a measurement tool based on the methods of the computer image analysis was made. The tool gives the repeatable result, measurement error does not exceed 4.4% of the measured, which makes this tool useful in a non-invasive measurement of the biomass growth in the biotest based on *Lemna minor*. At the same time a full image documentation of the carried out experiment is made.

Keywords: Lemna, biotest, water monitoring, computer image analysis

Introduction

Biotests are very important in the assessment of water quality and they cannot be replaced by chemical methods [1]. Computer image analysis can help in enhancing the objectivity of such tests [2–4].

Common duckweed – *Lemna minor* is a small water perennial plant of flat, leather-like thalli (looking like small leaves, in fact originating from stems). Each *thallus* has one root. It usually reproduces vegetatively – sometimes completely covers the ponds where it was introduced. It grows in stagnant waters or waters with slow flow, prefers high concentration of biogenic elements such as N and P.

It is often used in hydrobotanic wastewater treatment plants, because of the increased degree of the adsorption of mineral compounds (containing N and P). Small size, easiness of cultivation in laboratory, short reproduction time (after about 1 – 4 days the biomass doubles) decided on the application of this species in biotests. The biotest using *Lemna minor* is a widely applied test detecting toxic substances in water. In Poland the biotest of duckweed was

formally confirmed and recommended by the Enactment of the Minister of Environment of 13th May 2004 [5].

Companies and institutes dealing with biomonitoring often introduce the modification of tests on *Lemna minor*. In classic biotests the biomass growth is measured by the comparison of the dry mass of the control and experimental samples of duckweed. This method does not allow the continuation of the experiment. Another method is manual counting the thalli, regardless their size. More accurate method is the determination of the biomass growth by the measurement of the surface of thalli in experimental and control samples. This is a non-invasive method allowing the continuation of the experiment. To achieve this goal the attempt to build a measurement tool based on the methods of the computer image analysis was made. The tool using the techniques of the computer image analysis meets all the expectation for the biotest. It gives the repeatable result; measurement error does not exceed 4.4% of the measured value (interpretation in the categories of relative error), which makes this tool useful in a non-invasive measurement of the biomass growth in the biotest based on *Lemna minor*. At the same time a full image documentation of the carried out experiment is made.

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Experimental Procedures

For the acquisition of the image a digital camera Nikon Coolpix 995 was used. To make the results repetitive all the parameters (light, distance etc.) were the same. The duckweed was put into a beaker with water and photographed (Fig. 1.). Then after a series of measurements the camera was connected with the USB cable to the computer and images were transferred.



Fig. 1. Duckweed in a beaker.

In the computer the program Aphelion was installed as well as an author-made macro. Then the images were analysed by the mentioned above macro. The results were given as an Excel sheet in two columns: image name – analysis result (Fig. 2.). The purpose of the work was to make measurement tool to extend the existing biotest on *Lemna* [5] by the possibility of a non-invasive test i.e. enabling to obtain results without ceasing the test, the measurement of the biomass growth by measuring the total surface of *thalli*.

Discussion of Results

The result of present studies is the proposal of the measurement method of the biomass growth by the computer image analysis. The repeatability of measurements was statistically analysed with the Bland Altman method [6, 7] on the level 4.4% in the categories of relative error.

The repeatability of the applied method was verified with statistical methods. Due to the fact that a high **correlation coefficient is a necessary condition for the compliance of measurement methods, but is not a sufficient condition** (i.e. does not automatically mean that methods are compatible) a presented in literature way of examining the compatibility of results of two measurement methods was applied [6, 7]. It also refers to the repeatability of results in experimental studies. The way of calculations is presented in detail [2].

Conclusions

The conclusions are the following: The measurement result does not exceed 4.4% of the measured value (Interpretation in the categories of relative error), which make the method useful. Also due to the low price of equipment and easiness of making the experiment the proposed method can significantly facilitate the applied so far tests on duckweed and consequently there is a chance for wider application of this method.

Picture Name	Area
DSCN7857.JPG	334
DSCN7858.JPG	355
DSCN7859.JPG	356
DSCN7860.JPG	360
DSCN7861.JPG	779
DSCN7862.JPG	673
DSCN7863.JPG	737
DSCN7864.JPG	807
DSCN7865.JPG	1302
DSCN7866.JPG	1331
DSCN7867.JPG	1232
DSCN7868.JPG	1246
DSCN7869.JPG	1712
DSCN7870.JPG	1652
DSCN7871.JPG	1652
DSCN7872.JPG	1671
DSCN7873.JPG	2306
DSCN7874.JPG	2368
DSCN7875.JPG	2338

Fig. 2. Example of macro for *Lemna*.

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Embryo – Tests

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Abstract

The water quality assessments based on physical, chemical and microbiological criteria has been used from many years. The scientist from Global Environmental Monitoring Centre recommend supplementing of environmental monitoring by new methods of biomonitoring. The most promising area of these studies in experimental embryology and ecotoxicology. This is bond the well prove fact that juvenile organism during their embryonic development show the increased sensibility on different environmental stress compared to adult individuals of the same species. Usually embryos and larvae are more sensitive to external factors. Thus they make good bioindicators. Application of early development stages of species used as biological indicators significantly increased sensitivity of biological monitoring of water quality.

Keywords: biomonitoring, embryotests, environmental monitoring, ecotoxicology, experimental embryology, bioindicators, detergents, surfactants

Introduction

Regulations referring to the protection of environment in Poland imply the need for the improvement and popularisation of the methods of on-line monitoring of water quality for the proper water management and the protection of fresh water ecosystems. The monitoring of inland waters quality is, however, still based mainly on the control of physico-chemical and microbiological parameters. This is not sufficient in the determination of the influence of pollution on water organisms. Full monitoring of water resources is carried out when, apart from the mentioned above parameters – bioindication methods and biotests are applied. They allow the impact of stressogenic factors on water organisms. Intensive development of research in environmental biotechnology and related disciplines (chemistry, biology, computer science and others) provided scientific premises for the improvement of the control methods referring to the quality of different components of environment, including water. Methods of environmental biomonitoring have been developed because of their scientific and practical values. In designing new biotests the increase of the sensitivity of methods and securing their repetitiveness is important. Less expensive and less complicated methods are preferred. The development of the studies on bioindica-

tion methods based on the embryonic development of fresh water organisms gives good prospects for very sensitive and cheap biotests. Developing embryos are more sensitive to pollution compared to adults of the same species. Thus making biotests based on juvenile forms of indicator organisms would significantly increase the sensitivity of biotests. The application of such biotests can contribute to securing environmental conditions for proper reproduction and consequently the protection of biodiversity.

Materials and methods

The main material for the experimental studies were the embryos of invertebrates *Lymnaea stagnalis* and *Tubifex tubifex*. Biotests were used to assess the influence of different concentrations of surfactants of the Brij series, commonly occurring in the pollutants of rivers. The values of the concentration of the pollutants causing LD 50% were selected. The results indicate big differentiation of the sensitivity of various developmental stages confirming the usefulness of embryologic criteria in the biological monitoring of waters.

Toxicological tests LD 50% i EC 50% were carried out for the population of 50 specimens of *Tubifex tubifex*, *Daphnia magna*, *Lymnaea stagnalis*. Selected chemical substances were tested for *Daphnia magna*, *Lymnaea*

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stagnalis 24hrs tests. The results of tests for *Tubifex tubifex*, *Lymnaea stagnalis* were compared to the results of the tests for *Daphnia magna*

(Determination of the inhibition of the mobility of *Daphnia magna* Straus – Standard no. – ISO 341: 1996 Water quality, EN ISO 6341: 1996)

Results

It's examples of the results of LD 50%:

Table 1. – LD 50% for tested water invertebrates (for tested detergents).

LD 50%	Adult organisms			Juvenile organisms	
	<i>Daphnia magna</i> Straus	<i>Tubifex tubifex</i>	<i>Lymnaea stagnalis</i>	<i>Tubifex tubifex</i>	<i>Lymnaea stagnalis</i>
Brij 35	0,08‰	0,07‰	0,06‰	0,05‰	0,05‰
Brij 58	0,07‰	0,04‰	0,03‰	0,03‰	0,01‰
Brij 72	0,09‰	0,08‰	0,08‰	0,06‰	0,07‰
Brij 76	0,05‰	0,04‰	0,04‰	0,02‰	0,02‰
Brij 78	0,05‰	0,03‰	0,02‰	0,02‰	0,009‰

The results indicate high sensitivity of embryonic and juvenile forms on the examined substances, which influence their development, and mortality (in low concentration of detergents in water solution). Embryonic stages of snails and tubifex are sensitivity form of indicator, with react on influence of detergents and their equivalents, which can be dangerous for water ecosystems.

Discussion

These substances affect the most sensitive elements of ecosystems. Assessment of the influents of pollutants on water organisms required not only sensitivity species but also developmental stages the most sensitive to selected pollutants (for surfactants the most sensitivity is hatching period). Tests based on embryonic stages of *Lymnaea stagnalis* and *Tubifex tubifex* are very promising tool, could be recommended for sensitive monitoring of water quality for proper reproduction of biological resources and protection aquatic ecosystems.

Conclusion

It has already been proved that early developmental stages of different water animal species are particularly sensitive to different water pollution [1]. Thus the introduction of embryological criteria allowed the increase of sensitivity and effectiveness of biological monitoring and the effectiveness of the protection of ecosystems and biological diversity (according to the recommendations of EU and UN) [2]. The application of the mentioned above methods of biomonitoring will be useful for environmen-

tal engineering (e.g. in the choice of such biotechnologies of wastewater treatment that would secure proper state of waters for adequate course of the development of species sensitive to pollution and in papers on the biomonitoring of the quality of surface waters [3].

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The Application of Laser Biostimulation for more Efficient Phytoremediation of Soil and Waste Water

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Abstract

During the last decades of the previous century it has been found, that the effects of a polarised laser light on the biological material have non-specific character. The light is able to cause effects of biostimulation at different organisms: microorganisms, plants and animals. The laser stimulation of plants material effects in a bigger growth of biomass when compared to control groups, increase of trace elements concentration in plants tissues as well as increase of phytoremediation abilities.

The aim of the experiment was to study the efficiency of sewage treatment by *Lemna minor* and an attempt to increase the tolerance on salinity and phytoremediation efficiency of various species of energetic willow (*Salix sp.*) by laser biostimulation. The application of coherent light stimulation of energetic willow increases the effectiveness of phytoremediation as a cheap method of post-mining reclamation.

Keywords: laser biostimulation, waste water, phytoremediation of soil

Introduction

Application of the laser photostimulation in environmental biotechnology has been introduced by Dobrowolski in 1975. It was found, that effects of polarised laser light on the biological material have non-specific character. Light is able to cause effects of biostimulation at different organisms e.g. microorganisms, bacteria, fungi, plants and animals [1, 2].

Effects of photostimulation by coherent light on plants biomass increase the base of the activation of biological mechanisms. It is related to enzymes activation and bioenergy conversion [3].

It was found that properly adjusted photostimulation by coherent light significantly speeds up cell divisions and causes a significant growth of biomass driving to quicker and more efficient uptake of biogenic elements contained in sewage and making eutrophication process slower. Extension of the vegetation season of plants was also a beneficial influence of photostimulation.

Irradiation of some plants with coherent laser light change concentration of trace elements in their tissues. A method of laser irradiation reducing or increasing contamination of some plants with toxic metals (accordingly to biostimulation parameters) was introduced as a result of long-term laboratory and field experiments [4, 5].

The laser biostimulation of plants increase their ecological valence in unfavourable environmental factors.

The material for laser photostimulation

Duckweed (*Lemna minor*), family *Lemnaceae* was used as a biological material in the first part study.

The second part included willow cuttings of Polish strains of *Salix viminalis* created at The Chair of Plant Breeding and Seed Production of The University of Warmia and Mazury, Olsztyn: Turbo, Start, Sprint as well as Swedish *Salix dasyclados* Loden and also more popular genotypes of *Salix viminalis* 1154 and *Salix amygdalina*.

The sources of coherent light

The following devices were used:

- Argon (Ar) laser / type ILA-120, C.Zeiss Jena/ wave length 514 nm , power 2 W m-2)
- laser diodes [LD]: wave length $\lambda=532\text{nm}$ and power 5 mW, wave length $\lambda=660\text{ nm}$ and power 21.9 mW,
- impulse medical laser [ML], Marp Electronic Type D68-1 wave length $\lambda=670\text{nm}$, power 20mW, energy 120J

Experimental procedures

The experimental groups of equal quantities were exposed to variable parameters of laser stimulation: the type of diode, length of wave, time and power of radiation. Initially, all plants in each group were in similar condition. In every experiment the control group of non-irradiated seedlings was also prepared. During cultivation, observations in equal time intervals were made on growth rate, health condition and changes in the number of plants.

To study the efficiency of sewage treatment of *Lemna minor* all groups were planted in ponds filled with partly treated sewage that was previously subjected to mechanical and biological treatment process in the municipal sewage treatment station in Kraków Płaszów.

Characteristics of experimental duckweed groups:

1. Control group: non-irradiated
2. LD: exposition time 3x3 s., wave length: 660 nm
3. Argonium laser (Ar): exposition time 3x3 s., wave length: 514 nm

There were 90 plants per each group in total.

The aim of the second part of the experiment was an attempt to increase the tolerance on salinity and phytoremediation efficiency by laser biostimulation of various species of energetic willow.

The cuttings of strains *Salix amygdalina*, *Salix viminalis* 1154 i *Salix viminalis* Turbo were divided on several groups, which were subsequently exposed to a laser light of variable irradiation parameters.

Experimental groups of *Salix viminalis* 1154:

- V1. Control group: non-irradiated,
- V2. LD: exposition time 3x30 s., wavelength: 532 nm (all seedlings were exposed),
- V3. ML: exposition time 3x3 s., wavelength: 670 nm (every leaf-bud were exposed),
- V4. ML: exposition time 3x30 s., wavelength: 670 nm (all seedlings were exposed),

Experimental groups of *Salix viminalis* Turbo:

- T1. Control group: non-irradiated,
- T2. ML: exposition time 3x30 s., wavelength: 670 nm (all seedlings were exposed).

There were 30 cuttings per each group in total. All groups were grown in hydroponic cultivation under 2% saline stress for 40 days.

Additionally, there were 90 seedlings prepared per group of *Salix viminalis*: Turbo, Start, Sprint and *Salix dasyclados* Loden which were later exposed to laser stimulation and planted on the soil with raised salt contamination at the area of a closed part of Salt Mine "Wieliczka". Before irradiation, each cuttings variety was divided into three equal groups:

1. Control group: non-irradiated,
2. LD: exposition time 3x30 s., wave length: 660 nm
3. ML: exposition time 3x30 s., wave length: 670 nm

Results

The laser stimulation of duckweed (*Lemna minor*) causes bigger growth of biomass, in comparison to control groups, the increase or reduction of trace elements (Zn, Cd,

Ni) concentration in plant tissues as well as the increase of phytoremediation abilities (Fig.1, Fig.2).

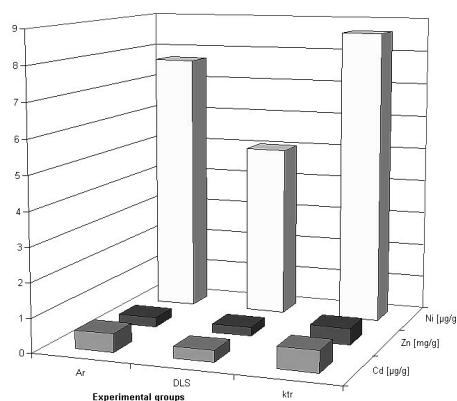


Fig.1. Content of Zn, Ni i Cd in the biomass of *Lemna minor* in experimental groups in 2004 (Ar – argon laser, DLS – laser diode, ktr – control group).

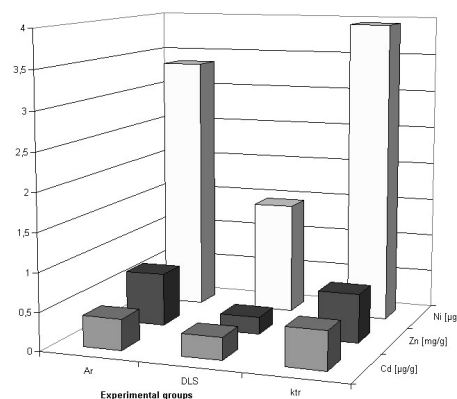


Fig.2. Content of Zn, Ni i Cd in the biomass of *Lemna minor* in experimental groups in 2005.

Photostimulation of willow cuttings effects in double biomass growth, larger leaves surface, much faster development and growth of roots. The plants in the exposure group also appeared to be more tolerant to salinity – did not wither or show yellowing – when compared to the control group.

Conclusions

It was found that properly adjusted photostimulation by coherent light significantly speeds up cell divisions and causes a significant growth of biomass driving to quicker and more efficient uptake of biogenic elements (N, K) contained in sewage making eutrophication process slower. Laser biotechnology is promising for more efficient bioremediation of trace and oligo-elements (Ni, Zn, Cd, Na) from sewage and contaminated soil, as well as for acceleration of reclamation process in different industrial centres and sustainable management of areas alongside main roads.

Proper photostimulation of some cultivated and water plants increase their resistance to sub-optimal physical and chemical conditions and higher growth rate and biomass production. The extension of the vegetation season of plants was also a beneficial influence of photostimulation.

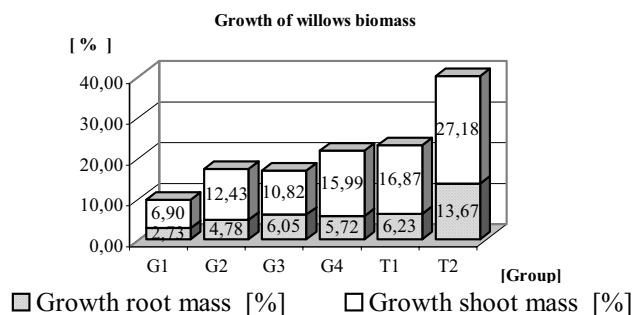


Fig.3. Growth of willows biomass in each group.

Observations allowed to conclude that properly selected parameters of stimulation with coherent light may increase salty soil reclamation capabilities of energetic willow and also have a positive effect on plants adaptation to unfavourable environmental conditions like raised soil salinity. Much faster development and growth of roots is very important especially for young seedlings, which are often weakened on the salty soil and suffer from water deficit.

The application of laser biostimulation of energy willow (*Salix* sp.) increase phytoremediation capabilities as a cheap method of soil reclamation. Most lands which were contaminated with salt as an effect of human activity are related to salt mining or coalmine where salty mining water is pumped up onto the surface. Those areas are usually lying fallow and need reclamation in order to be used for agricultural lands. Conventional chemical and mechanical soil purification methods are much more expensive then phytoremediation. Implementation of energetic willow to soil purification additionally provides an opportunity of agricultural use of wasteland and biomass harvest which could be used to produce green energy.

Acknowledgements

I wish to thank Professor Jan Dobrowolski the supervisor of our Ph.D. thesis. The study is the continuation of

long-lasting studies carried out by Prof. J. Dobrowolski. The study was financially supported by the Ministry of Science and Higher Education Grant Promotorski in 2006 (M. Śliwka) and AGH-UST, WGGiŚ – Badania Statutowe no. 11.11.150.651 in 2006.

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Cadmium and Lead Concentrations in Various Body Parts of Wild Animals in the Malopolska Region

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Abstract

The goal of presented investigations was determining cadmium and lead accumulation in various tissues and organs of roe–deer, hares and foxes killed in the Malopolskie province and assessment of spatial distribution of the studied metals in hare kidneys in the Malopolska region, depending on the degree of soil pollution with these metals. The highest amounts of cadmium accumulate in kidneys and then in livers of the analysed animals, particularly in roe–deer and hares. The other tissues and organs contained many–times smaller quantities of this metal. Lead content in the animal organs was much more uniform and greatest amounts of this metal accumulated in bones. Cadmium concentrations in hare kidneys may be a good indicator of environmental pollution and this metal mobility in the food chain.

Keywords: cadmium, lead, roe–deer, hare, fox, animal tissues and organs, spatial distribution of metals

Introduction

Due to geological and anthropogenic conditions, the Malopolskie province, beside the Śląskie province begins to the most heavy metal polluted regions in Poland [1, 2]. About 7.2% soils of the Malopolska region have been classified as distinctly polluted with cadmium and 4% with lead. Elevated content of these metals has been assessed on respectively 38 and 47% of arable lands in the Malopolska region [3]. In this area the most strongly polluted are the north–western part of the province (Olkusz, Bukowno and Trzebinia localities), i.e. the region of occurrence, extraction and processing of lead and zinc ores, as well as the neighbourhood of Steelworks at Nowa Huta, the district of Krakow and the areas situated east of the steelworks [4].

Animals living in a natural ecosystem usually accumulate considerably larger quantities of heavy metals than farm animals [5]. For example, pheasants killed near Warsaw had over 30 times more mercury in their muscle tissue and even several hundred times more of this element in livers than broiler chickens bred in the same region [6]. A review of literature on the subject reveals that individual heavy metals become accumulated in various animal tissues and organs. Generally metals accumulating in the soft tissues build forms more mobile in the organism, are more toxic and more easily washed out from the organism than metals occurring in the hard tissues and skin [7, 8].

Apart from mercury, cadmium and lead are counted among metals with the strongest toxic effect in the environment, particularly towards animal organisms. Their excessive accumulation in the organism may lead among others to irregularities in functioning of nervous system, respiratory and circulatory systems, disturbances in functions of kidneys, pathological changes in osseous system or may impair embryo development [8, 9].

The presented paper had two goals: 1) an attempt at determining cadmium and lead accumulation in various body parts of roe–deer, hares and foxes killed in the Malopolskie province and 2) assessment of spatial distribution of the investigated metals in hare kidneys in the Malopolska region depending on the degree of soil pollution with heavy metals.

Materials and methods

The material for analyses was gathered with the assistance from hunters' circles operating in several counties near Krakow, the north–western part of the Malopolskie province, in a considerable measure susceptible to the natural and anthropogenic pollution with heavy metals and, for comparison the two municipalities at a far distance from considerable sources of pollution (Krynica and Ciężkowice). In order to determine distribution of cadmium and lead in organisms of wild animals, samples of various organs were collected from 11 roe–deer, 27 hares

and 17 foxes. Additionally kidneys from 181 hares killed subsequently in various localities of the Malopolska region were also collected.

Fresh samples were taken to a laboratory, frozen and kept at -18°C until analysed. Cadmium and lead content was assessed after samples mineralization in a mixture of concentrated nitric(V) and chlorous(VII) acids (3:1), in Philips 9100X atomic absorption spectrophotometer using flame method and background correction with deuterium lamp (D_2). For testing, some selected samples were also assayed in JY 238 ULTRACE atomic emission spectrometer (ICP-AES).

The detection limit of applied AAS methods of the studied metals assessment, determined on the basis on multiple assessments of their concentrations in a blind sample plus six fold value of computed standard deviation of these measurements [9] was 0.017 for cadmium and $0.08 \text{ mg} \cdot \text{dm}^{-3}$ for lead. Precision and accuracy of the used methods were verified on the basis of two certified materials of dried liver (BLRM-A and BLRM-B) from the University of Giesen (Germany).

Statistical parameters of the obtained results were computed using Statistica 5 programme. The maps showing spatial distribution of cadmium content in hare kidneys were made using Surfer 6.0 for Windows and Corel Draw 9.0 for Windows.

Results and discussion

Table 1 contains mean concentrations of cadmium and lead converted into dry mass content, assessed in 13 organs and tissues of roe-deer in 11 different materials from hares and in 5 from foxes.

Despite the fact that cadmium concentrations in soils and plants are usually many times lower than lead content in these materials [4], the level of both metals accumulation in the tissues of the studied wild animals, which are a subsequent link of food chain, was similar. It corroborates the information about a better solubility of cadmium in soil and its considerably greater mobility between various elements of the environment in comparison to lead, which even at heavy pollution becomes strongly adsorbed on solid soil particles [4, 10].

bones and $64.30 \text{ mg} \cdot \text{kg}^{-1}$ in kidneys. Carnivorous foxes accumulated apparently smaller quantities of cadmium in respective tissues than roe-deer and hares, which in their diets prefer: young grasses, herbs, cereals, legumes, berries, mushrooms, etc. [11]. Lead content in dry mass of the analysed tissues of the studied animals was more uniform and fell within the $0.94\text{--}6.94 \text{ mg} \cdot \text{kg}^{-1}$ range, respectively in roe-deer skin and kidneys, $1.22\text{--}3.34 \text{ mg} \cdot \text{kg}^{-1}$ respectively in the heart and liver of hares and $5.14\text{--}10.8 \text{ mg} \cdot \text{kg}^{-1}$ in kidneys and bones of foxes.

A comparison of mean contents of cadmium and lead in the same five tissues sampled from all three animal species (kidneys, livers, lungs, bones and muscles) shows that hares accumulated the greatest amounts of cadmium (on average $14.0 \text{ mg} \cdot \text{kg}^{-1} \text{ d.m.}$), roe-deer had lesser amounts ($10.0 \text{ mg} \cdot \text{kg}^{-1} \text{ d.m.}$), whereas foxes gathered evidently smallest quantities ($3.6 \text{ mg} \cdot \text{kg}^{-1} \text{ d.m.}$ for the five tissues). In the case of lead accumulated in the analogous tissues by the tested animals, the order was the opposite: foxes (7.0) > roe-deer (3.5) > hares ($2.8 \text{ mg} \cdot \text{kg}^{-1}$).

Attention should be also paid to considerable variability of the tested metals concentrations in individual animal tissues and organs. Mean content of relative standard deviation describing cadmium diversification in all analysed tissues is 81, and even 94% for lead. This index values showing variability of cadmium and lead concentrations in muscle tissue, particularly in roe-deer and hares, which are mostly intended for consumption, are alarming. They range between 110 and 195%. It means that beside animals characterized by a low content of heavy metals in their muscles and permissible from the usability for consumption viewpoint [12], there may be found specimens whose carcasses are unsuitable for consumption. Some quantities of lead assessed in the tissues of killed animals may result from an inadequate cleaning of shooting wounds [13], however cadmium was mostly either inhaled by the animals or absorbed with food [9].

Figures 1 and 2 show cadmium and lead concentrations in wet mass of tissues and organs of the analysed animals.

Definitely the greatest amounts of cadmium, particularly in the herbivorous, accumulate in kidneys and livers. Assuming cadmium concentration in kidneys as 100%, this metal content in roe-deer livers was 10.0 and in hares

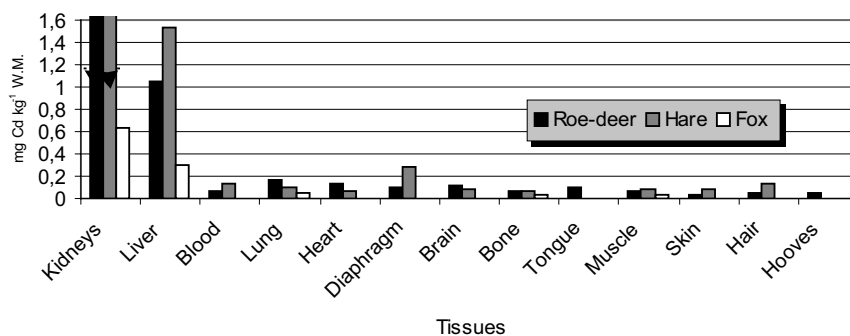


Fig. 1. Cadmium concentrations in wet mass of organs and tissues in roe-deer, hares and foxes.

In roe-deer cadmium concentration in the dry matter of analysed tissues ranged between 0.06 mg in bones and hooves and $45.80 \text{ mg} \cdot \text{kg}^{-1}$ in kidneys, whereas in hares it was generally slightly higher, ranging between 0.07 mg in

9.1%. Above 1% of this value was assessed in lungs (1.6), heart (1.2) and brain (1.1%) of roe-deer and in hare diaphragm 1.7%). Also in foxes the largest quantities of cadmium among the five analysed tissues of this species were

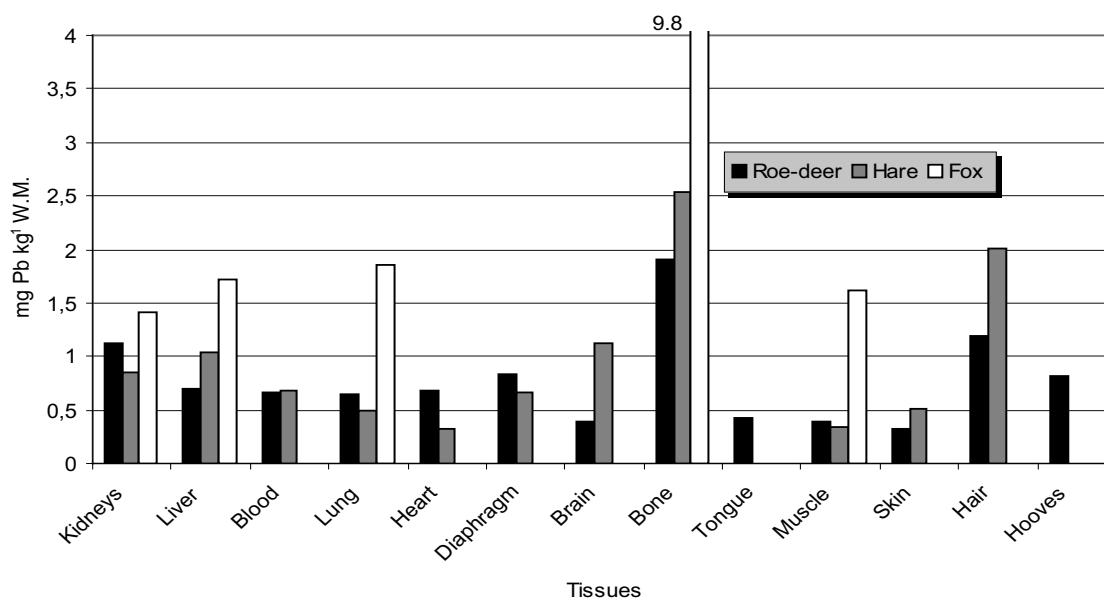


Fig. 2. Lead concentrations in wet mass of organs and tissues in roe-deer, hares and foxes.

found in kidneys and livers. However, the contents were respectively: 16 and over 3 times lower than in the analogous tissues in roe-deer, whereas in comparison with hares almost 26 times lower than in kidneys and 5 times in liver.

Lead concentrations in the tested tissues and organs of wild animals were much more uniform than cadmium accumulation. Kidneys and livers accumulated elevated amounts of lead but the largest concentrations were assessed in bones of all three animal species and only slightly less was found in the hair of roe-deer and hares. Great ability of foxes to accumulate lead in their bodies should be emphasized. In all five analysed fox tissues evidently bigger quantities of this metal were found than in the same tissues in roe-deer or hares.

In his decree published in 2001 [12] The Minister of Health determined permissible concentrations of heavy metals in animal products qualified for human consumption. The analysis of muscle samples revealed slightly exceeded permissible cadmium concentrations ($0.05 \text{ mg} \cdot \text{kg}^{-1} \text{ f.m.}$) only in single samples, whereas the threshold of allowable lead content in the mammal meat ($0.20 \text{ mg} \cdot \text{kg}^{-1} \text{ f.m.}$) was exceeded in over a half of roe-deer samples and in about 60% samples from hares. Excessive cadmium concentrations were also assessed in livers from 72% of roe-deer and 81% of hares, as well as in kidneys in 87% of roe-deer and 94% of hares. Inadmissible lead content was found in livers of 80% of roe-deer and 92% of hares, and also in kidneys of 41% of roe-deer and 66% of hares.

Due to very intensive accumulation of the studied metals in hare kidneys and strong diversification of this feature, kidneys from 181 subsequent hares killed in various localities of the Malopolska region were collected additionally in order to determine the spatial distribution of cadmium and lead content in animals from various parts of the studied area.

Diversification of cadmium content, in conversion to concentrations in dry kidney mass of all 208 analysed hares ranged very widely between 2.5 and $307.0 \text{ mg} \cdot \text{kg}^{-1}$ at mean content $58.6 \text{ mg} \cdot \text{kg}^{-1} \text{ d.m.}$ The mean was even 7

times higher in comparison with cadmium concentrations assessed in hare kidneys in Slovakia [14]. The assessed content of lead in hare kidneys fell with the $0.8\text{--}34.7 \text{ mg}$ range at an average of $6.0 \text{ mg} \cdot \text{kg}^{-1}$.

The obtained results of cadmium concentration assessments in hare kidneys, were plotted onto the Malopolskie province map using Surfer 6.0 graphic programme. This made possible to specify the areas where the analysed animals contained the greatest quantities of lead and cadmium.

The highest concentrations of cadmium were found in the kidneys of animals obtained from the terrains situated north west and south of Krakow (Fig. 3). The first one is within the influence of extraction and processing of lead and zinc ores in the neighbourhood of Olkusz and Bukowno localities, where in some places cadmium concentrations in soil exceed even $100 \text{ mg} \cdot \text{kg}^{-1} \text{ d.m.}$ [4, 15]. On the other hand, the area south of Krakow is in a major part covered with soils formed from flysch rock with small cadmium content but very acid, which increases this metal phytoavailability and facilitates its entering the food chain [4, 16]. Evidently lower amounts of cadmium were registered in hares north-east of Krakow where chernozem soils prevail, with good crop cultures and not susceptible to direct hazard of heavy metal pollution, as well as in the region east of Nowa Huta where soils contain elevated amounts of heavy metals but at the same time are generally characterized by a neutral or even alkaline reaction, which limits metal uptake by plants [4, 17].

Spatial distribution of lead in the studied hare kidneys (Fig. 4) shows that increased amounts of this element cumulate in the animals obtained in the area of the Olkuski County and in the north-western part of the Krakowski County. On the other hand hares obtained south of Krakow from the Wielicki and Myslenicki Counties and from the neighbourhood of Proszowice (eastern region) contained the lowest amounts of lead in their kidneys.

It is also worth emphasizing the fact that hares from the areas distanced from large sources of heavy metals (Krynica and Ciężkowice municipalities) accumulated

Table. 1. Mean content of investigated heavy metals in dry matter of organs and tissues of roe-deer, hares and foxes ($\text{mg} \cdot \text{kg}^{-1}$ d.m.) and relative standard deviation (RSD - %).

Organ / Tissue	Animal	Number of samples	Cd		Pb	
			Content	RSD	Content	RSD
Kidneys	Roe-deer	11	45.80	112	6.94	157
	Hare	27	64.30	78	3.22	92
	Fox	17	2.26	93	5.14	26
Liver	Roe-deer	11	3.26	112	4.24	154
	Hare	27	5.01	85	3.34	96
	Fox	17	0.96	88	5.56	67
Blood	Roe-deer	11	0.40	99	3.89	67
	Hare	27	0.57	80	2.78	109
Lungs	Roe-deer	11	0.84	90	2.97	90
	Hare	27	0.40	115	2.05	68
	Fox	17	0.18	34	7.76	56
Heart	Roe-deer	10	0.52	87	1.99	84
	Hare	27	0.23	66	1.22	69
Diaphragm	Roe-deer	11	0.40	120	2.20	152
	Hare	25	1.08	95	2.46	112
Brain	Roe-deer	11	0.55	127	1.81	101
	Hare	27	0.31	78	4.33	89
Bones	Roe-deer	11	0.06	36	2.17	84
	Hare	27	0.07	59	2.82	115
	Fox	17	0.04	28	10.8	113
Tongue	Roe-deer	11	0.44	122	1.66	93
Muscles	Roe-deer	11	0.24	110	1.35	195
	Hare	27	0.30	150	1.29	127
	Fox	17	0.13	48	5.84	52
Skin	Roe-deer	11	0.12	18	0.94	57
	Hare	27	0.25	49	1.53	90
Hair	Roe-deer	11	0.08	57	1.53	27
	Hare	26	0.15	87	2.37	88
Hooves	Roe-deer	11	0.06	34	1.02	106

similar amounts of cadmium and lead as the animals from the area with the lowest concentrations of these metals originating from the investigated regions in the vicinity of Krakow.

Intensive cadmium accumulation in hare kidneys not only in the region heavily polluted with this metal but also in conditions favourable for its bioavailability, as well as high variability of cadmium concentrations in hare kidneys confirm suggestions found in literature concerning potential use of this metal concentration monitoring in animal tissues in bioindicative research [8, 18]. The concept be additionally supported by the fact of a possible formation in soil of readily soluble cadmium forms, its easy uptake by plants and considerable mobility in the food chain [4, 19], as well as hares' resident type of life since their acreage of habitation usually covers several dozen hectares and during their seasonal migrations the animals do not move further than several kilometres [20].

Conclusions

1. The largest amounts of cadmium in wild animals, particularly herbivorous become accumulated in kidneys, lesser in livers, whereas the other organs and tissues contain many times smaller quantities of this metal.

Lead concentrations in animal organisms are much more uniform than cadmium accumulation and the greatest quantities gather in bones.

2. Ability of individual wild animals for heavy metal accumulation in their tissues and organs depends on the metal and changes in the following order:
cadmium: hares > roe-deer > foxes,
lead: foxes > roe-deer > hares.
3. The highest concentrations of cadmium and lead in kidneys were accumulated by hares from the areas heavily polluted with heavy metals situated north west of Krakow and in case of cadmium also from more wooded areas to the south, with prevalent acid soils which favour this metal entering the food chain.
4. Monitoring of cadmium content in hare kidneys may prove a good bioindicator of biological hazard of food chain contamination with this metal.

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The Long Time Prognosis for Psycho–Intellectual Development of Children Living in Different Parts of the Very Polluted Town Piekary Śląskie, Upper Silesian District Of Poland

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Abstract

The aim of the study is to present the trends of changes of blood lead concentration among children over 1986 – 2005 in Piekary Śląskie, in different parts of the town. The material of this study comprises: 353 children aged 10 – 15, examined in 1986 – 1989, 5503 children aged 6 – 15, examined in 1992 – 2001 and 2187 children aged 3 – 12, examined in 2004 – 2005. Prophylactic – therapeutic activity caused the lowering of blood lead concentration from 19 µg/dl (in 1986) to 5.5 – 8.0 µm/dl (in 2004 – 2005) in children living in Piekary Śląskie.

Keywords: psycho–intellectual development, blood lead levels, children, Piekary Śląskie, Poland

Introduction

The disturbed psycho–intellectual development of children living in Piekary Śląskie connected with higher than 5.5 µg/dl blood lead levels among 185 children in 1995 was observed [1–3].

Piekary Śląskie is a town situated in the Upper Silesia in Poland. In 1995 there were 66984 inhabitants on 3967 ha, 21.4% of them were children. The history of the town dates from 11th century. Over the last 3 centuries zinc and lead mining and metallurgy developed intensively.

In 1986 the measuring points were organized in Piekary Śląskie by Sanitary – Epidemic District in Katowice. The town has old parts with architecture build in 17th–18th century for coalminers (without bath–rooms) and modern districts with comfortable flats and small family houses surrounded with gardens and old trees.

Experimental Procedures

The material of this study comprises:

1. 353 children aged 10 – 15, examined in 1986 – 1989,
2. 5503 children aged 6 – 15, examined in 1992 – 2001.
3. 2187 children aged 3 – 12, examined in 2004 – 2005.

The estimations of blood lead concentration in children were carried out in the Central Laboratories of Heavy Metals Toxicology in Miasteczko Śląskie – till 1993 and then in Institute of Environmental Health and Work Medicine in Sosnowiec. Blood was collected in closed system of vacuum test – glasses with anticoagulant – the vacutainer type.

Environmental Health Outpatient Department in Piekary Śląskie apart from selecting the children with high lead blood concentration for treatment in Paediatric Department in Zabrze developed the proecological education of parents, children and schoolteachers.

Results

Among 353 children examined in 1986 – 1989 – 85.3% had lead concentrations in blood over 14.0 µg/dl and among about 60% of them the values exceeded 19 µg/dl.

The permanent decrease of blood lead levels in 5503 in children aged 6–15 years (especially in elder ones) was showed in 1992 – 2001. In 2004 – 2005 further decrease of lead blood levels in children aged 3–12 years was observed (Tables 1 and 2). It was found in parts of the town Piekary Śląskie with modern architecture (Brzozowice – Kamień, Wieczorka).

Discussion

The achievements of permanent decrease of lead blood levels of children in 1986–2005 were possible because of activities of Environmental Health Outpatient Department

in Piekary Śląskie together with Silesian Children's Help Association "Bratek" [2, 3].

School children were sent to mountains villages in Beskid Sądecki such as: Muszyna and Żegiestów Zdrój for 3 weeks lasting camps. The special treatment (inhalation,

Table 1. Number of examined in 2004 * – 2005, 2187 children aged 3 – 12 years living in different parts of Piekary Śląskie.

AGE	NUMBER OF CHILDREN LIVING IN DISTRICTS					NUMBER OF CHILDREN EXAMINED
	NUMBER OF CHILDREN	DĄBRÓWKA WIELKA *	BRZEZINY ŚLĄSKIE *	BRZOSOWICE – KAMIEN *	CENTRUM ^	
3 – 6 years 393 (100%)	67 21 (31%)	97 33 (34%)	564 161 (28,5%)	578 178 (31%)	606	
7 – 12 years 1784 (100%)	247 101 (40,7%)	351 304 (86,6%)	1097 451 (41,1%)	1674 380 (23%)	1657 548 (33%)	

* examined in 2004 year

^ examined in 2005 year

Table 2. Average blood Pb levels (µg/dl) in 2187 children living in Piekary Śląskie (2004 * i 2005 ^).

District	Age (yr)	Pb				
		< 5,5	5,6 – 10,0	10,1 – 15,0	15,1 – 20,0	> 20,0
Dąbrówka Wielka *	3 – 6	81% [17]	19% (4)			
	7 – 12	87,1% (88)	12,9% [13]			
Brzeziny Śląskie *	3 – 6	24,2% (8)	54,5% [18]	15,1% (5)	6% (2)	
	7 – 12	28,5% (100)	42,7% (150)	9,9% (35)	3,9% [12]	2% (7)
Brzozowie – Kamień *	3 – 6	79,5% (128)	19,3% (31)	1,2% (2)		
	7 – 12	75,8% (320)	21,9% (99)	2,1% (10)		
Centrum ^	3 – 6	79% (141)	19% (33)	2% (3)		0,01% (1)
	7 – 12	82% (310)	17% (64)	1% (5)	0,01% (1)	
Osiedle Wieczorka ^	3 – 6	86% (380)	13,3% (61)	0,7% (3)		
	7 – 12	93% (508)	7% (39)	0,01% (1)		

irradiation with the sollux lamp, corrective gymnastics, swimming) and tourist programme were held. Above 3000 children in 1992 – 2005 participated in these camps subsidised by public institutions and private remittances. It was the only form of going out from the polluted town Piekary Śląskie for children with high concentration of lead in blood – living in poor social conditions.

The results confirmed our former findings including family live conditions, unemployment of parents, sex (means boys) of children influencing the higher lead blood levels [1–3].

In different parts of Piekary Śląskie with high or low degree of environmental pollution and old or new type of architecture the blood lead levels of children were connected.

In modern parts of the town with lower environmental pollution the results were better for children – very rare above 5,5 – 8,0 µg/dl lead blood levels. The higher levels showed the relation to worse psycho-intellectual development of children living in Piekary Śląskie examined in 1995 [1–3].

The negative influence of environmental pollution from many years – on health, infant morbidity and mortality in Upper Silesia was published by us [1–10].

Conclusions

1. Prophylactic – therapeutic activity of the Environmental Health Outpatient Department in Piekary Śląskie made possible to select children aged 3 – 15 who are endangered with high lead concentration in blood.
2. The Silesian Children's Help Association "Bratek" organized prophylactic treatment at camps for over 3000 children of school age with the blood lead concentration above 8 µg/dl.
3. The activities caused the lowering of blood lead levels in children living in Piekary Śląskie from 19 µg/dl to 5,5 – 8,0 µm/dl, which are not dangerous for psycho-intellectual development.

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Etiology of Cancer in Epidemiological Studies Concerning Nutrition, Disturbances of Immunology System, Deficit of Microelements and some other Phenomena such as Viral Infections

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Abstract

In Piekary Śląskie monitoring system of air pollution was introduced in 1986. The town has old parts with architecture build in 17th–18th century for coalminers (without bath–rooms) and the modern districts with comfortable flats and small family houses surrounded with gardens and old trees. The incidence of various types of cancer in women and men living in districts of Piekary Śląskie with high and low environmental pollution was examined. Breast cancer in 38.0% of women living in highly polluted districts of Piekary Śląskie and 34.8% in areas with low environmental pollution was observed. The other kinds of cancer are in various percentages in parts of the town.

Keywords: epidemiological studies, cancer, nutrition, immunology, microelements, environmental pollution, Piekary Śląskie

Introduction

Our examinations were made in the region of the most polluted part of Poland – Silesian district [1]. It covers only 2,1% of our country in the south – western area with population about 4 million.

The problems of environmental carcinogenesis are still unsolved. In very the polluted town of Piekary Śląskie with the industrial history from 16th century the correlation with degree of environmental pollution and lead levels in blood among children aged 3–14 was showed [2].

Genetic disturbances in children living in another polluted town – Miasteczko Śląskie in UE group study we have published [3].

In Piekary Śląskie monitoring system of air pollution was introduced in 1986. The town has old parts with architecture build in 17th–18th century for coalminers (without bath–rooms) and modern districts with comfortable flats and small family houses surrounded with gardens and old trees.

Experimental procedures

Living conditions, kind of occupation, nutrition habits, breast feeding in women and infants, incidence of viral infections among patients of the Oncologic Out–patient and Environmental Health Out–patient Departments in Piekary Śląskie were investigated.

The data were gathered in a special questionnaire. For example a questionnaire for mothers comprises: name and surname, age, education and occupation, morbidity of cancer in the family of mother and father; for mother – questions: parity, abortions, contraception, breast–feeding in infants.

Morbidity and mortality rates in various kinds of cancer in different parts of Piekary Śląskie with high and low environmental pollution were examined. In women with breast cancer the laboratory investigations of immunology system and modified diet, selenium usage were introduced.

Women after surgery, chemical therapy and x–rays treatment have the possibility of rehabilitation in the Oncology Department in Ustroń Zdrój in Sanatorium Electron. Psychotherapy, changes in diet and physical rehabilitation within 4 weeks periods, in 2 years intervals – were very effective in women suffered from breast cancer.

Information concerning positive prophylactic and therapeutic effects of selenium in carcinogenesis recently published in preventive actions among women with breast cancer was used [4,5].

Results

Table 1. shows the air pollution with allowed value in Piekary Śląskie in 1999 – 2002.

Table 2. presents the average monthly value of air pollution in 2002.

Table 3. presents the incidence of various types of cancer in women and men living in districts of Piekary Śląskie with high and low environmental pollution. Breast cancer in 38.0% of women living in high-polluted districts

Discussion

In the Upper Silesia – a highly polluted district of Poland epidemiological studies concerning the environmental influence on cancer from many years have been made in Oncology Institute in Gliwice [5].

Our investigations in population of Piekary Śląskie with the high blood lead levels in children were done [2].

In Poland high mortality rate in women with breast cancer up to 40% as the highest in UE was observed. In USA breast cancer in women being the first cause of 20% mortality is still decreased [13, 14].

Low blood Se levels were found to be associated with an increased incidence and mortality from various types of cancer. Sodium selenite has been shown to be the most effective in both in vitro and in vivo carcinogenesis studies.

Table 1. Air pollution in Piekary Śląskie in years 1999-2002.

No	Substance	Unit	Value allowed	Years			
				1999	2000	2001	2002
1	NO ₂	µg/m ³	40	26	23	25	31
2	SO ₂	µg/m ³	40 ¹⁾ 20	36	33	34	37
3	PM10	µg/m ³	40	56 ²⁾	58	52	57
4	CO	µg/m ³	-	1100	950	880	

¹⁾ 40-µg/m³ value allowed to 31.12.2002; 20-µg/m³ value allowed from 1/01/2003

²⁾ value increased above value allowed

Table 2. Average monthly value of air pollution in year 2002 [µg/m³].

Month	SO ₂	PM10	NO ₂	NO _x
January (1)	86	88	58	108
February (2)	46	68	46	70
March (3)	39	59	45	66
April (4)	29	49	-	-
May (5)	26	49	-	-
June (6)	18	33	-	-
July (7)	17	35	-	-
August (8)	25	46	20	32
September (9)	22	45	21	33
October (10)	30	54	27	47
November [11]	42	65	29	57
December [12]	68	91	28	59
Average in year	37	57	31	55
Value allowed in				
2002	40	40	40	40
2003	20			30

of Piekary Śląskie and 34.8% in low environmental pollution was observed. The other kinds of cancer are in various percentages in parts of the town.

Table 4. shows risk and protective factors connected with breast cancer according to review of actual world publications [6–12].

Selenite by virtue of oxidizing make cancer cells vulnerable to the immune system destruction. Selenite may directly activate NK cells, inhibit angiogenesis without undesirable decrease in the oxidative potential of cellular environment. Sodium selenite in view of its relative low toxicity, might become a drug of choice for many types of cancer including leukaemia – according to Prof. Lipiński's opinion [4].

Table 3. Cancer morbidity in women and men living in Piekary Śląskie.

Cancer	Districts of high pollution *							Districts of low pollution ^						
	Women			Men			Total	Women			Men			Total
Age Kinds	< 40	41 – 60	> 60	< 40	41 – 60	> 60	Number %	< 40	41 – 60	> 60	< 40	41 – 60	> 60	Number %
BREAST		12	34				46 (38,0%)	2	16	30				48 (34,7%)
Gastro-Intestinal		6	9		6	15	36 (29,8%)		7	17		6	14	44 (31,9%)
Urinary tract			2			1	3 (2,5%)				1	1		2 (1,5%)
Thyroid		2					2 (1,6%)		2					2 (1,5%)
Genitals		1	6	1		2	10 (8,2%)	1	2	4		1	4	12 (8,7%)
Lung			1			3	4 (3,3%)		4	2		1	3	10 (7,2%)
Skin	2	2	2		1	3	10 (8,2%)	1	1	2			7	11 (8,0%)
Bones					1		1 (0,9%)		1				1	2 (1,5%)
Lymph glands		4	2		2	1	9 (7,4%)	1		4	1		1	7 (5,0%)
Total	2	27	56	1	10	25	121 100%	5	33	59	2	9	30	138 100%
	85 (70%)			26 (30%)				97 (70%)			41 (30%)			

* – Dąbrówka Wielka, Brzeziny Śląskie, Brzozowie – Kamień

^ – Centrum, Osiedla Wieczorka, Kozłowa Góra

Table 4. Risk and protective factors connected with breast cancer.

Risk factors	Protective factors	References
Earlier menarche < 11 years (9)	Longer breast-feeding > 1 year (6,9,10,12)	Andrieu N. et al. : J.Natl.Cancer- Inst.. 2006: 98 (8): 535– 544. (6)
Later menopause (9)	Women BRCA1 who breast- fed for more than 1 year- less likely have breast cancer than those who never breast fed OR- 0,55 (95%CI - 0,38–0,80, p=0,001) (11)	ESHRE- Capri- Workshop- Group. Hum.Reprod. Update. 2004: 10(4): 281–293. (9) Jernstrom H. et al. J Natl Cancer Inst. 2004: 96 [14] : 1094–1098 [11]
Never breast- feeding, breast feeding < than 1 year (10)	Young age of first childbirth (10)	Ursin G. I and all: Br.J.Cancer 2005 : 93(3): 364–371 (10)
Menopause treatment with combined estrogen and progesteron (9)	Multiparity (12)	Becher H., . Int. J. Epidemiol. 2003: 32(1): 38– 48 [12]
In BRCA2 mutation first childbirth at later age than 20 [12]		
History of abortion [12]		

Breast cancer in women living in Poland is late diagnosed. Negative influence of stress, high red meat and animal fat concentration in diet, some genetic predispositions are the most important factors of bad results in diagnostics and treatment of breast cancer [5, 12–14].

Lack of breast-feeding or short time of that in women increased the risk for breast cancer. The protective influence of breast-feeding above 1 year in women with gene BRCA1 has been showed [7]. The usage of oral contraception, menarche < 11 years, menopause > 50 years increased risk of breast cancer [7, 11].

Analysis of 47 epidemiological studies in 30 country in a group of 50302 women with breast cancer and 96973 healthy women showed in group of breast cancer lower parity (2,2 or 2,6) and shorter time of breast feeding (9,8 or 15,6 months).

The risk of breast cancer decreased of 4,3% in women who breast-fed infants above 12 months.

Conclusions

1. Breast cancer in our preliminary study in 38,0% of women living in high polluted districts of Piekary Śląskie and in 34,8% in low environmental pollution was observed
2. The gastro-intestinal and lung cancer incidence seems to be independent of environmental pollution. The other kinds of cancer in similar or lower percentages were diagnosed in low polluted parts of Piekary Śląskie.
3. The preventive actions and further studies concerning the incidence of cancer among people living in polluted town Piekary Śląskie are needed.

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Concluding Remarks

Teaching and Learning Towards Sustainable Life Across Disciplinary Boundaries – Overview

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The first impression which most people gain, when they scan the complex social, economic and ecological problems of our time, is that the individual can achieve nothing. Positive acts of the individual are dismissed as being of negligible significance, leaving the overall problem essentially unaltered. There is an equal tendency to dismiss negative acts of the individual, considering them not worthy of concern.

This wave of consciousness should not intimidate us and take control of our minds. We have a countervailing power within us. This power is drawn from involvement of the individual and of the group with systems. A general overview on that relation provides the model of human action and its extension in more recent times. The interaction of the individual and of the group with oneself and with the system of which they are part can help to generate a culture of attentiveness (awareness) with distinctly positive effects. By raising the level of attentiveness (awareness), it is possible to enhance substantially both action regulation in the cognitive sphere, which manifest itself in the setting of targets and subsidiary targets and in the heuristic pursuit of solutions etc., and interactions with the system or systems, which we aspire to control.

Further extension of the model of human action in the direction of an integrated model of complex problem solving or control of complex systems will help to bridge the gap between classical scientific theories (such as decision theory, psychological theories of behaviour and others) and human action intended to achieve sustainable development. Experts tell us that the big problems in sustainable development are caused through partly inadequate and partly missing interlinks within and between the systems of which we humans are a part, and which conceptually should succeed in joining given contexts and relationships together.

The system human mind and its interaction with one or more other systems is the content of further considerations. Through the sensory perception of external world information action regulation (or action steering) in the actor's mind is of utmost importance. By that we mean the actor has, – in order to contribute to sustainability – to formulate subsidiary global goals or goals for a region and / or a spe-

cific location. Moreover the actor must identify the mutual relationship and interdependence of the variables. He or she must develop projections, plans, models, test hypothesis and monitor the implementation of action programmes within the own mind before real actions in the system(s) outside of the individual will be taken.

The actor must also master his or her emotions, if in certain situations stress and anxiety may come up. That happens, if for example an actor is missing information related to an important and urgent decision. That is a very short summary of action regulation (action steering), which can be optimally done or only sub-optimally or even badly. Action regulation needs disciplinary, inter- and / or transdisciplinary thinking, related to the elements and phases mentioned above. Action regulation (action steering) for sustainability can be learned.

Society is not well served by a discipline-based culture, which is divisive, elitist and exclusive. It has proved to be not an asset, but rather a liability in society's balance sheet. The time has come for interdisciplinary analysis and synthesis and new interdisciplinary visions.

The social, economic and ecological dimensions of the major problems facing us suggest that we transform our social cybernetics into sustainable development cybernetics or shortly sustainability cybernetics.

Because it has always been, and continues to be, inter- and multidisciplinary in its outreach, the concept of Case Method Research and Case Method Application is predestined to be of tangible benefit in the pursuit of this goal. Closing the gap between a desired point of destination and a given point of departure, and in so doing, overcoming a variety of hindrances who require the resources of many different disciplines, is a common task that we should be prepared to share with one another. And each problem solving process is linked with one or more systems.

On the base of the given outline on complex problem solving related to sustainable development focus should be on environmental values and methodologies for assessing environmental and sustainability values. That, however, demands a new project. Therefore the paper is open ended.

Historic Cities and Nature

A. Wagner

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1. Factors harmful for natural environment are also harmful for cultural monuments. Thus taking care of the quality of environment would result in increasing the attractiveness of historical cities.
2. Historical cities are places where nature-based tourism is not only possible, but also makes an interesting supplementation of traditional tourism. Many organisms managed to live in urban conditions or in other artificially made biotopes (e.g. water bodies). It is necessary to provide information about these organisms.
3. The co-operation between individuals and organisations from different countries can help in solving similar environmental problems. These similar problems can occur in geographically remote areas.

Directions of Interdisciplinary Co-operation

S. Twardy

IMUZ – MOB Kraków

1. A sustainable development of the Carpathian rural areas under conditions of low-input agro-environment farming (present state-identification-transformation directives – implementation of activities-expectations and the results, prognosis).
The problem refers to whole Carpathians extending from the territory of Austria through the Czech Republic, Slovakia, Poland, Ukraine and Hungary up to Romania.
2. Harmonisation of agro-forest economy with taking into consideration a building the water storage capacities and water resources protection in the upper Vistula basin up to Zawichost section.
Research topics will include the following subjects: structural land use, identification of pollution sources and the methods of their elimination as well as prognosis of a qualitative and quantitative improvement of the water resources.
3. Identification, conflict resolutions and an impact evaluation of the service sector in recreation activities (tourism, agro-tourism, health resorts and winter sports) on the environment.
Apart the positives one can register as well as the negatives of widely understood tourism. Its impact on the environment, particularly the soil and water, is already clearly observed. An identification and alleviation of the environmental conflicts is a harmonisation element of agricultural space utilisation and nature resources.

Environmental Monitoring Session – Report

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The author provided some information about sensors for smell and spectroscopic measurements, which could be useful for environmental monitoring as well as for improvement of quality and productivity in sustainable economy.

Prof. Smoron and Dr. Kuzniar reported about the effects of tourism and agriculture on contamination of rivers and could demonstrate the seasonal effects of tourism in a protected area. Dr. Kopacz and Prof. Twardy could support these finding and provided more details on the seasonal patterns of contamination of the rivers in the western Carpathian area. Also they could report that water quality has improved compared with 1970ies.

Prof. Juda–Rezler provided information about air pollution and health effect thereof. We learned, that particles

have the strongest effect on health. Also Prof. Juda–Rezler told us about the changes in contribution of air pollution which have shifted towards traffic as the major cause of pollution.

Prof. Ribas Ozonas joined the first part of session II and provided valuable information on biological effects of electromagnetic fields, which are not confined to heating of tissue but could be concentrated by radiation absorbing elements, which might lead to focussed effects on tissue.

Prof. Cebulska–Wasilewska’s report about pollution and risk of cancer was impressing. Her dedication to protect children from deseases by monitoring environmental parameters and taking appropriate action accordingly deserves our deepest respect not only in terms of science.

Air Quality Monitoring

J. Walczewski

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It is absolutely necessary that cooperation between meteorology, pollution monitoring and environmental medicine be closer and operational.

We should look at the positive experiences from the time of experiments MONAT–84 and MONAT–85 (years 1984 and 1985)

It is also necessary, to make broader operational application of the Atmospheric Boundary Layer monitoring with use of Sodar, Doppler Sodar and Lidar, in aspect of

observations of changes of the mixing layer height, atmospheric stability and wind directions. This monitoring should be closely connected with the Air Quality Monitoring and monitoring of the smoke plumes with use of satellite images.

The forecasting of the air quality is necessary. It may be based on application of dispersion models existing in Poland, with close cooperation of meteorology and the Air Protection Services.

Proposals for the interdisciplinary projects (after EURO–ECO 2006 Conference)

1. Air Pollution: State, Impacts on Human Health and Cultural Heritage Response

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Background

During last fifteen years Poland has been done much toward its sustainable development, which led to the decrease of atmospheric emissions and to the significant improvement in the air quality. However, in some locations in Poland, including urban areas, air quality problems still persist. European Union (EU) air quality limit values as well as World Health Organisation (WHO) guidelines are frequently exceeded in many urban hotspots, while evidence of the adverse health effects of air pollutants, especially fine particulates (PM_{2,5}) and ground-level ozone is continuously rising.

Emissions to the air are directly connected with the composition of energy supplies. Poland is among the countries in which hard and brown coal are the primary energy sources. Production and consumption of energy on the basis of coal combustion is one of the major emission sources of greenhouse gases, acidifying gases and nutrients, photo-oxidants precursors, and organic and inorganic contaminants to atmosphere, water and land. This is because coal may contain more than 60 impurities, which can be volatilised during coal combustion, and then either penetrate the control equipment in a gas phase or condensed and became attached to fly ash. These pollutants can then enter the atmosphere as gases or on particles and undergo physical and chemical transformation. Finally they can also be deposited (dry and wet deposition) to the land, water or ecosystems as gases or particulates.

Integrated Assessment Models (IAMs) of Air Pollution represent a tool for ambient air and materials/ecosystems quality assessment and management. The IAMs are build as a system of modules, including emission generation, emission control options and costs, atmospheric dispersion of pollutants and environmental/materials and/or human sensitivities. The modules are linked and include feedback line in the form of an optimisation model. Such an integrated system allows for scenario analysis as well as for decision support in finding optimal (within accepted objective functions) abatement strategies.

It is proposed to develop and apply the Urban Scale Integrated Assessment Model (for selected city in Poland, e.g.: Cracow), which would assist in urban air quality management.

Methodology of Work

The work within the interdisciplinary project may be carried out within four major areas:

- Area 1: Assessment of current and future drivers and fluxes. Main objective will be to identify energetic and municipal coal combustion as well as vehicle fuel combustion as a major anthropogenic drivers of environment in Poland. An organized approach is needed for the integration and synthesis of results from the past projects in order to use them in models simulating the causes and consequences of the current change in the environment due to coal/vehicles fuel combustion and to predict future changes.
- Area 2: Assessment of past, current and future state of the environment. Main objective will be to collect available air pollution monitoring data to assess past and current air quality as well as to implement urban air quality model for future predictions based on operational links between various drivers/pressures and the state of air, ecosystems and cultural heritage as qualified and quantified by selected indicators.
- Area 3: Analysis of environmental and socio-economic impacts. Main objective will be to develop/ further improve and apply methodologies for the evaluation of the impacts of air pollution on human health and cultural heritage.
- Area 4: Scientific support of policy responses and management options. The main objective will be to propose future management options and the scenarios of socio-economic benefits.

2. Proposals for Future Cooperation

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In a modern knowledge-based society more and more important role will be played by sound-tourism. It will be important in culture-related education (e.g. in historic cities) and in environmental education (e.g. regions of national parks) and health-related education (e.g. regions of health resorts). Using the opportunities connected with this new area of tourism will make more and more important factor of sustainable development in regions of particular natural and cultural values. The condition for using this opportunity is better than so far co-operation of local decision-makers (administrative units) and multidisciplinary teams of scientists (from different universities of complementary research fields) facing real needs of local societies.

To increase the attractiveness the offers from scientific teams for the administration it is necessary to train administrative staff in this field. A great chance in gaining votes during elections can be the development of job market in qualified tourism and its base in modern environmental engineering, as well as permanent education of all age and professional groups etc. **Therefore it is very useful to incorporate real needs of the potential labour market in sustainable development (enterprises, administrative units, etc.) into the programme of related studies** (including training periods and subjects of seminars, diploma and doctoral works). **This is a real chance of reduction of unemployment in many countries**, as well as for reduction of negative impact of mass tourism on the natural environment (e.g. by dissemination the best available biotechnology in linkage with ecological engineering, as well as education for common action in this field). Especially important is better dissemination of good practice in innovative environmentally-friendly and technologies for promotion sustainable development (especially regions of top quality cultural landscape).

One of such technology is application of laser biotechnology for reduction of some risk factors of mass, motorised tourism to natural environment (ecosystems), human health and top quality cultural heritage. As a result of application of empirically selected algorithm of photostimulation of plants and microorganisms it is possible significantly increase efficiency of biological cleaning of sewage (e.g. waste water from tourists centres) accelerate formation of protective green areas alongside main roads and parking places reclamation of deteriorated areas and increase efficiency of industrial plantations instead of cultivation of

vegetables in regions contaminated e.g. by motorization, etc. At the some time this innovative technology give a chance for promotion sustainable development of historical cities, reclamation of post-industrial regions and especially for the national parks, health resorts and nature heritage (see report by J. W. Dobrowolski from Badania Statutowe, Wydz. GGiS AGH, No. 11.11.150.651 in 2006). Application of laser photostimulation of biological materials is also a tool for increase biomass production in energy plantations, hydro-botanic wastewater treatment plants and biogas as a result of biodegradation of organic wastes, etc. Such kind of complex use of environmentally-friendly laser biotechnology could contribute not only to protection of culture landscape attractive for mass tourism but also for extra financial income in rural regions in different countries. Stimulation of growth of irradiated cuttings of some bushes may be also contribution of the Polish scientists to development a joint projects for promotion water eco-tourism and protection rivers regions with Hungarian experts. Their successfully introduced new construction made of used up tyres supporting flood bank. This is example of one of real perspectives of interdisciplinary and international cooperation for introduction complementary experiences useful for protection against flooding and sustainable development of regions attractive for sound-tourism initiated within Network of rivers regions Union des Terres de Rivieres.

Constant training of experts (including establishment and proper management of international database for e-learning, postgraduate courses, etc.) is also necessary to show the needs and at the same time reality of **considerable extending the interdisciplinary co-operation** into larger and larger number of natural, medical, agricultural, social and economic sciences as well as culture... A good example can be International Workshops carried out by the chairman of the Conference in Polish national parks from 1972 and organised for a few years Workshops in Florence, Italy by Del Bianco Foundation or Workshops within the European Project Smart History in the Cinque Terre National Park in Italy. Such workshops make a particular chance for **linkage sound-tourism with education for sustainable development**. Good practice for promotion common action focused on Sustainable Development may be network of several universities and many administrative units from UE countries within Union of Associations of the Rivers Regions (UATdR) within European INTER-REG III C Programme. **Development of cooperation and**

training within such network is recommended for integration cooperation of local societies from similar regions, supported by decision-makers and experts from natural, technical and socio-economical sciences.

Tourism makes common interest (especially among young generation). Thus, if properly organised it can make an important field of the promotion of pro-environmental culture and contribute to the implementation of the concept of sustainable development and protection of nature and culture heritage in different regions of Europe and world. The education of tourists, local communities and decision-makers (with the application of modern technical devices, including computer science, remote sensing, photogrammetry etc.) creates a chance to make a knowledge-based society that will consciously and creatively participate in the improvement of the state of environment and sustainable development. Such education helps in getting familiar with different cultures and stimulates friendly relationships with people of different nations and world regions. This can encourage democratisation of decision-making processes (greater participation of educated society e.g. in the implementation of pro-environmental concepts of management in different regions) in linkage with global co-operation for more efficient protection of the whole Biosphere and prevention of irreversible effects to human health, nature and cultural monuments. This makes a chance for the implementation of the concept proposed by Dobrowolski in 1967 and implemented for the first time during the National Summer School on Human Environment in the first in Europe International Park in the Pieniny Mountains in 1968 (based on voluntary activity of the thousands of university students within scientific teams – environmental NGOs). Good practice exchange from different countries (by making the network for constant co-operation in the interdisciplinary case study, problem-solving training, database management and mining for dissemination useful experiences) will allow the development of these activities with the benefit for all and young generation in particular.

A particular role in this co-operation will be played by greater use of the progress of science and technology (first of all in environmental biotechnology within environmental engineering) for the improvement of the state of environment and making numerous workplaces including sound tourism and wide base for sustainable development of regions of greatest natural and cultural values in linkage with different European Programme like INTERREG III, CULTURA 2000, ASIA Links, etc. as well as new 7 Frame Programme.

The participants of 11th International Conference on Sustainable Development in Krakow, Poland 18th – 19th September 2006 would like to recommend establishment of **International Network for Permanent Exchange of**

Methodological Experiences and Creative Promotion of Sustainable Development (including linkage between sound-tourism, modern environmental engineering and education) and focused on more efficient primary prevention of environmental risk factors for human health, ecosystems and culture landscape. Development of international sound-tourism is promising for dissemination both knowledge about nature and culture heritage in different countries, as well as methods and technologies for more efficient protection this treasure of Mankind. Referring to the precursory conception of former rector of AGH Prof. Goetel of sustainable management of the natural resources over 50 years ago and eco-tourism followed by long-term interdisciplinary case studies and problem-solving training of experts and open for all education for common action in the field of 11 International Conferences from 1989 to 2006 – the participants of the Conference recommend to **establish at AGH Interdisciplinary Centre of Sustainable Development and Environmental Biotechnology** (focused on primary prevention and dissemination of innovative high-tech, pilot project based on case studies and training of experts in this field for different countries), as well as **development of long-term activity like International Schools and Workshops on Sustainable Development and Open for all Education** (e.g. by Open University, Internet, etc.) focused on sustainable development in similar regions and on international scale. One of important activity of this Centre should be **eco-tourism and education for promotion environmentally-friendly biotechnology for primary prevention and sustainable development of regions of top quality nature and culture heritage** – following training activity initiated in this field in Poland in 1968. This field of activity is very promising for the future interdisciplinary cooperation of scientists, students and practitioners as well as for making to be involved all interested people into common action of stakeholders and tourists for sustainable development.

Some of the participants of the Conference would like to organize in Italy and Poland in September 2007 an international school of sustainable development and eco-tourism in protected regions (for professors, your scholars and university students). We would like to develop interdisciplinary pilot projects within new 7th Framework Programme and the Union des Terre de Rivières.